New England Highway – Muswellbrook bypass

Biodiversity Assessment Report

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Transport for NSW

New England Highway – Muswellbrook bypass

Biodiversity Assessment Report

August 2021

Prepared by WSP and Transport for NSW

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Executive summary

Transport for NSW is proposing to build a New England Highway bypass of Muswellbrook (the proposal – subject to assessment in this report). The proposal is located to the east of Muswellbrook and connects the New England Highway to the north and south of the Muswellbrook township.

Four threatened ecological communities listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) were recorded within the study area, these included:

- Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered)
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions (Endangered)
- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands (Critically Endangered)
- Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered).

Two of the above BC Act listed threatened ecological communities within the study area were also consistent with two Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed threatened ecological communities being:

- Central Hunter Valley eucalypt forest and woodland (Critically Endangered)
- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands (Critically Endangered).

One threatened flora species, *Eucalyptus camaldulensis* (River Red Gum), listed as an Endangered Population within the Hunter catchment under the BC Act was recorded. About 12 naturally occurring *Eucalyptus camaldulensis* (River Red Gum) individuals occurred within the study area, all individuals would be avoided and not affected by the proposal.

Field surveys recorded 11 threatened fauna species including:

- Varied Sittella (*Daphoenositta chrysoptera*) listed as Vulnerable under the BC Act
- Little Lorikeet (*Glossopsitta pusilla*) listed as Vulnerable under the BC Act
- White-bellied Sea-eagle (*Haliaeetus leucogaster*) listed as Vulnerable under the BC Act
- Dusky Woodswallow (*Artamus cyanopterus cyanopterus*) listed as Vulnerable under the BC Act
- Speckled Warbler (*Chthonicola sagittata*) listed as Vulnerable under the BC Act
- Little Eagle (*Hieraaetus morphnoides*) listed as Vulnerable under the BC Act
- Southern Myotis (*Myotis macropus*) listed as Vulnerable under the BC Act
- Squirrel Glider (*Petaurus norfolcensis*) listed as Vulnerable under the BC Act
- Koala (*Phascolarctos cinereus*) listed as Vulnerable under the BC Act and EPBC Act
- Grey-headed Flying-fox (*Pteropus poliocephalus*) listed as Vulnerable under the BC Act and EPBC Act
- Striped Legless Lizard (*Delma impar*) listed as Vulnerable under the BC Act and EPBC Act.

Likelihood of occurrence assessments identified an additional 31 threatened fauna species of having a moderate or high likelihood of occurrence within the study area and therefore likely to be impacted by the proposal. These species include:

- 12 woodland birds
- Three waterfowls
- Three forest owls
- Three predatory birds; and
- Ten mammal species.

Assessments of impact significance were conducted for all threatened species and ecological communities considered likely to be affected by the proposal. These impact assessments

determined that the proposal is unlikely to lead to a significant impact on threatened species, populations, ecological communities or their habitats.

The key impact on biodiversity associated with the proposal would involve the direct removal of up to 97.92 ha of native vegetation and associated habitats. Of this, 75.66 ha consists of derived native grasslands (DNG) and 22.26 ha consists of low, moderate and good condition remnant native vegetation. Of this 22.26 ha of remnant native vegetation 11.02 ha was in low condition, 10.68 ha was in moderate condition and 0.56 ha was classified as good condition.

It is noted that this area of clearing represents a worst-case scenario as the construction footprint includes some additional areas which would not likely be impacted upon by the proposal. These additional areas have been included in this assessment to allow flexibility during design and construction to accommodate temporary structures and ancillary features such as access tracks, site compounds and laydown areas.

A summary of native vegetation removal required is presented in the table below:

Plant community type (PCT)	Condition class	BC Act	EPBC Act	Percent cleared in NSW	Construction footprint (ha)
PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	Moderate	Endangered[1]	Critically Endangered[5]	77%	8.82
	Low (Remnant)		-		4.93
	Low (DNG)		-		38.39
PCT 1604 Narrow-leaved Ironbark – Grey Box – Spotted Gum shrub – grass woodland of the central and lower Hunter	Low (Remnant)	Endangered[2]	-	71%	0.67
PCT 1605 Narrow-leaved Ironbark – Native Olive shrubby open forest of the central and upper Hunter	Moderate	Endangered[1]	Critically Endangered[5]	32%	0.06
PCT 1607 Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter	Good	Critically Endangered[3]	Critically Endangered[6]	51%	0.56
	Low (Remnant)		-		0.09
	Low (DNG)		-		1.02
PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	Good	Critically Endangered[3]	Critically Endangered[6]	64%	-
	Moderate				0.02
	Low (Remnant)		-		5.07
	Low (DNG)		-		31.19
PCT 42 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Low (Remnant)	Endangered[4]	-	95%	0.08
	Low (DNG)		-		3.38

Plant community type (PCT)	Condition class	BC Act	EPBC Act	Percent cleared in NSW	Construction footprint (ha)
PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)	Moderate	-	-	50%	1.78
	Low (Remnant)	-	-		0.18
	Low (DNG)	-	-		1.68
Total area of DNG					**75.66**
Total area of remnant vegetation					**22.26**
Total native vegetation impacted					**97.92**

1. Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions (Central Hunter Grey Box-Ironbark Woodland) – listed as Endangered under BC Act
2. Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions (Central Hunter Ironbark - Spotted Gum -Grey Box Forest) – listed as Endangered under the BC Act
3. White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions (White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland) – listed as Critically Endangered under the BC Act
4. Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions (Hunter Floodplain Red Gum Woodland) – listed as Endangered under the BC Act
5. Central Hunter Valley eucalypt forest and woodland – listed as Critically Endangered under the EPBC Act
6. White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland – listed as Critically Endangered under the EPBC Act.

Given the proposal is not considered likely to lead to a significant impact on threatened species, populations, ecological communities or their habitats, a Species Impact Statement (SIS) is not required under the BC Act to support this proposal. In respect to Matters of National Environmental Significance (MNES) including threatened flora, fauna and communities, a referral of this proposal for consideration as a controlled action under the EPBC Act is not required.

Additional mitigation measures should be implemented to address potential impacts on wildlife movement for fauna such as the Koala, Squirrel Glider and Spotted-tailed Quoll. These additional mitigation measures include implementation of an aerial fauna crossing to the north and the construction of a large-spanned bridge over Muscle Creek which would minimise impacts on wildlife movement. With the implementation of the recommended mitigation measures proposed it is unlikely that residual impact of the proposal would result in a significant impact to biodiversity within the locality.

It is however Transport for NSW's policy that biodiversity offsets (or where offsets are not reasonable or feasible, supplementary measures) would be provided for impacts that exceed predetermined thresholds. The Transport for NSW's '*Guidelines for Biodiversity Offsets'* (November 2016) indicates that the following offsets would be required by the proposal given residual impacts associated with the construction footprint exceed the predetermined thresholds as specified in the guideline:

- 22.96ha of White box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC in moderate to good condition
- 55.24ha of Central Hunter Grey Box – Ironbark Woodland TEC in moderate to good condition (at least 35.52ha consistent with EPBC Act listing for Central Hunter Valley eucalypt forest and woodland)
- 66.78ha of habitat for national and NSW listed threatened fauna specoes (including 66.78ha of species credit habitat for the Squirrel Glider and Koala)
- 36.81ha of habitat for Southern Myotis
- 0.16ha of Type 1 key fish habitat.

A Biodiversity Offset Strategy would be developed to identify biodiversity credits and/or supplementary measures for these entities.

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Glossary of terms for this template

Definitions

*	Denotes exotic species
BAM	Biodiversity Assessment Method 2020 (previous edition 2017) that supports the *Biodiversity Conservation Act 2016* (NSW).
Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: • Genetic diversity – the variety of genes (or units of heredity) in any population • Species diversity – the variety of species • Ecosystem diversity – the variety of communities or ecosystems.
Biodiversity credits	Ecosystem credits or species credits
Biodiversity credit report	The report produced by the Biodiversity Assessment Method Calculator (BAM-C) that sets out the number and class of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site, or on land to be biodiversity certified, or that sets out the number and class of biodiversity credits that are created at a biodiversity stewardship site (Department of Planning Industry and Environment, 2020).
Biodiversity offsets	Management actions that are undertaken to achieve a gain in biodiversity values on areas of land in order to compensate for losses to biodiversity values from the impacts of development (Department of Planning Industry and Environment, 2020).
Biodiversity Assessment Calculator (BAM-C)	The web application that provides decision support to assessors and proponents by applying the BAM, and which calculates the number and class of biodiversity credits required to offset the impacts of a development or created at a biodiversity stewardship site (Department of Planning Industry and Environment, 2020).
Biodiversity values map	Is established per clause 7.3 of the Biodiversity Conservation Regulation 2017 (NSW). Development within an area identified on the map requires assessment using the BAM.
Candidate species	Species considered likely to occur within the study area based on the presence of suitable habitat and outcome of likelihood of occurrence assessment.
Construction footprint	The construction footprint is the area required to build the proposal. This includes the area needed for temporary work, such as sedimentation basins, drainage channels, access roads, construction compounds and ancillary sites. This includes the area of land that is directly impacted on by the proposal that is being assessed under the *Environmental Planning and Assessment Act 1979* (NSW), including access roads, and areas used to store construction materials. It includes the construction and operational areas for the proposal.
Critical habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an endangered species, an endangered population or an endangered ecological community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation, 2004b). Critical habitat is listed under both the *Biodiversity Conservation Act 2016* (NSW) and the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) and both the state (DPIE) and commonwealth (DAWE) environment agencies maintain a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under the relevant state and commonwealth legislation.
Cryptic species	An inconspicuous species which can be difficult to identify.

Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Refer to Clause 228(2) of the Environmental Planning and Assessment Regulation 2000 (NSW) for cumulative impact assessment requirements.
Department of Planning, Industry and Environment (DPIE)	The NSW Department develops and implements state policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage and administers the *Biodiversity Conservation Act 2016* (NSW).
Department of Agriculture, Water and the Environment (DAWE)	This Commonwealth Department that develops and implements national policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage and administers the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).
Development footprint	The area to be directly impacted by the proposal during construction activities. Analogous with construction footprint (see definition for construction footprint).
Direct impact	Where a primary action is a substantial cause of a secondary event or circumstance which has an impact on a protected matter (Commonwealth of Australia, 2012). Direct impacts on biodiversity values include those related to clearing native vegetation and threatened species habitat, and impacts on biodiversity values prescribed by the Biodiversity Conservation Regulation 2017 (NSW) (Department of Planning Industry and Environment, 2020).
Ecosystem credit	A measurement of the value of threatened ecological communities and threatened species habitat for species that can be reliably predicted to occur with a Plant Community Type. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at an offset site.
Ecosystem credit species	A measurement of the value of threatened species habitat for species that can be reliably predicted to occur with a PCT (Department of Planning Industry and Environment, 2020).
Exotic	Introduced from outside the area (Stralberg et al., 2009). Used in the context of this report to refer to species introduced from overseas.
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic component.
High Threat Weed	Vascular plants not native to Australia that if not controlled would invade and outcompete native species. A list of high threat weeds is available as part of the BAM Calculator (https://www.lmbc.nsw.gov.au/bamcalc).
IBRA bioregion and subregions	A bioregion identified under the Interim Biogeographic Regionalisation for Australia (IBRA) system, which divides Australia into bioregions and subregions based on their dominant landscape-scale attributes.
Indirect impact	An impact on biodiversity values that occurs when development related activities affect threatened species, threatened species habitat, or ecological communities in a manner other than direct impact (Department of Planning Industry and Environment, 2020). Compared to direct impacts, indirect impacts often: • Occur over a wider area than just the site of the development • Have a lower intensity of impact in the extent to which they occur compared to direct impacts • Occur off site • Have a lower predictability of when the impact occurs • Have unclear boundaries of responsibility (Office of Environment and Heritage, 2017).

Key Threatening Processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation, 2004b). Key Threatening Processes are listed under the *Biodiversity Conservation Act 2016* (NSW), the *Fisheries Management Act 1994* (NSW) and the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant state and Commonwealth legislation.
Locality	Taken to be a real chance or possibility (Department of Environment and Conservation, 2004b).
Likely	The area within 10 kilometres of the study area.
Local population	The population that occurs in the study area. In cases where multiple populations occur in the study area or a population occupies part of the study area, impacts on each subpopulation must be assessed separately (Department of Planning Industry and Environment, 2020).
MNES	Matters of national environmental significance are matters which are protected under Part 3 of the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) and include: • World heritage properties • National heritage properties • Wetlands of international importance • Listed threatened species and communities • Listed migratory species • Great Barrier Reef • Nuclear actions • Water resource, in relation to coal seam gas development and large coal mining development • Commonwealth marine areas.
Migratory species	Species protected as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Listed migratory species are those listed in the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA) and Republic of Korea – Australia Migratory Bird Agreement (RoKAMBA). Listed migratory species also include any native species identified in an international agreement approved by the Minister (Matthei, 1995). Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).
Mitchell landscape	Landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000 (Department of Environment and Climate Change, 2002).
Mitigation	Action to reduce the severity of an impact.
Mitigation measure	Any measure that facilitates the safe movement of wildlife and/or prevents wildlife mortality.
Native vegetation	a. Trees (including any sapling or shrub or any scrub) b. Understorey plants c. Groundcover (being any type of herbaceous vegetation) d. Plants occurring in a wetland. A plant is native to New South Wales if it was established in New South Wales before European settlement (*Biodiversity Conservation Act 2016*).
Operational footprint	The area that would be subject to ongoing operational impacts from the proposal. This includes the road, surrounding safety verges and infrastructure, fauna connectivity structures and maintenance access tracks and compounds.

Plant Community Type (PCT)	Plant Community Types (PCTs) and their relationship to a vegetation formation and vegetation class is managed and maintained in the BioNet Vegetation Classification Database. PCTs were developed as an unambiguous master community-level classification and consolidated two existing vegetation classifications – the NSW Vegetation Classification and Assessment database & the Biometric Vegetation Types database (Environment Energy and Science Group, 2020c).
Population	A group of organisms, all of the same species, occupying a particular area (Department of Planning Industry and Environment, 2020).
Priority Weeds	An introduced species listed under the *Biosecurity Act 2015* (NSW). Under the Act, priority weeds have specific control measures for each region.
Proposal	The construction of an about eight kilometre bypass of Muswellbrook in New South Wales.
Proposed road corridor	The proposed road corridor is defined as the final operational road reserve and includes the entire operational footprint for the proposal. The proposed road corridor comprises the amended LEP corridor. This area would generally also match the property acquisition boundaries (noting that some areas required for construction only are likely to be leased).
Region	A bioregion defined in a national system of bioregionalisation. For this study, this is the Sydney Basin Bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway and Cresswell, 1995).
Significant	Important, weighty, or more than ordinary (as defined by the Department of Environment and Climate Change, 2007).
Species credits	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Biodiversity Data Collection.
Species credit species	Threatened species or components of species habitat that are identified by the Threatened Species Data Collection as requiring assessment for species credits (Department of Planning Industry and Environment, 2020).
Species credit	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Biodiversity Data Collection.
Species richness	Species richness is simply the number of species present in a sample, community, or taxonomic group. Species richness is one component of the concept of species diversity, which also incorporates evenness, that is, the relative abundance of species (Matteson and Langellotto, 2010).
Species Profile and Threats Database (SPRAT)	A government managed database to provide information about species and ecological communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).
Study area	The area surveyed during field work, this area would be directly affected by the proposed development (construction footprint) and includes additional areas likely to be affected by the development, either directly or indirectly (Department of Environment and Climate Change, 2007).
Target species	A species has been identified within the study area or is considered to have a moderate to high likelihood of occurrence and may be impacted by the proposal. A species that is the focus of a study or intended beneficiary of a conservation action or connectivity measure.
Threatened biodiversity	Threatened species, populations or ecological communities, or their habitats as listed under the *Biodiversity Conservation Act 2016* (NSW)*, Fisheries Management Act 1994* (NSW) or the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).

Threatened Biodiversity Data Collection	Part of the BioNet database, published by EES Group and accessible from the BioNet website at www.bionet.nsw.gov.au.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as Threatened) under the *Biodiversity Conservation Act 2016* (NSW)*, Fisheries Management Act 1994* (NSW) or the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). Capitalisation of the terms 'threatened', 'vulnerable', 'endangered' or 'critically endangered' in this report refers to listing under the relevant state and/or commonwealth legislation.
Viable local population	A population that has the capacity to live, develop, and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (Department of Environment and Climate Change, 2007).
Weed	A plant growing out of place or where it is not wanted: often characterised by high seed production and the ability to colonise disturbed ground quickly (Stralberg et al., 2009). Weeds include both exotic and Australian native species of plant naturalised outside of their natural range.

Abbreviations

BAM	Biodiversity Assessment Method
BAM-C	Biodiversity Assessment Method - Calculator
BAR	Biodiversity Assessment Report
BDAR	Biodiversity Development Assessment Report
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BAR	Biodiversity Assessment Report
AOBV	Areas of Outstanding Biodiversity Value
CEMP	Construction Environmental Management Plan
DAWE	Department of Agriculture, Water and the Environment (Australian Government)
DNG	Derived native grassland
DPIE	NSW Department of Planning, Infrastructure and Environment
DPI	NSW Department of Primary Industries
EEC	Endangered Ecological Community
EES Group	Environment, Energy and Science Group within DPIE
EIS	Environmental Impact Statement
EP&A Act	*Environment Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FM Act	*Fisheries Management Act 1994* (NSW)
GDE	Groundwater dependent ecosystems
ha	Hectares
IBRA	Interim Biogeographical Regionalisation of Australia
km	Kilometres
KMA	Koala Management Area
LGA	Local Government Area
m	Metres
MNES	Matters of national environmental significance
NSW	New South Wales
PCT	Plant Community Type
REF	Review of Environmental Factors
SAII	Serious and Irreversible Impact
SEARs	Secretaries Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
TBDC	Threatened Biodiversity Data Collection
TECs	Threatened Ecological Communities

1 Introduction

1.1 Proposal background

The New England Highway is part of the inland Sydney to Brisbane National Land Transport Network and the primary route connecting the Hunter with Maitland and Newcastle.

Roads and Maritime (now Transport for NSW) initially carried out a route selection study for the proposed bypass of Muswellbrook in 1998. Three options were selected and displayed between December 2000 to February 2001 which later became unviable.

A new preferred route option for the bypass was selected by the NSW Government in 2005. This preferred route option was included in the Muswellbrook Local Environmental Plan 2009 to preserve the route for the future construction of the bypass.

Since the route preservation in 2009, Transport for NSW have been investigating the feasibility of and potential environmental constraints associated with the proposed bypass of Muswellbrook. This process has involved the preparation of two Preliminary Environmental Investigations (PEIs) to identify initial environmental constraints associated with several route options. These investigations informed the determination of a preferred route option which is now subject to assessment under s5.5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Timing for construction of the proposal has not yet been confirmed and is subject to proposal approval however is expected to commence in late 2022. Construction would take about two years to complete. The NSW Government has committed $266 million to fund the proposal.

1.2 The proposal

Transport for NSW proposes to build a New England Highway bypass of Muswellbrook. The proposal is located to the east of Muswellbrook and connects the New England Highway to the north and south of Muswellbrook (Figure 1.1). An overview of the construction footprint for the proposal is shown in Figure 1.2. The proposal has been developed to concept design level and would be further refined subject to detailed design development and innovation.

Key features of the proposal would include:

- About nine kilometres of new highway (the bypass) with a single lane in each direction and a wide centreline treatment
- Connection with the New England Highway at the southern end of the proposal, which provides all traffic movements (southern connection)
- A 38 metre bridge over the new proposed bypass at the southern connection
- A 76 metre long bridge over Muscle Creek Road and Main North rail line
- A 114 metre long bridge over Muscle Creek
- Connection with Coal Road, which provides all traffic movements (Coal Road Intersection)
- A 43 metre long bridge over Coal Road
- A 367 metre long bridge over Sandy Creek Road, Sandy Creek, Main North railway line and southbound exit ramp
- Connection with the New England Highway at the northern end of the proposal, which provides all traffic movements (northern connection).

Additional features and aspects of the proposal include:

- Demolition of buildings
- Vegetation clearing
- Tie-in with the New England Highway at the northern and southern ends of the proposal
- Utility adjustment or relocation, including electricity, water and telecommunications
- Operational spill containment basins
- Drainage infrastructure
- Property adjustments
- Provision of permanent access roads for maintenance activities

- Property access and local road adjustments including Burtons Lane, Koolbury Flats Row, Milpera Drive, Muscle Creek Road and Coal Road
- Earthworks including construction of embankments
- Temporary ancillary facilities during construction including site offices, site compounds, stockpile sites, laydown areas, concrete and asphalt batch plants, and temporary access tracks including creek crossings
- Fauna infrastructure
- Finishing roadworks including pavement, road stabilisation, kerb and gutter, signage, lighting and line marking works
- Demobilisation of ancillary facilities following the completion of the construction of the proposal
- Landscaping works
- Processing of materials
- Minor creek diversions
- Relocation of the overhead vehicle classifier at the northern connection.

1.3 Study area

The proposal is located to the east of the Muswellbrook township in NSW (Figure 1.1). It is located within a generally disturbed landscape dominated by agricultural properties, an active mine tenure and associated infrastructure (including road, rail and transmission easements). Vegetation remnants within this landscape are largely modified and fragmented however still retain wildlife connectivity values and provide potential habitat for a variety of threatened biodiversity values.

The following areas are discussed throughout the Biodiversity Assessment Report (BAR) and are defined as:

- **Construction footprint:** The construction footprint is the area required to build the proposal. This includes the area needed for temporary work, such as sedimentation basins, drainage channels, access roads, construction compounds and ancillary sites (Figure 1.2)
- **Proposed road corridor:** The proposed road corridor is defined as the final operational road reserve and includes the entire operational footprint for the proposal. The proposed road corridor comprises the amended Local Environment Plan corridor. This area would generally also match the property acquisition boundaries (noting that some areas required for construction only are likely to be leased)
- **Study area**: The study area includes the construction footprint and areas surveyed as part of the biodiversity assessment
- **Locality:** This is taken to be a 10 kilometre radius surrounding the study area
- The study area is located in the Sydney Basin bioregion (Hunter subregion) (Thackway and Cresswell, 1995).

1.4 Report objectives

The objectives of this report are to:

- Inform the design and evaluation of the proposal
- Form part of the impact assessment of the New England Highway – Muswellbrook bypass proposal to fulfil the requirements of Division 5.1 of the EP&A Act
- Provide biodiversity assessment information for the preparation of the proposal's Review of Environmental Factors (REF) document(s)
- Consider all matters affecting or likely to affect terrestrial and aquatic biodiversity as a result of the proposal
- Identify any likely biodiversity offset obligations in accordance with the *'Guidelines for Biodiversity Offsets'* (Roads and Maritime Services, 2016).

This report identifies and assesses the likely impacts to species, populations and communities listed as threatened under the *Biodiversity Conservation Act 2016* (BC Act), *Fisheries Management Act 1994* (FM Act) and matters of national environmental significance (MNES) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.5 Legislative context

A REF has been prepared to satisfy Transport for NSW duties under s5.5 of the EP&A Act to "examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity" and s.5.5 in making decisions on the likely significance of any environmental impacts. This BAR forms part of the REF being prepared for the proposal and assesses the biodiversity impacts of the proposal to meet the requirements of the EP&A Act.

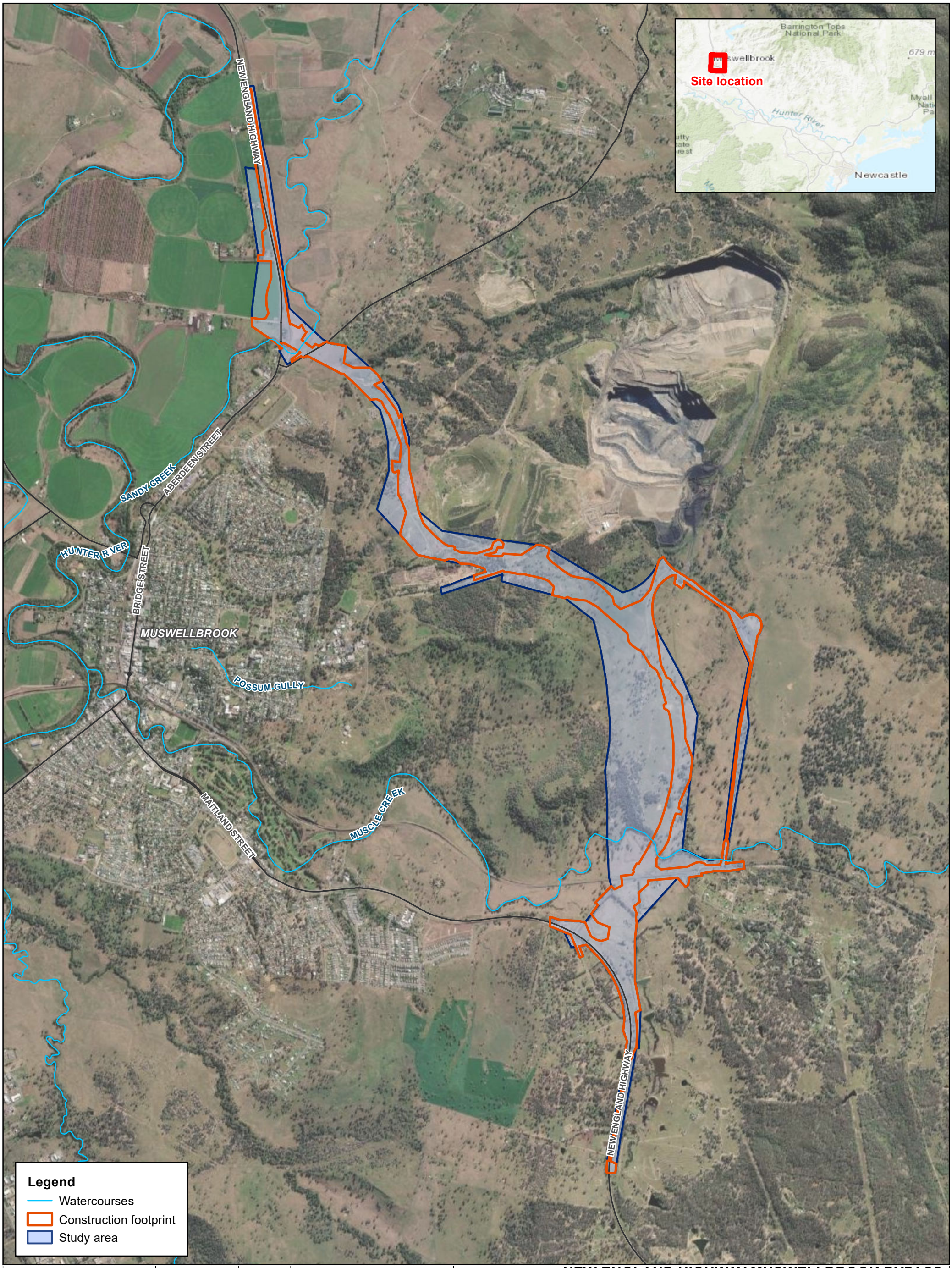
Sections 7.3 of the BC Act and Part 7A of the FM Act require that the significance of the impact on threatened species and endangered ecological communities is assessed using a five-part test. Where a significant impact is likely to occur, a Species Impact Statement (SIS) must be prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) or a Biodiversity Development Assessment Report (BDAR) must be prepared by an accredited assessor in accordance with the Biodiversity Assessment Method (BAM).

In September 2015, a "strategic assessment" approval was granted by the Federal Minister for the Environment in accordance with the EPBC Act. The approval applies to Transport for NSW road activities being assessed under Division 5.1 (formerly Part 5) of the EP&A Act with respect to potential impacts on nationally listed threatened species, ecological communities and migratory species.

As a result, Transport for NSW road proposals are assessed via an REF which:

- Must address and consider potential impacts on nationally listed threatened species, populations, ecological communities and migratory species, including application of the "avoid, minimise, mitigate and offset" hierarchy
- Do not require referral to the Commonwealth Department of Agriculture, Water and the Environment (DAWE) for these matters, even if the activity is likely to have a significant impact
- Must use the Biodiversity Offset Scheme to offset proposal impacts.

To assist with this, assessments are required in accordance with the '*Matters of National Environmental Significance: Significant impact guidelines* 1.1. *Environment Protection and Biodiversity Conservation Act 1999'* (Department of the Environment, 2013c).



Map: PS114532_BDAR_002_A3	Author: - Victor.Lau	
Date: 23/07/2021	Approved by: - T.Lambert	

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community; NSWSS

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Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

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NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT

Figure 1.1
Locality

SANDY CREEK
ST HELIERS ROAD
NEW ENGLAND HIGHWAY
SANDY CREEK ROAD
BURTONS LANE
ABERDEEN STREET
LONHRO PLACE
BURGUNDY STREET
LEXIA STREET
CABERNET STREET
CHARDONNAY STREET
SHIRAZ STREET
QUEEN STREET
COMMON ROAD
INDUSTRIAL CLOSE
BRENTWOOD STREET
COAL ROAD

Legend

- Watercourse
- Access Tracks
- Operational Basins
- Concept Design - AECOM (08-07-2021)
- Construction footprint
- Construction Compounds
- Study area
- Cadastre

Map: PS114532_BDAR_008_A6	Author: V.Lau
Date: 27/08/2021	Approved by: - T.Bangel

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Coordinate system: GDA 1994 MGA Zone 56

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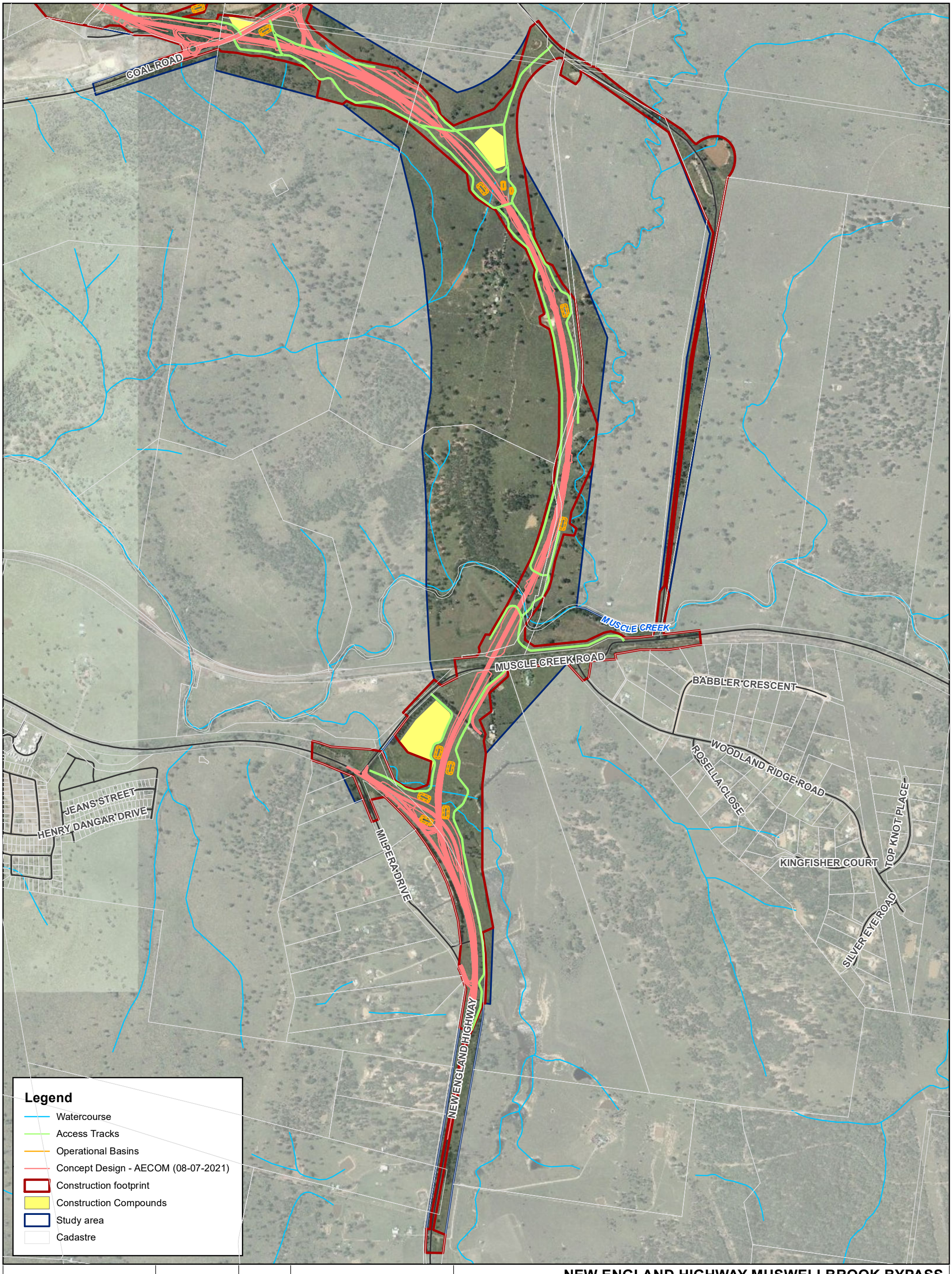
Figure 1.2a
The proposal



Map: PS114532_BDAR_008_A6 | Author: V.Lau

Date: 27/08/2021 | Approved by: - T.Bangel

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NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT

Figure 1.2b
The proposal

2 Methods

2.1 Personnel

The contributors to the preparation of this report, their qualification and roles are summarised in Table 2.1.

Table 2.1 Contributors and their roles

Name	Role	Qualifications
Alex Cockerill	Ecology National Team Executive – Project director and technical review	Bachelor of Science (Hons); Accredited BAM Assessor (BAAS17020)
Tanya Bangel	Senior Ecologist – Project manager, field survey and report preparation	Bachelor of Environmental Science and Management (Hons); Diploma of Conservation and Land Management; Accredited BAM Assessor (BAAS18076)
Toby Lambert	Principal Ecologist – Field survey, report preparation and technical review	Bachelor of Environmental Science; Accredited BAM Assessor (BAAS17046)
Nathan Cooper	Senior Ecologist – Field survey and report preparation	Bachelor of Environmental Science; Graduate Diploma Ornithology; Diploma Applied Science, Environmental Technology
Julia Emerson	Ecologist – Field survey	Bachelor of Environment; Certificate 3 Conservation and Land Management; Accredited BAM Assessor (BAAS18034)
Clementine Watson	Ecologist – Field survey	Bachelor of Environmental Science and Management; Accredited BAM Assessor (BAAS18164)
Gavin Shelley	Ecologist – Field survey	Bachelor of Environmental Science and Management
Jayme Lennon	Graduate Ecologist – Field survey	Bachelor of Environmental Science
Emily Mitchell	GIS Consultant – Mapping and data management	Bachelor of Development Studies; Master of Information Technology; Certificate IV Spatial Information Services
Rob Suansri	GIS Consultant – Mapping and data management	Bachelor of Science (Hons); Master of Science in Geoscience
Victor Lau	Graduate GIS Consultant – Mapping and data management	Bachelor of Engineering (Hons) in Geospatial Engineering

All work was carried out under the appropriate licences, including scientific licences as required under Clause 22 of the *National Parks and Wildlife Regulations 2002*, Section 132C of the *National Parks and Wildlife Act 1974* (NSW) (License Number: SL100630) as well as an animal research authority issued by the Department of Trade and Investment, Regional Infrastructure and Services.

2.2 Background research

A background review of existing information was completed to identify the existing environment within the locality. Specifically, this review focused on identifying the following:

- The likely distribution of vegetation communities, based on previous mapping and aerial photograph interpretation, to allow for targeted field verification
- A list of candidate threatened species and populations of plants to consider during vegetation surveys and habitat assessment
- A list of candidate threatened species and populations of animals and migratory animals to consider during field-based habitat assessment
- Local landscape-scale features of potential significance to biodiversity; e.g. riparian zones and potential wildlife movement corridors
- Baseline information and following evaluation, determining whether additional surveys, mapping and reporting is required
- If any Areas of Outstanding Biodiversity Value were present.

The desk-based assessment included analysis of the following resources:

- Existing biodiversity reports prepared for the proposal including:
  - *Muswellbrook Bypass – Preliminary biodiversity investigation* (WSP, 2020)
  - *HW9 New England Highway Muswellbrook Bypass Preliminary Environmental Investigation* (Hills Environmental, 2016)
  - *Muswellbrook Bypass – Preliminary Environmental Investigation* (Hills Environmental, 2013)
- Local broad-scale vegetation mapping of the study area:
  - *State Vegetation Type Map: Upper Hunter v1.0. VIS_ID 4894* (Department of Planning Industry and Environment, 2019)
  - *The Vegetation of the Central Hunter Valley, New South Wales* (Peake, 2006)
  - *Hunter, Central and Lower North Coast Vegetation Classification and Mapping* (Somerville, 2009)
- Priority weed lists for the Hunter region (Department of Primary Industries, 2020b)
- Topographic maps and aerial photographs.

Records of threatened species, populations and ecological communities known or predicted to occur in the locality of the study area were obtained from a range of databases as detailed in Table 2.2.

Table 2.2 Database searches completed

Database	Search date	Area searched	Reference
BioNet Atlas of NSW Wildlife	14 June 2019 27 March 2020	10km buffer around the study area and subregion search	Office of Environment Energy and Science (2020)
Protected Matters Search Tool	14 June 2019 27 March 2020	10km buffer around the study area	Department of Environment and Energy (2020a)
PlantNet	14 June 2019 27 March 2020	LGA spatial search	Royal Botanic Gardens (2020)
NSW Department of Primary Industries (Fishing and Aquaculture) spatial data	14 June 2019 27 March 2020	10km buffer around the study area	Department of Primary Industries (2020a)

Database	Search date	Area searched	Reference
Coastal SEPP search NSW Department of Planning and Environment	14 June 2019 27 March 2020	10km buffer around the study area	NSW Department of Planning and Environment (2018)
Critical habitat registers			
NSW Areas of Outstanding Biodiversity Value Register	14 June 2019 27 March 2020	10km buffer around the study area	Environment Energy and Science Group (2020a)
Australian Government Critical Habitat register	14 June 2019 27 March 2020	10km buffer around the study area	Department of Agriculture Water and the Environment (2020)
DPI Critical Habitat Register	14 June 2019 27 March 2020	10km buffer around the study area	NSW Department of Primary Industries (2020)
Bureau of Meteorology Atlas of Groundwater Dependant Ecosystems	14 June 2019 27 March 2020	10km buffer around the study area	Bureau of Meteorology (2020)

2.3 Habitat assessment and likelihood of occurrence

A habitat assessment was completed to assess the likelihood of occurrence of each threatened species, population and community (threatened biodiversity) identified with the potential to occur in the study area. All threatened biodiversity identified during the background research were considered. The habitat assessment was utilised to inform the identification of appropriate targeted surveys and was revisited after the surveys were completed based on the habitat components identified in the study area. The assessment was based on the habitat profile for the species and other habitat information in the Threatened Species Profile Database (Environment Energy and Science Group, 2020d). The assessment also included consideration of the dates and locations of nearby records and information about species populations in the locality.

The assessment results are summarised in section 3 (Existing environment) and are provided in full in the likelihood of occurrence assessments in Appendix A (Habitat assessment tables).

For this study, the likelihood of occurrence of threatened and migratory species and populations was determined based on the criteria shown in Table 2.3 below.

Table 2.3 Likelihood of occurrence classification and criteria

Likelihood	Criteria
Recorded	The species was observed in the study area during the current survey
High	It is highly likely that a species inhabits the study area and is dependent on identified suitable habitat (i.e. for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the locality (10 kilometre) and is known or likely to maintain resident populations in the study area. Also, includes species known or likely to visit the study area during regular seasonal movements or migration.

Likelihood	Criteria
Moderate	Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on habitat within the study area, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
Low	It is unlikely that the species inhabits the study area and has not been recorded recently in the locality (10 kilometre). It may be an occasional visitor, but habitat like the study area is widely distributed in the local area, meaning that the species is not dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the study area or the species are non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
None	Suitable habitat is absent from the study area.

2.4 Field survey

The field survey aimed to ground-truth the results of the background research and habitat assessment. As such, all threatened species, populations and communities that were considered likely to occur within the study area were targeted during the field survey to determine presence or likely occurrence. A description of all field surveys completed to inform this report is provided below.

2.4.1 Weather conditions

Weather conditions can affect activity (and therefore detectability) of some species. If adverse weather conditions occur during field surveys the validity of survey techniques are affected and can impact the probability of detecting a species if present within the study area.

During the field survey program weather conditions were variable with low to high winds and temperatures recorded. Generally low amounts of rainfall were received during the survey program. A summary of the weather conditions experienced during the survey program is provided in Table 2.4.

Table 2.4 Field survey dates and weather conditions

Date	Temp. Min. (°C)	Temp. Max. (°C)	Wind direction / speed (Km/hr)	Rain (mm)
18 June 2019	10.8	16.3	WNW / 20	0
19 June 2019	1.5	16.3	WSW / 31	0.2
20 June 2019	-2.8	16.7	SSE / 17	0
21 June 2019	-2.5	13.9	S / 24	0
24 June 2019	9.2	-	-	0.2
30 September 2019	8.1	24.4	SE / 44	0
1 October 2019	11.1	24.8	SSE / 33	0
2 October 2019	5.4	28.3	W / 35	0
3 October 2019	7.4	30.7	E / 26	0
2 December 2019	12.7	22.0	W / 83	0.8

Date	Temp. Min. (°C)	Temp. Max. (°C)	Wind direction / speed (Km/hr)	Rain (mm)
3 December 2019	13.5	30.5	W / 57	1.2
4 December 2019	13.9	32.2	W / 59	0
5 December 2019	13.2	35.9	WNW / 76	0
24 February 2020	16.5	24.3	S / 24	0
25 February 2020	18.3	29.6	NW / 17	5.4
26 February 2020	18.9	31.0	SW / 74	0.2
27 February 2020	17.8	25.6	S / 28	8.4
28 February 2020	11.3	27.9	SE / 44	0.2
12 June 2020	6.2	19.0	SE / 26	0
17 August 2020	9.5	17.9	WNW / 44	0.2
18 August 2020	3.5	19.0	NW / 43	0.4
19 August 2020	7.1	20.5	NW / 69	0.2
20 August 2020	9.7	15.9	W / 72	0
21 August 2020	3.4	17.3	NW / 48	0.6
6 October 2020	8.9	24.7	S / 30	0
7 October 2020	15.3	25.8	S / 26	0
8 October 2020	12.7	30.2	NW / 61	0
9 October 2020	11.7	22.9	W / 44	0
12 October 2020	7.1	28.3	S / 35	0
13 October 2020	9.4	28.9	SE / 30	0
14 October 2020	10.5	26.9	S / 39	0

Note: Source from Scone Airport (Station: 061363).

2.4.2 Vegetation surveys

The field surveys aimed to ground-truth the results of the background research including desktop analysis of vegetation and habitat assessment. The floristic diversity and possible presence of threatened species was assessed using a combination of survey techniques including; plot-based (quadrat/transect), rapid assessments, parallel line transverses and two-phase grid-based systematic surveys in accordance with the relevant guidelines.

Verification of existing vegetation mapping

Vegetation within the study area and locality has been previously mapped at the regional scale by the following:

- *State Vegetation Type Map: Upper Hunter v1.0. VIS_ID 4894* (Department of Planning Industry and Environment, 2019)
- *Hunter, Central and Lower North Coast Vegetation Classification and Mapping* (Somerville, 2009) (HCCREMs)
- *The Vegetation of the Central Hunter Valley, New South Wales* (Peake, 2006).

Field validation (ground-truthing) of this existing mapping within the study area was completed to confirm the vegetation structure, dominant canopy species, native diversity, underlying geology, condition and presence of threatened ecological communities. This was based on the completion of random meanders, rapid data points and drive by assessments.

Fifty two vegetation integrity plots, as described in the BAM (Office of Environment & Heritage, 2017), were completed across all vegetation types recorded.

The information collected during the survey was used to determine the Plant Community Type (PCT) for each vegetation type recorded as detailed in the BioNet Vegetation Classification System (Environment Energy and Science Group, 2020c) and whether vegetation within the study area aligned to any state or commonwealth listed ecological communities.

Mapping of derived native grasslands

Native grasslands within the study area have been assigned to corresponding PCTs from which they were derived as part of this assessment. Where this occurs the derived native grassland (DNG) has been assigned to a low condition form (i.e. Low (DNG) condition).

Although the BioNet Vegetation Classification Database does not recognise derived grasslands as constituting part of these PCTs, the native grasslands identified on site do align and form part of threatened ecological communities listed under the BC Act and EPBC Act.

Specifically, this assessment was completed to achieve the following:

- Accurately define specific impacts associated with the proposal
- Identify and differentiate between DNG which forms and does not form part of BC Act and/or EPBC Act threatened ecological communities
- Identify vegetation which forms potential habitat for threatened flora and fauna species (i.e. vegetation associations identified as potential habitat for each species on their Environment, Energy and Science (EES) Group species profile).

Although *Cynodon dactylon* (Couch) is considered a native species in NSW it is widely cultivated for lawn and pasture. Therefore, the species was considered introduced within the study area unless it formed a diagnostic species of a PCT as determined by the BioNet Vegetation Classification Database or an equivalent broad-scale vegetation mapping profile description.

Condition of vegetation

The vegetation within the study area was firstly assessed to a PCT and then aligned to a vegetation zone which is defined in the BAM as '*areas of the same PCT that are in relatively homogenous condition'* (Department of Planning Industry and Environment, 2020). A broad condition state infers that the vegetation has a similar tree cover, shrub cover, ground cover, weediness or combinations of these attributes which determine vegetation condition.

The broad condition states that were applied to vegetation within the study area are summarised in Table 2.5. These factors were defined by using factors such as levels of disturbance, weed invasion and resilience.

Table 2.5 Vegetation broad condition states

Broad condition state	Description	Equivalent BBAM condition for offsetting (RMS, 2016)
Good	Native vegetation where all tree, shrub, grass and/or forb structural growth form groups expected for a PCT are present. This condition type displays resilience to weed invasion. Weeds may exist in this vegetation type but generally exhibit <20% foliage cover.	Moderate to Good

Broad condition state	Description	Equivalent BBAM condition for offsetting (RMS, 2016)
Moderate	Vegetation where one or more structural understorey components is either entirely removed or severely reduced. On site, vegetation has generally retained a native canopy but the understorey and/or groundcover layers are generally co-dominated by exotic species or have been structurally modified due to previous and current land use practices. For example, vegetation generally exhibits between 5–49% foliage cover. The midstorey and understorey stratums may have been structurally modified due to previous clearing or agricultural grazing.	Moderate to Good
Low (Remnant)	Vegetation has retained a native canopy or the canopy cover is showing some signs of regeneration. The understorey and groundcover layers of this condition are absent or the understorey is generally dominated or co-dominated by exotic species (i.e. exotic perennial groundcover foliage cover >50%). Native species diversity is generally relatively low and the mid and low stratums have been structurally modified. This condition type also included scattered paddock trees and regrowth vegetation.	Moderate to Good
Low (Derived Native Grasslands)	PCTs that have changed to an alternative stable state because of land management practices since European settlement. Over-storey structural components of derived communities have either entirely been removed or are severely reduced (i.e. derived native grasslands with or without scatted paddock trees). Exotic weed cover is <50%.	Low
Native Plantings (including mine rehabilitation)	Areas where native plant species (both indigenous and non-indigenous to the region) have been planted. Groundcover component may be either dominated or co-dominated by native and exotic species depending on current or historic land management practices. This condition class includes areas which have been rehabilitated following mining activities.	n/a

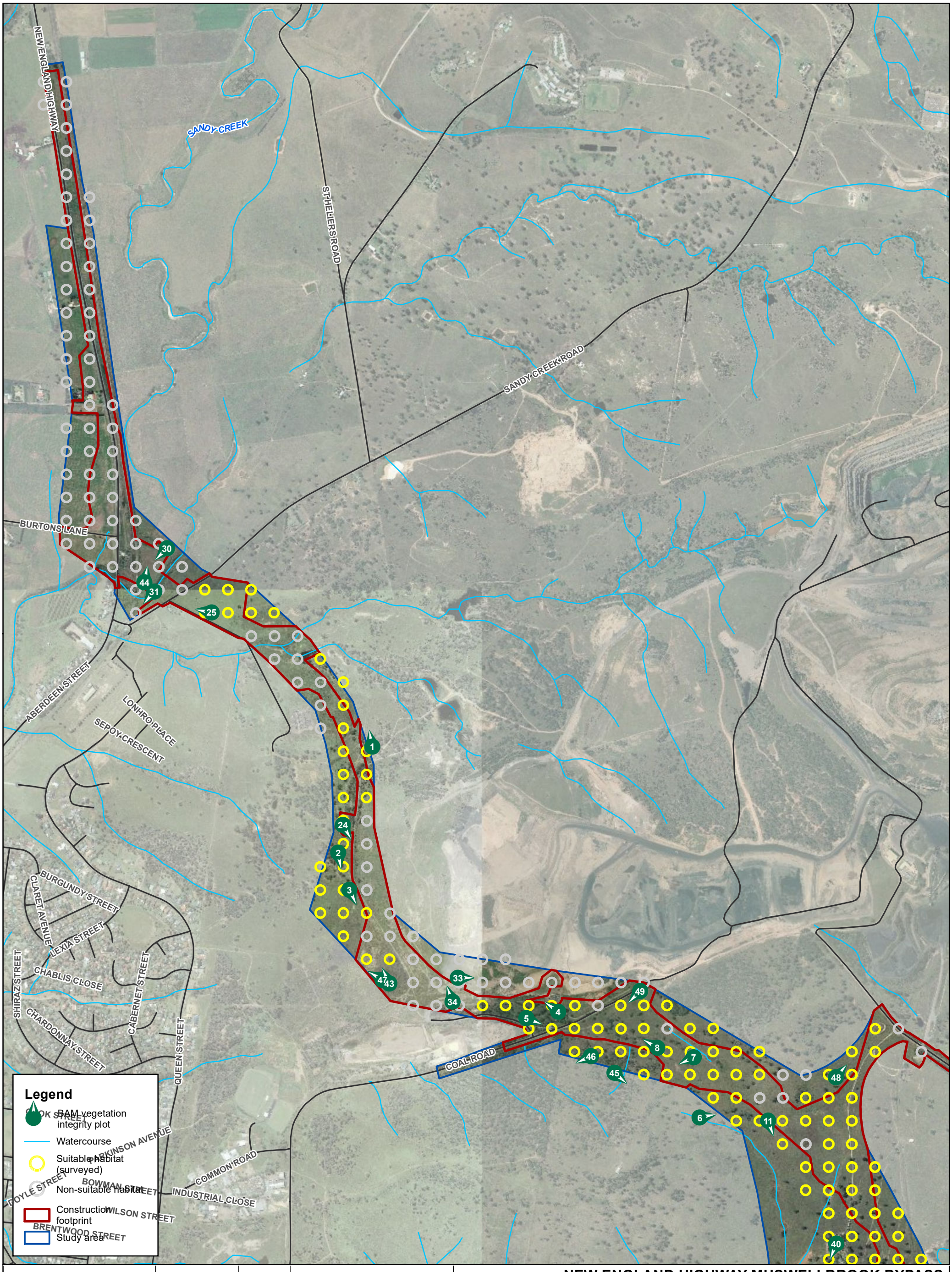
Plot and transect survey

Vegetation surveys were carried out in accordance with the BAM (Office of Environment & Heritage, 2017). A plot based full floristic survey was carried out based on a 20 metre x 20 metre quadrat, with function data collected using and 20 metre x 50 metre plot (henceforth referred to as a vegetation integrity plot (VI plot)).

Native vegetation recorded within the study area was aligned to PCTs as contained in the BioNet Vegetation Classification Database (Environment Energy and Science Group, 2020c). This was achieved by identifying native vegetation to formation, class and type and its corresponding threatened ecological community (where applicable). Furthermore, other characteristics such as floristic composition, underlying geology, soil type, landform and other description attributes were collected where available and assessed against BioNet Vegetation Classification Database PCT profiles.

Areas of non-native vegetation were also identified and mapped. Data was collected in these areas through random meanders and rapid point assessments to identify the composition and abundance of non-native vegetation within the study area.

The number of VI plots completed for each identified vegetation zone is provided in Table 2.6 while the location of each VI plot is provided in Table 2.7 and illustrated in Figure 2.1.



Map: PS114532_BDAR_001_A5	Author: V.Lau	
Date: 23/07/2021	Approved by: - T.Bangel	

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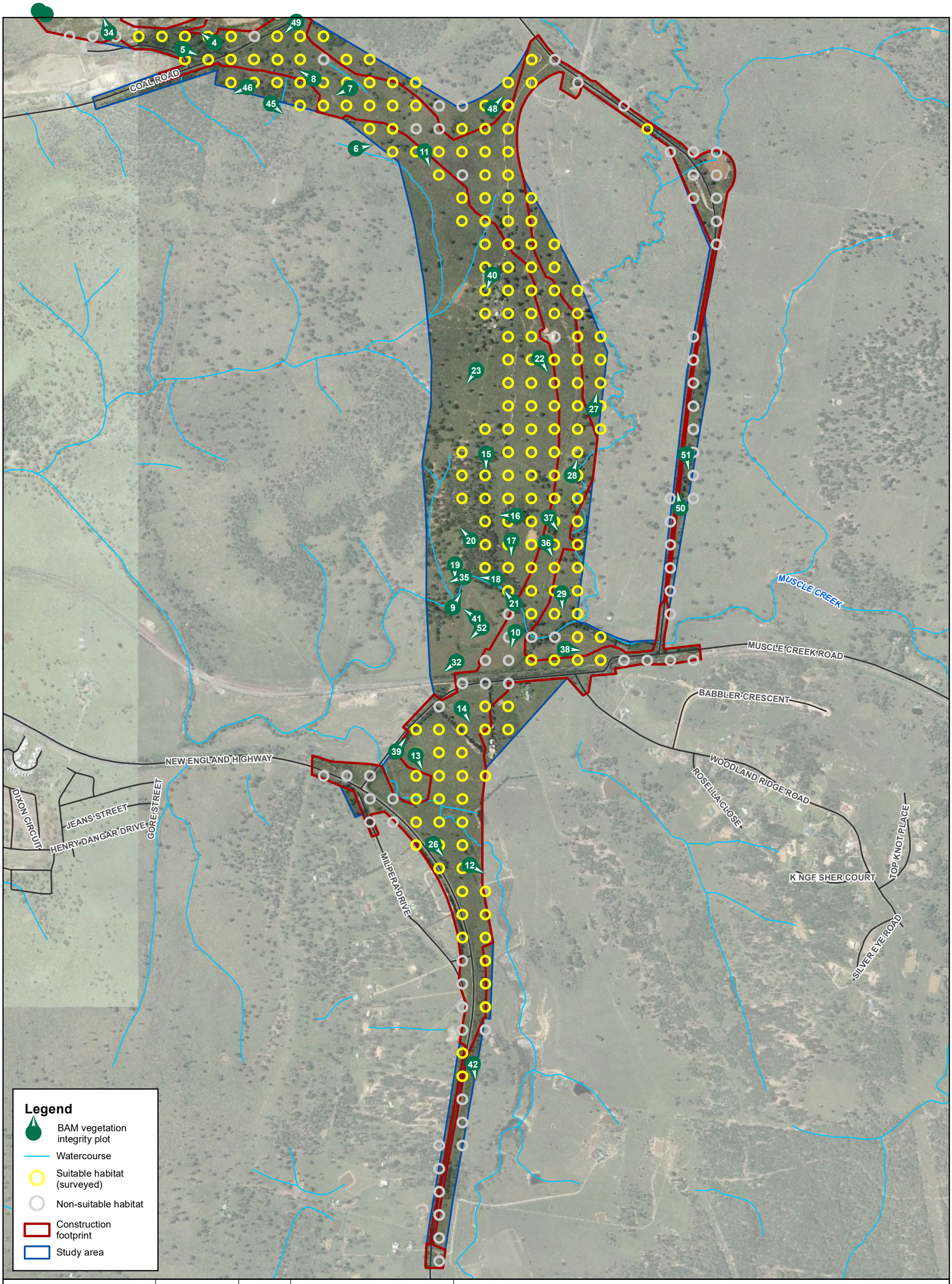
Figure 2.1a
Flora survey effort



Map: PS114532_BDAR_001_A5	Author: V.Lau		0 0.25 0.5 km 1:15,000
Date: 23/07/2021	Approved by: - T.Bangel		*Coordinate system: GDA 1994 MGA Zone 56* Scale ratio correct when printed at A3

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Figure 2.1b
Flora survey effort

Table 2.6 Vegetation survey effort

Plant community type	Vegetation zone	Area in study area (ha)	Minimum Number of VI plots required (BAM 2017)	BAM VI plots completed
Native PCTs				
PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	Moderate	43.30	4	Q1, Q5, Q6, Q8, Q15, Q16 & Q20
	Low (Remnant)	11.65	3	Q2, Q40, Q48 & Q49
	Low (DNG)	98.52	5	Q3, Q7, Q11, Q18, Q22, Q23 & Q25
PCT 1604 Narrow-leaved Ironbark – Grey Box – Spotted Gum shrub – grass woodland of the central and lower Hunter	Low (Remnant)	0.81	1	Q24
PCT 1605 Narrow-leaved Ironbark – Native Olive shrubby open forest of the central and upper Hunter	Moderate	3.51	2	Q45 & Q46
PCT 1607 Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter	Good	2.16	2	Q4 & Q17
	Low (Remnant)	0.11	1	Q47
	Low (DNG)	1.02	1	Q43
PCT 1693 Yellow Box – Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	Good	0.64	1	Q35
	Moderate	1.13	1	Q42
	Low (Remnant)	14.22	3	Q12, Q26, Q29, Q37, Q40, Q50 & Q51
	Low (DNG)	52.77	5	Q13, Q14, Q19, Q27, Q36 & Q38
PCT 42 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Low (Remnant)	0.53	1	Q41
	Low (DNG)	12.72	3	Q10, Q32 & Q52
PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)	Moderate	7.05	3	Q9, Q21 & Q28
	Low (Remnant)	0.30	1	Q31
	Low (DNG)	3.20	2	Q30 & Q44

Plant community type	Vegetation zone	Area in study area (ha)	Minimum Number of VI plots required (BAM 2017)	BAM VI plots completed
Miscellaneous ecosystems				
Highly disturbed areas with no or limited native vegetation	n/a	119.57	None required as vegetation is not native and does not align to a recognised NSW PCT	Random meanders
Urban/exotic plantings	n/a	1.42		
Cropping	n/a	16.58		
Native plantings (including mine rehabilitation)	n/a	11.03	3	Q33, Q34 & Q39

Table 2.7 BAM VI plots completed within the study area

Plot ID	Vegetation type	Condition	Easting	Northing	Orientation
Q1	PCT 1691	Moderate	303524	6430321	350
Q2	PCT 1691	Low (Remnant)	303377	6429860	150
Q3	PCT 1691	Low (DNG)	303425	6429700	155
Q4	PCT 1607	Good	304328	6429173	280
Q5	PCT 1691	Moderate	304191	6429144	110
Q6	PCT 1691	Moderate	304942	6428714	80
Q7	PCT 1691	Low (DNG)	304916	6428975	245
Q8	PCT 1691	Moderate	304758	6429017	300
Q9	PCT 485	Moderate	305361	6426728	5
Q10	PCT 42	Low (DNG)	305631	6426621	195
Q11	PCT 1691	Low (DNG)	305238	6428701	160
Q12	PCT 1693	Low (Remnant)	305433	6425612	120
Q13	PCT 1693	Low (DNG)	305200	6426087	155
Q14	PCT 1693	Low (DNG)	305399	6426291	150
Q15	PCT 1691	Moderate	305504	6427393	165
Q16	PCT 1691	Moderate	305630	6427125	345
Q17	PCT 1691	Low (DNG)	305613	6427017	260
Q18	PCT 1607	Good	305546	6426852	275
Q19	PCT 1693	Low (DNG)	305370	6426901	180
Q20	PCT 1691	Moderate	305438	6427018	320

Plot ID	Vegetation type	Condition	Easting	Northing	Orientation
Q21	PCT 42	Moderate	305626	6426746	280
Q22	PCT 1691	Low (DNG)	305735	6427806	150
Q23	PCT 1691	Low (DNG)	305461	6427754	215
Q24	PCT 1604	Low (Remnant)	303397	642981	150
Q25	PCT 1691	Low (DNG)	302829	6430902	280
Q26	PCT 1693	Low (Remnant)	305281	6425708	140
Q27	PCT 1693	Low (DNG)	305920	6427588	10
Q28	PCT 485	Moderate	305877	6427300	335
Q29	PCT 1693	Low (Remnant)	305831	6426788	175
Q30	PCT 485	Low (DNG)	302636	6431178	225
Q31	PCT 485	Low (Remnant)	302581	6430992	220
Q32	PCT 42	Low (DNG)	305376	6426493	230
Q33	Native plantings	n/a	303900	6429342	90
Q34	Native plantings	n/a	303915	6429231	340
Q35	PCT 1693	Good	305432	6426863	250
Q36	PCT 1693	Low (DNG)	305763	6427008	155
Q37	PCT 1693	Low (Remnant)	305775	6427117	145
Q38	PCT 1693	Low (DNG)	305846	6426548	95
Q39	Native plantings	n/a	305115	6426105	35
Q40	PCT 1691	Low (Remnant)	305531	6428168	200
Q41	PCT 42	Low (Remnant)	305463	6426681	305
Q42	PCT 1693	Moderate	305447	6424751	170
Q43	PCT 1607	Low (DNG)	303598	6429295	335
Q44	PCT 485	Low (DNG)	302539	6431032	10
Q45	PCT 1605	Moderate	304573	6428908	130
Q46	PCT 1605	Moderate	304471	6428980	245
Q47	PCT 1607	Low (Remnant)	303569	6429310	300
Q48	PCT 1691	Low (Remnant)	305532	6428888	40
Q49	PCT 1691	Low (Remnant)	304683	6429262	225
Q50	PCT 1693	Low (Remnant)	306345	6427159	350
Q51	PCT 1693	Low (Remnant)	306369	6427390	170
Q52	PCT 42	Low (DNG)	305485	6426641	225

Note: GPS co-ordinates in Zone 56, GDA94

2.4.3 Targeted flora surveys

Targeted threatened flora surveys were conducted for candidate species that were considered to have a moderate or higher likelihood of occurrence (Appendix A). Targeted flora surveys were completed by conducting reference checks, parallel line traverses, random meanders, rapid point assessments and by completing BAM VI plots. A summary of the targeted flora surveys completed is provided in section 2.4.6 (Summary of survey effort) and Table 2.8.

Vegetation integrity plots

Plot and transect surveys were carried out in accordance with the BAM (Office of Environment & Heritage, 2017). At each plot and transect survey location, dedicated 20 minute searches were conducted for threatened species assessed as having a moderate or high likelihood of occurrence within each vegetation type sampled. The number of plots completed for each identified vegetation zone is provided in Table 2.6 while the location of each VI plot is provided in Table 2.7 and illustrated in Figure 2.1.

Parallel line traverses

Targeted flora surveys in the form of parallel line transverses were used to search for threatened species assessed as having a moderate or high likelihood of occurrence within the study area. This involved two ecologists searching along parallel transverses across potential habitat for each threatened species with reference to previous guidelines for *NSW threatened plant surveys* (Office of Environment & Heritage, 2016).

Two-phase grid-based systematic surveys

Targeted flora surveys completed in 2020 were conducted using the two-phase grid-systematic survey technique as detailed in the newer *Surveying threatened plants and their habitats* (Department for Planning Industry and Environment, 2020) given the large area of suitable habitat present.

This method involved nesting a grid of 100 square metres within a 1 square kilometre grid from a topographic map which was overlayed on the study area. Surveys were taken at the intersect of each of the 100 square metre gridlines where suitable habitat occurred. At each location, a 40 square metre area was systematically surveyed for the target species

More intensive parallel traverses were completed within areas of higher quality habitat where the habitat intersected the proposal's 20 percent design construction footprint.

Random meander

Random meander surveys are a variation of the transect type survey and were completed in accordance with the technique described by Cropper (1993), whereby the recorder walks in a random meander throughout the study area recording all species observed (including threatened species), boundaries between various vegetation communities and condition of vegetation. The time spent in each vegetation community was generally proportional to the size of the community, its species richness and records of threatened plants.

Random meander surveys were conducted to locate candidate threatened species and populations within the area of suitable habitat. Where a threatened flora species was located, parallel field traverses were then conducted to determine the size and extent of the population.

2.4.4 Targeted fauna surveys

Fauna surveys were conducted within the study area during all survey periods in 2019 and 2020. Surveys were undertaken for threatened species identified during desktop assessments, that were considered likely to use habitats within the study area. Survey session seasonality was selected to target candidate species with seasonal survey requirements and activity. While fauna surveys were undertaken, habitat assessments were also conducted to assess the value of the habitats present for threatened fauna. Throughout all survey periods, opportunistic observations of all fauna species were recorded. Fauna survey locations are provided in Figure 2.2.

Generally, surveys followed the methods described in the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft* (Department of Environment and Conservation, 2004b). Targeted surveys and methodology are outlined below, and a summary of survey effort is provided in section 2.4.6 (Summary of survey effort) and Table 2.9.

Nocturnal surveys

Nocturnal surveys were conducted in February and August 2020, consisting of spotlighting, call playback and stag watches. The methodologies of each survey technique are described below.

Spotlighting

The objective of this survey technique was to target arboreal, flying and large ground-dwelling mammals, as well as nocturnal birds, reptiles and amphibians. Spotlighting was done after dusk within suitable habitat within the study area. Two person hours of survey effort were carried out each night on foot using two spotlights. The survey concentrated on areas that contained suitable habitat for nocturnal species, with sighted animals identified to the species level.

Call playback

Call playback was used to survey for threatened owls (i.e. Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*) and Masked Owl (*Tyto novaehollandiae*)) and arboreal mammals (i.e. Koala (*Phascolarctos cinereus*) and Squirrel Glider (*Petaurus norfolcensis*)) using the methods of Kavanagh and Peake (1993) and Debus (1995).

Call playback was conducted after dusk each night, within suitable habitat in the study area. For this survey an initial listening period of 10 minutes was undertaken, followed by a spotlight search for 10 minutes to detect any animals in the immediate vicinity. The calls of the target species were then played intermittently for five minutes followed by a 10-minute listening period. After the calls were played, another 10 minutes of spotlighting was carried out in the vicinity to check for animals attracted by the calls, but not vocalising. Calls were broadcast using a portable call playing device and amplified through a megaphone.

Stag watches

Stag watches were undertaken at dusk in areas where large hollow-bearing trees were identified within or immediately adjacent the proposal's 20% design. The aim of dusk stag watches is to identify hollow dwelling fauna including owls, yangochiropteran bats and arboreal mammals that are using any hollow-bearing trees for breeding purposes. Following stag watches, spotlighting transects were undertaken near known or likely utilised hollow-bearing trees.

Diurnal bird surveys

Formal 20-minute bird surveys and opportunistic sightings

Bird surveys were completed by actively walking through the nominated site (transect) over a period of 20 minutes. All birds were identified to the species level, either through direct observation or identification of calls. Bird surveys were completed during different times of the day, but generally occurred in the morning and evening. Birds were also recorded opportunistically during all other surveys.

Blossom nomad targeted surveys

Blossom nomads such as the Swift Parrot (*Lathamus discolor*), Regent Honeyeater (*Anthochaera phrygia*) and Little Lorikeet (*Glossopsitta pusilla*) are dependent on the variable mosaic of blossom resources at local, regional and state scales. While the Little Lorikeet is generally locally nomadic in response to blossom resources, the Swift Parrot and Regent Honeyeater are usually only winter visitors to coastal NSW regions for blossom. The Swift Parrots retire to Tasmania during the summer breeding period and as such only foraging habitat is likely to occur in NSW.

Opportunistic blossom surveys were undertaken within remnant vegetation in the study area for Little Lorikeet and other blossom nomad activity during June and September 2019 and August 2020. In addition, habitat and the presence of blossom and/or lerp resources were noted and identified within the study area for the potential utilisation by threatened blossom nomads.

Targeted seasonal surveys were also completed in spring 2019 to identify the presence or signs of breeding Regent Honeyeaters within areas considered likely to be utilised by the species.

Predatory bird breeding habitat targeted survey

Predatory birds generally require tall living or dead standing trees (stags) to enable the construction of large stick nests in which they require to reproduce. Targeted and opportunistic surveys were undertaken within remnant vegetation in the study area for the following predatory bird species:

- Little Eagle (*Hieraaetus morphnoides*)
- Square-tailed kite (*Lophoictinia isura*)
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*).

Specifically, these surveys involved random meanders through potential habitat in search for active or non-active nests likely to be used by these species.

Koala spot assessments

In addition to habitat assessment, the Spot Assessment Technique (SAT) was undertaken within the study area to identify the presence and / or level of Koala (*Phascolarctos cinereus*) usage within native vegetation. The SAT identifies local Koala tree species preferences by measuring the rate at which each surveyed tree is utilised by Koalas.

The SAT involves measuring activity within the immediate area surrounding a tree of any species known to have been utilised by Koalas, or otherwise considered to be of some importance for Koala conservation and/or assessment purposes. A minimum of 29 surrounding trees are sampled systematically for Koala faecal pellets for 1 metre around the base of each tree. The activity of Koala usage for each SAT is then expressed as the percentage equivalent of the proportion of the surveyed trees within each SAT. The percentage is then compared to prescribed ranges for activity levels for Koalas within NSW (Phillips and Callaghan, 2011).

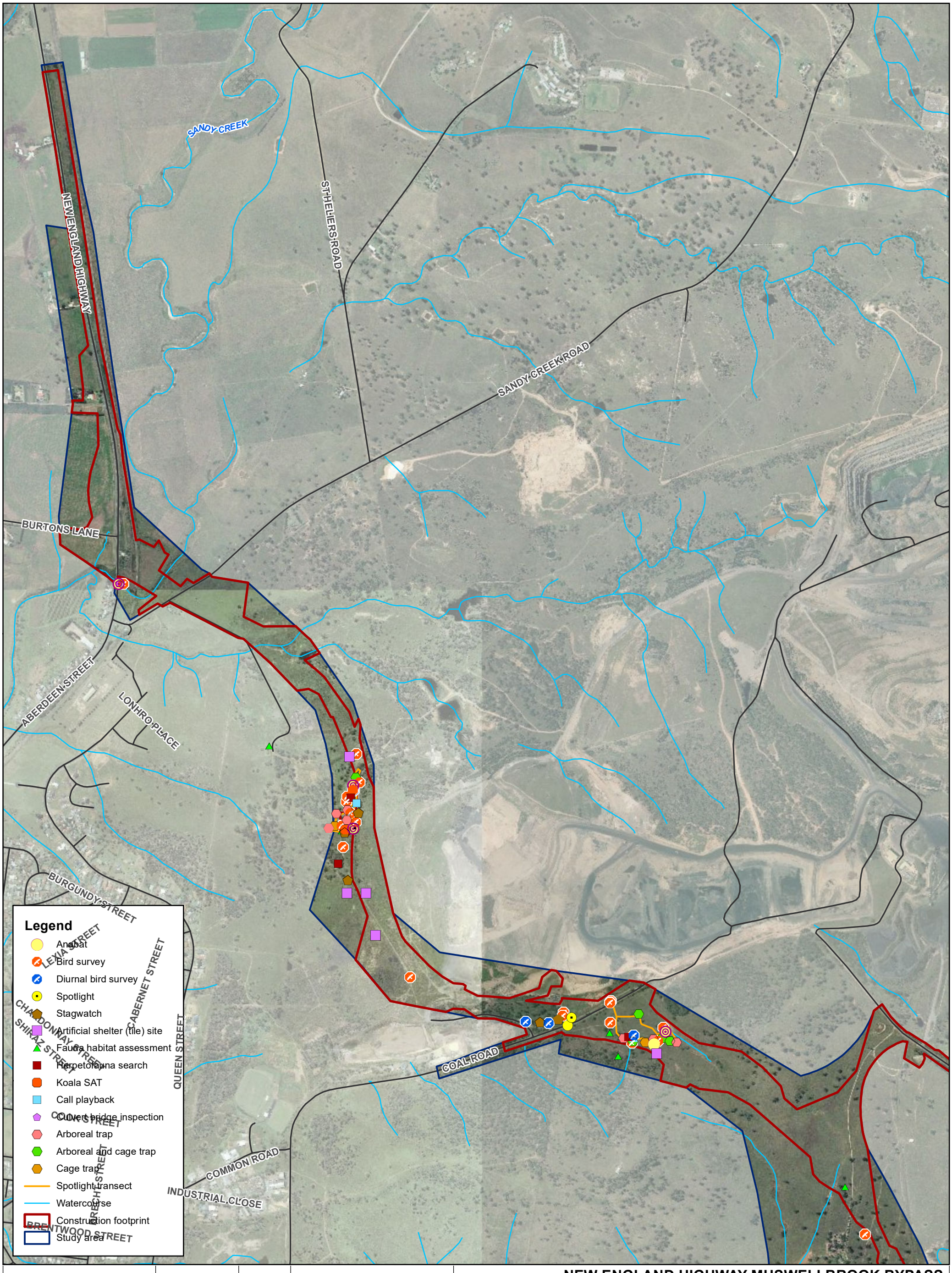
A total of three SAT surveys were completed within the study area (Figure 2.2).

Artificial shelter site surveys

Targeted surveys for Striped Legless Lizard (*Delma impar*) were completed via the laying of artificial shelters (i.e. concrete roof tiles). This method was used as it was deemed less destructive than searches of microhabitats such as under rocks, leaf litter, fallen timber, bark and debris.

Six locations containing potentially suitable habitat were sampled in the study area using 50 tiles (Figure 2.2). Tiles were arranged in a grid of 10 x 5 tiles with 5 metre spacing between tiles. The survey was undertaken during peak seasonal activity period (September to May), with tiles installed on:

- 2 December 2019 and checked between 24 and 28 February 2020 and again between the 17 and 21 August 2020
- Between 17 and 21 August 2020 and checked between 6 and 9 October 2020.



Map: PS114532_BDAR_007_A3	Author: V.Lau
Date: 23/07/2021	Approved by: - T.Bangel

0 0.25 0.5 km

1:15,000

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

Data source: © Department of Customer Service 2020
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri

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NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT

Figure 2.2a
Fauna survey effort

COAL ROAD
MUSCLE CREEK
MUSCLE CREEK ROAD
BABBLER CRESCENT
WOODLAND RIDGE ROAD
ROSELLA CLOSE
TOP KNOT PLACE
KINGFISHER COURT
SILVER EYE ROAD
JEANS STREET
HENRY DANGAR DRIVE
MILPERA DRIVE
NEW ENGLAND HIGHWAY

Legend

- Anabat
- Bird survey
- Diurnal bird survey
- Diurnal bridge inspection
- Diurnal culvert inspection
- Spotlight
- Stagwatch
- Artificial shelter (tile) site
- Fauna habitat assessment
- Herpetofauna search
- Koala SAT
- Call playback
- Culvert bridge inspection
- Arboreal trap
- Arboreal and cage trap
- Cage trap
- Spotlight transect
- Watercourse
- Construction footprint
- Study area

Map: PS114532_BDAR_007_A3	Author: V.Lau
Date: 23/07/2021	Approved by: - T.Bangel

0 0.25 0.5 km

1:15,000

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

Data source: © Department of Customer Service 2020
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri

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NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT

Figure 2.2b
Fauna survey effort

C:\Users\AUVL502876\WSP O365\AU WKG Geospatial AIS PS114532_Muswellbrook_Bypass\5_Shared\GIS\54_Production\Maps\524_BDAR\PS114532_BDAR_007_A3.mxd

Arboreal and terrestrial mammal trapping

Arboreal Elliot trapping

Squirrel Glider (*Petaurus norfolcensis*) and Brush-tailed Phascogale (*Phascogale tapoatafa*) were surveyed using arboreal set Elliott Type B trapping methods. Live capture and release Elliott Type B traps were set in three transects of eight traps for four consecutive nights in late February 2020. Each trap was baited with a mixture of oats, honey and vanilla essence and the immediate location was sprayed with an attractant of honey/vanilla essence water mix. Traps were checked at dawn each morning and captured animals were identified to species level before being released. All live trapping followed guidelines and policies for wildlife research in accordance with animal ethics protocols.

Terrestrial cage trapping

The Spotted-tailed Quoll (*Dasyurus maculatus*) was surveyed using live capture/release trapping methods; specifically wire cage traps. Cage traps were deployed during late February 2020 targeting broad fauna habitat types in the study area. Cage traps were baited with chicken legs and necks and cat food and set over a period of four nights. Cage traps were checked each morning with captured animals identified to species level and released at the site of capture. All live trapping followed guidelines and policies for wildlife research in accordance with animal ethics protocols.

Yangochiropteran bat surveys

Passive Ultrasonic Anabat detection

Passive Ultrasonic Anabat Bat detection (Anabat Express unit – Titley Scientific, Brendal QLD) was used to record and identify the echolocation calls of yangochiropteran bats foraging at 13 locations within the study area between 24–28 February 2020 (Figure 2.2). Sites were selected with consideration of broad fauna habitat types, suitable habitat, potential flight paths and areas generally free of obstructions to increase the chance of recording bat passes. Passive monitoring was achieved by setting Anabat bat detectors to record throughout the night.

Anabat Bat detectors recorded bat vocalisations throughout the full night, with the recording starting before dusk. Bat activity throughout the night does vary (Department of Environment and Conservation, 2004b, Taylor and Oneill, 1988), but the peak in activity is usually within a few hours of dusk.

Yangochiropteran bat call analysis was completed by Greg Ford (Principal Ecologist, Balance! Environmental). Analysis of calls recorded were completed using Analook (Version 4.7) software with reference to '*Bat Calls of NSW: Region Based Guide to the Echolocation Calls of Microchiropteran Bats'* (Pennay et al., 2004).

Yangochiropteran bat surveys also included diurnal inspections of bridges and culverts throughout the study area. In particular, the two bridges over Sandy Creek in the north, the wooden rail bridge over Muscle Creek and the two concrete box culverts which occur underneath the New England Highway and Muscle Creek Road to the south (Figure 2.2 The inspections were completed during daylight hours to determine whether suitable roosting habitat for threatened yangochiropteran bats was present.

Harp trapping

Like other Long-eared Bat species Corben's Long-eared Bat (*Nyctophilus corbeni*) uses understorey strata for foraging and they roost in hollow-bearing trees. Although many yangochiropteran bat species are detectable through use of Anabat call detection methodologies, the vocal differences between *Nyctophilus* spp. are too subtle to reliably differentiate between the various species occurring in the locality. Therefore, surveys for Corben's Long-eared Bat needed to be conducted with a methodology that enabled bats to be identified in the hand.

Harp traps are excellent for capture and release of yangochiropteran bats and they are well suited to the capture of *Nyctophilus* spp. due to their propensity to use lower forest strata for their foraging habits. Site selection for the setting of harp traps included several rationales, such as targeting woodland habitats in areas where hollow-bearing trees provided potential roosting sites and where suitable flyways were detected in forest and woodland settings.

Harp traps were set at each location over a two-consecutive night period in February 2020 (surveys best conducted between October and April). Captured bats were identified to species level, sexed, measured and weighed. Bats were released immediately after processing during dark conditions (Figure 2.2).

Culvert yangochiropteran bat exit survey

A series of three box culverts positioned under Muscle Creek Road was inspected (amongst others) during diurnal hours to gauge its potential for use by bats. Due to the provision of expansion gaps and substantial quantity of Fairy Martin mud nests located therein, a dusk exit survey was also completed on 27 February 2020, followed by a spotlight transect through the culvert cells.

Habitat tree assessment

Comprehensive hollow-bearing tree survey

A comprehensive hollow-bearing tree (HBT) survey was undertaken within the 20 percent design construction footprint. This survey excluded the remainder of the study area including the extended study area which were added after the surveys were completed. The aim of the survey was to identify all habitat trees within the 20 percent design construction footprint, due to their importance to diversity of threatened fauna species.

Four hollow size diameter ranges were recorded during the survey to encompass a range of fauna size guilds including:

- Very small hollows (<5cm) which are typically suited to bats and very small arboreal mammals
- Small hollows (6–15cm) suited to bats, small arboreal mammals and small birds
- Medium hollows (15–25cm) for larger arboreal mammals and medium sized birds
- Large hollows (>25cm) which are suitable for large birds like cockatoos and large forest owls such as the Powerful Owl, Barking Owl and Masked Owl.

The tree location, species, diameter of the hollow, approximate height and the location of hollows and other general comments were also recorded.

Trees containing large hollows

Special consideration was given trees which contained large hollows (>25cm in diameter) due to their importance as potential breeding resources for large forest owls such as Powerful Owl, Barking Owl and Masked Owl.

A survey to locate trees containing large hollows was completed within the study area. The survey excluded the extended study area which was added after the survey was completed. The location of each tree containing a large hollow was recorded using a hand-held GPS. This survey aided in locating suitable trees to targeted during the winter nocturnal surveys as described in the above methodology.

Opportunistic sightings

Opportunistic sightings of animals were recorded during field surveys. Evidence of animal activity, such as scats, diggings, scratch marks, nests, dreys and burrows, was also noted. This provided indirect information on animal presence and activity.

During these surveys, a hand-held GPS was used to record the locations of:

- Hollow-bearing trees
- Aquatic habitats
- Rock outcrops.

Fauna habitat assessment

Fauna habitat assessments were undertaken to assess the likelihood of threatened fauna species (those species known or predicted to occur within the locality from the literature and database review) occurring within the study area. Fauna habitat assessments were the primary assessment tool in assessing whether threatened species are likely to occur within the study area, if they are not observed during field surveys.

Fauna habitat characteristics assessed included:

- Structure and floristics of the canopy, understorey and ground cover, including the presence of flowering and fruiting trees representing potential foraging resources
- Presence of hollow-bearing trees offering potential roosting and breeding habitat for arboreal mammals, birds and reptiles
- Presence of ground cover vegetation, leaf litter, rock outcrops and fallen timber increasing niche opportunity for ground-dwelling mammals, birds and herpetiles
- Presence of waterways (ephemeral or permanent) and water bodies.

Eleven formal habitat assessments were completed across the study area; five within the study area and six located immediately adjacent to the study area. The purpose of completing these habitat assessments was to extrapolate the potential fauna habitat resources available for location populations (including fallen timber and hollow resources) to assist in assessing impacts associated with the proposal on local fauna populations.

Condition of fauna habitat

The following criteria were used to evaluate the condition of habitat values:

- **Good:** A full range of fauna habitat components are usually present (for example, old-growth trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact
- **Moderate:** Some fauna habitat components are missing or greatly reduced (for example, old-growth trees and fallen timber), although linkages with other remnant habitats in the landscape are usually intact, but sometimes degraded
- **Poor:** Many fauna habitat elements in low quality remnants have been lost, including old growth trees (for example, due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive clearing in the past.

2.4.5 Aquatic surveys

The habitat value of waterways (i.e. habitat sensitivity and classification of waterways for fish passage) is characterised in accordance with *NSW DPI (Fisheries) document Policy and Guidelines for fish habitat conservation and management* (Department of Primary Industries, 2013).

Detailed aquatic fauna survey is warranted if a proposal crosses any Class 1 watercourse (Major fish habitat) or a Class 2 watercourse (Moderate fish habitat) that has been identified as having a moderate or high potential to be occupied by a threatened aquatic species of animal.

Aquatic habitat assessments were completed to determine whether waterways provided potential habitat for threatened aquatic species. No threatened aquatic habitat was identified and as such no targeted surveys were required.

Key fish habitat

Key Fish Habitat has been mapped as occurring along Sandy Creek, Muscle Creek and some areas of their unnamed tributaries (Department of Primary Industries, 2019). Habitat assessments were completed at each of these waterbodies to confirm potential habitat for threatened aquatic species.

2.4.6 Summary of survey effort

Targeted surveys were completed for threatened flora and fauna species identified as having a moderate to high chance of occurring. Surveys generally adhered to the methods described in the *NSW Guide to Surveying Threatened Plants* (Office of Environment & Heritage, 2016), *Surveying threatened plants and their habitats* (Department for Planning Industry and Environment, 2020) and the *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities – Working Draft* (Department of Environment and Conservation, 2004b).

The survey effort undertaken for threatened flora species for the proposal is summarised in Table 2.8 with threatened fauna survey effort shown in Table 2.9.

Table 2.8 Survey effort for candidate threatened flora species

Scientific name	Survey technique	Survey effort	Optimum survey period	Period surveyed	Comments
Acacia pendula	Targeted surveys – BAM VI Plots, parallel line traverses, two-phase grid-based systematic surveys and random meanders Opportunistic sightings while conducting other surveys.	Targeted: • BAM VI plots – around 44 hours • Parallel line traverses – around 48 hours • Two-phase grid-based – around 40 hours. Random meanders and opportunistic sightings – around 368 person hours in habitat	All year	18, 19, 20, 21 & 24 June 2019 30 September 2019 1, 2 & 3 October 2019 2, 3, 4 & 5 December 2019 24, 25, 26, 27 & 28 February 2020 12 June 2020 17, 18, 19, 20 & 21 August 2020 6, 7, 8 & 9 October 2020 12, 13 & 14 October 2020	-
Cymbidium canaliculatum			All year		
Eucalyptus glaucina			All year		
Pomaderris queenslandica			All year		
Eucalyptus camaldulensis		Targeted: • BAM VI plots – around 4 hours • Parallel line traverses – around 24 hours • Two-phase grid-based – around 40 hours. Random meanders and opportunistic sightings – around 368 person hours in habitat	All year		
Diuris tricolor	Targeted surveys – BAM VI plots, parallel line traverses, two-phase grid-based systematic surveys and random meanders Opportunistic sightings while conducting other surveys	Targeted: • BAM VI plots – around 42 hours • Parallel line traverses – around 48 hours • Two-phase grid-based – around 120 hours. Random meanders and opportunistic sightings – around 120 person hours in habitat	September-October	30 September 2019 1, 2 & 3 October 2019 6, 7, 8 & 9 October 2020 12, 13 & 14 October 2020	Reference populations visited during October 2020 survey period to confirm flowering period.
Ozothamnus tesselatus			September-October		-
Pterostylis chaetophora			September-November		

Scientific name	Survey technique	Survey effort	Optimum survey period	Period surveyed	Comments
Prasophyllum sp. *Wybong*	Targeted surveys – BAM VI plots, parallel line traverses, two-phase grid-based systematic surveys and random meanders Opportunistic sightings while conducting other surveys	Targeted – around 120 person hours in habitat Random meanders and opportunistic sightings – around 168 person hours in habitat	September-December	30 September 2019 1, 2 & 3 October 2019 6, 7, 8 & 9 October 2020 12, 13 & 14 October 2020 2, 3, 4 & 5 December 2019	–
Thesium australe	Targeted surveys – BAM VI plots, parallel line traverses and random meanders Opportunistic sightings while conducting other surveys	Targeted – 32 person hours in habitat Random meanders and opportunistic sightings – around 112 person hours in habitat	November-February	2, 3, 4 & 5 December 2019 24, 25, 26, 27 & 28 February 2020	–

Table 2.9 Survey effort for candidate threatened fauna species

Species targeted	Survey technique	Survey effort	Optimum survey period	Period surveyed	Comments
Birds					
Diurnal Forest birds					
Diamond Firetail	Standard 20 minute search of a 2 hectare area Opportunistic sightings Targeted roosting habitat surveys	18 x standard 20 minute searches 31 days of opportunistic daylight surveys 5 days of opportunistic daylight surveys for blossom nomads 2 days of searching for roosting habitat	All year	June & October 2019, February 2020 All survey periods (opportunistic surveys) August 2019 & 2020 (blossom nomads) October 2019, August & October 2020	Surveys undertaken across multiple vegetation communities within the study area
Dusky Woodswallow			All year		
Gang-gang Cockatoo			October-January Breeding		
Latham's Snipe			All year		
Little Eagle			August-October Breeding		
Little Lorikeet			All year		
Painted Honeyeater			All year		
Scarlet Robin			All year		
Flame Robin			All year		
Square-tailed Kite			September-January breeding		
Spotted Harrier			All year		
Speckled Warbler			All year		
Varied Sittella			All year		
Brown Treecreeper (eastern subspecies)			All year		
Black-chinned Honeyeater (eastern subspecies)			All year		

Species targeted	Survey technique	Survey effort	Optimum survey period	Period surveyed	Comments
Grey-crowned Babbler (eastern subspecies)			All year		
Australian Painted Snipe			All year		
Turquoise Parrot			All year		
Hooded Robin			All year		
Black-necked Stork			All year		
Black Falcon			All year		
White-bellied Sea-eagle			July-December		
White-throated Needle-tail			All year		
Freckled Duck			All year		
Magpie Goose			All year		
Regent Honeyeater			All year (winter & spring preferred)		
Swift Parrot			All year (winter & spring preferred)		
Nocturnal birds of prey					
Powerful Owl	Spotlighting surveys Owl call playback and stag watches Large hollow bearing tree survey	4 nights and 3 nights 9 trees stag watched 2 days	May-August Breeding	February 2020 & August 2020 (spotlighting and call playback) August 2020 (stag watches) December 2019 (large hollow bearing tree survey)	-
Barking Owl			May-December Breeding		
Masked Owl			May-August Breeding		

Species targeted	Survey technique	Survey effort	Optimum survey period	Period surveyed	Comments
Arboreal nocturnal mammals					
Koala	Scat searches (SPOT Assessment)	3 x Spot Assessment Technique sites (SATs)	All year	February 2020 (SPOT, spotlighting and call playback) All survey periods (opportunistic surveys)	Scats collected were sent for expert confirmation.
	Spotlight transects	8 transects			
	Call playback	8 call playback events			
	Opportunistic sightings	31 days – 7 nights			
Squirrel Glider	Spotlight transects Call playback (Squirrel Glider) Arboreal Elliott B trapping Habitat assessments	8 spotlighting transects 8 call playback events 28 Elliott B traps x 4 consecutive nights – 112 trap nights	All year	February 2020 (Spotlighting, call playback & trapping) August 2020 (Spotlighting & call playback)	-
Brush-tailed Phascogale			December-June		
Greater Glider			All year		
Grey-headed Flying-fox	Spotlight transects	8 transects	All year October–December Breeding	February & August 2020 (spotlighting) All survey periods (opportunistic surveys)	Targeted searches for roosting camps completed within study area. No camps were identified within or near study area.
	Opportunistic sightings & searches for camps	31 days – 7 nights			

Species targeted	Survey technique	Survey effort	Optimum survey period	Period surveyed	Comments
Spotted-tailed Quoll	Opportunistic sightings	10 days – 7 nights	All year	February & August 2020	-
	Cage traps	24 cage traps x 4 consecutive nights – 96 trap nights		February 2020	
	Spotlight transects	8 transects		February & August 2020	
Yangochiropteran bats					
Little Bent-winged Bat	Anabat surveys Harp trapping Hollow-bearing tree surveys Searches for caves, artificial structures, culvert inspections etc.	13 anabat (acoustic recordings) nights 2 harp traps x 2 consecutive nights x 3 trap locations – 8 harp trap nights 10 days	December-February Breeding	February 2020 (anabats & harp trapping) June 2019 (anabats and habitat searches)	Habitat Assessments undertaken to identify any key habitat within study area (i.e. caves, culverts, water bodies etc.) – absence of important breeding habitat (e.g. caves) within study area. Culverts inspected where present.
Southern Myotis			October-March		
Large-eared Pied Bat			November–January Breeding		
Large Bent-wing Bat			December–February Breeding		
Eastern Cave Bat			November–January Breeding		
Eastern False Pipistrelle			All year		
Eastern Coastal Free-tailed Bat			All year		
Yellow-bellied Sheathtail-bat			All year		
Corben's Long-eared Bat			All year		
Greater Broad-nosed Bat			All year		

Species targeted	Survey technique	Survey effort	Optimum survey period	Period surveyed	Comments
Reptiles					
Striped Legless Lizard	Artificial shelter site surveys Opportunistic sightings Habitat assessments	3 artificial shelter site survey grids – each site checked twice 3 artificial shelter site survey grids – each site checked once	September-December	Grid out December 2019 and checked in February & August 2020 Grid out in August 2020 and checked in October 2020	–
Pale-headed Snake	Spotlighting transects Opportunistic surveys Habitat assessments	4 nights – 8 transects	November-March	February 2020	–

2.5 Limitations

No sampling technique can eliminate the possibility that a species is present within a study area. For example, some species of plant may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis and may not be present within the study area during surveys. The conclusions in this report are based upon data acquired for the proposal and the environmental field surveys, therefore, they are merely indicative of the environmental condition of the study area at the time of preparing the report, including the presence or otherwise of species. It should be recognised that study area conditions, including the presence of threatened species, can change with time.

Targeted surveys have been conducted to detect target sedentary animal species and threatened flora species that are considered likely to occur within the study area based on habitat characteristics and previous records. As the actual distribution and the range of habitat utilised by some species is not fully understood, there is always a small possibility that other species could occur on the site despite being considered to have a low likelihood of occurrence based on their known range and known habitats.

2.5.1 Other limitations

Other limitations relating to the conclusions contained in this report are detailed in the following sections.

Reliance on externally supplied information

In preparing this study, WSP has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations. Except as otherwise stated in the study, WSP has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this study (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. WSP will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

Study for benefit of client

This document has been prepared for the exclusive benefit of the client and no other party. WSP assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with in this study, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in this study (including without limitation matters arising from any negligent act or omission of WSP or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in this study).

Other parties should not rely upon the study or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

2.5.2 Changing circumstances

To the best of WSP's knowledge, the proposal presented and the facts and matters described in this study reasonably represent the client's intentions at the time of preparation of the study. However, the passage of time, the manifestation of latent conditions or the impact of future events (including a change in applicable law) may have resulted in a variation of the proposal and of its possible environmental impact.

WSP will not be liable to update or revise this assessment to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the document.

3 Existing environment

This section describes the environmental context of the study area including abiotic and biotic features of the landscape area. The context of the study area assists in assessing likelihood of occurrence for threatened species and determining PCTs.

3.1 Summary of landscape features

The landscape context of the study area, including Interim Biogeographic Regionalisation for Australia (IBRA) bioregions and subregions, Mitchell landscapes, catchment areas and land uses are described in Table 3.1.

Table 3.1 Landscape features

Landscape feature	Subject land
IBRA bioregion / subregion	Sydney Basin Bioregion / Hunter Subregion
NSW landscape regions (Mitchell landscapes)	Central Hunter Foothills (majority of study area) and Upper Hunter Channels and Floodplain (along Muscle Creek and Sandy Creek alluvial areas)
Local Government Area (LGA)	Muswellbrook Shire Council
Native vegetation extent in the buffer area	53% native vegetation cover within a 500m buffer of the construction footprint (linear infrastructure)
Rivers and streams	Sandy Creek to the north and Muscle Creek and its unnamed tributaries to the south of the study area
Important and local wetlands	No important wetlands occur within the study area
Connectivity features	Vegetation within the study area forms part of a fragmented landscape. Although fragmented, small to large patches of remnant woodland habitat and derived native grasslands occur within the study area which provide wildlife connectivity to other remnants in the locality. Key wildlife connectivity values occur: • Along and immediately north of Muscle Creek • Immediately south of Coal Road • Along the border of Muswellbrook Coal Company's mine lease and the AusGrid power station.
Areas of Geological Significance and Soil Hazard Features	The site does not contain any areas of geological significance
Areas of outstanding biodiversity value	No declared areas of outstanding biodiversity value occur in or near the site
Key Fish Habitat	Key Fish Habitat has been mapped along Sandy Creek and Muscle Creek and its unnamed tributaries within the study area (Department of Primary Industries, 2019)

3.2 Plant community types

Seven native PCTs and four non-native miscellaneous ecosystems were recorded within the study area. The seven native vegetation communities were assigned to 17 discrete vegetation zones based on broad vegetation class criteria outlined in Table 3.2.

A summary of the vegetation types recorded within the study area and construction footprint are outlined in Table 3.2 and illustrated in Figure 3.1. Detailed description and selection justification for each PCT and vegetation zone is provided below.

Table 3.2 Plant community types

Plant community type (PCT)	Condition class	Threatened ecological community (BC Act)?	Threatened ecological community (EPBC Act)?	Area (ha) study area	Area (ha) impacted
Native plant community types					
PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	Moderate	Yes – Central Hunter Grey Box-Ironbark Woodland (Endangered)	Yes – Central Hunter Valley eucalypt forest and woodland (Critically Endangered)	43.30	8.82
	Low (Remnant)		No	11.65	4.93
	Low (DNG)		No	98.52	38.39
PCT 1604 Narrow-leaved Ironbark – Grey Box - Spotted Gum shrub – grass woodland of the central and lower Hunter	Low (Remnant)	Yes – Central Hunter Ironbark – Spotted Gum -Grey Box Forest (Endangered)	No	0.81	0.67
PCT 1605 Narrow-leaved Ironbark – Native Olive shrubby open forest of the central and upper Hunter	Moderate	Yes – Central Hunter Grey Box – Ironbark Woodland (Endangered)	Yes – Central Hunter Valley eucalypt forest and woodland (Critically Endangered)	3.51	0.06

Plant community type (PCT)	Condition class	Threatened ecological community (BC Act)?	Threatened ecological community (EPBC Act)?	Area (ha) study area	Area (ha) impacted
PCT 1607 Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter	Good	Yes – White Box – Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Critically Endangered)	Yes – White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	2.16	0.56
	Low (Remnant)		No	0.11	0.09
	Low (DNG)		No	1.02	1.02
PCT 1693 Yellow Box – Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	Good	Yes – White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Critically Endangered)	Yes – White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	0.64	0.00
	Moderate			1.13	0.02
	Low (Remnant)		No	14.22	5.07
	Low (DNG)		No	52.77	31.19
PCT 42 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Low (Remnant)	Hunter Floodplain Red Gum Woodland (Endangered)	No	0.53	0.08
	Low (DNG)		No	12.72	3.38
PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)	Moderate	No	No	7.05	1.78
	Low (Remnant)	No	No	0.30	0.18
	Low (DNG)	No	No	3.20	1.68
Total extent of native vegetation				**253.64**	**97.92**

Plant community type (PCT)	Condition class	Threatened ecological community (BC Act)?	Threatened ecological community (EPBC Act)?	Area (ha) study area	Area (ha) impacted
Non-native miscellaneous ecosystems					
Highly disturbed areas with no or limited native vegetation	n/a	No	No	119.57	78.46
Urban/exotic plantings	n/a	No	No	1.42	0.48
Native plantings (including mine rehabilitation)	n/a	No	No	11.03	5.87
Cropping	n/a	No	No	16.58	5.36
Total extent of non-native vegetation				**148.60**	**90.17**
Total native and non-native vegetation				**402.24**	**188.09**

Legend

- Watercourse
- Construction footprint
- Study area
- Cadastre

Plant community types

- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (remnant) (Critically Endangered BC Act)

Miscellaneous ecosystems

- Highly disturbed areas with no or limited native vegetation
- Cropping
- Urban/exotic plantings

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Figure 3.1a
Plant Community Types

Legend

- Watercourse
- Construction footprint
- Study area
- Cadastre

Plant community types

- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (derived native grassland) (Endangered BC Act)
- PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion) - Low condition (remnant)
- PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion) - Low condition (derived native grassland)

Miscellaneous ecosystems

- Highly disturbed areas with no or limited native vegetation
- Cropping
- Urban/exotic plantings
- Native plantings (including mine rehabilitation)

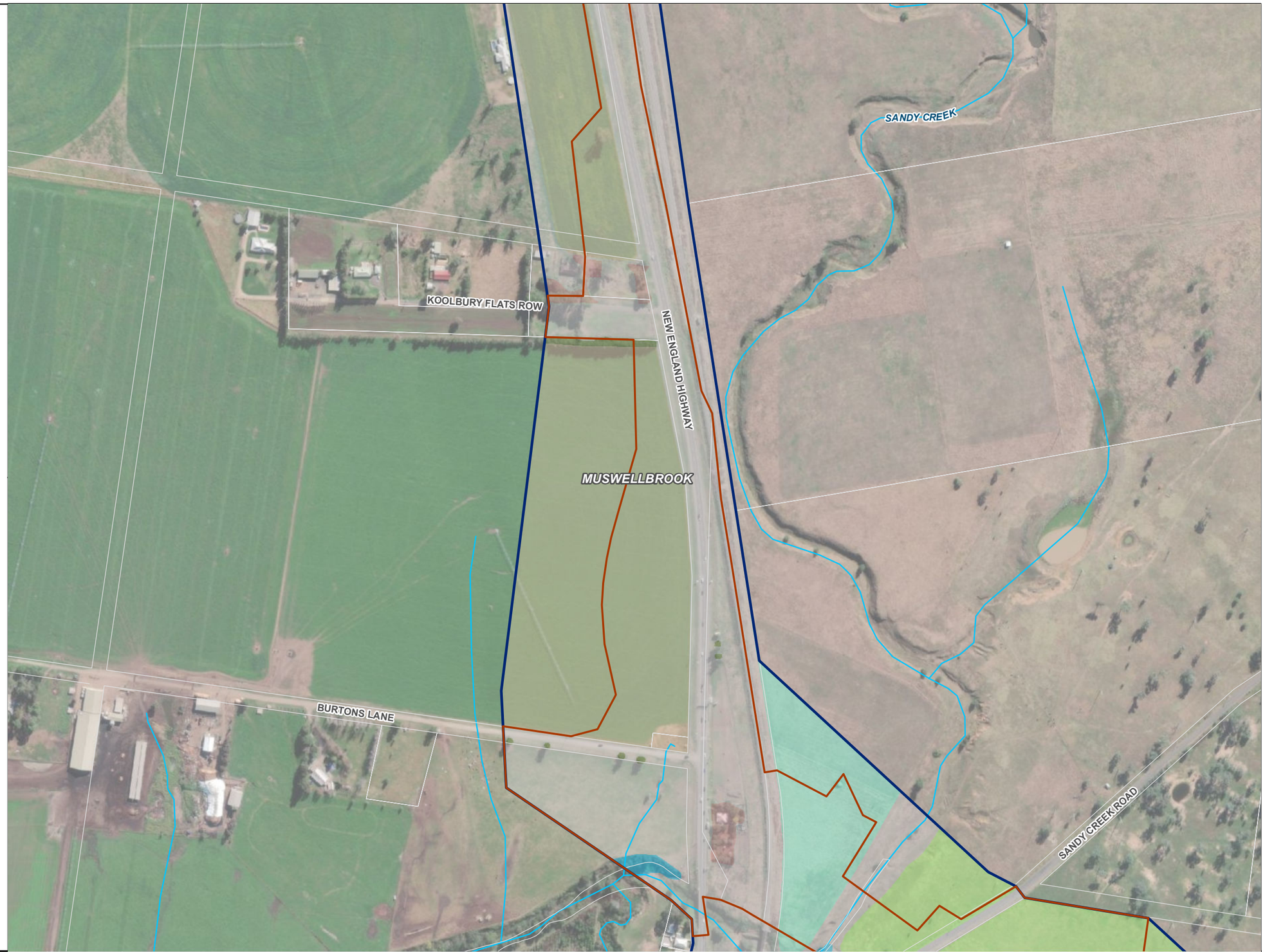

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Figure 3.1b
Plant Community Types

Legend

- Watercourse
- Construction footprint
- Study area
- Cadastre

Plant community types

- PCT 1604 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter - Low condition (remnant) (Endangered BC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Moderate condition (Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (remnant) (Endangered BC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (derived native grassland) (Endangered BC Act)
- PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion) - Low condition (remnant)
- PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion) - Low condition (derived native grassland)

Miscellaneous ecosystems

- Highly disturbed areas with no or limited native vegetation
- Native plantings (including mine rehabilitation)

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Figure 3.1c
Plant Community Types

Legend

- Watercourse
- Construction footprint
- Study area
- Cadastre

Plant community types

- PCT 1605 Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter - Moderate condition (Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1607 Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter - Good condition (Critically Endangered BC Act and EPBC Act)
- PCT 1607 Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter - Low condition (remnant) (Critically Endangered BC Act)
- PCT 1607 Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter - Low condition (derived native grassland) (Critically Endangered BC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Moderate condition (Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (remnant) (Endangered BC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (derived native grassland) (Endangered BC Act)

Miscellaneous ecosystems

- Highly disturbed areas with no or limited native vegetation
- Urban/exotic plantings
- Native plantings (including mine rehabilitation)

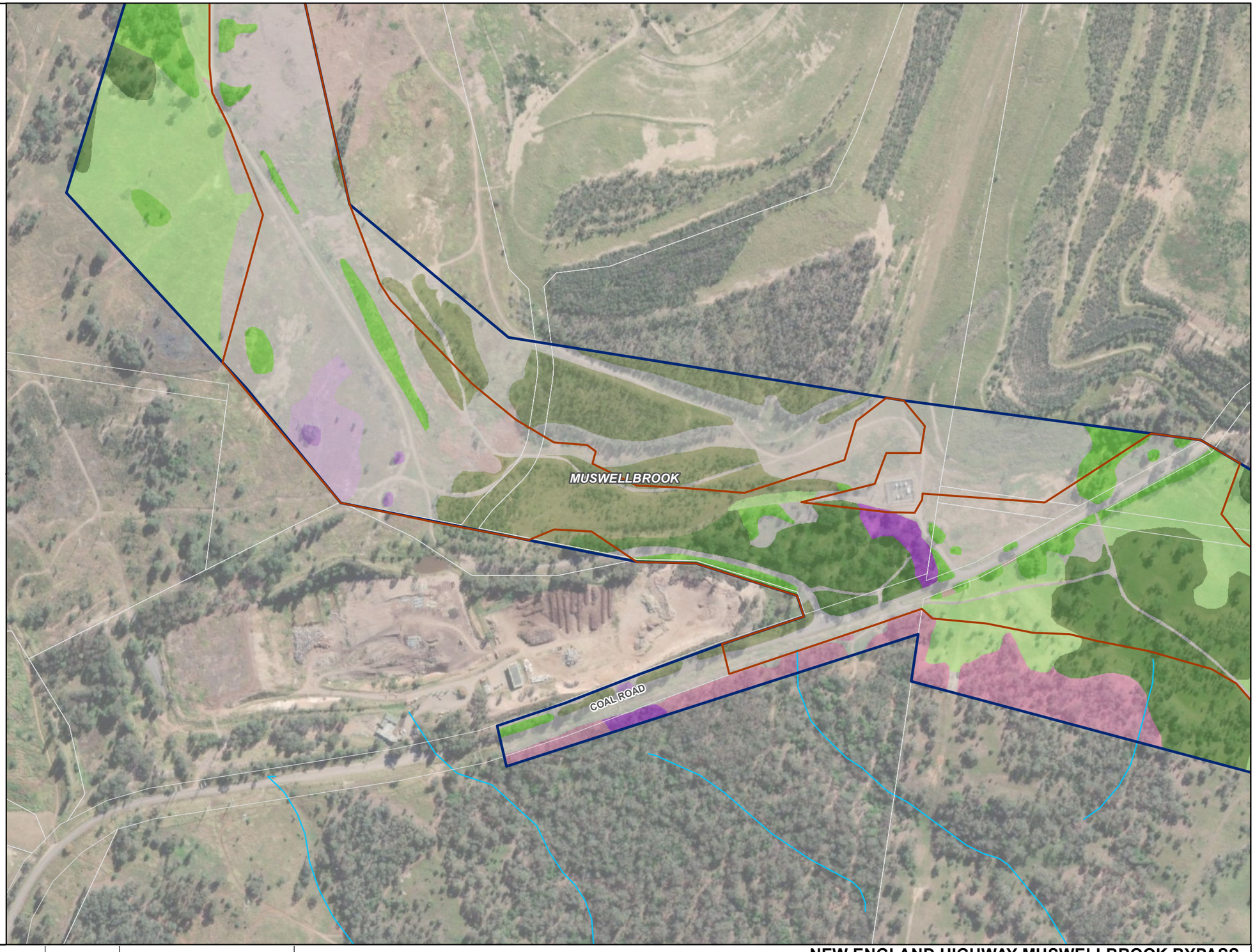

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Figure 3.1d
Plant Community Types

Legend

- Watercourse
- Construction footprint
- Study area
- Cadastre

Plant community types

- PCT 1605 Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter - Moderate condition (Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Moderate condition (Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (remnant) (Endangered BC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (derived native grassland) (Endangered BC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (remnant) (Critically Endangered BC Act)
- PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion) - Moderate condition

Miscellaneous ecosystems

- Highly disturbed areas with no or limited native vegetation
- Native plantings (including mine rehabilitation)

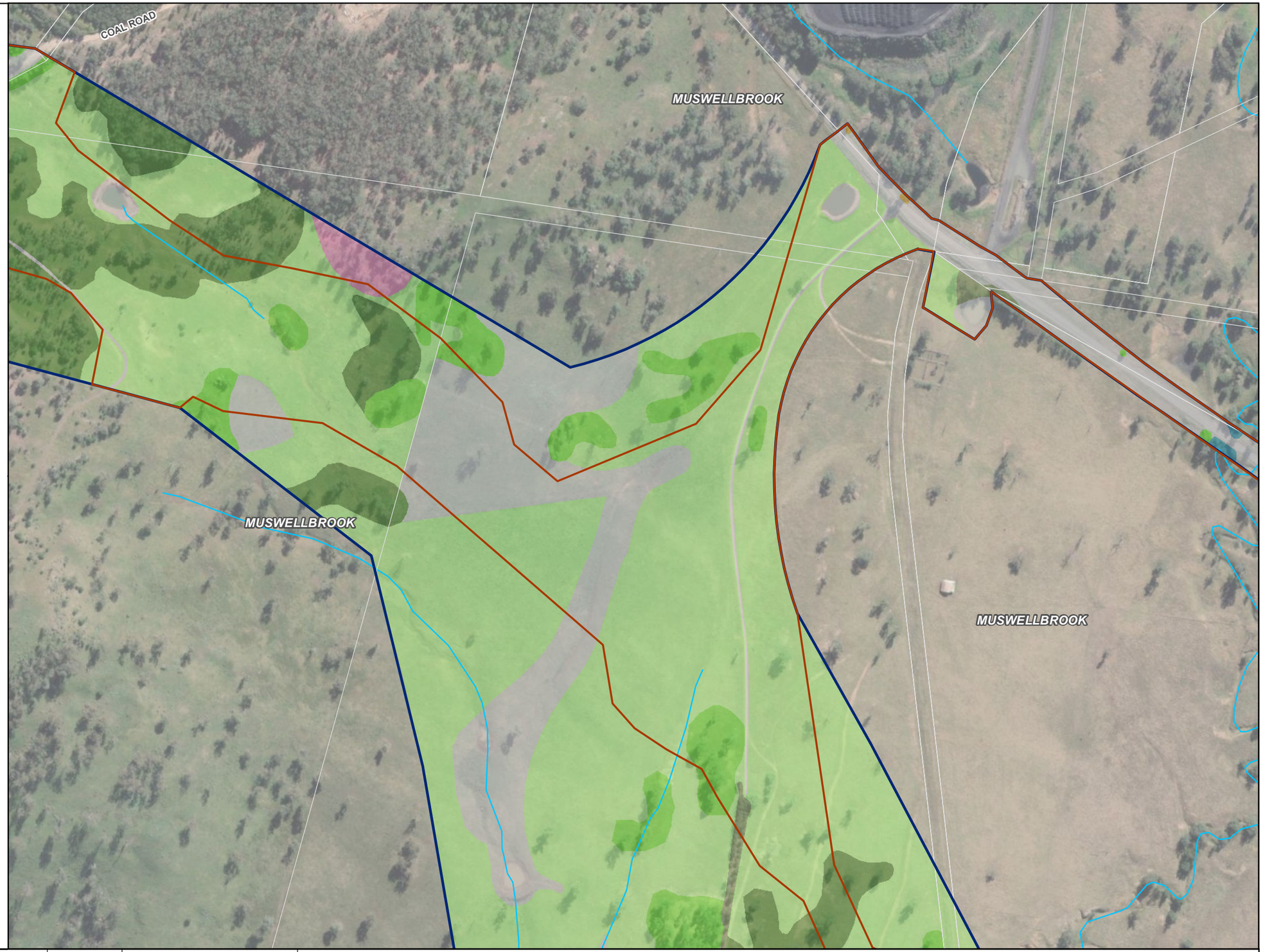

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Figure 3.1e
Plant Community Types

Legend

- Watercourse
- Construction footprint
- Study area
- Cadastre

Plant community types

- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Moderate condition (Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (remnant) (Endangered BC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (derived native grassland) (Endangered BC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (remnant) (Critically Endangered BC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (derived native grassland) (Critically Endangered BC Act)
- PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion) - Moderate condition

Miscellaneous ecosystems

- Highly disturbed areas with no or limited native vegetation
- Native plantings (including mine rehabilitation)

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Figure 3.1f
Plant Community Types

Legend

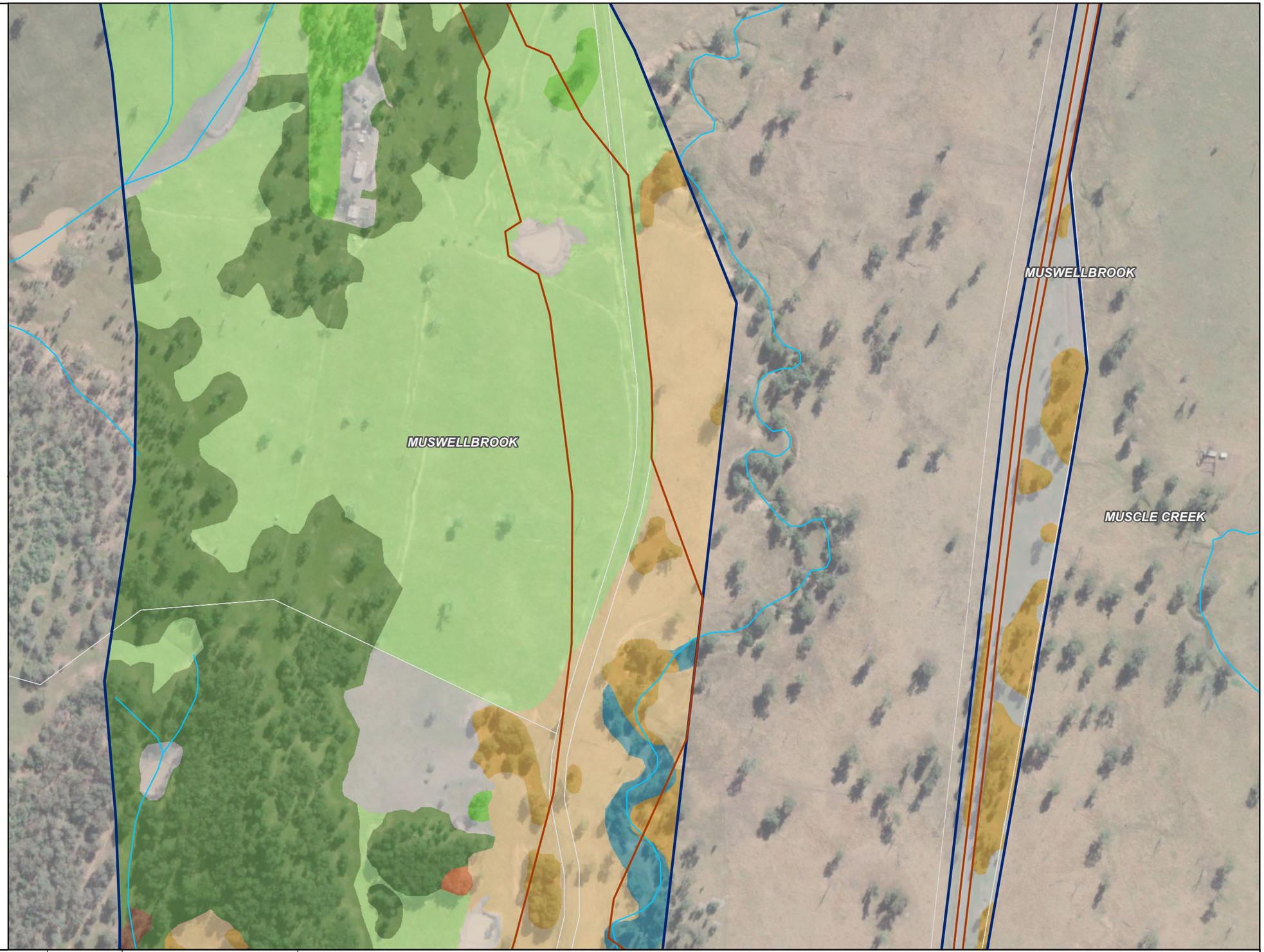
- Watercourse
- Construction footprint
- Study area
- Cadastre

Plant community types

- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Moderate condition (Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (remnant) (Endangered BC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (derived native grassland) (Endangered BC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Good (Critically Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Moderate (Critically Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (remnant) (Critically Endangered BC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (derived native grassland) (Critically Endangered BC Act)
- PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion) - Moderate condition

Miscellaneous ecosystems

- Highly disturbed areas with no or limited native vegetation
- Native plantings (including mine rehabilitation)



Map: PS114532_BDAR_003_A4	Author: Victor.Lau		
Date: 20/07/2021	Approved by: - T.Lambert		

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

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NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT

Figure 3.1g
Plant Community Types

Legend

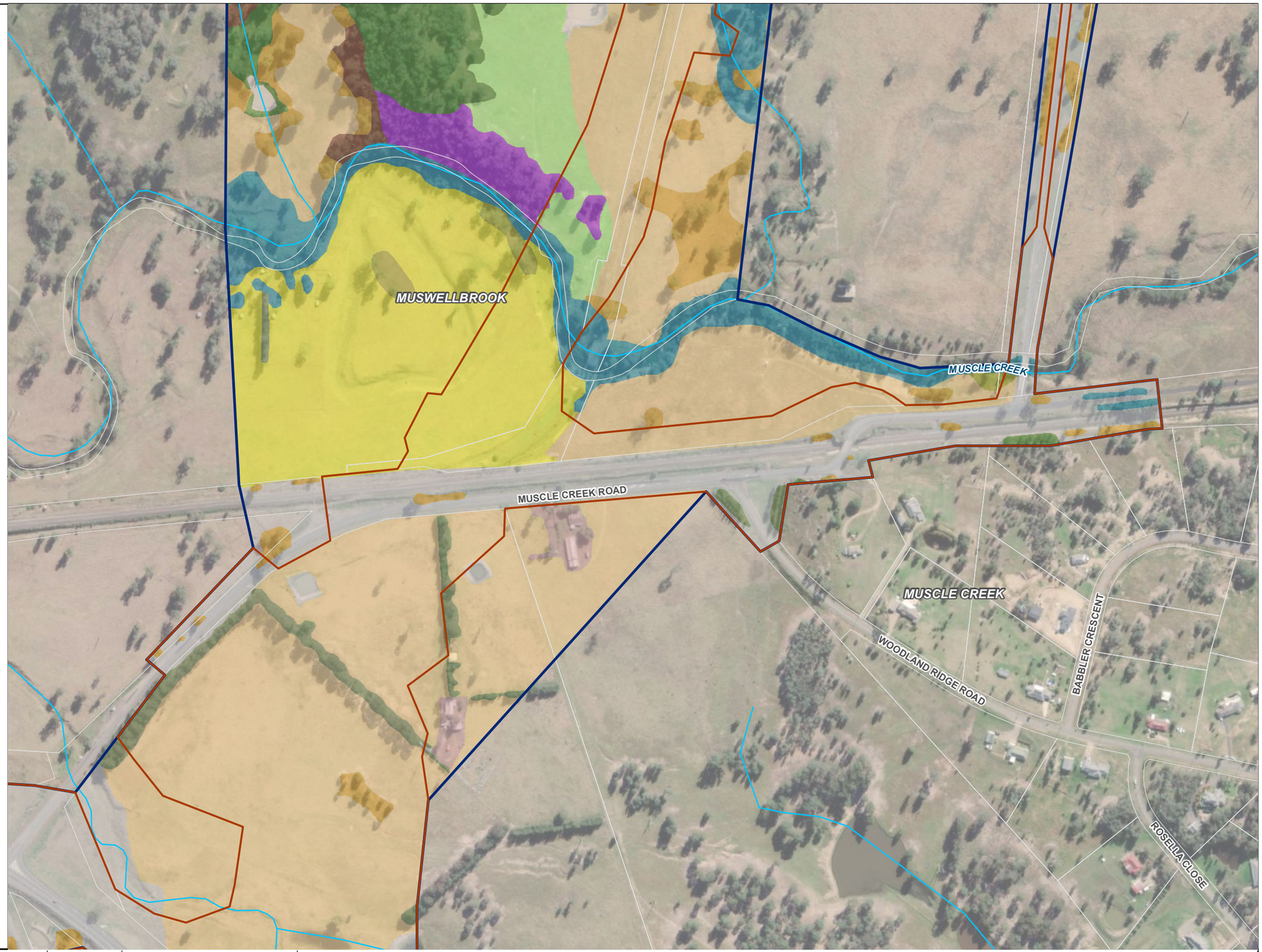
- Watercourse
- Construction footprint
- Study area
- Cadastre

Plant community types

- PCT 1607 Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter - Good condition (Critically Endangered BC Act and EPBC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Moderate condition (Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (derived native grassland) (Endangered BC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Good (Critically Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (remnant) (Critically Endangered BC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (derived native grassland) (Critically Endangered BC Act)
- PCT 42 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley - Low condition (remnant) (Endangered BC Act)
- PCT 42 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley - Low condition (derived native grassland) (Endangered BC Act)
- PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion) - Moderate condition

Miscellaneous ecosystems

- Highly disturbed areas with no or limited native vegetation
- Urban/exotic plantings
- Native plantings (including mine rehabilitation)



Map: PS114532_BDAR_003_A4	Author: Victor.Lau
Date: 20/07/2021	Approved by: - T.Lambert

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT

Figure 3.1h
Plant Community Types

Legend

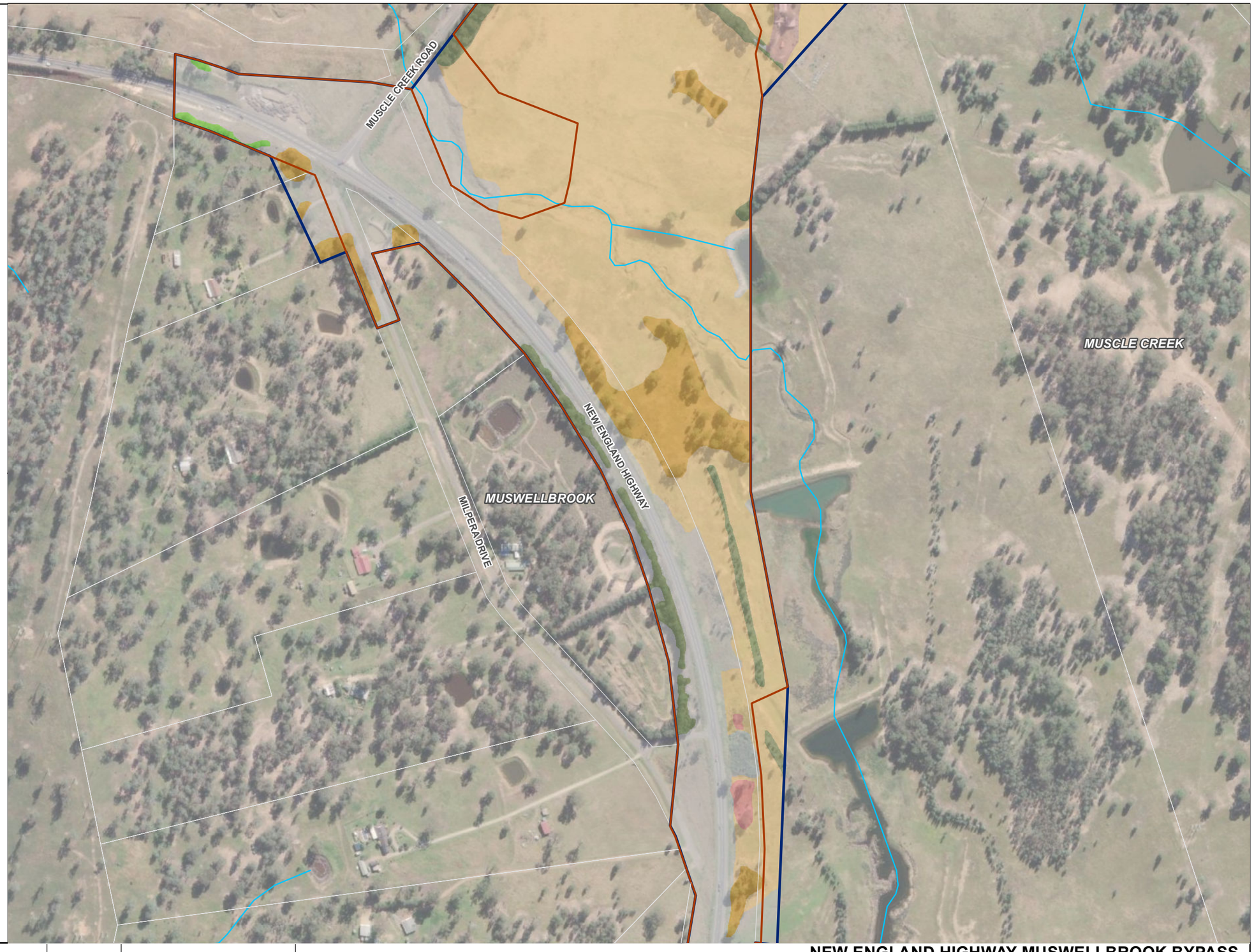
- Watercourse
- Construction footprint
- Study area
- Cadastre

Plant community types

- PCT 1604 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter - Low condition (remnant) (Endangered BC Act)
- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (remnant) (Endangered BC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (remnant) (Critically Endangered BC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (derived native grassland) (Critically Endangered BC Act)

Miscellaneous ecosystems

- Highly disturbed areas with no or limited native vegetation
- Urban/exotic plantings
- Native plantings (including mine rehabilitation)



Map: PS114532_BDAR_003_A4	Author: Victor.Lau
Date: 20/07/2021	Approved by: - T.Lambert

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NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT

Figure 3.1i
Plant Community Types

Legend

- Watercourse
- Construction footprint
- Study area
- Cadastre

Plant community types

- PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Low condition (remnant) (Endangered BC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Moderate (Critically Endangered BC Act and Critically Endangered EPBC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (remnant) (Critically Endangered BC Act)
- PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains - Low condition (derived native grassland) (Critically Endangered BC Act)

Miscellaneous ecosystems

- Highly disturbed areas with no or limited native vegetation

Map: PS114532_BDAR_003_A4	Author: Victor.Lau
Date: 20/07/2021	Approved by: - T.Lambert

Data source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Coordinate system: GDA 1994 MGA Zone 56

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NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT

Figure 3.1j
Plant Community Types

PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter

The occurrence of this vegetation type within the study area is illustrated in Figure 3.1 with photographic representation provided in Photo 3.1 to Photo 3.3. An overview of floristic and structural composition is presented in Table 3.3 and a general description provided below.

Vegetation formation: KF_CH3 Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

Other mapping sources:

- MU 156 Narrow-leaved Ironbark/Grey Box grassy woodland (Somerville, 2009)
- MU 10 Central Hunter Box – Ironbark Woodland (Peake, 2006).

Estimate of percent cleared: 77%

Conservation status: This vegetation type is consistent with the Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions threatened ecological community listed as Endangered under the BC Act. Moderate condition patches of PCT 1691 also meet the Central Hunter Valley eucalypt forest and woodland threatened ecological community listed as Critically Endangered under the EPBC Act.

Landscape position: Occurs on slopes, undulating hills and occasionally on small rocky knolls throughout the study area north of Muscle Creek on soils derived from Permian geology.

PCT justification: Occurs as an open woodland with a sparse mid-storey. Floristic composition and dominance is consistent with PCT 1691 i.e. canopy dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus moluccana* (Grey Box) and *Brachychiton populneus* subsp. *populneus* (Kurrajong). Furthermore, the ground stratum species consisted a combination of grasses, ferns and herbs which are diagnostic of PCT 1691.

Based on floristic, geographic and geological characteristics, this vegetation type is considered consistent with the scientific description and distribution information outlined for PCT 1691 within BioNet Vegetation Classification (Environment Energy and Science Group, 2020c).

Vegetation zones: Three distinct vegetation zones were assigned within this vegetation type based on broad condition state which included:

- **Moderate:** Over-storey cover is intact however the understorey and/or groundcover layers were structurally modified. The groundcover was generally dominated by native species (i.e. native perennial groundcover foliage cover >50%). Native species diversity was generally moderate to high
- **Low (Remnant):** Native over-storey largely remains however has been structurally modified in the past. The mid-storey and groundcover layers were generally absent or very sparse. The groundcover was dominated or co-dominated by exotic species (i.e. exotic perennial groundcover foliage cover generally >50%). Native species diversity was generally relatively low. This condition type also included some areas of regrowth vegetation
- **Low (DNG):** This condition class no longer contains over-storey or mid-storey components and instead occurs as a DNG of PCT 1691. Scattered isolated paddock trees occurred within this condition. Understorey is dominated by native grass, forb and fern species however is generally low in diversity. Exotic perennial cover was <50%.

Vegetation integrity survey plots: Q1, Q2, Q3, Q5, Q6, Q7, Q8, Q11, Q15, Q16, Q18, Q20, Q22, Q23, Q25, Q40, Q48 and Q49 - see Appendix B (Flora and fauna species recorded) for full floristic and structural data.

Photo 3.1 PCT 1691 Low (Remnant)

Photo 3.2 PCT 1691 Low (DNG)

Photo 3.3 PCT 1691 Moderate

Table 3.3 PCT 1691 overview of floristic and structural composition

Structure	Average height and height range (m)	Average cover (%)	Typical species
Trees	18–25	20–35	*Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus moluccana* (Grey Box) and *Brachychiton populneus* subsp. *populneus* (Kurrajong). *Angophora floribunda* (Rough-barked Apple) was also dominant in small areas at some locations.
Small trees	3–6	5–20	*Geijera parviflora* (Wilga), *Notelaea microcarpa* var. *microcarpa* (Native Olive), *Psydrax odorata* (Shiny-leaved Canthium), *Acacia implexa* (Hickory Wattle) and rarely *Allocasuarina luehmannii* (Buloke).
Shrubs	0.5–3	5–30	*Bursaria spinosa* subsp. *spinosa* (Native Blackthorn), *Acacia decora* (Western Silver Wattle), *Acacia paradoxa* (Kangaroo Thorn), *Breynia oblongifolia* (Coffee Bush), *Dodonaea viscosa* (Sticky Hop-bush), *Acacia falcata* (Hickory Wattle), *Maireana microphylla* (Small-leaf Bluebush) and *Swainsona galegifolia* (Smooth Darling-pea)
Ground covers	0.5–1.5	40–60	*Aristida ramosa* (Purple Wire Grass), *Bothriochloa macra* (Red Grass), *Cymbopogon refractus* (Barbed Wire Grass), *Sporobolus creber* (Slender Rats-tail Grass), *Dichondra repens* (Kidney Weed), *Cheilanthes* species, *Austrostipa scabra* (Speargrass), *Sida corrugata* (Corrugated Sida), *Lomandra multiflora* subsp. *multiflora* (Many-flowered Mat-rush), *Dichopogon fimbriatus* (Nodding Chocolate Lily), *Chrysocephalum apiculatum* (Common Everlasting), *Calotis lappulacea* (Yellow Burr-daisy), *Brunoniella australia* (Blue Trumpet) and *Eremophila debilis* (Winter Apple)

PCT 1604 Narrow-leaved Ironbark – Grey box – Spotted Gum shrub – grass woodland of the central and lower Hunter

The occurrence of this vegetation type within the development site is illustrated in Figure 3.1 with photographic representation provided in Photo 3.4. An overview of floristic and structural composition is presented in Table 3.4 and a general description provided below.

Vegetation formation: KF_CH3 Grassy Woodlands

Vegetation class: Coastal Valley Grassy Woodlands

Other mapping sources:

- MU 75 Narrow-leaved Ironbark/Grey Box/Spotted Gum shrub/ grass open forest (Somerville, 2009)
- MU 27 Central Hunter Ironbark – Spotted Gum – Grey Box Forest (Peake, 2006).

Estimate of percent cleared: 71%

Conservation status: This vegetation type is consistent with the Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions threatened ecological community listed as Endangered under the BC Act. No patches of PCT 1604 recorded within the study area meet the Central Hunter Valley eucalypt forest and woodland threatened ecological community listed as Critically Endangered under the EPBC Act.

Landscape position: Occurred on an undulating hill on soils derived from Permian geology.

PCT Justification: Occurred as an open forest dominated by *Corymbia maculata* (Spotted Gum) and *Eucalyptus moluccana* (Grey Box) with *Eucalyptus crebra* (Narrow-leaved Ironbark). Midstorey component was absent however the ground stratum species consisted of a combination of grasses, ferns and herbs which are diagnostic of PCT 1604 including *Eremophila debilis* (Winter Apple), *Cymbopogon refractus* (Barbed Wire Grass), *Cheilanthes sieberi* subsp. *sieberi* (Poison Rock Fern) and *Glycine tabacina*.

Based on floristic, geographic and geological characteristics, this vegetation type is considered consistent with the scientific description and distribution information outlined for PCT 1604 within BioNet Vegetation Classification (Environment Energy and Science Group, 2020c).

Vegetation zones: One distinct vegetation zone was assigned within this vegetation type based on broad condition state which included:

- **Low (Remnant):** Native over-storey largely remains however has been structurally modified in the past. The mid-storey and groundcover layers were generally absent or very sparse. The groundcover of this condition was dominated by exotic species (i.e. exotic perennial groundcover foliage cover >50%). Native species diversity was generally relatively low.

Vegetation integrity survey plots: Q24 – see Appendix B (Flora and fauna species recorded) for full floristic and structural data.

Photo 3.4 PCT 1604 Low (Remnant)

Table 3.4 PCT 1604 overview of floristic and structural composition

Structure	Average height and height range (m)	Average cover (%)	Typical species
Trees	16–25	20–40	*Corymbia maculata* (Spotted Gum), *Eucalyptus moluccana* (Grey Box) and *Eucalyptus crebra* (Narrow-leaved Ironbark)
Small trees	–	–	Absent
Shrubs	–	–	Absent
Ground covers	0.1–1.5	30–50	*Enchylaena tomentosa* (Ruby Saltbush), *Sida hackettiana* (Golden Rod), *Eremophila debilis* (Winter Apple), *Austrostipa verticillata* (Slender Bamboo Grass)), *Aristida ramosa* (Purple Wire Grass), *Bothriochloa macra* (Red Grass), *Cymbopogon refrac*tus (Barbed Wire Grass), *Cheilanthes sieberi* subsp. *sieberi* (Poison Rock Fern) and *Glycine tabacina* Understorey of this community was largely dominated by *Galenia pubescens* var. *pubescens** (Galenia) which is an exotic perennial herb

PCT 1605 Narrow-leaved Ironbark Native Olive shrubby open forest of the central and upper Hunter

The occurrence of this vegetation type within the development site is illustrated in Figure 3.1 with photographic representation provided in Photo 3.5. An overview of floristic and structural composition is presented in Table 3.5 and a general description provided below.

Vegetation formation: KF_CH5A Dry Sclerophyll Forests (Shrub/grass sub-formation)

Vegetation class: North-west Slopes Dry Sclerophyll Woodlands

Other mapping sources:

- MU 76 Narrow-leaved Ironbark/Native Olive shrubby open forest (Somerville, 2009)
- MU 10 Central Hunter Box – Ironbark Woodland (Peake, 2006).

Estimate of percent cleared: 32%

Conservation status: This vegetation type is consistent with the Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions threatened ecological community listed as Endangered under the BC Act. Moderate condition patches of PCT 1605 also meet the Central Hunter Valley eucalypt forest and woodland threatened ecological community which is listed as Critically Endangered under the EPBC Act.

Landscape position: Occurs on soil derived from Permian geology on slopes and undulating foothills.

PCT Justification: Formed an open forest with a canopy dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark) and a small tree layer dominated by *Notelaea microcarpa* var. *microcarpa* (Native Olive). Ground stratum species consisted a combination of grasses, ferns and herbs which are diagnostic of PCT 1605.

Based on floristic, geographic and geological characteristics, this vegetation type is considered consistent with the scientific description and distribution information outlined for PCT 1605 within BioNet Vegetation Classification (Environment Energy and Science Group, 2020c).

Vegetation zones: One distinct vegetation zone was assigned within this vegetation type based on broad condition state which included:

- **Moderate:** Over-storey cover is intact however the understorey and/or groundcover layers were structurally modified. The groundcover was generally dominated by native species (i.e. native perennial groundcover foliage cover >50%). Native species diversity was generally moderate to high.

Vegetation integrity survey plots: Q45 and Q46 – see Appendix B (Flora and fauna species recorded) for full floristic and structural data.

Photo 3.5 PCT 1605 Moderate

Table 3.5 PCT 1605 overview of floristic and structural composition

Structure	Average height and height range (m)	Average cover (%)	Typical species
Trees	16–24	20–40	*Eucalyptus crebra* (Narrow-leaved Ironbark) and occasional small patch of *Angophora floribunda* (Rough-barked Apple) and *Brachychiton populneus* subsp. *populneus* (Kurrajong) individual
Small trees	4–8	10–30	*Notelaea microcarpa* var. *microcarpa* (Native Olive)
Shrubs	1–3	0–5	*Acacia paradoxa* (Kangaroo Thorn), *Bursaria spinosa* subsp. *spinosa* (Native Blackthorn) and *Exocarpos cupressiformis* (Cherry Ballart)
Ground covers	0.1–1.2	35–60	*Austrostipa scabra* (Speargrass), *Cymbopogon refractus* (Barbed Wire Grass), *Aristida ramosa* (Purple Wire Grass), Lomandra species, *Plantago debilis*, *Cyperus gracilis* (Slender Flat-sedge), *Cheilanthes distans* (Bristly Cloak Fern), *Cheilanthes sieberi* subsp. *sieberi* (Poison Rock Fern), *Einadia hastata* (Berry Saltbus), *Eragrostis megalosperma*, *Dichondra* sp. Inglewood (Kidney Weed), *Calotis lappulacea* (Yellow Burr-daisy) and Wahlenbergia species

PCT 1607 Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter

The occurrence of this vegetation type within the development site is illustrated in Figure 3.1 with photographic representation provided in Photo 3.6 to Photo 3.8. An overview of floristic and structural composition is presented in Table 3.6 and a general description provided below.

Vegetation formation: KF_CH5A Dry Sclerophyll Forests (Shrub/grass sub-formation)

Vegetation class: North-west Slopes Dry Sclerophyll Woodlands

Other mapping sources:

- MU 78 Blakely's Red Gum/Narrow-leaved Ironbark shrubby woodland (Somerville, 2009).

Estimate of percent cleared: 51%

Conservation status: This vegetation type is consistent with the White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland threatened ecological community listed as Critically Endangered under the BC Act. Good condition patches of PCT 1607 also meet the Critically Endangered listing for this threatened ecological community under the EPBC Act.

Landscape position: Occurs on flats and lower to mid-slopes generally on soils derived of sandstone geology.

PCT Justification: Open forest with a mixed Eucalypt canopy with a sparse mid-storey. This community formed a transitional community between PCT 1691 and PCT 1693 within the study area sharing similar characteristics and positioned generally between the two communities.

Floristic composition and dominance is consistent with PCT 1607 i.e. canopy co-dominated by *Eucalyptus blakelyi* (Blakely's Red Gum), *Angophora floribunda* (Rough-barked Apple) and *Eucalyptus crebra* (Narrow-leaved Ironbark). *Eucalyptus blakelyi* was dominant to co-dominate throughout the community. Furthermore, the ground stratum species consisted a combination of grasses, ferns and herbs which are diagnostic of PCT 1607.

Based on floristic, geographic and geological characteristics, this vegetation type is considered consistent with the scientific description and distribution information outlined for PCT 1607 within BioNet Vegetation Classification (Environment Energy and Science Group, 2020c).

Vegetation zones: Three distinct vegetation zones were assigned within this vegetation type based on broad condition state which included:

- **Good:** Vegetation was structurally intact, weed cover was generally low and characteristic species of the community were recorded
- **Low (Remnant):** Native over-storey largely remains however has been structurally modified in the past. The mid-storey and groundcover layers were generally absent or very sparse. The groundcover was dominated or co-dominated by exotic species (i.e. exotic perennial groundcover foliage cover >50%). Native species diversity was generally relatively low
- **Low (DNG):** This condition class no longer contains over-storey or mid-storey components and instead occurs as a DNG of PCT 1607. Scattered isolated paddock trees occurred within this condition. Understorey is dominated by native grass, forb and fern species however generally in low diversity. Exotic cover was <50%.

Vegetation integrity survey plots: Q4, Q17, Q43 and Q47 – see Appendix B (Flora and fauna species recorded) for full floristic and structural data.

Photo 3.6 PCT 1607 Low (Remnant)

Photo 3.7 PCT 1607 Low (DNG)

Photo 3.8 PCT 1607 Good

Table 3.6 PCT 1607 overview of floristic and structural composition

Structure	Average height and height range (m)	Average cover (%)	Typical species
Trees	18–25	30–50	*Eucalyptus blakelyi* (Blakely's Red Gum), *Angophora floribunda* (Rough-barked Apple), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Brachychiton populneus* subsp. *populneus* (Kurrajong)
Small trees	4–8	5–20	*Notelaea microcarpa* var. *microcarpa* (Native Olive) and *Acacia implexa* (Hickory Wattle)
Shrubs	1–3	0–15	*Bursaria spinosa* subsp. *spinosa* (Native Blackthorn), *Acacia decora* (Western Silver Wattle), *Acacia paradoxa* (Kangaroo Thorn), *Breynia oblongifolia* (Coffee Bush)
Ground covers	0.1–1.5	40–60	*Microlaena stipoides* var. *stipoides* (Weeping Grass), *Cyperus gracilis* (Slender Flat-sedge), *Dichondra repens* (Kidney Weed), *Calotis lappulacea* (Yellow Burr-daisy), *Aristida ramosa* (Purple Wiregrass) and *Chloris ventricosa* (Plump Windmill Grass)

PCT 1693 Yellow Box – Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains

The occurrence of this vegetation type within the development site is illustrated in Figure 3.1 with photographic representation provided in Photo 3.9 to Photo 3.12. An overview of floristic and structural composition is presented in Table 3.7 and a general description provided below.

Vegetation formation: KF_CH3 Grassy Woodlands

Vegetation class: Western Slopes Grassy Woodlands

Other mapping sources:

- MU 158 Yellow Box/Rough-barked Apple grassy woodland (Somerville, 2009)
- MU 13 Hunter Floodplain Red Gum Woodland Complex (Peake, 2006).

Estimate of percent cleared: 64%

Conservation status: This vegetation type is consistent with the White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland threatened ecological community listed as Critically Endangered under the BC Act. Good and moderate condition patches of PCT 1693 also meet the Critically Endangered listing for this threatened ecological community under the EPBC Act.

Landscape position: Occurs on the floodplain and lower slopes which border the Muscle Creek floodplain within the study area.

PCT Justification: Generally occurred as an open grassy woodland. This vegetation type was comprised of a mixed Eucalypt canopy of *Eucalyptus melliodora* (Yellow Box), *Angophora floribunda* (Rough-barked Apple), *Eucalyptus blakelyi* (Blakely's Red Gum) and *Eucalyptus tereticornis* (Forest Red Gum). Hybrids of *Eucalyptus blakelyi* (Blakely's Red Gum) and *Eucalyptus tereticornis* (Forest Red Gum) were also observed throughout this community.

The mixed Eucalypt canopy and landscape position of this vegetation type correlates to the 'mixed variant' of MU 13 Hunter Floodplain Red Gum Woodland Complex as described by (Peake, 2006). Although MU 13 (Peake, 2006) aligns to PCT 42 which subsequently corresponds to the Hunter Floodplain Red Gum Woodland threatened ecological community this vegetation type was assigned to PCT 1693. Assignment of vegetation to PCT 1693 was done given the dominance and/or co-dominance of *Eucalyptus melliodora, Eucalyptus blakelyi* and red gum species (*Eucalyptus blakelyi, Eucalyptus tereticornis* and hybrids of the two) making this vegetation type more consistent with the White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland threatened ecological community rather than the Hunter Floodplain Red Gum Woodland threatened ecological community.

Based on floristic, geographic and geological characteristics, this vegetation type is considered consistent with the scientific description and distribution information outlined for PCT 1693 within BioNet Vegetation Classification (Environment Energy and Science Group, 2020c).

Vegetation zones: Four distinct vegetation zones were assigned within this vegetation type based on broad condition state which included:

- **Good:** Vegetation was structurally intact, weed cover was generally low and characteristic species of the community were recorded
- **Moderate:** Over-storey cover is intact however the understorey and/or groundcover layers were structurally modified. The groundcover was generally dominated by native species (i.e. native perennial groundcover foliage cover >50%). Native species diversity was generally moderate to high
- **Low (Remnant):** Native over-storey largely remains however has been structurally modified in the past. The mid-storey and groundcover layers were generally absent or very sparse. The groundcover was dominated or co-dominated by exotic species (i.e. exotic perennial groundcover foliage cover >50%). Native species diversity was generally relatively low

- **Low (DNG):** This condition class no longer contains over-storey or mid-storey components and instead occurs as a DNG of PCT 1693. Scattered isolated paddock trees occurred within this condition. Understorey is dominated by native grass, forb and fern species however generally in low diversity. Exotic cover was <50%.

Vegetation integrity survey plots: Q12, Q13, Q14, Q19, Q26, Q27, Q29, Q35, Q36, Q37, Q38, Q40, Q42, Q50 and Q51 – see Appendix B (Flora and fauna species recorded) for full floristic and structural data.

Photo 3.9 PCT 1693 Good

Photo 3.10 PCT 1693 Moderate

Photo 3.11 PCT 1693 Low (Remnant)

Photo 3.12 PCT 1693 Low (DNG)

Table 3.7 PCT 1693 overview of floristic and structural composition

Structure	Average height and height range (m)	Average cover (%)	Typical species
Trees	20–40	35–50	*Eucalyptus melliodora* (Yellow Box), *Angophora floribunda* (Rough-barked Apple), *Eucalyptus blakelyi* (Blakely's Red Gum), *Eucalyptus tereticornis* (Forest Red Gum) and *Brachychiton populneus* subsp. *populneus* (Kurrajong)
Small trees	4–8	0–15	*Notelaea microcarpa* var. *microcarpa* (Native Olive)
Shrubs	1–3	0–5	*Bursaria spinosa* subsp. *spinosa* (Blackthorn) and *Solanum cinereum* (Narrawa Burr)
Ground covers	0.1–1.2	30–50	*Aristida ramosa* (Purple Wiregrass), *Chrysocephalum apiculatum* (Common Everlasting), *Chloris ventricosa* (Plump Windmill Grass), *Dichondra repens* (Kidney Weed), *Brunoniella australis* (Blue Trumpet), *Cymbopogon refractus* (Barbed Wire Grass), *Swainsona galegifolia* (Smooth Darling-pea), *Eragrostis leptostachya* (Paddock Lovegrass) and *Asperula conferta* (Common Woodruff)

PCT 42 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley

The occurrence of this vegetation type within the development site is illustrated in Figure 3.1 with photographic representation provided in Photo 3.13 to Photo 3.14. An overview of floristic and structural composition is presented in Table 3.8 and a general description provided below.

Vegetation formation: KF_CH9 Forested Wetlands

Vegetation class: Eastern Riverine Forests

Other mapping sources:

- MU 196 River Red Gum/River Oak riparian woodland of the Hunter Valley (Somerville, 2009)
- MU 13 Hunter Floodplain Red Gum Woodland Complex (Peake, 2006).

Estimate of percent cleared: 95%

Conservation status: This vegetation type is consistent with the Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions threatened ecological community listed as Endangered under the BC Act. This vegetation type does not align with any threatened ecological community listed under the EPBC Act.

This community also contained a small population of *Eucalyptus camaldulensis* (River Red Gum) which is an Endangered Population in the Hunter catchment. See section 3.8 (Threatened flora species) for more details.

Landscape position: Occurred on the floodplain and floodplain rises of Muscle Creek on alluvial clay and/or sandy soils.

PCT Justification: Floristic composition and dominance is consistent with PCT 42 i.e. canopy contained *Eucalyptus camaldulensis* (River Red Gum) and understorey was dominated by *Cynodon dactylon* (Couch) with *Solanum cinereum* (Narrawa Burr), *Rumex brownii* (Swamp Dock), *Urtica incisa* (Stinging Nettle), *Austrostipa verticillata* (Slender Bamboo Grass) and *Sporobolus creber* (Slender Rat's Tail Grass).

While *Eucalyptus tereticornis* (Forest Red Gum) was the dominant canopy species this is not unusual within the Central Hunter. As specified by Peake (2006), at marginal sites *Eucalyptus camaldulensis* can be taken over by *Eucalyptus tereticornis* in upstream locations. This relates to vegetation within the study area as it occurs in the upper reaches of Muscle Creek which is a tributary of the Hunter River.

At the periphery of PCT 42 patches mapped within the study area, *Eucalyptus melliodora* (Yellow Box) began to be co-dominant and form a sparse open woodland. Although, this vegetation is consistent with the description of MU 13 Hunter Floodplain Red Gum Woodland Complex as described by Peake (2006) the co-dominance and/or dominance of *Eucalyptus melliodora, Eucalyptus blakelyi* (Blakely's Red Gum) and hybrids of *Eucalyptus tereticornis* (Forest Red Gum) and *Eucalyptus blakelyi* was used to divide the Hunter Floodplain Complex into two PCTs; being PCT 42 and PCT 1693.

Areas which were considered likely to align to the White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland threatened ecological community listed as Critically Endangered under the BC Act and EPBC Act where assigned to PCT 1693. Alternatively, remaining patches where *Eucalyptus tereticornis* dominated or occurred in proximity to *Eucalyptus camaldulensis* were assigned to PCT 42.

Based on floristic, geographic and geological characteristics, this vegetation type is considered consistent with the scientific description and distribution information outlined for PCT 42 within BioNet Vegetation Classification (Environment Energy and Science Group, 2020c).

Vegetation zones: Two distinct vegetation zones were assigned within this vegetation type based on broad condition state which included:

- **Low (Remnant):** Native over-storey largely remains however has been structurally modified in the past. The mid-storey and groundcover layers were generally absent or very sparse. The groundcover was dominated or co-dominated by exotic species (i.e. exotic perennial groundcover foliage cover >50%). Native species diversity was generally relatively low
- **Low (DNG):** This condition class no longer contains over-storey or mid-storey components and instead occurs as a DNG of PCT 42. Scattered isolated paddock trees occurred within this condition. Understorey is dominated by native grass, forb and fern species however generally in low diversity. Exotic cover was <50%.

Vegetation integrity survey plots: Q10, Q32, Q41 and Q52 – see Appendix B (Flora and fauna species recorded) for full floristic and structural data.

Photo 3.13 PCT 42 Low (Remnant)

Photo 3.14 PCT 42 Low (DNG)

Table 3.8 PCT 42 overview of floristic and structural composition

Structure	Average height and height range (m)	Average cover (%)	Typical species
Trees	25–30	10–20	*Eucalyptus tereticornis* (Forest Red Gum) and *Eucalyptus camaldulensis* (River Red Gum)
Small trees	–	–	Absent
Shrubs	–	–	Absent
Ground covers	0.1–1	80–100	*Cynodon dactylon* (Couch), *Chloris truncata* (Windmill Grass), *Aristida ramosa* (Purple Wiregrass), *Solanum cinereum* (Narrawa Burr), *Rumex brownii* (Swamp Dock), *Urtica incisa* (Stinging Nettle), *Austrostipa verticillata* (Slender Bamboo Grass), *Sporobolus creber* (Slender Rat's Tail Grass) and *Erodium crinitum* (Blue Storksbill). Given disturbance the understorey of this community also contains a high number of exotic pasture species such as *Lolium perenne** (Perennial Ryegrass), *Echium plantagineum** (Paterson's Curse), *Senecio madagascariensis** (Fireweed), *Galenia pubescens** (Galenia) and *Malva parviflora** (Small-flowered Mallow).

PCT 485 River Oak riparian grassy tall woodland of the western Hunter valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)

The occurrence of this vegetation type within the development site is illustrated in Figure 3.1 with photographic representation provided in Photo 3.15 to Photo 3.18. An overview of floristic and structural composition is presented in Table 3.9 and a general description provided below.

Vegetation formation: KF_CH9 Forested Wetlands

Vegetation class: Eastern Riverine Forests

Other mapping sources:

- MU 195 River Oak riparian forest of the western Hunter (Somerville, 2009)
- MU 30 Hunter Valley River Oak Forest (Peake, 2006).

Estimate of percent cleared: 50%

Conservation status: This vegetation type does not align with any threatened ecological community listed under the BC Act or the EPBC Act.

Landscape position: Occurred along low lying riparian corridors associated with Muscle Creek to the south and Sandy Creek to the north of the study area.

PCT Justification: Vegetation occurred as a grassy riparian forest. Floristic composition and dominance is characteristic of PCT 485 i.e. canopy contained a canopy dominated by *Casuarina cunninghamiana* subsp. *cunninghamiana* (River Oak) with an understorey dominated by *Microlaena stipoides* var. *stipoides* (Weeping Grass), *Cynodon dactylon* (Couch), *Aristida ramosa* (Purple Wiregrass), *Austrostipa verticillata* (Slender Bamboo Grass), *Sporobolus creber* (Slender Rat's Tail Grass), *Rumex brownii* (Swamp Dock) and *Bothriochloa macra* (Red Grass).

Based on floristic, geographic and geological characteristics, this vegetation type is considered consistent with the scientific description and distribution information outlined for PCT 485 within BioNet Vegetation Classification (Environment Energy and Science Group, 2020c).

Vegetation zones: Three distinct vegetation zones were assigned within this vegetation type based on broad condition state which included:

- **Moderate:** Over-storey cover is intact however the understorey and/or groundcover layers were structurally modified. The groundcover was generally dominated by native species (i.e. native perennial groundcover foliage cover >50%). Native species diversity was generally moderate to high
- **Low (Remnant):** Native over-storey largely remains however has been structurally modified in the past. The mid-storey and groundcover layers were generally absent or very sparse. The groundcover was generally dominated or co-dominated by exotic species (i.e. exotic perennial groundcover foliage cover >50%). Native species diversity is generally relatively low
- **Low (DNG):** This condition class no longer contains over-storey or mid-storey components and instead occurs as a DNG of PCT 485. Scattered isolated paddock trees occurred within this condition. Understorey is dominated by native grass, forb and fern species cover however generally in low diversity, exotic cover was <50%.

Vegetation integrity survey plots: Q9, Q21, Q28, Q30, Q31 and Q44 – see Appendix B (Flora and fauna species recorded) for full floristic and structural data.

Photo 3.15 PCT 485 Moderate

Photo 3.16 PCT 485 Moderate

Photo 3.17 PCT 485 Low (Remnant)

Photo 3.18 PCT 485 Low (DNG)

Table 3.9 PCT 485 overview of floristic and structural composition

Structure	Average height and height range (m)	Average cover (%)	Typical species
Trees	15–25	35–55	*Angophora floribunda* (Rough-barked Apple) and *Casuarina cunninghamiana* subsp. *cunninghamiana* (River Oak)
Small trees	–	–	Absent
Shrubs	0.5–2	0–5	Largely absent except for the occasional *Bursaria spinosa* subsp. *spinosa* (Blackthorn) and *Solanum cinereum* (Narrawa Burr)
Ground covers	0.1–1.5	40–60	*Microlaena stipoides* var. *stipoides* (Weeping Grass), *Cynodon dactylon* (Couch), *Aristida ramosa* (Purple Wiregrass), *Austrostipa verticillata* (Slender Bamboo Grass), *Sporobolus creber* (Slender Rat's Tail Grass), *Rumex brownii* (Swamp Dock) and *Bothriochloa macra* (Red Grass)

Miscellaneous ecosystem – highly disturbed areas with no or limited native vegetation

This vegetation type does not align to any recognised plant community type in NSW due to its limited native vegetation and degraded condition. As such, it has been aligned to Highly disturbed areas with no or limited native vegetation. Within the study area this vegetation type was mostly dominated by exotic perennial grass species such as *Ehrharta erecta** (Panic Veldtgrass), *Cenchrus clandestinum** (Kikuyu), *Megathyrsus maximus** (Guinea Grass), *Eragrostis curvula** (African Love Grass), *Chloris gayana** (Rhodes Grass), *Melinus repens** (Red Natal Grass) and *Bidens pilosa** (Cobblers Pegs).

This vegetation type was recorded in areas where >50% of the understorey was comprised of exotic species and no canopy was present. Overall, this vegetation formed 119.57ha within the study area (Figure 3.1).

Miscellaneous ecosystem – urban/exotic plantings

This vegetation type does not align to any recognised plant community type in NSW and is the result of ornamental landscape plantings. This miscellaneous ecosystem was generally located in small patches in proximity to residential properties occupying 1.42ha of the study area. The location of urban/exotic plantings is illustrated in Figure 3.1 and depicted in Photo 3.20.

Miscellaneous ecosystem – cropping

This vegetation type does not align to any recognised plant community type in NSW and is the result of agricultural sowing practices. This miscellaneous ecosystem was located to the north of the study area immediately adjacent the New England Highway occupying 16.58ha of the study area. The location of cropping areas is illustrated in Figure 3.1 and depicted in Photo 3.21.

Miscellaneous ecosystem – native plantings (including mine rehabilitation)

This vegetation type does not align to any recognised plant community type in NSW as it is comprised of native plantings for mine rehabilitation works and largely as wind rows for agricultural practices. This vegetation type either occurred as either planted trees imitating a woodland / forest or as a shrub land. While this community is not considered a native PCT it does provide habitat for threatened fauna species tolerant of disturbed ecosystems.

This vegetation type was largely comprised of endemic and non-endemic native species such as *Eucalyptus dawsonii* (Slaty Gum), *Eucalyptus melliodora* (Yellow Box), *Eucalyptus blakelyi* (Blakely's Red Gum), *Eucalyptus crebra* (Narrow-leaved Ironbark), *Corymbia maculata* (Spotted Gum), *Eucalyptus moluccana* (Grey Box), *Casuarina glauca* (Swamp Oak) and *Casuarina cunninghamiana* subsp. *cunninghamiana* (River Oak). Acacia species were also commonly planted in some of the mine rehabilitation areas including *Acacia decora* (Western Silver Wattle), *Acacia deanei* subsp. *deanei* (Deane's Wattle), *Acacia nesophila* and *Acacia macradenia* (Zig Zag Wattle).

There were also some threatened planted identified as being planted within some of these areas. These species included *Eucalyptus camaldulensis* (River Red Gum) and *Acacia pendula* (Weeping Myall). *Eucalyptus nicholii* (Narrow-leaved Black Peppermint) and *Eucalyptus scoparia* (Wallangarra White Gum) were also recorded in urban/exotic planting areas.

This miscellaneous ecosystem was located as scattered patches throughout the study area occupying a total of 11.03ha. The location of cropping areas is illustrated in Figure 3.1 and depicted in Photo 3.19 and Photo 3.22.

Photo 3.19 Mine rehabilitation

Photo 3.20 Urban/exotic plantings

Photo 3.21 Cropping

Photo 3.22 Native plantings

3.3 Flora recorded

Within the study area, a total of 345 flora species were recorded. Of these, 138 species (40%) were exotic species or native planted ornamental species and 207 species (60%) were native. One threatened flora Endangered Population was recorded within the study area; *Eucalyptus camaldulensis* (River Red Gum) listed under the BC Act. A full inventory of flora species recorded and vegetation integrity plot data is presented in Appendix B (Flora and fauna species recorded).

3.3.1 Priority weeds

Of the 138 exotic species recorded, 10 are listed as Priority Weeds under the NSW *Biosecurity Act 2015* (Biosecurity Act) for the Greater Hunter Local Land Service region and seven are listed Weeds of National Significance (WONs) (Table 3.10). Under the Biosecurity Act, land managers are required to follow the regional and non-regional duties which have been allocated to each Priority Weed.

Table 3.10 Weeds of concern recorded within the study area

Scientific name	Common name	Priority weed duty	WONS
*Lycium ferocissimum**	African boxthorn	**Prohibition on dealings** Must not be imported into the state or sold.	Yes
*Tamarix aphylla**	Athel pine		Yes
*Senecio madagascariensis **	Fireweed		Yes
*Opuntia stricta**	Prickly Pear		Yes
Salix sp.	Willow		Yes
*Bryophyllum x houghtonii**	–	**Regional recommended measure** Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment. Land managers reduce impacts from the plant on priority assets.	–
*Echium plantagineum**	Paterson's curse	**Regional recommended measure** Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment. Land managers reduce impacts from the plant on priority assets.	–
*Hyparrhenia hirta**	Coolatai grass	**Regional recommended measure** The plant should not be bought, sold, grown, carried or released into the environment. Land managers should mitigate the risk of the plant being introduced to their land. Land managers should mitigate spread from their land. Land managers to reduce impacts from the plant on priority assets.	–

Scientific name	Common name	Priority weed duty	WONS
*Opuntia aurantiaca**	Tiger Pear	**Prohibition on dealings** Must not be imported into the state or sold. **Regional recommended measure** Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment. Land managers reduce impacts from the plant on priority assets.	Yes
Rubus fruticosus species aggregate*	Blackberry	**Prohibition on dealings** Must not be imported into the state or sold. **Regional recommended measure** The plant should not be bought, sold, grown, carried or released into the environment. Land managers should mitigate the risk of the plant being introduced to their land. Land managers should mitigate spread from their land. Land managers to reduce impacts from the plant on priority assets.	Yes

3.4 Fauna recorded

A total of 153 fauna species were recorded within the study area (see Appendix B (Flora and fauna species recorded)) of which 144 were native (94%) and nine were introduced (6%). This included a total of 113 bird species, 23 mammals, nine reptiles, seven amphibians and one fish species.

Twelve threatened fauna species were recorded in the study area (Table 3.11). Further details on threatened fauna species recorded is provided in section 3.8.2 (Threatened fauna species) and section 3.12.3 (Threatened fauna listed under the EPBC Act).

Table 3.11 Threatened or migratory fauna recorded in the study area

Scientific name	Common name	BC Act[1]	EPBC Act[2]
Daphoenositta chrysoptera	Varied Sittella	V	–
Glossopsitta pusilla	Little Lorikeet	V	–
Hirundapus caudacutus	White-throated Needle-tail	–	V, M
Artamus cyanopterus	Dusky Woodswallow	V	–
Hieraaetus morphnoides	Little Eagle	V	–
Pyrrholaemus sagittatus	Speckled Warbler	V	–
Delma impar	Striped Legless Lizard	V	V
Phascolarctos cinereus	Koala	V	V
Petaurus norfolcensis	Squirrel Glider	V	–
Myotis macropus	Southern Myotis	V	–
Pteropus poliocephalus	Grey-headed Flying-fox	V	V
Haliaeetus leucogaster	White-bellied Sea-eagle	V	–

1. Vulnerable (V), Endangered (E), Endangered Population (E2), Critically Endangered (CE) as listed on the BC Act
2. Vulnerable (V), Endangered (E), Critically Endangered (CE), Migratory (M) as listed on the EPBC Act.

3.5 Fauna habitat types

The suitability, size and configuration of the fauna habitat correlated broadly with the PCTs summarised in section 3.2 (Plant community types) and illustrated in Figure 3.1. These areas provided habitat for a range of fauna guilds including birds, reptiles, amphibians, fish and mammals.

Habitat features recorded within the study area were largely dominated by open forest/woodland, riparian woodland, native grasslands and cleared land with scattered trees and/or native plantings. There were also areas of aquatic fauna habitat in the form of artificially constructed dams as well as naturally occurring watercourses.

Although some of the vegetated fauna habitat associated with the study area is highly disturbed and modified, it protects the integrity of adjoining remnants and supports wildlife movement within a fragmented mosaic landscape which many fauna species locally depend upon.

A description of each of these broad fauna habitats are described below in section 3.5.1 (Terrestrial fauna habitats) to section 3.5.4 (Habitat for local populations).

Table 3.12 Broad fauna habitat type and corresponding PCTs

Fauna habitat description	Corresponding PCT
Open forest/woodland	• PCT 1691 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter • PCT 1604 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter • PCT 1693 Yellow Box - Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains • PCT 1605 Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter • PCT 1607 Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter
Riparian woodland	• PCT 42 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley • PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)
Native grassland	Low (DNG) condition forms of native PCTs.
Cleared land with scattered trees and/or native plantings	• Highly disturbed areas with no or limited native vegetation • Urban/exotic plantings • Native plantings (including mine rehabilitation) • Cropping
Aquatic habitat	Artificially constructed dams and naturally watercourses including Muscle Creek, Sandy Creek and their unnamed tributaries

3.5.1 Terrestrial fauna habitats

Open forest/woodland

The habitat type was one of the dominant fauna habitat types occurring throughout the study area. Although large areas of this habitat on site were fragmented and disturbed in nature there were areas which contained important habitat attributes such as hollow-bearing trees, leaf litter and fallen timber which are required by some species for foraging, roosting and breeding.

Canopy was largely dominated by a mix of Eucalypt species such as *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus moluccana* (Grey Box), *Eucalyptus melliodora* (Yellow Box) and *Corymbia maculata* (Spotted Gum) which provide blossom and hollow resources for a wide range of fauna species. These trees species and this habitat type within the locality is relatively common however, like the study area, most areas shows evidence of disturbance as it is susceptible given its location on high to moderate fertility soils.

Although the mid-stratum was largely sparse or absent, the habitat type did contain microhabitats such as hollow bearing trees, leaf litter, fallen timber and bush rock. The surface and partially embedded bush rock within the study area provides habitat for reptiles and small terrestrial mammals. Furthermore, the understorey generally contained a good diversity of native groundcover species which provides foraging resources for a range of species in the forms of seeds, insects and rodents.

Riparian woodland

Riparian woodland occurred predominantly along Muscle Creek, Sandy Creek and their unnamed tributaries within the study area. Whilst many of the watercourses and drainage lines are ephemeral and at most times dry, Muscle Creek is a perennial watercourse which contained water even during the severe drought condition experienced leading up to the field survey program.

Riparian woodlands within the study area varied in condition however all showed evidence of disturbance from agriculture including substrate compaction, large areas of bare ground, erosion and weed incursions. Although disturbed this habitat type did contain many large old hollow-bearing trees and fallen timber which provide habitat for a range of birds, mammals, reptiles and amphibians. Where water did occur, areas of important permanent water reserves were available for a range of fauna species during drought conditions.

Sandy Creek and the unnamed tributaries and drainage lines within the study area were significantly more disturbed than riparian woodland along Muscle Creek. These areas generally contained more severe weed incursions, lower native species diversity and contained fewer habitat features.

The higher quality patches of this fauna habitat type along Muscle Creek provide foraging and roosting habitat for a range of common and threatened fauna species such as the Regent Honeyeater, Squirrel Glider and Speckled Warbler.

Native grassland

Native grassland habitat was derived of native PCTs which had been previously cleared for agriculture. These native grasslands varied in condition (i.e. native versus exotic species diversity and cover) based on the intensity of current and past livestock grazing practices and other land uses.

All native overstorey and midstorey were absent from this habitat type aside from the occasional isolated paddock tree. These isolated paddock trees play an important role in providing habitat (including both foraging and breeding habitat) to a range of fauna species and in maintaining connectivity between larger remnants within the locality. Moreover, this habitat type provides foraging resources for a range of species in the forms of seeds, insects and rodents.

Furthermore, this habitat type contained surface and partially embedded bush rock. This microhabitat provides habitat for reptiles and small terrestrial mammals including the threatened Striped Legless Lizard which was recorded within the study area from this habitat type.

Cleared land with scattered trees and native plantings

Miscellaneous ecosystems for the most part provide habitat for common and introduced fauna. Native plantings however did contain nectar producing plants such as *Eucalyptus camaldulensis* (River Red Gum) and *Corymbia maculata* (Spotted Gum) which provide potential foraging opportunities for threatened nectarivorous species such as the Grey-headed Flying-fox. Furthermore, areas of mine rehabilitation also contained numerous Acacia species which would also provide foraging resources. These native plantings would also attract insects which are likely to attract threatened insectivorous species such as yangochiropteran bats.

3.5.2 Aquatic fauna habitats

Most waterways within the study area are typical of a highly modified agricultural landscape. While they have defined banks they are largely ephemeral, likely to flow only during periods of high rainfall and have limited aquatic habitat. These waterways were either not classified as Key Fish Habitat (Department of Primary Industries, 2013) and/or based on observations were likely to align to Class 4 (unlikely key fish habitat). Aquatic habitats within these waterways are largely absent, ephemeral and unlikely to support aquatic or wetland vegetation. Two exceptions to this include:

- Sandy Creek
- Muscle Creek.

No detailed aquatic surveys have been completed although general observations and habitat assessments results are provided below.

Sandy Creek

Sandy Creek occurs where the construction footprint re-joins the New England Highway north of the Muswellbrook township.

Sandy Creek is a tributary of the Hunter River and is recognised as Key Fish Habitat (Department of Primary Industries, 2013). During all inspections completed, no standing water and only very limited aquatic habitat was recorded, even following periods of substantial rainfall. This waterway is however likely to flow and contain large volumes of water following periods of extended high rainfall based on the observed height of the creek banks (>2 metre high).

Within the study area, Sandy Creek is considered at present to be a Class 3 watercourse (i.e. minimal key fish habitat). Although the creek has defined banks it is ephemeral in nature and does not appear to support native aquatic or wetland vegetation given its highly disturbed nature. As such, Sandy Creek and its tributaries within the study area are likely to align to Type 3 (minimally sensitive key fish habitat). This assessment may be subject to change if seasonal conditions were to improve in the future.

Muscle Creek

Muscle Creek occurs in the south of the study area flowing in an east to west direction on the Muswellbrook Coal Mine tenure. The creek is a tributary of the Hunter River and is recognised as Key Fish Habitat (Department of Primary Industries, 2013). Despite drought conditions this watercourse retained water and is likely to be perennial in nature. During severe drought (based on observations in June 2019) the watercourse may have intermittent flow however is likely to retain pools of water. It also appears to support aquatic vegetation (such as *Bolboschoenus caldwellii, Juncus usitatus* and *Cycnogeton procerum*) and provides aquatic habitat for fauna species (including microhabitats such as snags and rocks). Mosquito Fish (*Gambusia affinis*) were observed within Muscle Creek.

Within the study area, Muscle Creek is considered a Class 2 watercourse (i.e. moderate key fish habitat) as it has well defined banks, semi-permanent to permanent water, pools and contains freshwater aquatic vegetation. Furthermore, Muscle Creek is likely to align to Type 1 (highly sensitive key fish habitat) given the presence of microhabitats such as rocks, snags and gravel.

Alternatively, the main unnamed tributary of Muscle Creek which runs south directly into Muscle Creek was considered at present to be a Class 3 watercourse (i.e. minimal key fish habitat). Although the tributary had defined banks it was ephemeral in nature and did not appear to support native aquatic or wetland vegetation given its highly disturbed nature. As such, within the study area, it is likely to align to Type 3 (minimally sensitive key fish habitat). This assessment may be subject to change if seasonal conditions were to improve in the future.

3.5.3 Fauna microhabitats

Hollow bearing tree resources

Sixteen of the 43 threatened fauna species considered to be affected by the proposal use hollow tree resources for breeding and roosting. While many attributes of tree hollows may be selected by hollow using species, such as hollow depth, entrance size and hollow type, hollows are more likely to occur and be used by wildlife in large trees that are many decades or even centuries old (Goldingay 2009).

Hollow-bearing trees occurred throughout the study area providing potential roosting and breeding habitat for a range of threatened and non-threatened predatory birds, woodland birds, arboreal mammals and yangochiropteran bats. A total of 134 hollow-bearing trees were identified within and surrounding the study area as part of surveys conducted (Figure 3.2). Trees which contained large hollows suitable for forest owls were generally localised in riparian vegetation and as scattered paddock trees along and immediately adjacent to the Muscle Creek floodplain.

Comprehensive hollow-bearing tree surveys of all hollow sizes were limited to within and immediately surrounding the 20 percent construction footprint. These surveys recorded 65 hollow-bearing trees, of which 12 occur directly within the 20 percent construction footprint. An analysis of the 65 hollow-bearing trees within and immediately adjacent to the 20 percent construction footprint identified that eight different tree species were recorded as well as dead stags. These 65 trees contained a total of about 288 hollows encompassing 82 very small hollows, 149 small hollows, 39 medium hollows and 18 large hollows. The most important tree species for hollow occurrence within the surveyed area were *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus moluccana* (Grey Box), *Eucalyptus blakelyi* (Blakey's Red Gum), *Schinus molle* var. *areira* (Peppercorn Tree), *Eucalyptus tereticornis* (Forest Red Gum) and *Eucalyptus melliodora* (Yellow Box). Hollow-bearing tree data collected as part of this assessment is presented in Appendix C.

Since the completion of the comprehensive hollow-bearing tree survey the construction footprint has been expanded to encompass areas needed for temporary works such as sedimentation basins, drainage channels, access roads, construction compounds and ancillary sites to support the construction of the proposal. A total of 42 hollow bearing trees have been recorded within the 80 percent construction footprint, based on data collected as part of the comprehensive hollow-bearing tree survey of the 20 percent construction footprint and the large hollow tree survey. There is however potential for more hollow-bearing trees to occur within the 80 percent construction footprint where it extends past the 20 percent construction footprint as comprehensive surveys have not been conducted in these areas.

Despite comprehensive hollow-bearing tree surveys having not been completed throughout the 80 percent construction footprint it is anticipated that no more than 42 hollow-bearing trees will be impacted by the proposal. Given the temporary nature of the works to occur in areas which have not been subjected to comprehensive surveys it is anticipated that trees containing hollow resources will be able to be avoided through careful site selection. Furthermore, impacts to the 42 hollow-bearing trees assessed in this report may also be reduced through further design changes and site selection. As outlined in the avoid, minimise and mitigate measures in Section 5, the final design will prioritise locating impacts within areas that do not contain native treed or grassland areas.

Graph 1 Hollows within the 20% design construction footprint

Nesting resources

During spring targeted surveys, numerous bird nests were recorded across the study area. The concentration of nests were largely focused around Muscle Creek in the south of the study area where vegetation was in higher condition. All nests recorded were identified as being most likely used by non-threatened bird species (such as Australian Raven, Western Gerygone and Magpie-larks) as per detailed results in Appendix C.

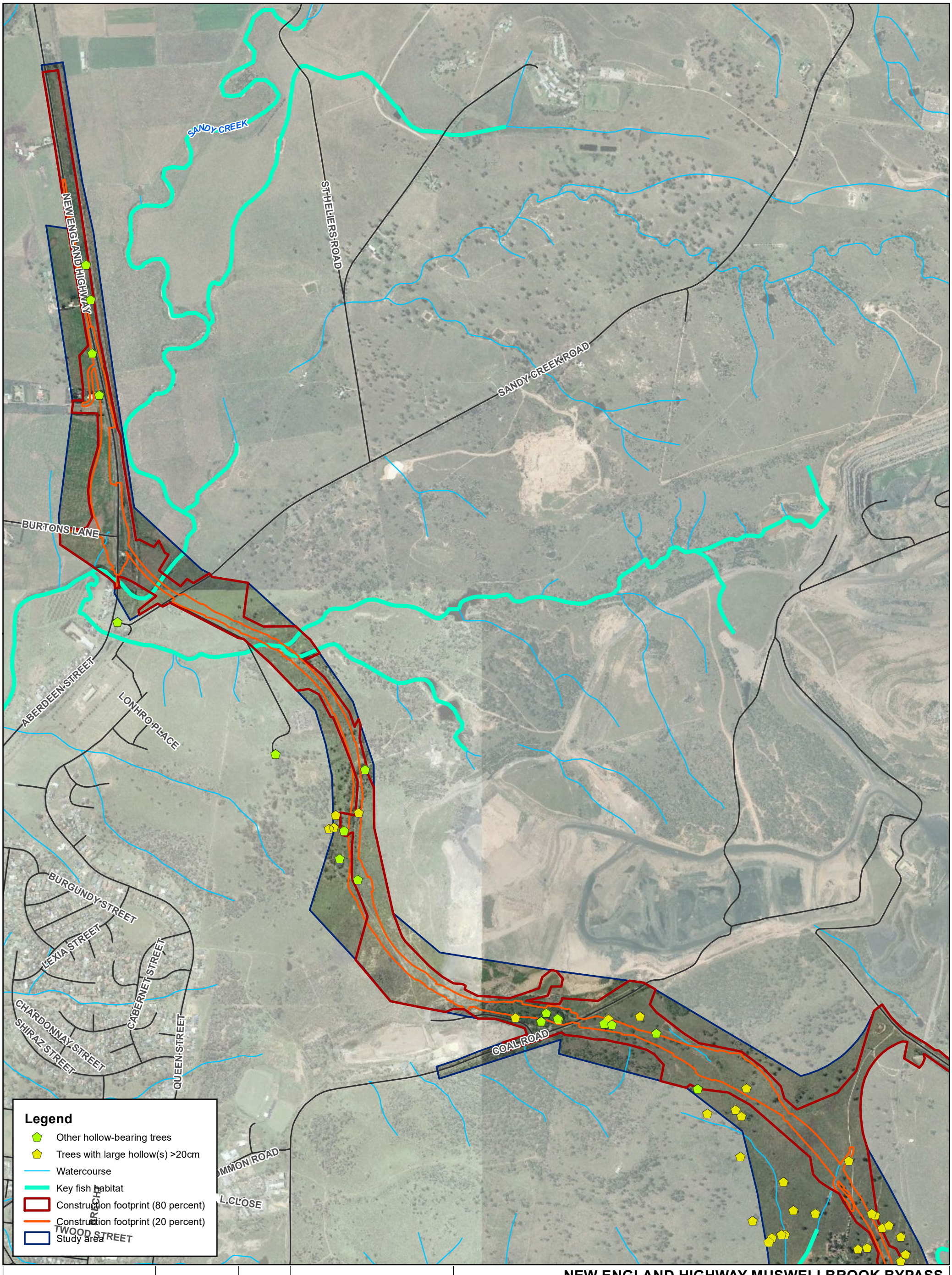
One large predatory stick nest was recorded in the upper branches of a large stag about 100m from the western boundary of the study area. Although not actively used at the time of survey, it is considered most likely to be a Wedge-tailed Eagle nest given the size and presence of two mature individuals flying high above the location where the nest occurred.

Feeding resources

Fauna occurring within the locality are likely to use a range of foraging resources. Flora species in the study area provide a variety of foraging resources from a range of species that together would flower throughout much of the year. However, at the time of survey, few species showed significant flowering. This may however be a result of drought conditions experienced across NSW leading into the field survey program.

Although varied, foraging resources within the study area were largely restricted to canopy, sub-canopy and groundcover species. Given the study area's long history of agricultural and mining disturbances, much of the shrub stratum was either absence or sparse in cover. An exception to this was within vegetation along and immediately north of Muscle Creek.

Most of the vegetation likely to be impacted upon by the proposal consists of fragmented remnants whilst the larger more intact remnants within the study area have been avoided through detailed design. Given the larger intact tracts of native vegetation adjacent to the study area would be retained, feeding resources contained within the construction footprint would likely provide a small proportion of the available to fauna in the wider locality.



Map: PS114532_BDAR_006_A5	Author: V.Lau	0 0.25 0.5 km 1:15,000	**NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT**
Date: 23/07/2021	Approved by: - T.Bangel	*Coordinate system: GDA 1994 MGA Zone 56*	**Figure 3.2a** Hollow-bearing trees and aquatic habitat
Data source: © Department of Customer Service 2020 Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri		Scale ratio correct when printed at A3	

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COAL ROAD
MUSCLE CREEK
MUSCLE CREEK ROAD
BABBLER CRESCENT
WOODLAND RIDGE ROAD
ROSELLA CLOSE
TOP KNOT PLACE
KINGFISHER COURT
SILVER EYE ROAD
JEANS STREET
HENRY DANGAR DRIVE
MILPERA DRIVE
NEW ENGLAND HIGHWAY

Legend

- Other hollow-bearing trees
- Trees with large hollow(s) >20cm
- Watercourse
- Key fish habitat
- Construction footprint (80 percent)
- Construction footprint (20 percent)
- Study area

Map: PS114532_BDAR_006_A5	Author: V.Lau
Date: 23/07/2021	Approved by: - T.Bangel

0 0.25 0.5 km

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Data source: © Department of Customer Service 2020
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri

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Figure 3.2b
Hollow-bearing trees and aquatic habitat

Artificial structures

The study area includes several built structures that area known to occasionally provide habitat opportunities for threatened species such as yangochiropteran bats. These structures are described in detail below.

Wooden bridge

A single lane old wooden rail bridge with a span of about 2 metres and with in-stream piles occurs to the south of the study area across Muscle Creek. This existing bridge is no longer used however appears structurally sound. This bridge was surveyed for its potential to provide habitat for fauna, especially for yangochiropteran bats. This bridge is depicted below in Photo 3.23.

No bats were observed roosting under the bridge during the survey period and no evidence of usage was observed however access was limited. The timber is relatively intact however there were a few minor cracks and crevices recorded on the underside of the bridge which may provide potential roosting habitat for yangochiropteran bats. Although no bats were observed roosting under the bridge it is likely that several bat species would utilise the riparian forest habitat surrounding the bridge for foraging and roosting.

Concrete box culverts

There are two concrete box culverts within the study area which facilitate the flow of water associated with an unnamed tributary of Muscle Creek in the south of the study area (one under Muscle Creek Road and one under the New England Highway). These culverts were inspected for their potential to provide habitat for threatened fauna, especially as representing potential roosting locations for yangochiropteran bats. These culverts are depicted below in Photo 3.24 and Photo 3.25.

Potential roosting habitat identified within the culverts during the inspection included:

- Small circular drains – all appeared dry and no active use was identified, could be potentially used by bats
- Expansion joint crevices between concrete panels – these crevices appeared unused at the time of the survey
- Fairy Martin (*Petrochelidon ariel*) mud nests – corners of each culvert ceiling where occupied by numerous Fairy Martin nests. Some nests were actively being used and built at the time of the inspection. Many of the nests were disused and could provide potential habitat for yangochiropteran bats to reside in.

Two Southern Myotis (*Myotis macropus*) individuals were recorded roosting within the concrete box culvert located under Muscle Creek Road (location provided later in Figure 3.5). Specifically, one individual was observed sheltering in an expansion joint crevice and the other was observed within an abandoned Fairy Martin nest.

Photo 3.23 Wooden bridge

Photo 3.24 Concrete box culvert with Fairy Martin nests

Photo 3.25 Concrete box culvert expansion joints

3.5.4 Habitat for local populations

Habitat assessments were completed within and immediately adjacent to the study area to compare key habitat resources available for use by fauna species. The results of these habitat assessments are provided in Appendix C and a summary if provided below in Table 3.13.

A T-Test (Two-sample assuming equal variance) was completed in Microsoft Excel to determine whether the mean number of hollow bearing trees, number of hollows, length of fallen timber and the number of canopy stem classes present were significantly different between habitat surveyed within versus immediately adjacent the study area. The results of each T-Test concluded that none of the habitat attributes tested were significantly different within versus outside the study area.

Most of the vegetation likely to be impacted upon by the proposal consists of fragmented remnants whilst the larger more intact remnants within the study area have been avoided through design. Given the larger intact tracts of native vegetation adjacent to the construction footprint would be retained and similar habitat resources were recorded outside the study area, it is likely that key habitat resources would remain available in the surrounding landscape for local populations of fauna. The proposal would however likely remove a small proportion of the habitat resources available to fauna in the locality.

Table 3.13 Summary of habitat assessments completed within and immediately adjacent the study area

Habitat features	Inside study area	Adjacent study area	Significant difference?
Mean number of hollow bearing trees	1	1.3	No
Mean total number of hollows	4.4	3.3	No
Mean length of fallen timber (m)	18.4	20.5	No
Mean number of canopy stem classes	5.2	4.2	No
Regeneration of canopy species present	Largely yes	Largely yes	n/a
Blossom resources present	Yes	Yes	n/a
Leaf litter present	Yes	Yes	n/a

3.6 Threatened ecological communities

Four BC Act listed threatened ecological communities were identified within the study area. These threatened ecological communities included:

- Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered under BC Act)
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions (Endangered under BC Act)
- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands (Critically Endangered under BC Act)
- Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered under BC Act).

A detailed description and comparison of each BC Act listed threatened ecological community is provided below. Figures 3.3 a–e show the locations of the threatened ecological communities.

3.6.1 Central Hunter Grey Box – Ironbark Woodland

Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions is listed as Endangered under the BC Act. Two PCTs recorded within the study area were considered candidates to form part of this threatened ecological community listing. These PCTs included:

- PCT 1691 PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter
- PCT 1605 PCT 1605 Narrow-leaved Ironbark Native Olive shrubby open forest of the central and upper Hunter.

All patches of PCT 1691 and PCT 1605 recorded within the study area are considered consistent with the BC Act Central Hunter Grey Box – Ironbark Woodland listing as they conform with the following locality, floristics, landscape and geological characteristics as detailed in the NSW Scientific Committee Final Determination (NSW Scientific Committee, 2019a):

- Occur on Permian sediments in the Hunter Valley
- Formed an open woodland or open forest on slopes and undulating hills
- Even if above ground individuals of some species may be absent at some time, they are considered likely to be present below ground in the soil seed bank
- Contained characteristic species representative Central Hunter Ironbark -Spotted Gum – Grey Box Forest as listed under Paragraph 2 of the NSW Scientific Determination including

a canopy dominated by *Eucalyptus moluccana* (Grey Box) and/or *Eucalyptus crebra* (Narrow-leaved Ironbark)
- Occurred within the Muswellbrook LGA and NSW Sydney Basin IBRA Bioregion.

3.6.2 Central Hunter Ironbark – Spotted Gum – Grey Box Forest

Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions is listed as Endangered under the BC Act. One PCT recorded was considered a candidate to form part of this threatened ecological community; *PCT 1604 Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter.*

All patches of PCT 1604 recorded within the study area are considered consistent with the BC Act *Central Hunter Ironbark -Spotted Gum – Grey Box Forest* listing as they conform with the following locality, floristics, landscape and geological characteristics as detailed in the NSW Scientific Committee Final Determination (NSW Scientific Committee, 2019b):

- Occur on Permian sediments in the Hunter Valley
- Even if above ground individuals of some species may be absent at some time, they are considered likely to be present below ground in the soil seed bank
- Typically formed an open woodland contained characteristic species representative Central Hunter Ironbark -Spotted Gum – Grey Box Forest as listed under Paragraph 2 of the NSW Scientific Determination including a canopy dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark), *Corymbia maculata* (Spotted Gum) and *Eucalyptus moluccana* (Grey Box)
- Occurred within the Muswellbrook LGA and NSW Sydney Basin IBRA Bioregion.

3.6.3 White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands

White Box Yellow Box Blakely's Red Gum Woodland and Derived Native Grasslands is listed as Critically Endangered under BC Act. Two PCTs recorded within the study area were considered candidates to form part of this threatened ecological community listing. These PCTs included:

- PCT 1693 Yellow Box – Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains
- PCY 1607 Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter.

All of these vegetation types were considered consistent with the BC Act White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland listing as they conform with the following locality, floristics, landscape and geological characteristics of the threatened ecological community as detailed in the NSW Scientific Committee Final Determination (NSW Threatened Species Scientific Committee, 2020):

- Occur on fertile soils within the central tablelands at elevations between 400 and 800 metres above sea level
- Occur as grassy woodland or as native grassland derived from grassy woodlands
- Are consistent with the threatened ecological community description for in the Upper Hunter as described in the Part 4.6 of the NSW Scientific Determination whereby:
  - The community may occur in the Upper Hunter where the Great Dividing Range is low and were the climate is suited to western species
  - The canopy may be co-dominated or dominated by *Eucalyptus melliodora* (Yellow Box) and/or *Eucalyptus blakelyi* (Blakely's Red Gum) in the eastern part of the community's range
- Contain characteristic species representative of White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grasslands as listed under Part 1 of the NSW Scientific Determination
- Occur within the NSW Sydney Basin Bioregion.

A precautionary approach has been taken in assigning PCT 1607 to this threatened ecological community. Although it is not formally recognised by the BioNet Vegetation Classification Database (Environment Energy and Science Group, 2020c) as forming part of this threatened community, vegetation within the study area shares floristic composition and structural characteristics of the threatened community.

PCT 1607 is a transitional vegetation community which shares characteristics with PCT 1691, PCT 1693 and PCT 485 however given the dominance or co-dominance of *Eucalyptus blakelyi* (Blakely's Red Gum) and its location within the landscape it is considered to meet the criteria for this threatened ecological community best. As such, PCT 1607 has been considered in this document as forming part of the White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands threatened ecological community listed under the BC Act.

3.6.4 Hunter Floodplain Red Gum Woodland

Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions is listed as Endangered under the BC Act. One PCT recorded was considered a candidate to form part of this threatened ecological community; *PCT 42 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley.*

All patches of PCT 42 recorded within the study area are considered consistent with the BC Act *Hunter Floodplain Red Gum Woodland* listing as they conform with the following locality, floristics, landscape and geological characteristics as detailed in the NSW Scientific Committee Final Determination (NSW Scientific Commitee, 2019):

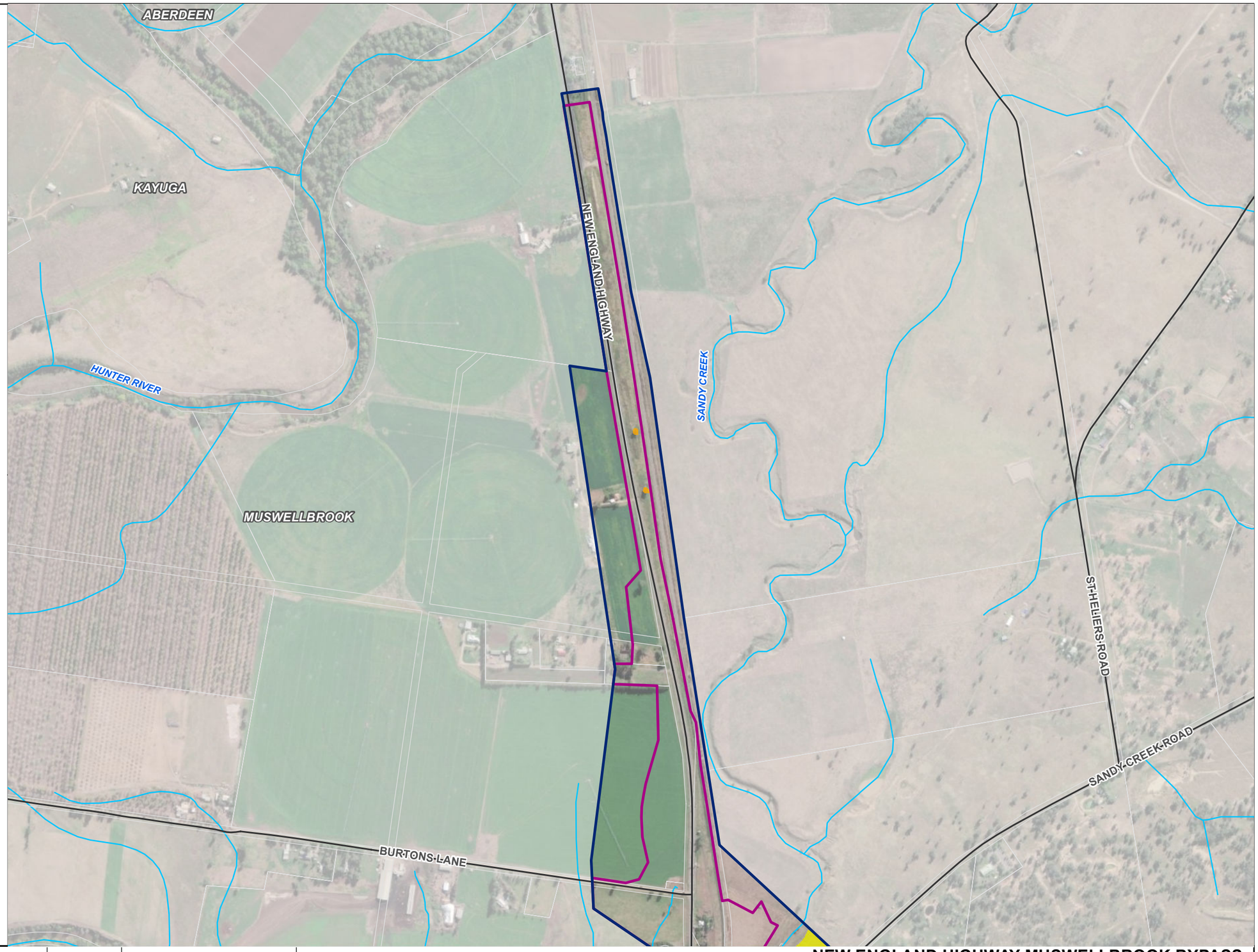
- Occur on floodplains and associated floodplain rises along a tributary of the Hunter River (i.e. Muscle Creek)
- Even if above ground individuals of some species may be absent at some time, they are considered likely to be present below ground in the soil seed bank
- Typically form a tall woodland and contained characteristic species representative Hunter Floodplain Red Gum Woodland as listed under Paragraph 2 of the NSW Scientific Determination
- Occur within the Muswellbrook LGA and NSW Sydney Basin IBRA Bioregion.

Legend

- Watercourse
- Construction footprint
- Study area

BC Act listing

- Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered BC Act)
- White Box - Yellow Box - Blakely's Red Gum Woodland (Critically Endangered BC Act)



Map: PS114532_BDAR_004_A5	Author: Victor.Lau
Date: 23/07/2021	Approved by: T.Bangel

Data source: Metromap 2019 Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Figure 3.3a
Threatened ecological communities

Legend

- Watercourse
- Construction footprint
- Study area

BC Act listing

- Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered BC Act)
- Central Hunter Ironbark—Spotted Gum —Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions (Endangered BC Act)
- White Box - Yellow Box - Blakely's Red Gum Woodland (Critically Endangered BC Act)

EPBC Act listing

- Central Hunter Valley Eucalypt Forest and Woodland (Critically Endangered EPBC Act)
- White Box - Yellow box - Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands (Critically endangered EPBC Act)

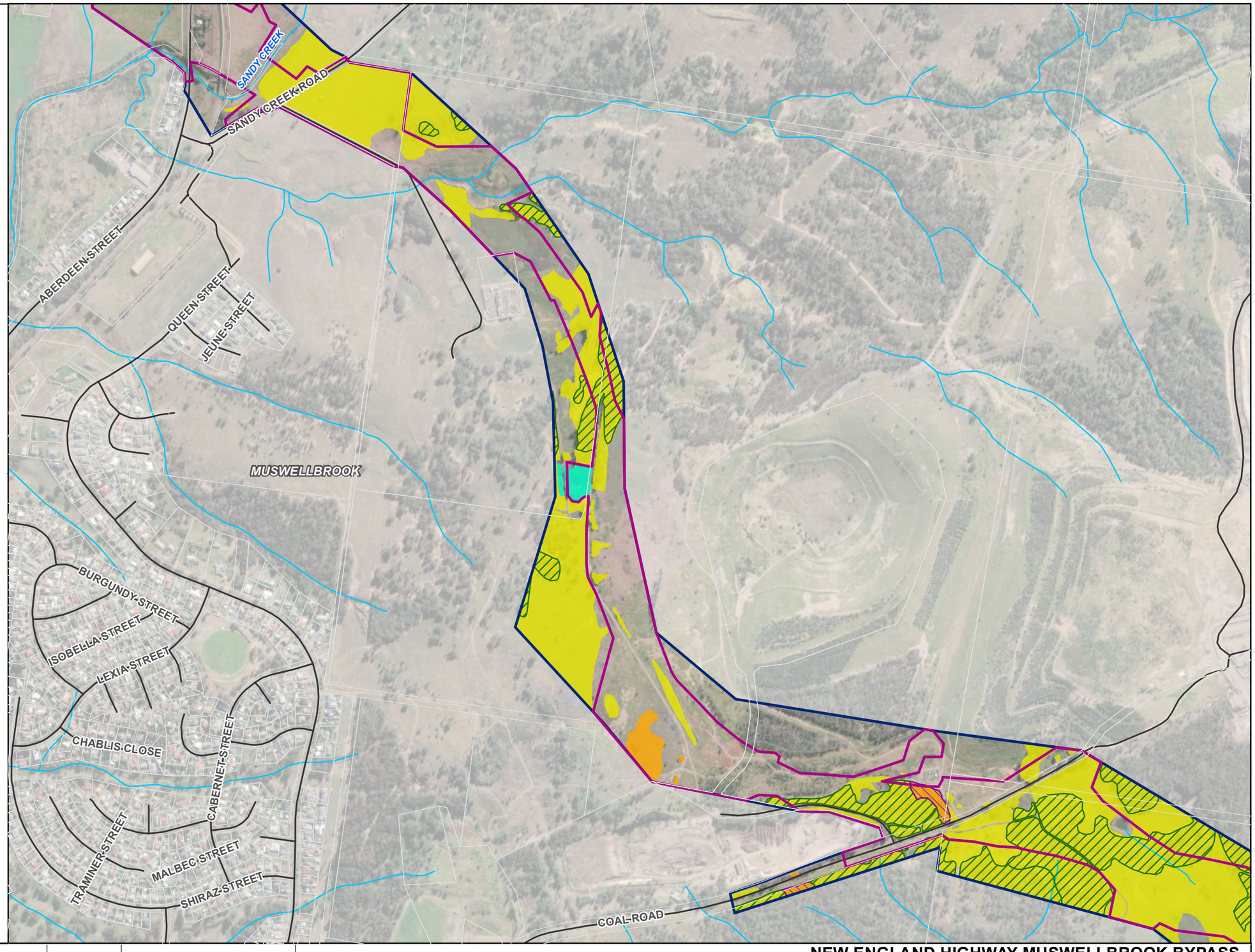

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Figure 3.3b
Threatened ecological communities

Legend

- Watercourse
- Construction footprint
- Study area

BC Act listing

- Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered BC Act)
- White Box - Yellow Box - Blakely's Red Gum Woodland (Critically Endangered BC Act)

EPBC Act listing

- Central Hunter Valley Eucalypt Forest and Woodland (Critically Endangered EPBC Act)
- White Box - Yellow box - Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands (Critically endangered EPBC Act)

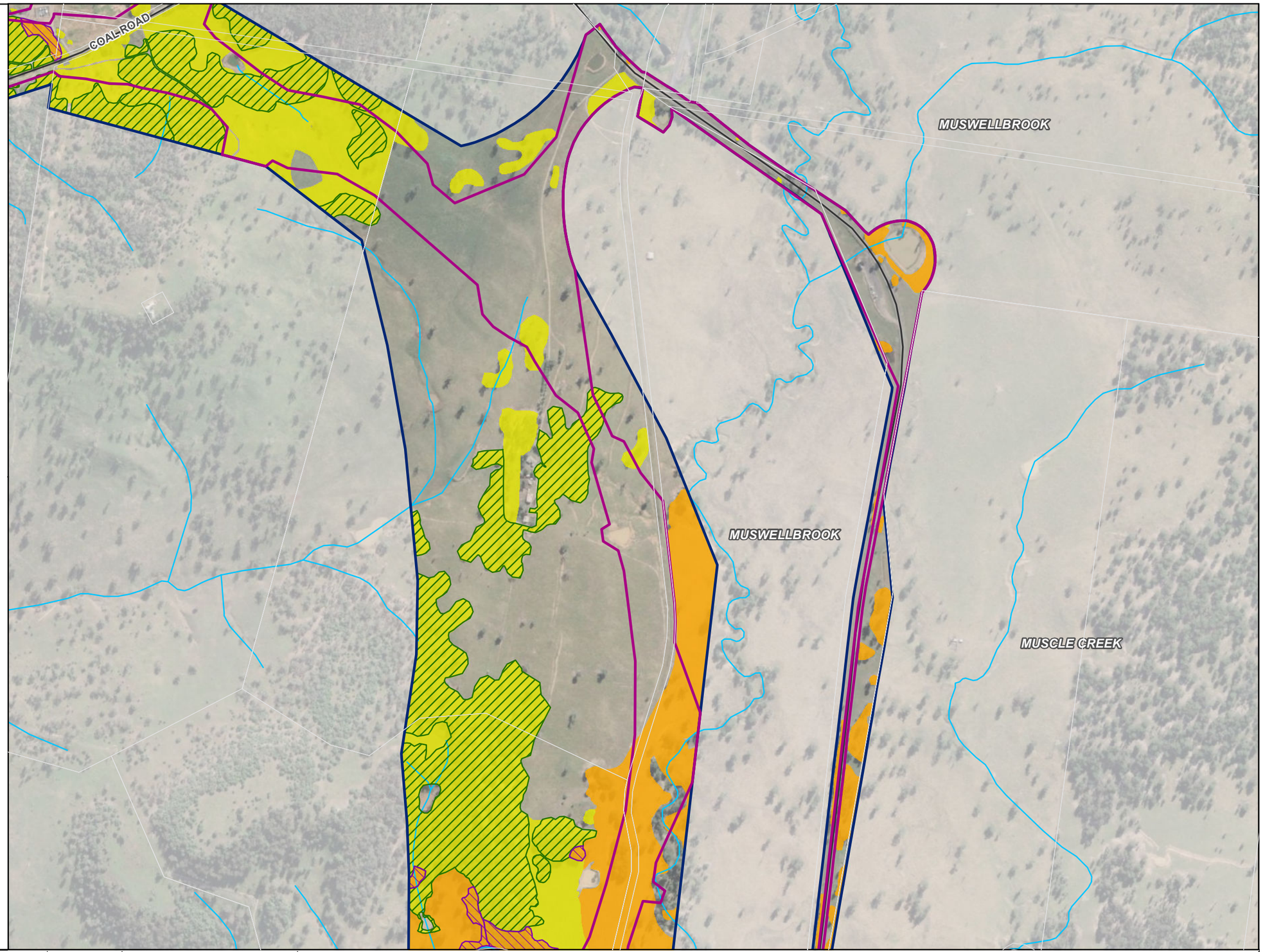

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Figure 3.3c
Threatened ecological communities

Legend

- Watercourse
- Construction footprint
- Study area

BC Act listing

- Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered BC Act)
- Central Hunter Ironbark—Spotted Gum —Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions (Endangered BC Act)
- Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered BC Act)
- White Box - Yellow Box - Blakely's Red Gum Woodland (Critically Endangered BC Act)

EPBC Act listing

- Central Hunter Valley Eucalypt Forest and Woodland (Critically Endangered EPBC Act)
- White Box - Yellow box - Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands (Critically endangered EPBC Act)

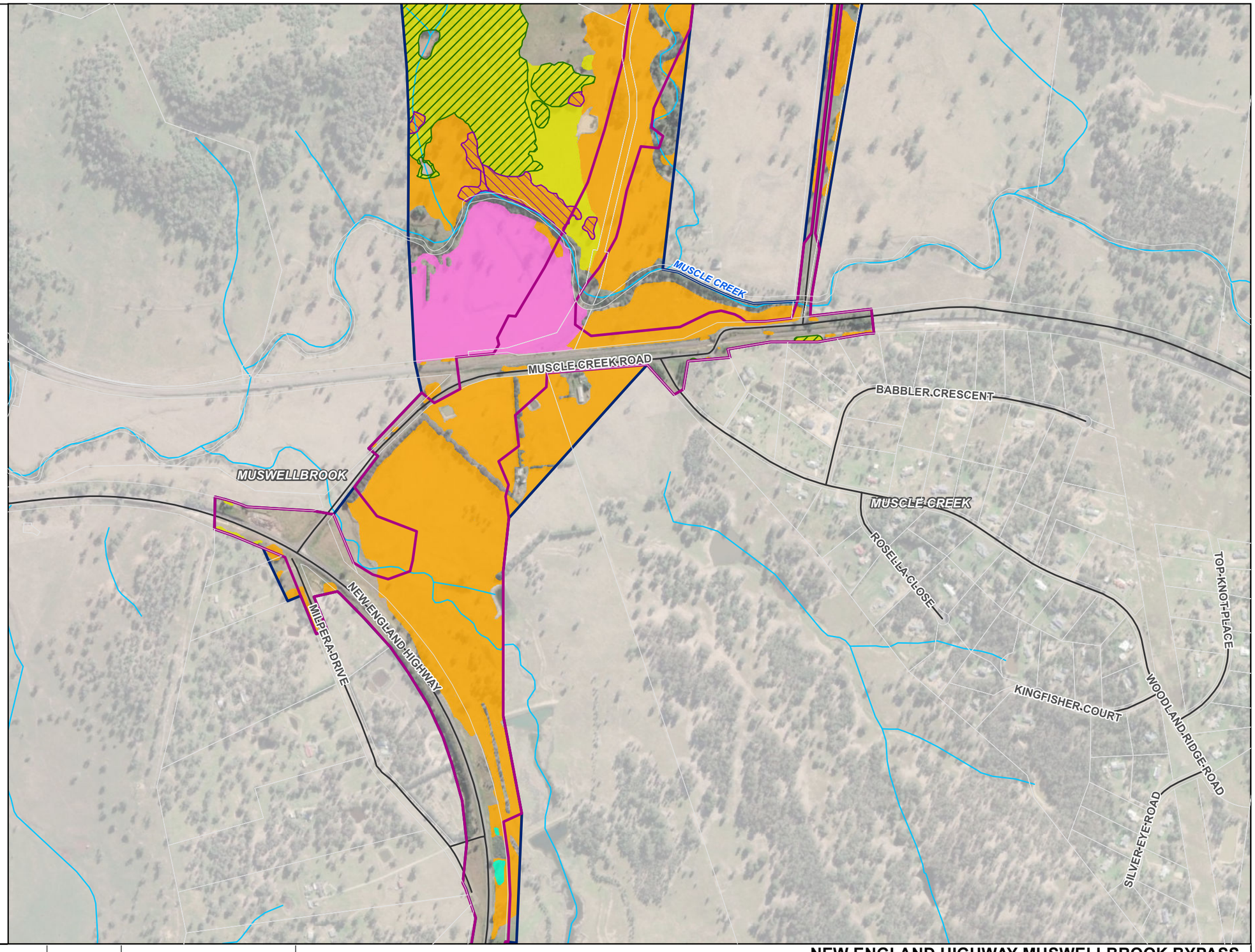

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Figure 3.3d
Threatened ecological communities

Legend

- Watercourse
- Construction footprint
- Study area

BC Act listing

- Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered BC Act)
- Central Hunter Ironbark—Spotted Gum —Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions (Endangered BC Act)
- White Box - Yellow Box - Blakely's Red Gum Woodland (Critically Endangered BC Act)

EPBC Act listing

- White Box - Yellow box - Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands (Critically endangered EPBC Act)

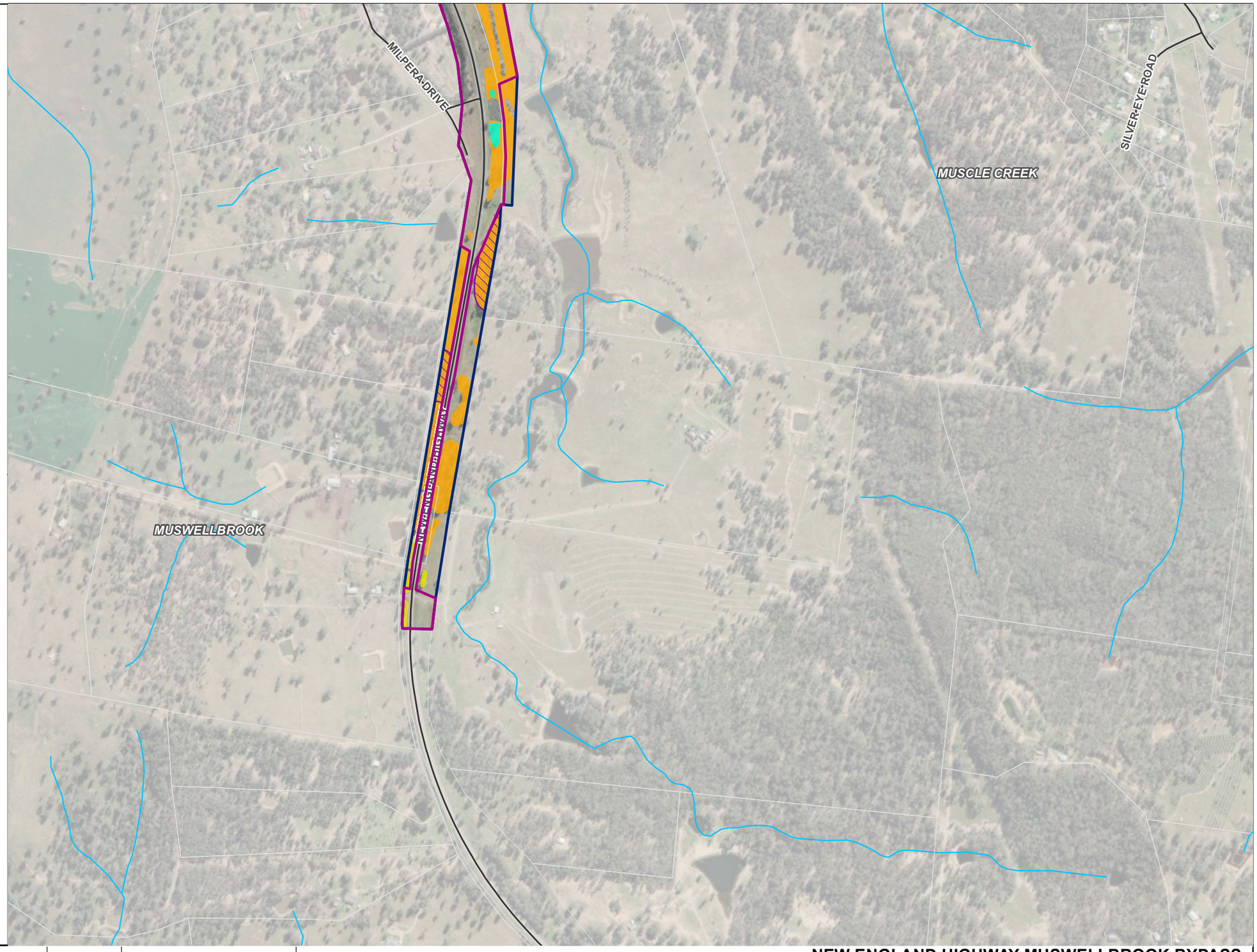

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Figure 3.3e
Threatened ecological communities

3.7 Groundwater dependent ecosystems

Groundwater dependant ecosystems (GDEs) are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater (Department of Land and Water Conservation, 2002). When considering GDEs, groundwater is generally defined as the saturated zone of the regolith (the layer of loose rock resting on bedrock, constituting the surface of most land) and its associated capillary fringe, however it excludes soil water held under tension in soil pore spaces (the unsaturated zone or vadose zone) (Eamus et al., 2006).

GDEs include a diverse range of ecosystems from those entirely dependent on groundwater to those that may use groundwater while not having a dependency on it for survival (i.e. ecosystems or organisms that use groundwater opportunistically or as a supplementary source of water) (Hatton and Evans, 1998). Eamus et al. (2006) considers the following broad classes of these ecosystems:

- Aquifer and cave ecosystems, where stygofauna (groundwater-inhabiting organisms) may reside within the groundwater resource. The hyporheic zones (see ecosystem 5 in figure above) of rivers and floodplains are also included in this category because these ecotones often support stygobites (obligate groundwater inhabitants)
- All ecosystems dependent on the surface expression of groundwater. This category includes base-flow rivers and streams, wetlands (see ecosystems 2 and 3 in Figure 3.4), some floodplains and mound springs and estuarine seagrass beds. While it is acknowledged that plant roots are generally below ground, this class of groundwater dependant ecosystems requires a surface expression of groundwater, which may, in many cases, then soak below the soil surface and thereby become available to plant roots
- All ecosystems dependent on the subsurface presence of groundwater, often accessed via the capillary fringe (non-saturated zone above the saturated zone of the water table) when roots penetrate this zone. This class includes terrestrial ecosystems such as River Red Gum (*Eucalyptus camaldulensis*) forests on the Murray–Darling basin (see ecosystems 1 and 4 in Figure 3.4). No surface expression of groundwater is required in this class of groundwater dependant ecosystems.

GDEs possess a range of values, including being important and sometimes rare ecosystems in themselves, as well as providing important ecosystem services such as water purification (Department of Land and Water Conservation, 2002).

The dependence (or interaction) of the vegetation communities identified within the construction footprint, on groundwater was determined by aligning them with the groundwater dependant ecosystem types identified by Eamus et al. (2006) (Figure 3.4).

Although Muscle Creek, Sandy Creek and their tributaries have not been mapped as having GDE potential within the study area, they have been mapped downstream within the locality as having high GDE potential, especially where they adjoin or get closer to the Hunter River (national assessment) (Bureau of Meteorology, 2020). Considering this, riparian vegetation along these waterways are considered to have high GDE potential.

Based on regional studies, PCT 42 and PCT 485 are highly likely to be GDEs, which are reliant on surface expressions of groundwater or on subsurface groundwater in the study area (Bureau of Meteorology, 2020). Alternatively, PCT 1604, PCT 1605, PCT 1607 and PCT 1691 have low GDE potential. Given the position of PCT 1693 within the landscape (i.e. along the floodplain of Muscle Creek and lower slopes surrounding the floodplain) it is considered likely that PCT 1693 is a terrestrial GDE which may access the water table on an intermittent basis.

Given the above, PCTs identified within the study area are considered likely to be classified as the following (Figure 3.4).

- PCT 42 and PCT 485: riparian GDEs
- PCT 1604, PCT 1605, PCT 1607, PCT 1691: vadophytic vegetation
- PCT 1693: terrestrial GDEs accessing water table.

The proposal has potential to directly and indirectly interfere with subsurface and/or groundwater flows associated with the GDEs identified above within the study area.

In addition to the above, a wetland was identified bordering the northern boundary of the study area between Muscle Creek Road and the New England Highway. The wetland is an intermittent linear waterway which has been artificially modified (via the construction of dam walls) to allow water to pool for agriculture. This wetland is unlikely to be directly impacted by the proposal as it occurs outside the construction footprint and the study area. The proposal has potential however to indirectly impact this wetland via changes to hydrology and sedimentation.

No groundwater aquifer or cave systems were identified within the study area from the field surveys and desktop assessment.

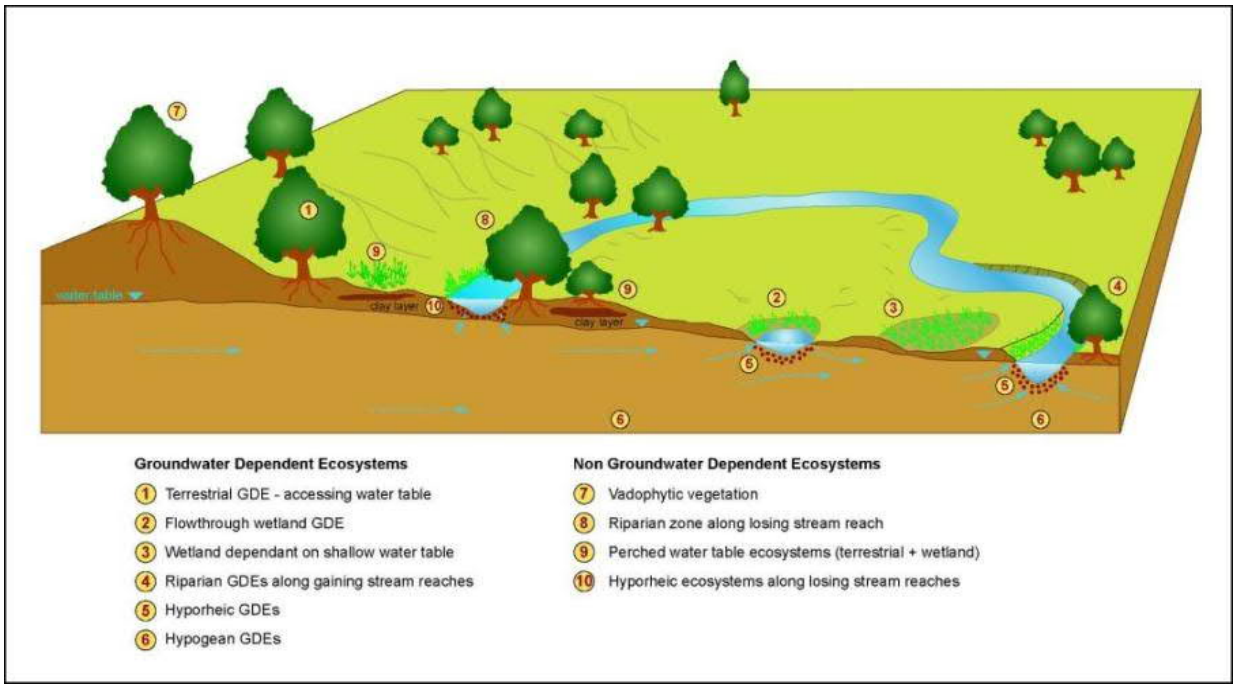

Figure 3.4 Conceptual biophysical model of groundwater dependent ecosystems

3.8 Threatened species and populations

3.8.1 Threatened flora species

The desktop assessment identified 63 BC Act listed threatened flora species as being known or predicted to occur in the locality of the study area. Of these 10 were considered to have a moderate likelihood of occurrence based on the habitat available within the study area (Appendix A (Habitat assessment tables) and Table 3.14). These species became candidate for detailed targeted surveys. Targeted threatened flora surveys have been completed for all but candidate species.

Table 3.14 outlines candidate species, their conservation status, potential occurrence and whether they are likely to be affected by the proposal. Each species affected is considered further with respect to Section 5A of the EP&A Act and MNES significance assessments which are provided Appendix D (Tests of significance).

Table 3.14 Threatened flora habitat assessment and surveys results

Scientific name	Common name	Status		Potential occurrence	Serious and irreversible impact entity?	Affected species?
		BC Act[1]	EPBC Act[2]			
Acacia pendula	Weeping Myall, Boree	E2	–	Moderate	Yes	No – surveyed
Cymbidium canaliculatum	Tiger Orchid	E2	–	Moderate	No	No – surveyed
Diuris tricolor	Pine Donkey Orchid, Painted Diuris	V, E2	–	Moderate	No	No – surveyed
Eucalyptus camaldulensis	River Red Gum	E2	–	Recorded	No	Yes – indirect impacts only
Eucalyptus glaucina	Slaty Red Gum	V	V	Moderate	No	No – surveyed
Ozothamnus tesselatus	–	V	V	Moderate	No	No – surveyed
Pomaderris queenslandica	Scant Pomaderris	E1	–	Moderate	No	No – surveyed
Prasophyllum petilum	Tarengo Leek Orchid	E	E	Moderate	No	No – surveyed
Pterostylis chaetophora	–	V	V	Moderate	No	No – surveyed
Thesium australe	Austral Toadflax	V	V	Moderate	No	No – surveyed

1. Vulnerable (V), Endangered (E), Endangered Population (E2), Critically Endangered (CE) as listed on the BC Act
2. Vulnerable (V), Endangered (E), Critically Endangered (CE) as listed on the EPBC Act.

One Endangered Population was recorded within the study area. This Endangered Population is discussed in detail below.

Eucalyptus camaldulensis (River Red Gum)

Eucalyptus camaldulensis (River Red Gum) is listed as an Endangered Population in the Hunter catchment under the BC Act. A population of 12 *Eucalyptus camaldulensis* individuals were recorded within the study area during targeted seasonal surveys (Photo 3.26 to Photo 3.28). The species occurred immediately south of Muscle Creek in PCT 42 River Red Gum/River Oak riparian woodland wetland in the Hunter Valley.

The individuals recorded within the study area occurred as a cohort of semi-mature trees about 6–10 metre in height. These individuals did not appear to have been planted as they did not occur in rows similarly to those observed in the 'native plantings' miscellaneous ecosystem in nearby locations. As a precaution, these individuals are considered naturally occurring and therefore have been assessed as part of the Endangered Population in this report.

Planted specimens of *Eucalyptus camaldulensis* recorded within some areas of native plantings do not form part of this Endangered Population and as such have not been considered further in this assessment.

The location of *Eucalyptus camaldulensis* individuals identified within the study area are illustrated in Figure 3.3.

Photo 3.26 *Eucalyptus camaldulensis* (River Red Gum) recorded within the study area

Photo 3.27 *Eucalyptus camaldulensis* (River Red Gum) buds

Photo 3.28 *Eucalyptus camaldulensis* (River Red Gum) buds

3.8.2 Threatened fauna species

The desktop assessment identified 91 BC Act threatened fauna species as being known or predicted to occur in the locality of the study area. Of these 45 were considered to have a moderate to high likelihood to occur within the study area (Appendix A (Habitat assessment tables) and Table 3.15) based on the habitat available within the study area. These species became candidate species for detailed targeted fauna surveys.

Table 3.15 outlines candidate species, their conservation status, potential occurrence and whether they are likely to be affected by the proposal. Each species affected is considered further with respect to Section 5A of the EP&A Act and MNES significance assessments which are provided Appendix D (Tests of significance).

The location of threatened fauna species recorded within the study area are illustrated in Figure 3.5.

Table 3.15 Threatened fauna habitat assessment and surveys results

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Potential occurrence	Serious and irreversible impact entity?	Affected species?
Birds						
Anseranas semipalmata	Magpie Goose	V	–	Moderate	No	Yes
Anthochaera phrygia	Regent Honeyeater	CE	CE	Moderate	Yes – important areas only	Yes – no important areas within study area
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	–	Recorded	No	Yes
Callocephalon fimbriatum	Gang-Gang Cockatoo	V	–	Moderate	No	Yes
Chthonicola sagittata	Speckled Warbler	V	–	Recorded	No	Yes
Circus assimilis	Spotted Harrier	V	–	Moderate	No	Yes
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	–	Moderate	No	Yes
Daphoenositta chrysoptera	Varied Sittella	V	–	Recorded	No	Yes
Ephippiorhynchus asiaticus	Black-necked Stork	E	–	Moderate	No	Yes
Falco subniger	Black Falcon	V	–	Moderate	No	Yes
Glossopsitta pusilla	Little Lorikeet	V	–	Recorded	No	Yes
Grantiella picta	Painted Honeyeater	V	V	Moderate	No	Yes

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Potential occurrence	Serious and irreversible impact entity?	Affected species?
Haliaeetus leucogaster	White-bellied Sea-eagle	V	–	Recorded	No	Yes
Hieraaetus morphnoides	Little Eagle	V	–	Recorded	No	Yes
Lathamus discolor	Swift Parrot	CE	CE	Moderate	Yes – important areas only	Yes – foraging habitat only, no important areas within study area
Lophoictinia isura	Square-tailed Kite	V	–	Moderate	No	Yes
Melanodryas cucullata cucullata	Hooded Robin	V	–	Moderate	No	Yes
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	–	Moderate	No	Yes
Neophema pulchella	Turquoise Parrot	V	–	Moderate	No	Yes
Ninox connivens	Barking Owl	V	–	Moderate	No	Yes
Ninox strenua	Powerful Owl	V	–	Moderate	No	Yes
Petroica boodang	Scarlet Robin	V	–	Moderate	No	Yes
Petroica phoenicea	Flame Robin	V	–	Moderate	No	Yes
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	–	High	No	Yes
Rostratula australis	Australian Painted Snipe	E	E	Moderate	No	Yes
Stagonopleura guttata	Diamond Firetail	V	–	Moderate	No	Yes
Tyto novaehollandiae novaehollandiae	Masked Owl (southern mainland)	V	–	Moderate	No	Yes

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Potential occurrence	Serious and irreversible impact entity?	Affected species?
Mammals						
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Moderate	Yes – breeding habitat only	Yes – foraging habitat only
Dasyurus maculatus maculatus	Spotted-tailed Quoll	V	E	Moderate	No	Yes
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	–	High	No	Yes
Miniopterus australis	Little Bent-wing Bat	V	–	High	Yes – breeding habitat only	Yes – foraging habitat only
Miniopterus orianae oceanensis	Large Bent-winged Bat	V	–	High	Yes – breeding habitat only	Yes – foraging habitat only
Mormopterus norfolkensis	Eastern Coastal Free-tailed Bat	V	–	High	No	Yes
Myotis macropus	Southern Myotis	V	–	Recorded	No	Yes
Nyctophilus corbeni	Corben's Long-eared bat	V	V	Moderate	No	Yes
Petauroides volans	Greater Glider	–	V	Moderate	No	No – not recorded during targeted surveys
Petaurus norfolcensis	Squirrel Glider	V	–	Recorded	No	Yes
Phascogale tapoatafa	Brush-tailed Phascogale	V	–	Moderate	No	No – not recorded during targeted surveys
Phascolarctos cinereus	Koala	V	V	Recorded	No	Yes
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Recorded	No	Yes – no camps recorded
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	–	Moderate	No	Yes

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Potential occurrence	Serious and irreversible impact entity?	Affected species?
Scoteanax rueppellii	Greater Broad-nosed Bat	V	–	Moderate	No	Yes
Vespadelus troughtoni	Eastern Cave Bat	V	–	Moderate	Yes – breeding habitat only	Yes – foraging habitat only
Reptiles						
Delma impar	Striped Legless Lizard	V	V	Recorded	No	Yes – indirect impacts only
Hoplocephalus bitorquatus	Pale-headed Snake	V	–	Moderate	No	No – not recorded during targeted surveys

1. Vulnerable (V), Endangered (E), Critically Endangered (CE) as listed on the BC Act
2. Vulnerable (V), Endangered (E), Critically Endangered (CE) as listed on the EPBC Act.

SANDY CREEK
ST HELIERS ROAD
NEW ENGLAND HIGHWAY
SANDY CREEK ROAD
BURTONS LANE
ABERDEEN STREET
LONHRO PLACE
BURGUNDY STREET
LEXIA STREET
CABERNET STREET
CHARDONNAY STREET
SHIRAZ STREET
QUEEN STREET
COOK STREET
BEECH STREET
COMMON ROAD
INDUSTRIAL CLOSE
BRENTWOOD STREET
COAL ROAD

Legend

- Dusky Woodswallow
- Grey-headed Flying-fox
- Little Eagle
- Speckled Warbler
- Squirrel Glider
- Striped Legless Lizard
- Varied Sittella
- White-throated Needletail
- Watercourse
- Construction footprint
- Core Striped Legless Lizard native habitat area
- Study area

Map: PS114532_BDAR_005_A5	Author: V.Lau
Date: 23/07/2021	Approved by: - T.Bangel

0 0.25 0.5 km

1:15,000

Data source: © Department of Customer Service 2020
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

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NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT

Figure 3.5a
Threatened flora and fauna species

COAL ROAD
MUSCLE CREEK
MUSCLE CREEK ROAD
BABBLER CRESCENT
WOODLAND RIDGE ROAD
ROSELLA CLOSE
TOP KNOT PLACE
KINGFISHER COURT
SILVER EYE ROAD
JEANS STREET
HENRY DANGAR DRIVE
MILPERA DRIVE
NEW ENGLAND HIGHWAY

Legend

- Eucalyptus camaldulensis, Endangered population BC Act
- Dusky Woodswallow
- Grey-headed Flying-fox
- Koala scats
- Little Eagle
- Little Lorikeet
- Southern Myotis (roost)
- Southern Myotis
- Speckled Warbler
- Squirrel Glider
- Varied Sittella
- White-throated Needletail
- Watercourse
- Construction footprint
- Study area

Map: PS114532_BDAR_005_A5	Author: V.Lau
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0 0.25 0.5 km

1:15,000

Coordinate system: GDA 1994 MGA Zone 56

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NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT

Figure 3.5b
Threatened flora and fauna species

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3.9 Critical habitat

The registers of critical habitat listed under the EPBC Act, BC Act and FM Act searched during the desktop analysis and no critical habitat was found to occur within or in the locality of the study area.

3.10 Wildlife connectivity corridors

Wildlife corridors are generally links of native vegetation that join two or more areas of similar habitat and are critical for sustaining ecological processes, such as provision for animal movement and the maintenance of viable populations (Department of Environment, 2016).

Wildlife corridors in association with the study area are already subject to fragmentation due to the existing road and rail infrastructure. While these barriers are not impassable, they may already limit regular fauna movement.

Similarly, the majority of native vegetation in the locality has been historically cleared or thinned, which has also fragmented local wildlife connectivity.

The main remaining connected wildlife corridors are located:

- Along Muscle Creek and associated areas
- Areas to the north and south of Coal Road
- Remnant treed areas in the centre of the area between Sandy Creek and Coal Road.

These areas are the locations where species such as Squirrel Glider were recorded due to larger and more structurally intact habitats occurring.

While the study area is not likely to act as a key wildlife corridor in isolation, it nevertheless contains some important habitats and connectivity that requires further consideration as part of this BAR.

3.11 NSW State Environmental Planning Policies

There are two NSW State Environmental Planning Policies (SEPPs) that relate to biodiversity that are considered for the study area. These are:

- *State Environmental Planning Policy (Coastal Management) 2018* (Coastal Management SEPP)
- *State Environmental Planning Policy (Koala Habitat Protection) 2021* (Koala Habitat Protection SEPP).

An overview of each SEPP and the relevance to the study area is provided below.

3.11.1 State Environmental Planning Policy (Coastal Management) 2018

The Coastal Management SEPP was introduced to provide an integrated policy for coastal assets. Under the Coastal Management SEPP, areas of 'Coastal Wetlands' and 'Proximity Coastal Wetlands (100 metre buffer)' have been mapped across NSW.

None of the study area occurs within areas mapped as either Coastal Wetlands or their buffers as determined by the Coastal Management SEPP (NSW Department of Planning and Environment, 2018). As such, the proposal is considered unlikely to directly impact on mapped Coastal Wetlands.

3.11.2 State Environmental Planning Policy (Koala Habitat Protection) 2021

The Koala Habitat Protection SEPP came into effect on the 17 March 2021. Although the study area occurs in the Muswellbrook LGA which is listed under Schedule 1, the proposal does not require assessment in accordance with the SEPP as it is an activity being considered under Division 5.1 of the EP&A Act.

Targeted surveys conducted for the presence of Koala's, including Spot Assessment Technique across the study area, recorded evidence (in the form of scats) that the species is utilising habitat available within the study area. Refer to section 3.5 (Fauna habitat types) for the recorded Koala scat locations, which were all recorded at one of the SAT locations.

No koalas were otherwise observed within the study area, including scratches or other scats, or during spotlighting or the numerous other seasonal surveys.

In terms of local records on the BioNet Atlas of NSW Wildlife, a small number (<10) of Koala records within the locality over the last 15 or so years occur. This indicates a likely ongoing and sparsely occurring population of Koala.

3.12 Matters of National Environmental Significance

The focus of this section is threatened species, populations and communities and migratory species listed under the EPBC Act. It also included a discussion of the following MNES as they relate to biodiversity:

- World and national heritage
- Wetlands of international and national importance.

3.12.1 Threatened communities listed under the EPBC Act

Two EPBC Act listed threatened ecological communities were identified within the study area. These threatened ecological communities included:

- Central Hunter Valley eucalypt forest and woodland (Critically Endangered under EPBC Act)
- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands (Critically Endangered under EPBC Act).

A detailed description and comparison of each EPBC Act listed threatened ecological community is provided below.

Central Hunter Valley eucalypt forest and woodland

Three PCTs recorded within the study area were considered candidates to form part of the EPBC Act listed '*Central Hunter Valley eucalypt forest and woodland'* Critically Endangered EPBC Act listed threatened ecological community. These PCTs included:

- PCT 1604 Narrow-leaved Ironbark – Grey Box – Spotted Gum shrub – grass woodland of the central and lower Hunter
- PCT 1605 Narrow-leaved Ironbark Native Olive shrubby open forest of the central and upper Hunter
- PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter.

To be considered consistent with the Critically Endangered listing under the EPBC Act, the vegetation must be consistent with the criteria outlined in the '*Approved Conservation Advice (including listing advice) for the Central Hunter Valley eucalypt forest and woodland ecological community'* (Department of the Environment, 2015).

Specifically, the vegetation must meet:

- The key diagnostic characteristics AND
- At least the minimum condition thresholds for Category D (moderate quality condition).

Key diagnostic characteristics

A comparison of PCT 1604, PCT 1605 and PCT 1691 patches within the study area against the key diagnostic characteristic for *Central Hunter Valley eucalypt forest and woodland* is provided in Table 3.16.

Table 3.16 Comparison of EPBC Act Central Hunter eucalypt forest and woodland key diagnostic characteristics against PCT 1604, PCT 1605 and PCT 1691

Key diagnostic characteristics	PCT 1604 Low (Remnant)	PCT 1605 Moderate	PCT 1691 Moderate	PCT 1691 Low (Remnant)	PCT 1691 (Low (DNG)
It occurs in the Hunter River catchment (typically called the Hunter Valley region).	Yes, all occur within the Hunter River catchment.				
It typically occurs on lower hillslopes and low ridges, or valley floors in undulating country; on soils derived from Permian sedimentary rocks.	Yes, occurs on lower hillslopes and low ridges or valley floors in undulating country and occurs on Permian sedimentary rocks.				
It does not occur on alluvial flats, river terraces, aeolian sands, Triassic sediments, or escarpments.	Yes, none of the candidate PCTs occurs on alluvial flats, river terraces, Aeolian soils, Triassic sediments or escarpments.				
It is woodland or forest, with a projected canopy cover of trees of 10% or more; or with a native tree density of at least 10 native tree stems per 0.5 ha (at least 20 native tree stems/ha) that are at least one metre in height.	Yes, projected canopy cover is 10% or more; or with a canopy of at least 10 trees per 0.5 hectare. Where Low (Remnant) patches of PCT 1691 occur as shrubby acacia/eucalypt regrowth, canopy cover does not meet these thresholds.				No, occurs as derived native grassland with no canopy or a canopy of less than 10% projected foliage cover.
The canopy of the ecological community is dominated by one or more of the following four eucalypt species: *Eucalyptus crebra* (narrow-leaved ironbark), *Corymbia maculata* (syn. *E. maculata*) (spotted gum), *E. dawsonii* (slaty gum) and *E. moluccana* (grey box). OR A fifth species, *Allocasuarina luehmannii* (bulloak, buloke) dominates in combination with one or more of the above four eucalypt species, in sites previously dominated by one or more of the above four eucalypt species.	Yes, canopy is dominated by one of more of the following species: • *Eucalyptus crebra* (Narrow-leaved Ironbark) • *Eucalyptus moluccana* (Grey Box) • *Corymbia maculata* (Spotted Gum,); and/or • *Allocasuarina luehmannii (Buloke).*				Yes, isolated paddock trees included one or more of these five species. They were however largely absent.
Allocasuarina torulosa (forest oak/ she-oak, rose she-oak/oak), *Eucalyptus acmenoides* (white mahogany) and *E. fibrosa* (red/broad-leaved ironbark) are largely absent from the canopy of a patch.	Yes, no *Eucalyptus acmenoides* or *E. fibrosa* were recorded in these PCTs. *Allocasuarina torulosa* was largely absent except for the occasional individual in PCT 1605.				

Key diagnostic characteristics	PCT 1604 Low (Remnant)	PCT 1605 Moderate	PCT 1691 Moderate	PCT 1691 Low (Remnant)	PCT 1691 (Low (DNG)
A ground layer is present (although it may vary in development and composition), as a sparse to thick layer of native grasses and other native herbs and/or native shrubs.	Yes and no, northern patch groundcover is <50% exotic, southern patch is >50% native.	Yes, native groundcover is present	Yes, native ground-cover is present	Yes and no, majority of this condition had a groundcover <50% native.	Yes, native groundcover is present
Does this condition type meet the EPBC Act listing?	**Yes, meets criterion**	**Yes, meets criterion**	**Yes, meets criterion**	**Yes, meets criterion**	**No, does not meet criterion**

Patches of PCT 1604, PCT 1605 and PCT 1691 which met the key diagnostic characteristics of the threatened ecological community were further assessed against the minimum condition thresholds for the EPBC Act listed threatened ecological community as provided in Table 3.17.

Table 3.17 Condition categories (classes) and thresholds for Central Hunter Valley eucalypt forest and woodland ecological community

<table>
<tr><th>Category and rationale</th><th colspan="3">Thresholds</th></tr>
<tr><td>Class A. High quality condition e.g. A larger patch with good quality native understorey</td><td colspan="3">Patch size is ≥ 5 ha; AND
≥ 50% of perennial understorey vegetative cover is native; AND the patch contains at least 12 native understorey species.</td></tr>
<tr><td>Class B. High quality condition e.g. A patch with high quality native understorey</td><td colspan="3">Patch size is ≥ 0.5 ha AND
≥ 70% of perennial vegetative cover in each layer present[24] is native; AND the patch contains at least 12 native understorey species.</td></tr>
<tr><td>Class C. Moderate quality condition e.g. A patch with good quality native understorey</td><td colspan="3">Patch size is ≥ 0.5 ha; AND
≥ 50% of perennial understorey vegetative cover is native; AND the patch contains at least 12 native understorey species.</td></tr>
<tr><td rowspan="2">Class D. Moderate quality condition e.g. A moderate to large sized patch with: connectivity to a native vegetation area; or a mature tree; or a tree with hollows.</td><td colspan="3">Patch size is ≥ 2 ha; AND
≥ 50% of perennial understorey vegetative cover is native; AND</td></tr>
<tr><td>The patch is contiguous with another patch of native woody vegetation[25] ≥ 1 ha in area</td><td>OR</td><td>The patch has at least one large locally indigenous tree (≥ 60 cm dbh[26]), or at least one tree with hollows.</td></tr>
<tr><td colspan="4"><u>Notes to the above</u>
Perennial understorey vegetation cover (i.e. below the tree canopy) includes vascular plant species, of both the ground layer and the mid/shrub layer (where present), with a life-cycle of more than two growing seasons. The ground layer includes herbs (i.e. grasses and forbs) and some low shrubs (woody plants ≤ 0.5 m high). Measurement of perennial understorey vegetation cover excludes annuals, cryptogams, leaf litter or exposed soil.
In addition, please see the footnotes below and Section 1.5.4 of this document for further information to assist in determining the presence of the ecological community and significant impacts (including on the timing of surveys and sampling protocols).</td></tr>
</table>

Source: Approved Conservation Advice (including listing advice) for the Central Hunter Valley eucalypt forest and woodland ecological community (Department of the Environment, 2015).

Condition thresholds

To assess PCT 1604, PCT 1605 and PCT 1691 against the EPBC Act condition thresholds, each broad condition type was assessed against the attributes identified in the thresholds column in Table 3.17 (i.e. criteria relating to patch size, species composition, diversity and cover of introduced species characteristics). A summary of this condition assessment is provided below.

PCT 1604 Low (Remnant) condition:

- Patch size – northern polygon forms part of a patch which is greater than 5ha in size, southern polygon forms a patch which was less than 0.5 hectare in size
- Perennial understorey cover – northern patch perennial groundcover was greater than 50% exotic, southern polygon perennial understorey cover was greater than 50% native
- Understorey species diversity – both northern and southern polygons contained more than 12 native understorey species.

PCT 1605 Moderate condition:

- Patch size – all polygons formed part of a patch which was greater than 5 hectare in size
- Perennial understorey cover – perennial understorey cover was greater than 50% exotic
- Understorey species diversity – all patches contained more than 12 native understorey species.

PCT 1691 Moderate condition:

- Patch size – all polygons formed part of a patch which was greater than 5 hectare in size
- Perennial understorey cover – all patches had a predominantly native perennial groundcover
- Understorey species diversity – all patches contained more than 12 native understorey species.

PCT 1691 Low (Remnant) condition:

- Patch size – some polygons formed part of a patch which was greater than 5 hectare in size while others formed patches which were less than 0.5ha in size
- Perennial understorey cover – perennial understorey cover was greater than 50% exotic
- Understorey species diversity – no patches contained more than 12 native understorey species.

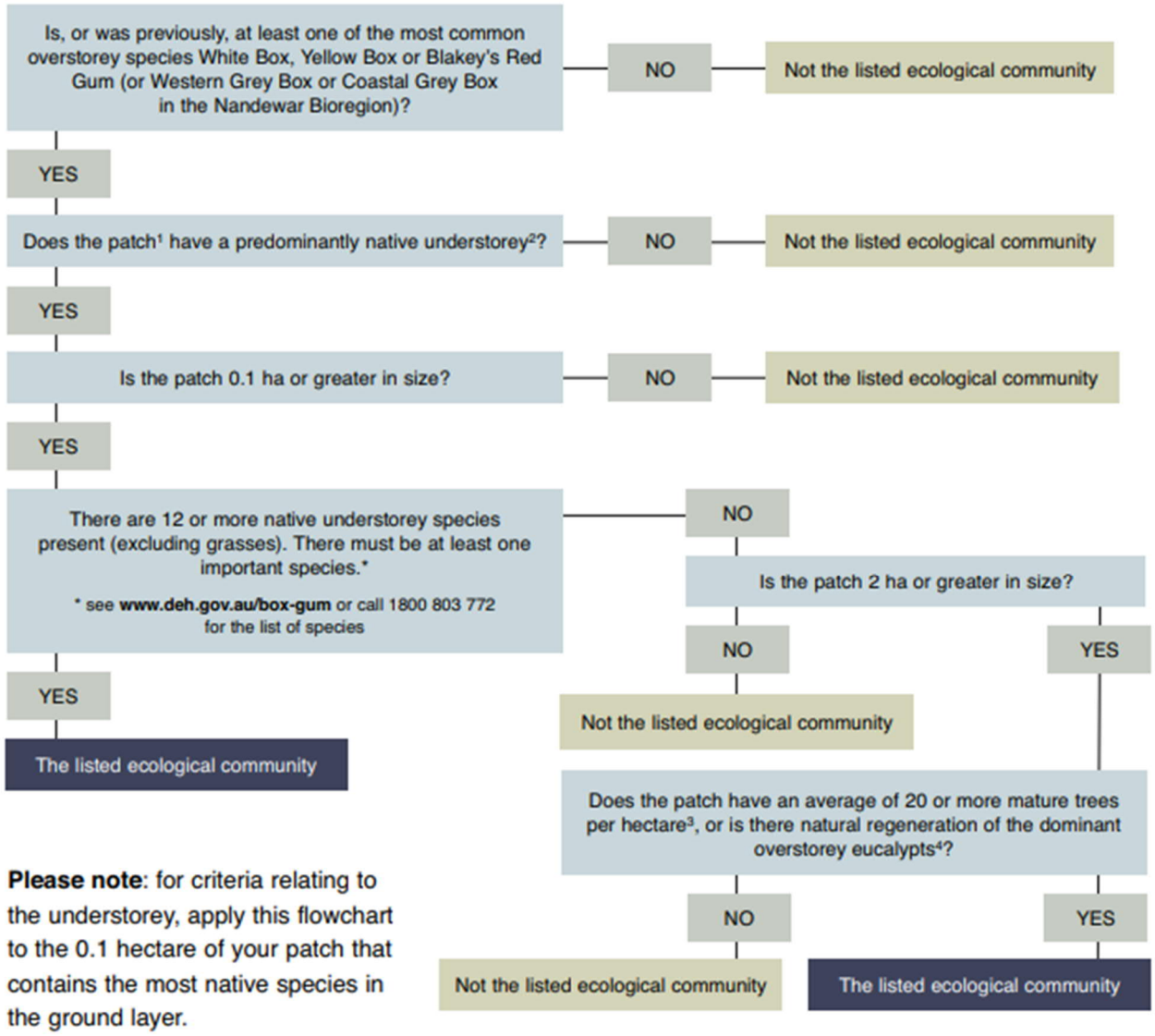
In conclusion, only moderate condition patches of PCT 1605 and PCT 1691 were assessed as being consistent with the EPBC Act listing for Central Hunter Valley eucalypt forest and woodland as they met both the key diagnostic characteristics and condition thresholds. Low condition patches of PCT 1604 and PCT 1691 did not meet the thresholds for the EPBC Act listing as they either occurred as derived native grassland or shrubby regrowth thereby lacking the 10% canopy cover required, contained a predominantly exotic understorey or did not form part of a patch which was greater than 0.5 hectare.

White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands

Two PCTs recorded within the study area were considered candidates to form part of the EPBC Act listed 'White Box – Yellow Box – Blakely's Red Gum grassy woodlands and derived native grasslands' Critically Endangered EPBC Act listed threatened ecological community. These PCTs included:

- PCT 1693 Yellow Box – Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains
- PCY 1607 Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter.

To be considered consistent with the Critically Endangered listing under the EPBC Act, the vegetation must be consistent with the criteria outlined in the *EPBC Act policy statement 3.5 – White box – Yellow box – Blakely's red gum grassy woodlands and derived native grasslands* (Department of the Environment and Heritage, 2006) and as summarised in Figure 3.7. An assessment of these two PCTs against these criteria is provided in Table 3.18.



[1] Patch – a patch is a continuous area containing the ecological community (areas of other ecological communities such as woodlands dominated by other species are not included in a patch). In determining patch size it is important to know what is, and is not, included within any individual patch. The patch is the larger of:
- an area that contains five or more trees in which no tree is greater than 75 m from another tree, or
- the area over which the understorey is predominantly native.

Patches must be assessed at a scale of 0.1 ha (1000m²) or greater.

[2] A predominantly native ground layer is one where at least 50 per cent of the perennial vegetation cover in the ground layer is made up of native species. The best time of the year to determine this is late autumn when the annual species have died back and have not yet started to regrow. (At other times of the year, you can determine whether something is perennial or not is if it is difficult to pull out of the soil. Annual species pull out very easily.)

[3] Mature trees are trees with a circumference of at least 125 cm at 130 cm above the ground.

[4] Natural regeneration of the dominant overstorey eucalypts when there are mature trees plus regenerating trees of at least 15 cm circumference at 130 cm above the ground.

Figure 3.6 Commonwealth White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland determining criteria

Table 3.18 PCT 1607 and PCT 1693 assessment against White Box – Yellow Box – Blakely's Red Gum grassy woodland and derived native grasslands EPBC Act determining criteria

Criteria	PCT 1607 Good	PCT 1607 Low (Remnant)	PCT 1607 Low (DNG)	PCT 1693 Good	PCT 1693 Moderate	PCT 1693 Low (Remnant)	PCT 1693 Low (DNG)
Is, or was previously, at least one of the most common overstorey species White Box, Yellow Box or Blakely's Rd Gum?	Yes as a whole, patches of this community are/or were either dominated or co-dominated by *Eucalyptus blakelyi* (Blakely's Red Gum)			Yes, canopy is or was dominated by *Eucalyptus melliodora* (Yellow Box) and/or *Eucalyptus blakelyi* (Blakely's Red Gum)			
Does the patch have a predominantly native understorey?	Yes, native groundcover is >50%	No, native groundcover is <50% native	Yes, native groundcover is >50%	Yes, native groundcover is >50%		Yes and no, most patches had a native groundcover >50%	Yes, native groundcover is >50%
Is the patch 0.1 ha or greater in size?	Yes, all patches >0.1ha in size	Partially, some patches <0.1ha in size	Yes, all patches >0.1ha in size	Yes, all patches >0.1ha in size		Predominantly yes, few patches are <0.1ha in size	Yes, all patches >0.1ha in size
There are 12 or more native understorey species present (excluding grasses). There must be at least one important species.	Yes, patch contained >12 native understory species and more than one important species	No, understorey generally contained fewer than 12 native understorey species, some locations did not contain an important species while others contained at least one important species		Yes, patch contained >12 native understory species and more than one important species		No, understorey generally contained fewer than 12 native understorey species, some locations did not contain an important species while others contained at least one important species	
Meet EPBC Act listing criteria?	**Yes, meets criteria**	**No, does not meet criteria**	**No, does not meet criteria**	**Yes, meets criteria**	**Yes, meets criteria**	**No, does not meet criteria**	**No, does not meet criteria**

The assessment concluded that most of the vegetation assigned to PCT 1607 and PCT 1693 did not meet the condition criteria of the EPBC Act listing for *White Box – Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grasslands* as it failed to meet one or more of the following criteria:

- Understorey species diversity
- Patch size
- Condition thresholds
- A canopy dominated by one of the characteristic tree species
- Or was too shrubby in nature.

Exceptions to this were good and moderate patches of PCT 1607 and PCT 1693 which did meet the condition thresholds and are therefore considered to form part of the Critically Endangered ecological community listed under the EPBC Act.

3.12.2 Threatened flora listed under the EPBC Act

The desktop assessment identified 41 EPBC Act listed threatened flora species as being known or predicted to occur in the locality of the study area. Of these, five were considered to have a moderate likelihood of occurrence (Appendix A and Table 3.19) based on habitat available in the study area. These species became candidate species for detailed targeted fauna surveys.

No EPBC Act listed threatened flora species were recorded within the study area during targeted surveys and therefore no EPBC Act listed flora species are considered likely to be impacted by the proposal.

Table 3.19 Threatened flora species listed on the EPBC Act with moderate or higher likelihood of occurrence

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Potential occurrence	Affected species?
Eucalyptus glaucina	Slaty Red Gum	V	V	Moderate. Associated habitat present in the form of PCT 1691 and PCT 1604. No individuals of this species were recorded during targeted surveys conducted under suitable seasonal survey conditions or have been recorded previously.	No – surveyed
Ozothamnus tesselatus	–	V	V	Moderate. Associated habitat present in the form of PCT 1691 and PCT 1604. No individuals of this species were recorded during targeted surveys conducted under suitable seasonal survey conditions or have been recorded previously.	No – surveyed
Prasophyllum sp. *Wybong* *(Prasophyllum petilum)*	Tarengo Leek Orchid	E	E	Moderate. Associated habitat present in the form of PCT 1691 and PCT 42. No individuals of this species were recorded during targeted surveys conducted under suitable seasonal survey conditions or have been recorded previously.	No – surveyed

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Potential occurrence	Affected species?
Pterostylis chaetophora	–	V	V	Moderate. Associated habitat present in the form of PCT 1691 and PCT 1604. No individuals of this species were recorded during targeted surveys conducted under suitable seasonal survey conditions or have been recorded previously.	No – surveyed
Thesium australe	Austral Toadflax	V	V	Moderate. Associated habitat present in the form of PCT 1691 and PCT 1605. No individuals of this species were recorded during targeted surveys conducted under suitable seasonal survey conditions or have been recorded previously.	No – surveyed

1. Vulnerable (V), Endangered (E), Critically Endangered (CE) as listed on the BC Act
2. Vulnerable (V), Endangered (E), Critically Endangered (CE) as listed on the EPBC Act

3.12.3 Threatened fauna listed under the EPBC Act

The desktop assessment identified 28 EPBC Act listed threatened fauna species as being known or predicted to occur in the locality of the study area (Appendix A). Of these, 11 were either recorded or are considered likely to utilise habitat identified within the study area (Table 3.20).

Four EPBC Act listed threatened fauna species was recorded within the study area during targeted survey (Figure 3.5). These species included:

- Striped Legless Lizard (*Delma impar*)
- White-throated Needletail (*Hirundapus caudacutus*)
- Koala (*Phascolarctos cinereus*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*).

Table 3.20 Threatened fauna species listed on the EPBC Act with moderate or higher likelihood of occurrence

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Potential occurrence	Affected species?
Anthochaera phrygia	Regent Honeyeater	CE	CE	Moderate. Study area contains suitable foraging and breeding habitat for the species.	Yes
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Moderate. Suitable foraging habitat, likely that local individuals may use the study area on at least an intermittent basis. No breeding habitat occurs within the study area	Yes – foraging habitat only
Dasyurus maculatus maculatus	Spotted-tailed Quoll	V	E	Moderate. Marginal habitat within study area, study area may occur within the home range of local individuals and intermittent occurrences cannot be discounted.	Yes
Delma impar	Striped Legless Lizard	V	V	Recorded. Suitable foraging and breeding habitat for the species.	Yes
Grantiella picta	Painted Honeyeater	V	V	Moderate. Study area contains suitable foraging and breeding habitat for the species.	Yes
Hirundapus caudacutus	White-throated Needletail	–	V	Recorded. Recorded foraging in air space above the study area. Unlikely to use terrestrial habitat associated with the study area.	Yes
Lathamus discolor	Swift Parrot	CE	CE	Moderate. Study area contains suitable foraging habitat for the species. May occasionally occur during seasonal blossoming events.	Yes – foraging habitat only
Nyctophilus corbeni	Corben's Long-eared Bat	V	V	Moderate. Potential foraging and roosting habitat occurs within the study area.	Yes
Phascolarctos cinereus	Koala	V	V	Recorded. Koala scats were recorded from one location within the study area.	Yes
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Recorded. Individuals were observed foraging and flying over the study area. No roost camps recorded. Habitat within study area forms part of this species' foraging range and is likely to occur during seasonal blossoming events.	Yes – no camps recorded
Rostratula australis	Australian Painted Snipe	E	E	Moderate. Study area contains marginal habitat for the species and may occur under suitable climatic conditions.	Yes

1. Vulnerable (V), Endangered (E), Critically Endangered (CE) as listed on the BC Act
2. Vulnerable (V), Endangered (E), Critically Endangered (CE) as listed on the EPBC Act.

Striped Legless Lizard (*Delmar impar*)

This species was recorded in three locations, two under the tiles set specifically to target this species and one in the same general location when undertaking natural habitat searches under rocks. Refer to Figure 3.5 for the recorded locations and corresponding known area of habitat.

They were all recorded in the same general location, being seemingly associated with the Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter – Low (DNG) condition. It appears that they are most likely occurring in association with this DNG as it likely contains a native grass structural diversity that this species needs. This species was however not recorded in the other tile locations (shown previously in Figure 2.2) that contained various types of habitats (including similar habitats) so this could also potentially be a discrete population.

White-throated Needletail (*Hirundapus caudacutus*)

This species was recorded once flying in the airspace above Muscle Creek. Its aerial habitats are unlikely to be impacted by the proposal.

Koala habitat summary

The Koala is listed as Vulnerable under the EPBC Act. There is likely a sparsely occurring population within the surrounds of Muswellbrook township and in the locality, with a small number of records (<10) within the last 15 or so years.

Under the EPBC Act an 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity, and/or
- Populations that are near the limit of the species range.

A single location of Koala activity was recorded within the study area via SAT results, refer to Figure 3.5. No other signs such as scratches, observations or vocalisations were recorded. The scats were located all under a single tree, with no other scats observed in any other location. This supports the theory that the local population is sparsely occurring and habitat within the construction footprint may be used on an intermittent basis during local movements, but it not likely to represent an important population.

The following species which broadly occur throughout the PCT's within the study area are listed as Feed Tree Species for the Central Coast koala management area under the NSW State Environmental Planning Policy (Koala Habitat Protection) 2020. It is noted however that the scat recorded was not recorded near either of these species.

- *Eucalyptus camaldulensis* River Red Gum
- *Eucalyptus tereticornis* Forest Red Gum.

Federal Koala Habitat assessment tool

The *'EPBC Act referral guidelines for the vulnerable Koala'* (Department of the Environment, 2014) contains a koala habitat assessment tool which allows an assessor to determine whether habitat within a given site classifies as '*habitat critical to the survival of the Koala'* and provides guidance on when a proposal should consider submitting an EPBC Act referral.

Although Transport for NSW are not obligated to refer impacts on MNES, such as the Koala, in accordance with the EPBC Act – Strategic Assessment, an assessment against the '*EPBC Act referral guidelines for the vulnerable Koala'* has been conducted to inform the assessment of impacts associated with the proposal on the Koala.

Specifically, the Koala Habitat Assessment Tool within the *'EPBC Act referral guidelines for the vulnerable Koala'* was used to determine whether Koala habitat within the study area classifies as '*habitat critical to the survival of the Koala'* (Figure 3.7). To be classified as habitat critical to the survival of the Koala vegetation must score 5 or above using the habitat assessment tool. A summary of the assessment completed is provided in Table 3.21.

Koala habitat within the study area scored 9 out of 10 using the Koala Habitat Assessment Tool. Therefore, habitat within the study area constitutes habitat critical to the survival of the species.

A comparison of the potential impacts of the proposal was assessed against Figure 2 of the '*EPBC Act referral guidelines for the vulnerable Koala'* (Department of the Environment, 2014). The guideline recommends a referral if a proposed action requires the removal of more than 20 hectares of habitat critical to the Koala (Figure 3.8). Although, this report assesses an impact of 22.26ha of habitat critical to the Koala this is a precautionary assessment. The construction footprint includes additional areas unlikely to be impacted to allow flexibility during construction and therefore represents a worst-case scenario. As such, final impacts to the species are likely to be less than the 20 hectares.

The study area supports the theory that there is a local population sparsely occurring and likely to use habitat affected by the proposal. The area of habitat to be affected would be up to 22.26ha. Through design however the proposal has avoided and minimised impacts to the highest areas of habitat within the study area and would further reduce residual impacts through the implementation of mitigation measures detailed in section 5.2 (Mitigation measures).

In accordance with Appendix A of the EPBC Act Strategic Assessment, Transport for NSW is not obligated to refer or gain approval for an impact on a nationally listed biodiversity entity. Furthermore, whilst the proposal would be impacting up to 22.26ha of habitat critical to the Koala the proposal is considered unlikely to have a significant impact on the species (Appendix D).

Attribute	Score	Inland	Coastal
Koala occurrence	+2 (high)	Evidence of one or more koalas within the last 5 years.	Evidence of one or more koalas within the last 2 years.
	+1 (medium)	Evidence of one or more koalas within 2 km of the edge of the impact area within the last 10 years.	Evidence of one or more koalas within 2 km of the edge of the impact area within the last 5 years.
	0 (low)	None of the above.	None of the above.
Vegetation composition	+2 (high)	Has forest, woodland or shrubland with emerging trees with 2 or more known koala food tree species, **OR** 1 food tree species that alone accounts for >50% of the vegetation in the relevant strata.	Has forest or woodland with 2 or more known koala food tree species, **OR** 1 food tree species that alone accounts for >50% of the vegetation in the relevant strata.
	+1 (medium)	Has forest, woodland or shrubland with emerging trees with only 1 species of known koala food tree present.	Has forest or woodland with only 1 species of known koala food tree present.
	0 (low)	None of the above.	None of the above.
Habitat connectivity	+2 (high)	Area is part of a contiguous landscape ≥ 1000 ha.	Area is part of a contiguous landscape ≥ 500 ha.
	+1 (medium)	Area is part of a **contiguous landscape** < 1000 ha, but ≥ 500 ha.	Area is part of a contiguous landscape < 500 ha, but ≥ 300 ha.
	0 (low)	None of the above.	None of the above.
Key existing threats	+2 (high)	Little or no evidence of koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for koala occurrence. Areas which score 0 for koala occurrence and have no dog or vehicle threat present	
	+1 (medium)	Evidence of infrequent or irregular koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for koala occurrence, **OR** Areas which score 0 for koala occurrence and are likely to have some degree dog or vehicle threat present.	
	0 (low)	Evidence of frequent or regular koala mortality from vehicle strike or dog attack in the study area at present, **OR** Areas which score 0 for koala occurrence and have a significant dog or vehicle threat present.	
Recovery value	+2 (high)	Habitat is likely to be important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.	
	+1 (medium)	Uncertain whether the habitat is important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.	
	0 (low)	Habitat is unlikely to be important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.	

Figure 3.7 EPBC Act Koala habitat assessment tool (Department of the Environment, 2014)

Table 3.21 Completed EPBC Act Koala habitat assessment tool for habitat within the study area

Attribute	Score	Habitat appraisal	
Koala occurrence	2	Desktop	Database searches identified approx. three Koala records within 3 kilometres of the construction footprint in the last 5 years.
		On-site	Scats recorded at one location within the study area.
Vegetation structure and composition	2	Desktop	Limited desktop information available
		On-site	Habitat ground-truthing was carried out during field surveys which identified two Koala feed tree species listed under Schedule 2 of the Koala Habitat Protection SEPP including • *Eucalyptus tereticornis* (Forest Red Gum) • *Eucalyptus camaldulensis* (River Red Gum) A An additional seven Koala feed trees listed as canopy tree species known to be used by Koalas within the Central Coast koala management area (KMA were recorded including: • *Allocasuarina torulosa* (Forest Oak) • *Casuarina glauca* (Swamp Oak) – planted • *Angophora floribunda* (Rough-barked Apple) • *Corymbia maculata* (Spotted Gum) • *Eucalyptus crebra* (Narrow-leaved Ironbark) • *Eucalyptus moluccana* (Grey Box) • *Eucalyptus melliodora* (Yellow Box). Furthermore, *Eucalyptus blakelyi* (Blakely's Red Gum) was also recorded and is also a canopy tree species known to be used by Koalas in the adjoining KMAs.
Habitat connectivity	2	The study area is a part of a contiguous landscape that is >1000ha, albeit still fragmented.	
Key existing threats	2	Desktop	No known koala mortality
		On-site	No known koala mortality
Recovery value	1	Uncertain – local vegetation subject to existing edge effects and fragmentation. It is however connected to large areas of likely Koala habitat in the locality and the local population is likely to be genetically robust and operate as a viable population.	
Total	**9**	**Decision: a score of 9 obtained therefore site contains potential critical habitat.**	

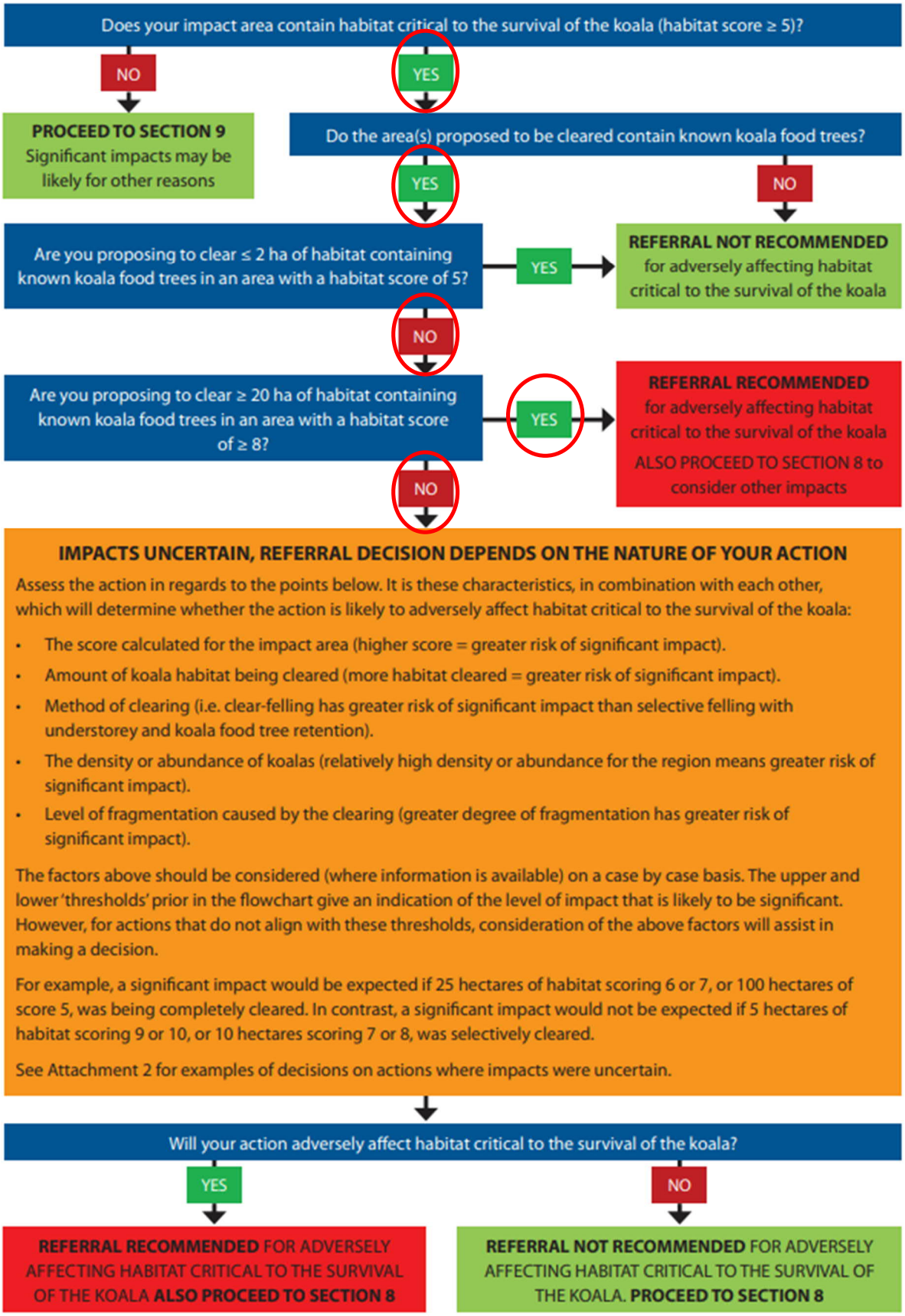


Figure 3.8 Assessment of adverse effects on habitat critical to the survival of the Koala (Department of the Environment, 2014)

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

No known camps occur or were recorded for this species, although this species was recorded during spotlighting. The significance of habitat for this species is considered to be low.

3.12.4 Migratory species

Migratory species are protected under international agreements, to which Australia is a signatory, including JAMBA, CAMBA, RoKAMBA and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Migratory species are considered Matters of NES and are protected under the EPBC Act.

Database searches identified 25 migratory species to potentially occur within the study area. During field surveys one migratory species listed under the EPBC Act, was recorded (White-throated Needletail). An additional six migratory species are considered to have a moderate likelihood of occurring within the study area (Table 3.22).

Table 3.22 Migratory fauna species recorded or with a moderate or higher likelihood of occurrence

Scientific name	Common name	Status		Potential occurrence
		BC Act[1]	EPBC Act[2]	
Anthochaera phrygia	Regent Honeyeater	CE	CE, M	Moderate
Gallinago hardwickii	Latham's Snipe	–	M	Moderate
Hirundapus caudacutus	White-throated Needletail	–	V, M	Recorded
Monarcha melanopsis	Black-faced Monarch	–	M	Moderate
Myiagra cyanoleuca	Satin Flycatcher	–	M	Moderate
Rhipidura rufifrons	Rufous Fantail	–	M	Moderate
Rostratula australis	Australian Painted Snipe	E	E, M	Moderate

1. Endnagered (E), Critically Endangered (CE) as listed on the BC Act
2. Migratory (M), Critically Endangered (CE), Endnagered (E), Vulnerable (V) as listed on the EPBC Act

The White-throated Needletail was recorded foraging in airspaces above the study area and it is considered likely that individuals would intermittently hunt in the aerial habitats associated with the locality during seasonal occurrences.

These species have the potential to utilise a wide variety of habitats, including disturbed / modified areas. The habitats within the study area are unlikely to constitute important habitat for any of the listed species, due to the habitat present is unlikely to support significant proportions of the population of any migratory species nor are the habitats critical to any life stage of these species. Due to their mobile nature, the mentioned species are likely to utilise higher quality habitat within the greater locality and where more extensive tracts of native vegetation occur.

3.12.5 Wetlands of international importance

Databases searches revealed one wetland of international importance within proximity to the study area; being The Hunter estuary wetlands. This wetland is located about 50–100 kilometres upstream from the study area.

The study area does not contain waterways that are connected to the above wetlands of international importance and therefore is considered unlikely to impact upon these wetlands.

3.12.6 World or national heritage

Databases searches revealed one national heritage place within 10 kilometres of the study area; being the Muswellbrook Post Office. This national heritage place is not located within the study area and is therefore unlikely to impacted by the proposal.

4 Impact assessment

A description of the proposal's potential impacts on biodiversity during the construction and operational phases are summarised in this chapter. The impacts have been separated into direct, indirect and cumulative impact categories and include the following:

- Construction impacts
  - Removal of native vegetation and threatened ecological communities
  - Removal of threatened flora species
  - Removal of threatened fauna habitat and habitat features
  - Injury and mortality of fauna.
- Indirect/operational impacts
  - Alteration to wildlife connectivity and habitat fragmentation
  - Edge effects on adjacent native vegetation and habitat
  - Invasion and spread of weeds
  - Invasion and spread of pests
  - Invasion and spread of pathogens and disease
  - Changes to hydrology
  - Impacts to Groundwater Dependent Ecosystems
  - Noise, light and vibration.
- Cumulative impacts.

Where applicable, impacts are also correlated with relevant key threatening processes. Impact evaluation, significance assessments and residual impacts are discussed further in section 5 (Avoid, minimise and mitigate impacts) and Appendix D.

4.1 Construction impacts

4.1.1 Removal of native vegetation

It is estimated that up to 97.92ha of native vegetation would require removal by the proposal. Of this, 75.66ha is comprised of DNG and 22.26ha consists of remnant vegetation.

It is noted that this area of clearing represents a worst-case scenario as the construction footprint includes some additional areas which would not likely be impacted upon by the proposal. These additional areas have been included in this assessment to allow flexibility during design and construction to accommodate temporary structures ancillary features such as access tracks, site compounds and laydown areas.

A breakdown of approximate native vegetation removal of each PCT and vegetation zone is provided below in Table 4.1. Discussion of relevant key threatening processes related to direct impact on vegetation are shown in Table 4.2.

The proposal would also result in the removal of areas of the following miscellaneous ecosystems:

- Cropping
- Highly disturbed areas with no or limited native vegetation
- Native plantings (including mine rehabilitation)
- Urban/exotic plantings.

Table 4.1 Impacts on native vegetation

Plant community type (PCT)	Condition class	BC Act	EPBC Act	Percent cleared in NSW	Construction footprint (ha)
PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	Moderate	Endangered[1]	Critically Endangered[5]	77%	8.82
	Low (Remnant)		–		4.93
	Low (DNG)		–		38.39
PCT 1604 Narrow-leaved Ironbark – Grey Box – Spotted Gum shrub – grass woodland of the central and lower Hunter	Low (Remnant)	Endangered[2]	–	71%	0.67
PCT 1605 Narrow-leaved Ironbark – Native Olive shrubby open forest of the central and upper Hunter	Moderate	Endangered[1]	Critically Endangered[5]	32%	0.06
PCT 1607 Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter	Good	Critically Endangered[3]	Critically Endangered[6]	51%	0.56
	Low (Remnant)		–		0.09
	Low (DNG)		–		1.02
PCT 1693 Yellow Box – Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	Good	Critically Endangered[3]	Critically Endangered[6]	64%	-
	Moderate				0.02
	Low (Remnant)		–		5.07
	Low (DNG)		–		31.19
PCT 42 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Low (Remnant)	Endangered[4]	–	95%	0.08
	Low (DNG)		–		3.38
PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)	Moderate	–	–	50%	1.78
	Low (Remnant)	–	–		0.18
	Low (DNG)	–	–		1.68
Total native vegetation impacted					**97.92**
Total area of native vegetation occurring as DNG					**75.66**
Total area of native vegetation occurring as remnant vegetation					**22.26**

1. Based on the VIS classification database.
2. Area to be cleared based on ground-truthed vegetation mapping within the study area.

Table 4.2 Key threatening processes associated with the removal of native vegetation

Key threatened process	BC Act	EPBC Act	Impact of the proposal
Clearing of native vegetation	X	Not listed	The proposal would contribute to this process through the clearing of 97.92ha of native vegetation. Of this, 75.66ha is comprised of DNG and 22.26ha is comprised of remnant woodland vegetation.
Land clearance	Not listed	X	

4.1.2 Removal of threatened flora

There would be no direct impacts on threatened flora species listed under the BC Act or the EPBC Act.

Although one threatened flora species listed as an Endangered Population under the BC Act; being *Eucalyptus camaldulensis* (River Red Gum), was recorded within the study area no individuals which form part of this Endangered Population would be impacted by the proposal. All direct impacts to this population have been avoided through design. Impacts of the proposal on this population would be limited to potential indirect impacts associated with the construction of the proposal however these are considered to be minor and temporary.

4.1.3 Removal of threatened fauna habitat

The extent of vegetation removal estimated to result from the proposal is outlined above in section 4.1.1 (Removal of native vegetation). This vegetation provides suitable habitat and habitat features for a range of threatened fauna species listed under the BC Act and/or EPBC Act. As such, direct impacts to habitat for threatened fauna species would occur during construction.

The direct impacts of the proposal on threatened fauna habitat has been estimated based on a worst-case scenario (i.e. removal of all vegetation within the construction footprint). A breakdown of the direct impacts on threatened fauna species is provided in Table 4.3.

Table 4.3 Impacts on threatened fauna and fauna habitat

Species	Potential occurrence	Impacted by proposal?	Impact (ha)
Australian Painted Snipe (*Rostratula australis*)	Moderate	Yes	2.41
Barking Owl (*Ninox connivens*)	Moderate	Yes	97.92
Black Falcon (*Falco subniger*)	Moderate	Yes	97.92
Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*)	Moderate	Yes	22.26
Black-necked Stork (*Ephippiorhynchus asiaticus*)	Moderate	Yes	2.41
Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)	Moderate	Yes	22.26
Corben's Long-eared Bat (*Nyctophilus corbeni*)	Moderate	Yes	97.92
Diamond Firetail (*Stagonopleura guttata*)	Moderate	Yes	22.26
Dusky Woodswallow (*Artamus cyanopterus*)	Recorded	Yes	22.26

Species	Potential occurrence	Impacted by proposal?	Impact (ha)
Eastern Cave Bat (*Vespadelus troughtoni*)	Moderate	Yes – foraging only	97.92
Eastern Coastal Freetail Bat (*Micronomus norfolkensis*)	High	Yes	97.92
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	High	Yes	97.92
Flame Robin (*Petroica phoenicea*)	Moderate	Yes	22.26
Gang-Gang Cockatoo (*Callocephalon fimbriatum*)	Moderate	Yes	22.26
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	Moderate	Yes	97.92
Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*)	High	Yes	22.26
Grey-headed Flying-fox (*Pteropus poliocephalus*)	Recorded	Yes – no camps	22.26
Hooded Robin (*Melanodryas cucullata cucullata*)	Moderate	Yes	22.26
Koala (*Phascolarctos cinereus*)	Recorded	Yes	22.26
Large Bent-winged Bat (*Miniopterus orianae oceanensis*)	High	Yes – foraging only	97.92
Large-eared Pied Bat (*Chalinolobus dwyeri*)	Moderate	Yes – foraging only	97.92
Little Bent-wing Bat (*Miniopterus australis*)	High	Yes – foraging only	97.92
Little Eagle (*Hieraaetus morphnoides*)	Recorded	Yes	97.92
Little Lorikeet (*Glossopsitta p*usilla)	Recorded	Yes	22.26
Magpie Goose (*Anseranas semipalmata*)	Moderate	Yes	2.41
Masked Owl (*Tyto novaehollandiae novaehollandiae*)	Moderate	Yes	97.92
Painted Honeyeater (*Grantiella picta*)	Moderate	Yes	22.26
Powerful Owl (*Ninox strenua*)	Moderate	Yes	97.92
Regent Honeyeater (*Anthochaera phrygia*)	Moderate	Yes	22.26
Scarlet Robin (*Petroica boodang*)	Moderate	Yes	22.26
Southern Myotis (*Myotis macropus*)	Recorded	Yes	12.27
Speckled Warbler (*Chthonicola sagittata*)	Recorded	Yes	22.26
Spotted Harrier (*Circus assimilis*)	Moderate	Yes	97.92
Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)	Moderate	Yes	22.26
Square-tailed Kite (*Lophoictinia isura*)	Moderate	Yes	97.92

Species	Potential occurrence	Impacted by proposal?	Impact (ha)
Squirrel Glider (*Petaurus norfolcensis*)	Recorded	Yes	22.26
Striped Legless Lizard (*Delma impar*)	Recorded	Yes – indirect impacts only	<0.01
Swift Parrot (*Lathamus discolor*)	Moderate	Yes – foraging only	22.26
Turquoise Parrot (*Neophema pulchella*)	Moderate	Yes	22.26
Varied Sittella (*Daphoenositta chrysoptera*)	Recorded	Yes	22.26
White-bellied Sea-eagle (*Haliaeetus leucogaster*)	Recorded	Yes	22.26
White-throated Needletail (*Hirundapus caudacutus*)	Recorded	Yes	97.92
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	Moderate	Yes	97.92

Key threatening processes associated with removal of key fauna habitat features are identified in Table 4.4 below.

Table 4.4 Key threatening processes associated with the removal of fauna habitat features

Key threatened process	BC Act	EPBC Act	Impact of the proposal
Loss of hollow-bearing trees	X	Not listed	About 42 hollow-bearing trees would require removal. It is anticipated that the number of hollow-bearing trees to be impacted will be reduced through further detailed design, especially within areas outside the poposed road corridor being used for temporary ancillary infrastructure.
Removal of dead wood and dead trees	X	Not listed	Dead wood on the ground scattered through the study area would require removal/translocation.
Bushrock removal	x	Not listed	Areas containing surface and partially submerged bush rock are likely to require remove/translocated.

4.1.4 Aquatic impacts

As discussed in section 3.5.2 (Aquatic fauna habitats), most of the watercourses within the study area likely to be affected by the proposal are ephemeral and in poor condition due to previous development, modification and activity within the catchment which has resulted in changes to hydrological conditions, increased input of nutrients, sedimentation, compaction and weed invasion. These ephemeral waterways are typical of a highly modified agricultural landscape. While they have defined banks and they limited to intermittent flows following periods of high extended rainfall and have limited aquatic habitat. These waterways were either not classified as Key Fish Habitat (Department of Primary Industries, 2013) and/or based on observations were likely to align to Class 4 (unlikely key fish habitat). Two exceptions to this include:

- Sandy Creek

- Muscle Creek.

Sandy Creek

Sandy Creek is a tributary of the Hunter River and is recognised as Key Fish Habitat (Department of Primary Industries, 2013). Within the study area, Sandy Creek is considered to be a Class 3 watercourse (i.e. minimal key fish habitat). Although the creek has defined banks it is ephemeral in nature and does not appear to support native aquatic or wetland vegetation, given its highly disturbed nature. As such, Sandy Creek and its tributaries within the study area are likely to align to Type 3 (minimally sensitive key fish habitat).

Impacts of the proposal on Sandy Creek would include the construction of a bridge which would extend over Sandy Creek Road, Sandy Creek, Main North railway line and southbound exit ramp. This bridge would be about 376 metres long and measure about 5.9 metres above Sandy Creek. There are already two bridges which extend over Sandy Creek to the west of the construction footprint for the rail and existing New England Highway. The construction of the Sandy Creek bridge would have an incremental impact on aquatic habitat however given the large span of the bridge and the highly disturbed nature of the waterbody, these impacts are unlikely to significantly exacerbate existing impacts.

Muscle Creek

Muscle Creek is a tributary of the Hunter River and is recognised as Key Fish Habitat (Department of Primary Industries, 2013). Within the study area, Muscle Creek is considered a Class 2 watercourse (i.e. moderate key fish habitat) as it has well defined banks, semi-permanent to permanent water, pools and contains freshwater aquatic vegetation. Furthermore, Muscle Creek is likely to align to Type 1 (highly sensitive key fish habitat) given the presence of microhabitats such as rocks, snags and gravel.

Impacts of the proposal on Muscle Creek would include the construction of a bridge that would extend over Muscle Creek. The bridge would be about 114 metres long and up to 14 metres high above Muscle Creek. There is already a wooden rail bridge which crosses Muscle Creek where the new bridge would be located (refer to Photo 3.23). The replacement of this bridge is likely to have an incremental impact on aquatic habitat present however is unlikely to significantly exacerbate existing impacts associated with the wooden bridge given its large span.

As outlined in Appendix A, no threatened species listed under the FM Act are considered likely to occur within any of the aquatic habitat identified due to its poor condition which is largely the result of past and current land uses such as agriculture, mining and associated infrastructure.

In summary, the proposal has potential to have minor impacts to Type 1 (moderately sensitive key fish habitat – Muscle Creek) and Type 3 (minimally sensitive key fish habitat – Sandy Creek) Key Fish Habitat. Muscle Creek is classified as a Class 2 watercourse (moderate key fish habitat) however all remaining watercourses within the study area were classified as either Class 3 (minimal key fish habitat) or Class 4 (unlikely key fish habitat).

Specific impacts which may arise from the construction of the two bridges could include on aquatic habitat present includes:

- Alterations to hydrology of the immediate area via the construction of drainage designed to convey flows towards catchments, culverts and containment basins
- Direct impacts on substrate and groundcover vegetation which may induce sedimentation, erosion and edge effects
- Long-term shading of waterway
- Aquatic vegetation and microhabitat (such as snags, river pebbles etc.) removal.

Impacts to aquatic habitat would be of low magnitude and standard mitigation measures would be implemented to limit impacts (see section 5 (Avoid, minimise and mitigate impacts)).

4.1.5 Injury and mortality

Injury and mortality of fauna could occur during both construction activities and during operation of the road. Specifically, injury and mortality may occur:

- During construction when vegetation and habitat is being cleared and when trenches are dug
- When machinery and plant is moved to, from and on site
- During public use of the road during the operational phase of the proposal.

These impacts in relation to the construction and operational phases of the proposal are discussed in this section. A summary of wildlife injury and mortality impacts, species to be impacted and the nature if these impacts is provided in Table 4.5.

During construction of the proposal

Fauna injury or death has the greatest potential to occur during construction when vegetation clearing would occur. The extent of this impact would be proportionate to the extent of vegetation that is cleared. Less mobile species (e.g. ground dwelling reptiles), or those that are nocturnal and nest or roost in trees during the day (e.g. arboreal mammals and yangochiropteran bat species), may find it difficult to rapidly move away from the clearing when disturbed.

Entrapment of wildlife in any trenches or pits that are dug is a possibility if the trenches are deep and steep sided. Wildlife may also become trapped in or may choose to shelter in machinery that is stored in the study area overnight. If these animals were to remain inside the machinery, or under the wheels or tracks, they may be injured or may die once the machinery is in use.

During operation of the proposal

There is a chance of fauna mortality during the operational phase of the proposal through vehicle collision (i.e. roadkill). Vehicle collision is a direct impact that reduces local population numbers. Mammals, reptiles, amphibians and birds are all at risk of vehicle strike.

As there is no definitive data on current rates of roadkill or fauna population densities in the study area, the consequences of vehicle strike on local populations of fauna is relatively unknown.

With the proposal constructing a new high speed (100 kilometres per hour) road the risk of vehicle strike within the locality has potential to incrementally increase, particularly for less mobile mammal species such as the Koala and Striped legless Lizard. The main impacts associated with this would include:

- Potential long-term decrease in the size of a local population via mortality from vehicle strike
- Creation of a new barrier (highway about 9 kmilometres in length with a single lane in each direction and a one metre linemarked centre) with steel post and rail system saefty barriers and concrete crash barrier on the approaches to bridge barriers or piers which may trap or increase the length of time an animal would need to spend on the road to cross thereby leading to an increase in chance of a collision with a vehicle.

The significance of such an impact cannot be predicted as there is no definitive data available, however these impacts would endeavour to be reduced through the implementation of mitigation measures detailed in section 5.2 (Mitigation measures).

Table 4.5 Potential for injury and mortality of fauna as a result of the proposal

Activity with potential to cause mortality	Native animals with potential to be affected	Nature and magnitude of the impact of the proposal
Vegetation/habitat removal during construction		
Removal of mature trees with hollows as well as dead standing trees	• Hollow-dependent bats (including threatened species as listed in Table 4.3) • Hollow-nesting and canopy-nesting birds (including threatened species as listed in Table 4.3) • Arboreal mammals • Arboreal reptiles • Arboreal frogs.	Vegetation removal would be undertaken in accordance with the mitigation measures detailed in section 5.2 (Mitigation measures). *Best practice management guidelines* (Roads and Traffic Authority, 2011, NSW Roads and Maritime Services, 2012) where considered to identify these appropriate mitigation measures to minimise fauna injury and mortality during construction. These measures however are unlikely to eliminate injury and mortality completely. Mortality of smaller species of native reptiles and frogs may occur. These smaller, non-threatened species are generally abundant and the mortality caused by the proposal is unlikely to have a substantial long-term impact on populations of these species. **Threatened birds, bats and mammals** The level of mortality and injury of both non-threatened and threatened species of birds, bats and mammals is likely to be low with the implementation of the mitigation measures mentioned above. The implementation of measures such as exclusion fencing, pre-clearance surveys and 'spotter-catchers' supervising vegetation clearance would reduce impacts associated with injury and mortality of fauna during the construction phase of the proposal.
Removal of understorey, groundcover and topsoil	• Small woodland birds species which nest in understorey vegetation and breed locally as listed (including threatened species listed in Table 4.3) • Ground-dwelling reptiles (including Stiped Legless Lizard) • Ground-dwelling mammals (including threatened species listed in Table 4.3) • Frogs.	
Machinery/plant and vehicle movements during construction		
Movement of machinery between locations within the study area	• Terrestrial reptiles, frogs and mammals • Birds.	Occasional mortality of native animals may occur during vehicle movements within the construction footprint. With the implementation of speed limits and briefing of staff, the level of construction-phase mortality of native wildlife is likely to be negligible.

Activity with potential to cause mortality	Native animals with potential to be affected	Nature and magnitude of the impact of the proposal
Roadkill post-construction	• Terrestrial, semi-aquatic and arboreal reptiles and frogs (inlcuding the Striped Legless Lizard) • Mammals (e.g. Koala, Squirrel Glider, Spotted-tailed Quoll and bat species) • Birds including owls, woodland birds, blossom nomads and raptors (including threatened species listed In Table 4.3).	All roads have potential to result in the mortality (roadkill) of native animals. The risk of roadkill is higher where roads and/or associated landscaped areas: • Traverse areas of substantial animal habitat • Are located near natural or artificial water bodies • Contain food sources (e.g. mown grass verges, nectar-producing shrubs) which attract animals to the road edge • Have high speed limits • Provide poor visibility of wildlife (e.g. due to bends, crests and poor lighting) • Contain multiple lanes in each direction. Threatened birds and bats likely to occur within the construction footprint are at low risk of roadkill, since majority of these species are mobile (fly) and generally feed high in the canopy of vegetation. However, some species such as forest owls and predatory birds (raptors) would readily feed on roadkill and would be placed at some risk of road-strike mortality. Threatened mammals, particularly the Koala, Squirrel Glider and Spotted-tailed Quoll are likely to occur within the study area and may cross the new road to access potential habitat in the broader landscape which makes them susceptible to vehicle collision. While it is not possible to eliminate the risk of roadkill occurring, it is possible to minimise roadkill through consideration of the above factors in the design of roads and associated landscaping and infrastructure. It is also possible to reduce roadkill risk by encouraging animals to cross roads more safely through provision of features such as: • Fauna fencing • Fauna rope bridges • Landscaping which encourages birds and bats to fly higher over roads. As part of the proposal the implementation of mitigation measures such as the installation of aerial fauna crossings and underpasses under bridges would reduce potential impacts on fauna. Overall, with adequate consideration of factors associated with roadkill in preparation of the detailed design, the proposal is unlikely to result in significant levels of roadkill mortality of threatened species.

4.2 Indirect/operational impacts

4.2.1 Alteration to wildlife connectivity and habitat fragmentation

Habitat fragmentation is the physical dividing up of one or more continuous habitats into separate smaller 'fragments'. This new dividing habitat type is often artificial and inhospitable to most species remaining within the fragments. These newly created habitats (cleared areas or planted roadside vegetation) are more likely to be used by species (mostly generalists) that are considered aggressive (Grey, Clarke et al. 1998) and can further impact on the population levels of the species remaining in the adjoining natural habitat fragments. In addition to the loss of habitat area, the process of fragmentation can impact on species within the newly created fragments in several ways, including barrier effects, genetic isolation, and edge effects.

The proposal would break apart continuous habitats into separate smaller fragments as it would create a new linear barrier through the landscape. The proposal would also result in an increase in isolation of habitats as the current habitat patches would be made smaller thereby increasing the physical distance between some habitat fragments. The isolation that may be caused by the proposal is not likely to have an appreciable impact on nomadic or migratory species such as birds. The proposal is likely to be detrimental to the dispersal of arboreal mammals and other species including frogs and reptiles, but the effects would only be marginally greater than that which is already experienced.

The predicted level of isolation from the proposal is not likely to be enough to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches. Functional connectivity for many species would remain in the study area. However, local division of some wildlife populations, isolation of key habitat resources, loss of genetic interchange, and loss of population viability for some species may result.

The new highway would divide remaining habitats in the study area creating a new barrier which serves some restriction to fauna movements between habitat patches. However, functional habitat connectivity for more mobile species (e.g. birds, flying-foxes, insectivorous bats, insects, plants) would still remain. The roadway would not totally prevent fauna movement between habitat fragments (fauna can and likely do cross the road) as no impassable barriers such as no solid concrete median strips would be constructed which would otherwise create a considerable hazard.

Given the potential for the proposal to have a negative impact on wildlife movement via the construction of new barrier within the landscape, an evaluation of connectivity and mitigation options to minimise these impacts was undertaken. Three options were evaluated based on risks and benefits (Table 4.6). Based on evaluation of these options, option 2 and 3 were determined as the most suitable outcomes for the proposal. These options provide road mitigation which would allow terrestrial wildlife movement across sections of the new highway whilst ensuring that road safety guidelines are adhered to.

Table 4.6 Connectivity option assessment

Option number	Proposed options	Negatives	Positives
1	'Do nothing' – maintain existing status – no mitigation	• Likely to increase fauna road kill impacts • Safety concerns to road users due to fauna collision.	• Low cost • Provides limited terrestrial connectivity.
2	Provide road mitigation with both under and over passes at key crossing locations, including consideration of fauna fencing	• Would result in additional clearing of intact remnant vegetation which provides habitat for threatened flora and fauna species. • Higher costs	• Reduce roadkill and provide for terrestrial/arboreal fauna crossing east - west • Retain access to habitat on either side of the road • Increase wildlife movement in the north and south where the main existing wildlife corridors occur.
3	Median strip consisting of a one meter wide linemarked centreline rather than constructed with Ezy Guard or solid concrete barriers	• High speed zone and volume of traffic with a lack of a physical barrier • Potential increase in safety concerns of road users.	• Widened center line is a recognised safety treatment in reducing head on collisions • Reduce width of road/barrier and reduce clearing footprint • Reduce road kill, particularly for local populations of less mobile mammals • Lower costs.

4.2.2 Edge effects on adjacent native vegetation and habitat

Linear infrastructure developments are known to cause disturbances in terms of reducing habitat quality in adjacent areas. This is largely linked to an increase in edge effects associated with fragmentation and the creation/increase in barriers. Edge effects lead to the following interferences which may be temporary or permanent:

- Altered soil moisture conditions
- Altered light conditions (shading, reduced-shading, artificial lighting)
- Noise and vibration (construction and operation)
- Weed invasion (associated with soil disturbance and roadside littering).

The proposal occurs within an area which is already subject to edge effects associated with existing road carriage way, transmission easements, agriculture and mining activities. The proposal has, where possible, been designed to avoid impacts to habitats that are of higher quality.

The proposal would however likely introduce new edge effects and incrementally increase existing edge effects within the study area. Given the current edge effects and highly modified nature of large areas which would be impacted this incremental increase is likely to be of low magnitude.

Mitigation measures to minimise impacts associated with edge effects are provided in section 5.2 (Mitigation measures).

4.2.3 Invasion and spread of weeds

Proliferation of weed and pest species is an indirect impact (i.e. not a direct result of proposal activities). Proliferation of weeds is likely to occur during construction and operation, although impacts would be greatest during vegetation clearing associated with the construction phase of the proposal. The most likely causes of weed dispersal and importation associated with the proposal include earthworks, movement of soil, and attachment of seed (and other propagules) to vehicles and machinery during all phases.

Weed invasion varies in intensity within the study area however is more largely concentrated in areas immediately adjacent existing road carriageways and transmission easements which are regularly maintained and/or disturbed (for example slashed to increase visibility). Additionally, areas which have experienced higher levels of agriculture and mining pressures are also subject to moderate to high levels of weed invasion. There are also areas within remnant vegetation in the study area which contain problematic weeds. As such, weeds must be managed during construction.

The management of weed spread an invasion is particularly important in areas immediately adjacent Striped Legless Lizard habitat towards the north of the alignment. Although currently exposed to weed incursion edge effects the results of the field investigations identified that the species did not occur in nearby areas dominated by seeded perennial exotic grasses (i.e. within areas of mine rehabilitation). This suggests that the species prefers the native grassland areas which are not dominated by perennial grasses which produce large tufts such as *Chloris gayana** (Rhodes Grass).

Mitigation measures designed to limit the spread and germination of weeds are provided in section 5.2 (Mitigation measures).

4.2.4 Invasion and spread of pests

From a biodiversity conservation perspective, pest animals include all species that have a negative impact on the functioning of natural ecosystems and/or the conservation of threatened biodiversity. Pests therefore include both exotic and native species. Exotic pests present or likely to occur on within the construction footprint include the Fox, Rabbit, Brown Hare, Cat, Common Myna, House Mouse, Black Rat, Common Starling and Dogs.

These species have the potential to affect uncommon or threatened indigenous biodiversity through predation (e.g. Black Rat, Cat, Fox, Dog), grazing (e.g. Rabbit, Brown Hare) and competition for breeding habitat (e.g. Common Myna and Common Starling).

Many highly invasive and destructive pest species which are found overseas or interstate have not yet become established or presently have restricted distributions in NSW. Several such species are the subject of Key Threatening Process listings (e.g. Red Imported Fire Ant, Yellow Crazy Ant, Large Earth Bumblebee, Cane Toad). The primary risk associated with these species is the importation of goods or materials from interstate or overseas locations where populations of these species are well established. If the importation of goods from overseas or interstate is required appropriate pest control mitigation measures would be applied.

The study area provides habitat for a range of commonly occurring pest species including European Fox and Rabbits. The proposals activities have the potential to disperse pest species out of the construction footprint across the surrounding landscape, but the magnitude of this impact would be low and mitigation measures are not deemed necessary.

4.2.5 Invasion and spread of pathogens and disease

Plant and animal pathogens can affect threatened biodiversity through direct mortality and modification to vegetation structure and composition. The following pathogens are considered to have potential to affect the biodiversity within the proposal footprint and are the subject of Key Threatening Process listings:

- Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*)
- Exotic Rust Fungi (order Pucciniales, e.g. Myrtle rust fungus *Uredo rangelii*)
- Phytophthora Root Rot Fungus (*Phytophthora cinnamomi*).

These three pathogens have all been recorded in the Sydney Basin bioregion and have potential to occur on within the construction footprint at present or in the future. The main way in which Exotic Rust Fungi and Phytophthora Root Rot Fungus may be spread is through the movement of infected plant material and/or soil. The construction and operation of the proposal may increase the risk of disturbing and spreading these pathogens. With the implementation of hygiene procedures for the use of vehicles and the importation of materials to the construction footprint, the risk of introducing these pathogens would, however, be low.

Preferential use of plant materials sourced on-site (e.g. mulch, seeds) used for vegetation restoration would also help to minimise this risk.

Amphibian Chytrid Fungus can be spread through the movement of infected animals or water (including mud or moist soil) from infected areas. With the implementation of hygiene procedures for the use of vehicles and the importation of materials to the proposal footprint, the risk of introducing this pathogen to uninfected areas is low.

Pathogens would be managed within the proposal site according to the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (Roads and Traffic Authority, 2011) (see section 5.2 (Mitigation measures)).

4.2.6 Changes to hydrology

The existing hydrological conditions of the construction footprint are already affected by altered landform and altered stormwater runoff and velocity as a result of surrounding land uses and existing roads. The proposal would however result in further alteration to the hydrology of the study area due to an increase in surface runoff.

Transport for NSW have used the study area's natural soil infiltration features and properties as a drainage design philosophy to minimise impacts associated with hydrology. The drainage systems designed have also considered the following to ensure alterations to the hydrology are minimised wherever practicable:

- Traverse drainage to convey run-off from upslope catchments beneath the bypass
- Longitudinal drainage to convey flows further towards swales or transverse culverts
- Bridge drainage to be piped and to provide adequate drainage of surface water which would be discharged via a spill containment basin or to an existing drainage infrastructure depending on the location and subject to detailed design
- Operational spill containment, including spill contamination basins.

It is recommended that the stormwater design for the proposal be done in accordance with 'Managing urban stormwater: Soils and construction, Volume 2D: Main Road Construction, Sydney' (Blue Book) (Department of Environment and Climate Change, 2008) to avoid potential impacts to surrounding native vegetation communities and habitat.

4.2.7 Groundwater dependent ecosystems

PCT 42, PCT 485 and PCT 1693 within the study area are likely to be opportunistic facultative GDEs that depend on the subsurface presence of groundwater (often accessed via the capillary fringe – subsurface water just above the water table) when an alternative source of water (i.e. rainfall) cannot be accessed to maintain ecological function. The remaining PCTs recorded are considered vadophytic vegetation types which are not reliant on groundwater.

The proposal has potential to directly and indirectly interfere with subsurface and/or groundwater flows associated with the GDEs identified within the study area. These impacts would be largely associated with the construction activities within proximity of Muscle Creek, Sandy Creek and their tributaries.

In addition, a wetland was identified bordering the northern boundary of the study area between Muscle Creek Road and the New England Highway. The wetland is an intermittent linear waterway which has been artificially modified (via the construction of dam walls) to allow water to pool for agriculture. This wetland is unlikely to be directly impacted by the proposal as it occurs outside the construction footprint. The proposal has potential however to indirectly impact this wetland via changes to hydrology and sedimentation.

Mitigation measures designed to reduce impacts on GDEs are provided in section 5.2 (Mitigation measures).

4.2.8 Noise, light and vibration

Considering the existing levels of noise and vibration from the surrounding land uses (including mine activities, existing roads and road traffic, existing rail corridors etc.), it is unlikely there would be a significant increase in noise and vibration during the operation of the proposal. This is likely due to most animal species within the construction footprint and surrounds already being habituated to periodic noise disturbance from human activity and road activity. Therefore, even though noise and vibration levels would increase biodiversity are unlikely to be significantly affected by the proposal's operational noise.

There is however potential for impacts to locally common fauna from noise and vibration during construction of the proposal. These impacts may result in fauna temporarily avoiding habitats adjacent to the construction however traffic noise is likely to be significant deterrent to most fauna groups already. The magnitude of this impact would be low and specific mitigation measures are not deemed necessary.

New roadway lighting or adjustments to existing lighting would be provided at the Milpera Drive and Muscle Creek Road intersection and the roundabout at the northern connection. Lighting would be designed in accordance with relevant guidelines and standards to minimise light spillage into residential properties and minimise glare that could impact on driver visibility. Lighting design would be further refined during the detailed design phase.

Lighting throughout the evening associated with the operational phase of the proposal may result in impacts on nocturnal fauna. Nocturnal species such as possums and yangochiropteran bats may avoid the habitat in the study area during these periods as 'daylight' conditions would be created. The magnitude of this impact would be low and mitigation measures are not deemed necessary. Additionally, there are species which forage on insects attracted to lights thereby these impacts may benefit some species.

4.3 Cumulative impacts

The potential cumulative biodiversity impact as a consequence of the construction and operation of the proposal are discussed here within the context of the existing environment. The proposal would not act alone in causing impacts to biodiversity. The incremental effects of multiple sources of impact (past, present and future) are referred to as cumulative impacts and provide an opportunity to consider the proposal within a strategic context.

In assessing the cumulative impact of a proposal, it is important to consider whether the additive effects of multiple projects may cause such a critical threshold to be reached for any threatened biodiversity affected.

Several developments are underway or planned in the locality, that also impact on biodiversity values that are likely to be impacted by the current proposal. Some of the projects in the locality that would contribute to cumulative impacts include:

- Five existing open cut coal mines occur within the Muswellbrook LGA including:
  - Muswellbrook Coal Company Extension A and B: Muswellbrook bypass proposal occurs within the mine lease of this coal mine. The coal mine required the removal of 19.1ha of DNG derived of PCT 1691, up to 23.7ha of vegetation consistent with PCT 1691 and/or PCT 1605 and 1.1ha of PCT 1693. Species considered to be impacted by the project included Square-tailed Kite, Grey-crowned Babbler, Spotted-tailed Quoll and numerous yangochiropteran bat species (HLA Envirosciences Pty Ltd, 2002)
  - Bengalla Mining Company: occurs to the west of the New England Highway towards Denman. The coal mine required the removal of 938.9 ha of native vegetation (of which 216.7 occurred as DNG and 722.2ha as remnant vegetation). Vegetation to be removed included 535.3ha (73.2ha remnant and 462.1ha of DNG) consistent with the White Box – Yellow Box – Blakely's Red Gum TEC, 9.4ha of Hunter Floodplain River Red Gum TEC and 6.7ha of Central Hunter Valley eucalypt forest and woodland TEC. Threatened species considered to be impacted by the project included *Cymbidium canaliculatum* and numerous woodland birds, blossom nomads, forest owls, yangochiropteran bats and the Squirrel Glider (Hansen Bailey, 2017)

    - Mangoola Open Cut Coal Mine Continued Operations Project: occurs to the west of the New England Highway towards Denman. Project required the removal of 570.76ha of native vegetation including 14.67ha of Hunter Floodplain Red Gum Woodland TEC, 6.3ha of Central Hunter Ironbark – Spotted Gum – Grey Box Forest TEC, 135.2ha of Central Hunter Grey Box – Ironbark Woodland TEC and 21.7ha of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland TEC. Threatened species impacted by the project include *Diuris tricolor, Prasophyllum petilum* and numerous woodland birds, blossom nomads, yangochiropteran bats and the Squirrel Glider (Umwelt, 2019)
    - Mt Arthur Coal Mine Open Cut Modification: occurs to the south west of Muswellbrook south of Thomas Mitchell Drive. Project required the removal of 229ha of native vegetation (including 173.3ha DNG and 55.7ha remnant). Vegetation to be removed included 1.7ha of Hunter Lowlands Red Gum Forest TEC, 0.1ha Hunter Valley Weeping Myall Woodland TEC, 35.4ha (35.2ha DNG and 0.2ha remnant) of vegetation consistent with the White Box – Yellow box – Blakely's Red Gum TEC, 7.1ha of Central Hunter Ironbark – Spotted Gum – Grey Box Forest TEC and 23.0ha of Central Hunter Grey Box – Ironbark Woodland TEC. Threatened species considered to be impacted by the project included *Acacia pendula* and numerous threatened woodland birds, blossom nomads and yangochiropteran bats (BHP Billiton, 2014)
    - Drayton South Coal Project: occurs about 13 kilometres south of Muswellbrook. The project requires the removal of 1,438ha of native vegetation (1,147.3ha of DNG and 290.7ha of remnant vegetation). Of this, 6.5ha is consistent with the White Box – Yellow Box – Blakely's Red Gum Woodland TEC, 15.2ha of Hunter Floodplain Redgum Woodland TEC and 247.9ha is consistent with the Central Hunter eucalypt forest and woodland TEC. Threatened species to be impacted by the project would include *acacia pendula, Eucalyptus camaldulensis, Cymbidium canaliculatum, Diuris tricolor* and numerous species of woodland bird, yangochiropteran bat and birds of prey (Cumberland Ecology, 2015)
- Dolwendee Quarry: located about 8 kilometres north of Denman. Project required the removal of 22.2ha of native vegetation including 7.4ha of remnant and 14.8ha of Central Hunter Grey Box – Ironbark Woodland TEC. Threatened species to be impacted by the project included *Diuris tricolor* and numerous species of woodland bird, yangochiropteran bat and the Squirrel Glider (Umwelt, 2015)
- Previous/upcoming New England Highway projects:
    - Scone bypass: located about 30 kilometres north of the Muswellbrook bypass proposal. Given the highly disturbed nature of the construction footprint no native removal and no threatened species habitat required removal by the project (GHD, 2015)
    - New England Highway upgrade of Singleton: has not yet commenced but is likely to have impacts on Central Hunter eucalypt forest and woodland TEC like the Muswellbrook bypass proposal (AECOM, 2020)
    - Belford to Golden Highway: located about eight kilometres south east of Singleton. Project requires the removal of 27.73ha of native vegetation including 11.23ha of TECs. This clearing included 18.6ha of Central Hunter Ironbark – Spotted Gum Grey box TEC of which 8.2ha is consistent with the EPBC Act Central Hunter Valley eucalypt forest and woodland. Threatened species to be impacted by the project include numerous woodland birds and yangochiropteran bats as well as Squirrel Glider and Grey-headed Flying-foxes (Environmental Property Services, 2016)
- Small-scale local residential developments: publicly available information for these developments do not provide sufficient information regarding impacts on biodiversity.

Impacts associated with the proposal would incrementally increase these impacts on biodiversity within the locality. The proposal's impacts however are unlikely to exacerbate current proposal impacts to a point where they would lead to a significant impact on biodiversity. In comparison to these other local developments the impacts of the proposal are relatively low.

4.4 Assessments of significance

Assessments of significance have been conducted for threatened species, populations or ecological communities which have been positively identified within the study area or that are considered to have a moderate or high likelihood of using habitat which would be affected by the proposal.

The proposed works are being assessed under Part 5, Division 5.1 of the EP&A Act. As such, assessments of significance have been undertaken in accordance with the following published guidelines and legislation:

BC Act listed threatened ecological communities and species:

- Part 7 Division 1 Section 7.3 of the BC Act - outlines the 'test of significance' that is to be undertaken to assess the likelihood of significant impact upon threatened species or ecological communities listed under the BC Act
- *Threatened Species Test of Significance Guidelines: The Assessment of Significance* (Office of Environment & Heritage, 2018) - outlines a set of guidelines to help applicants/proponents of a development or activity with interpreting and applying the factors of assessment in the former 'seven-part test'.

MNES:

- *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance for EPBC Act listed biodiversity* (Department of the Environment, 2013c) – guideline to assist in deciding whether an action would have a significant impact on EPBC Act matters and subsequently whether an EPBC Act referral may be required
- *EPBC Act referral guidelines for the vulnerable Koala* (Department of the Environment, 2014).

Combined assessments of significance have been conducted for groups of species that have similar life history and habitat requirements; e.g. small woodland birds, terrestrial mammals.

The overall outcome of the tests of significance (see Appendix D) indicates that the impacts to threatened biodiversity are unlikely to be significant. Given the proposal is not considered likely to lead to a significant impact on threatened species, populations, ecological communities or their habitats, a Species Impact Statement (SIS) is not required under the BC Act to support this proposal. In respect to MNES matters including threatened flora, fauna and communities, a referral of this proposal for consideration as a controlled action under the EPBC Act is not required.

The results of the significance assessments completed are summarised below in Table 4.7 for BC Act biodiversity values and Table 4.8 for MNES.

Table 4.7 Summary findings of the BC Act test of significance

Threatened species, populations or communities	Significance assessment question[1]					Likely significant effect?
	a	b	c	d	e	
Central Hunter Grey Box-Ironbark Woodland	X	N	N	N	Y	Unlikely
Central Hunter Ironbark – Spotted Gum – Grey Box Forest	X	N	N	N	Y	Unlikely
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	X	N	N	N	Y	Unlikely
Hunter Floodplain Red Gum Woodland	X	N	N	N	Y	Unlikely

Threatened species, populations or communities	Significance assessment question[1]					Likely significant effect?
	a	b	c	d	e	
Eucalyptus camaldulensis (River Red Gum) population within the Hunter catchment	X	N	N	N	Y	Unlikely
Australian Painted Snipe (*Rostratula australis*)	N	X	N	N	Y	Unlikely
Barking Owl (*Ninox connivens*)	N	X	N	N	Y	Unlikely
Black Falcon (*Falco subniger*)	N	X	N	N	Y	Unlikely
Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*)	N	X	N	N	Y	Unlikely
Black-necked Stork (*Ephippiorhynchus asiaticus*)	N	X	N	N	Y	Unlikely
Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)	N	X	N	N	Y	Unlikely
Corben's Long-eared Bat (*Nyctophilus corbeni*)	N	X	N	N	Y	Unlikely
Diamond Firetail (*Stagonopleura guttata*)	N	X	N	N	Y	Unlikely
Dusky Woodswallow (*Artamus cyanopterus*)	N	X	N	N	Y	Unlikely
Eastern Cave Bat (*Vespadelus troughtoni*)	N	X	N	N	Y	Unlikely
Eastern Coastal Freetail Bat (*Micronomus norfolkensis*)	N	X	N	N	Y	Unlikely
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	N	X	N	N	Y	Unlikely
Flame Robin (*Petroica phoenicea*)	N	X	N	N	Y	Unlikely
Gang-Gang Cockatoo (*Callocephalon fimbriatum*)	N	X	N	N	Y	Unlikely
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	N	X	N	N	Y	Unlikely
Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*)	N	X	N	N	Y	Unlikely
Grey-headed Flying-fox (*Pteropus poliocephalus*)	N	X	N	N	Y	Unlikely
Hooded Robin (*Melanodryas cucullata cucullata*)	N	X	N	N	Y	Unlikely
Koala (*Phascolarctos cinereus*)	N	X	N	N	Y	Unlikely

Threatened species, populations or communities	Significance assessment question[1]					Likely significant effect?
	a	b	c	d	e	
Large Bent-winged Bat (*Miniopterus orianae oceanensis*)	N	X	N	N	Y	Unlikely
Large-eared Pied Bat (*Chalinolobus dwyeri*)	N	X	N	N	Y	Unlikely
Little Bent-wing Bat (*Miniopterus australis*)	N	X	N	N	Y	Unlikely
Little Eagle (*Hieraaetus morphnoides*)	N	X	N	N	Y	Unlikely
Little Lorikeet (*Glossopsitta pusilla*)	N	X	N	N	Y	Unlikely
Magpie Goose (*Anseranas semipalmata*)	N	X	N	N	Y	Unlikely
Masked Owl (*Tyto novaehollandiae novaehollandiae*)	N	X	N	N	Y	Unlikely
Painted Honeyeater (*Grantiella picta*)	N	X	N	N	Y	Unlikely
Powerful Owl (*Ninox strenua*)	N	X	N	N	Y	Unlikely
Regent Honeyeater (*Anthochaera phrygia*)	N	X	N	N	Y	Unlikely
Scarlet Robin (*Petroica boodang*)	N	X	N	N	Y	Unlikely
Southern Myotis (*Myotis macropus*)	N	X	N	N	Y	Unlikely
Speckled Warbler (*Chthonicola sagittata*)	N	X	N	N	Y	Unlikely
Spotted Harrier (*Circus assimilis*)	N	X	N	N	Y	Unlikely
Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)	N	X	N	N	Y	Unlikely
Square-tailed Kite (*Lophoictinia isura*)	N	X	N	N	Y	Unlikely
Squirrel Glider (*Petaurus norfolcensis*)	N	X	N	N	Y	Unlikely
Striped Legless Lizard (*Delma impar*)	N	X	N	N	Y	Unlikely
Swift Parrot (*Lathamus discolor*)	N	X	N	N	Y	Unlikely
Turquoise Parrot (*Neophema pulchella*)	N	X	N	N	Y	Unlikely
Varied Sittella (*Daphoenositta chrysoptera*)	N	X	N	N	Y	Unlikely
White-bellied Sea-eagle (*Haliaeetus leucogaster*)	N	X	N	N	Y	Unlikely

Threatened species, populations or communities	Significance assessment question[1]					Likely significant effect?
	a	b	c	d	e	
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	N	X	N	N	Y	Unlikely

Notes: Y= Yes (negative impact), N= No (no or positive impact), X= not applicable, ?= unknown impact.

1. Significance Assessment Questions as set out in the BC Act:

a in the case of a threatened species, whether the proposed development or activity 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.

b in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:
- (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,

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

d whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

e whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process

Table 4.8 Summary findings of the EPBC Act significance assessments

Species/ecological community	Assessment of significance questions (EPBC Act)[1]									Important population[2]	Likely significant impact
	a	b	c	d	e	f	g	h	i		
Threatened Ecological Communities											
Central Hunter Valley eucalypt forest and woodland	N	N	N	N	N	N	N	N	N	n/a	Unlikely
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	N	N	N	N	N	N	N	N	N	n/a	Unlikely
Vulnerable species											
Corben's Long-eared Bat (*Nyctophilus corbeni*)	N	N	N	N	N	N	N	N	N	N	Unlikely
Grey-headed Flying-fox (*Pteropus poliocephalus*)	N	N	N	N	N	N	N	N	N	N	Unlikely
Koala (*Phascolarctos cinereus*)	N	N	N	N	N	N	N	N	N	N	Unlikely
Large-eared Pied Bat (*Chalinolobus dwyeri*)	N	N	N	N	N	N	N	N	N	N	Unlikely
Painted Honeyeater (*Grantiella picta*)	N	N	N	N	N	N	N	N	N	N	Unlikely

Species/ecological community	Assessment of significance questions (EPBC Act)[1]									Important population[2]	Likely significant impact
	a	b	c	d	e	f	g	h	i		
Striped Legless Lizard (*Delma impar*)	N	N	N	N	N	N	N	N	N	Y	Unlikely
White-throated Needletail (*Hirundapus caudacutus*)	N	N	N	N	N	N	N	N	N	N	Unlikely
Endangered species											
Australian Painted Snipe (*Rostratula australis*)	N	N	N	N	N	N	N	N	N	N	Unlikely
Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)	N	N	N	N	N	N	N	N	N	N	Unlikely
Critically Endangered species											
Regent Honeyeater (*Anthochaera phrygia*)	N	N	N	N	N	N	N	N	N	N	Unlikely
Swift Parrot (Lathamus discolor)	N	N	N	N	N	N	N	N	N	N	Unlikely

Notes: Y= Yes (negative impact), N= No (no or positive impact), X= not applicable, ?= unknown impact.

1. An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it would:
   - a lead to a long-term decrease in the size of an important population of a species
   - b reduce the area of occupancy of an important population
   - c fragment an existing important population into two or more populations
   - d adversely affect habitat critical to the survival of a species
   - e disrupt the breeding cycle of an important population
   - f modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
   - g result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
   - h introduce disease that may cause the species to decline, or
   - i interfere substantially with the recovery of the species.
2. A 'population of a species' as determined by the EPBC Act is an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited either a geographically distinct regional population, or a collection of location populations OR a population, or collection of local populations, that occurs within a particular bioregion. An important population as determined by the EPBC Act is a population of species that is likely to be key source populations either for breeding or dispersal, is likely to be necessary for maintaining genetic diversity, or is at or near the limit of the species range.

4.5 Impact summary

A summary of potential impacts that have been addressed in this report are presented in Table 4.9.

Table 4.9 Summary of impacts

Impact	Biodiversity values	Nature of impact	Extent of impact	Duration	Does the proposal constitute or exacerbate a key threatening process?	Confidence in assessment
Removal of native vegetation (including threatened ecological communities)	Native vegetation	Direct	97.92ha (including 22.26ha of remnant and 75.66ha of DNG)	Long term	• Clearing of native vegetation (BC Act) • Land clearance (EPBC Act)	Known
Removal of threatened fauna habitat removal and habitat features	Numerous threatened fauna species (refer to Table 4.3 for full listed of threatened species to be affected)	Direct	Up to 97.92ha of habitat (including 22.26ha of remnant and 75.66ha of DNG) 42 hollow bearing trees	Long term	• Clearing of native vegetation (BC Act) • Land clearance (EPBC Act) • Removal of dead wood and dead trees (BC Act) • Loss of Hollow-bearing Trees (BC Act) • Bushrock removal (BC Act).	Known
Aquatic impacts	Applicable to Muscle Creek, Sandy Creek and their unnamed tributaries	Direct / Indirect	Site based	Short term	• Instream structures and other mechanisms that alter natural flow	Known
Injury and mortality of fauna	Applicable to less mobile or sedentary fauna	Direct	Site based	Short term – construction phase Long term – operational phase	• n/a	Known

Impact	Biodiversity values	Nature of impact	Extent of impact	Duration	Does the proposal constitute or exacerbate a key threatening process?	Confidence in assessment
Wildlife connectivity and habitat fragmentation	Applicable to less mobile or sedentary fauna	Direct / Indirect	Local	Long term	• Clearing of native vegetation (BC Act) • Land clearance (EPBC Act)	Known
Edge effects on adjacent native vegetation and habitat	All areas of native vegetation adjacent the construction footprint	Indirect	Local	Long term	• Clearing of native vegetation (BC Act) • Land clearance (EPBC Act) • Invasion and establishment of exotic vines and scramblers (BC Act) • Invasion and establishment of Scotch Broom (*Cytisus scoparius*) (BC Act) • Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*) (BC Act) • Invasion, establishment and spread of Lantana camara (BC Act) • Invasion of native plant communities by Bitou Bush and Boneseed (BC Act) • Invasion of native plant communities by exotic perennial grasses (BC Act) • Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants (BC Act and EPBC Act).	Known

Impact	Biodiversity values	Nature of impact	Extent of impact	Duration	Does the proposal constitute or exacerbate a key threatening process?	Confidence in assessment
Invasion and spread of weeds	All areas of native vegetation Areas of Striped Legless Lizard habitat	Indirect	Local / Regional	Long term	• Invasion and establishment of exotic vines and scramblers (BC Act) • Invasion and establishment of Scotch Broom (*Cytisus scoparius*) (BC Act) • Invasion of native plant communities by African Olive (*Olea europaea* L. subsp. *cuspidata*) (BC Act) • Invasion, establishment and spread of Lantana camara (BC Act) • Invasion of native plant communities by Bitou bush and Boneseed (BC Act) • Invasion of native plant communities by exotic perennial grasses (BC Act) • Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants (BC Act and EPBC Act).	Known

Impact	Biodiversity values	Nature of impact	Extent of impact	Duration	Does the proposal constitute or exacerbate a key threatening process?	Confidence in assessment
Invasion and spread of pests	Applicable to all flora and fauna species and habitat	Indirect	Local / Regional	Long term	• Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) (BC Act and EPBC Act) • Competition and habitat degradation by feral goats (*Capra hircus*) (BC Act and EPBC Act) • Herbivory and environmental degradation caused by feral deer (BC Act) • Invasion and establishment of the Cane Toad (*Bufo marinus*) (BC Act) • The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*) (EPBC Act) • Predation and hybridisation of feral dogs (*Canis lupus familiaris*) (BC act) • Predation by the European Red Fox (*Vulpes vulpes*) (BC Act and EPBC Act) • Predation by the feral cat (*Felis catus*) (BC Act and EPBC Act) • Predation by Plague Minnow or Mosquito Fish (*Gambusia holbrooki*) (BC Act) • Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean (EPBC Act) • The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta* (fire ant) (EPBC Act) • Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (BC Act and EPBC Act).	Known

Impact	Biodiversity values	Nature of impact	Extent of impact	Duration	Does the proposal constitute or exacerbate a key threatening process?	Confidence in assessment
Invasion and spread of pathogens and disease	Applicable to all flora and fauna species and habitat	Indirect	Local / Regional	Long term	• Infection of native plants by *Phytophthora cinnamomi* (BC Act) • Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) (EPBC Act) • Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae (BC Act) • Infection by psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations (BC Act and EPBC Act) • Infection of frogs by amphibian chytrid causing the disease chytridiomycosis (BC Act) • Infection of amphibians with chytrid fungus resulting in chytridiomycosis (EPBC Act)	Known
Groundwater dependent ecosystems	All native vegetation	Indirect - operational	Local	Long term	• Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	Known
Changes to hydrology	All native vegetation	Direct/ Indirect	Local	Long term	• Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	Known
Noise, light and vibration	Applicable to all fauna species.	Direct/ Indirect	Local	Short term – operational Long-term – construction	• n/a	Known

5 Avoid, minimise and mitigate impacts

In managing biodiversity, Transport for NSW aims to achieve a balanced outcome, taking account of environmental considerations together with economic and community objectives. This includes a balanced approach to examining the environmental consequences of an activity, recognising that achieving an optimal outcome often requires compromise and decisions regarding environmental values. A key part of Transport for NSW's management of biodiversity for this proposal is the application of the 'avoid, minimise, mitigate and offset' hierarchy as follows:

1. Avoid and minimise impacts as the highest priority
2. Mitigate impacts where avoidance is not feasible or practicable in the circumstance
3. Offset where residual, significant unavoidable impacts would occur.

5.1 Avoidance and minimisation

Avoiding environmental impacts as the first step is consistent with the application of the precautionary principle. Transport for NSW's priority is to avoid impacts to the environment. This can be achieved by:

- Early consideration of environmental issues via the identification of constraints during the early phases of the proposal
- Avoidance and minimisation through design and selection of preferred alignment options
- Implementation of on-ground safeguards during construction, operation and maintenance of the activity.

A Preliminary Environmental Investigation was prepared during the early stages of concept design development of the proposal identified areas of high biodiversity value that should be avoided where possible such as areas which contained threatened ecological communities, known populations of threatened plants and areas of higher quality habitat. By avoiding and/or minimising impacts to these biodiversity values, a proposal REF was deemed to be the best approach for assessment for the proposal.

The primary method to avoid impacts is to locate activities away from areas of known or potential high biodiversity value. In identifying suitable work sites, the first preference is to locate existing cleared and disturbed areas that have good access, are not within immediate proximity to waterways, and that support good site management practices (for example, management of material stockpiles). The proposal compound sites and laydown areas have been proposed in highly disturbed areas to avoid impacts to biodiversity. Areas of focus to avoid have included:

- Known population of 12 *Eucalyptus camaldulensis* (River Red Gum) individuals recorded in the study area
- Threatened ecological communities
- Areas that contain known threatened fauna species populations and suitable fauna species habitat such as hollow-bearing trees
- Areas which contain high wildlife connectivity value.

The implementation of on-ground controls have also been included for the proposal to further reduce impacts on biodiversity values. The controls are discussed in section 5.2 (Mitigation measures).

5.2 Mitigation measures

Once all practicable steps to avoid or minimise impacts have been implemented at the detailed design phase, mitigation measures would be implemented to lessen the potential ecological impacts of the proposal. Mitigation measures are to be undertaken during the construction and operational phases.

The Transport for NSW biodiversity guidelines and procedures identify a range of mitigation techniques to be applied, including managing the vegetation clearing process, re-establishment of native vegetation at the end of a proposal, weed management, provision of supplementary fauna habitat (such as nest boxes for appropriate species), and installation of erosion and sediment controls as appropriate. Mitigation measures as outlined in the *Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects* (Roads and Traffic Authority, 2011) and *Wildlife Connectivity Guidelines for Road Projects* (NSW Roads and Maritime Services, 2012) are recommended for implementation. Additional species-specific and site-specific mitigation measures are also provided in Table 5.1.

Table 5.1 Proposed mitigation measures

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Removal of native vegetation	Native vegetation removal would be minimised through detailed design.	Detailed design	Effective	The predicted residual impact to native vegetation species habitat is estimated at up to 97.92ha (including 75.66ha of DNG and 22.26ha of remnant vegetation).
	Native vegetation removal would be minimised via selective placement of temporary ancillary facilities i.e. preference is to avoid areas of higher biodiversity value and to select areas already subject to disturbance.	Prior to and during construction	Effective	
	Pre-clearing surveys would be undertaken in accordance with *Guide 1: Pre-clearing process* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011)	Prior to construction	Effective	
	Exclusion zones would be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011)	During construction	Effective	
	Vegetation removal would be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011). This would include a two-staged clearing program for the removal of hollow-bearing trees. Final hollow resource impacts would be determined during this process.	During construction	Effective	
	Native vegetation would be re-established in accordance with *Guide 3: Re-establishment of native vegetation* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011).	During construction	Effective	
	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011) if threatened entities, not assessed in the biodiversity assessment, are identified in the construction footprint.	During construction	Proven	

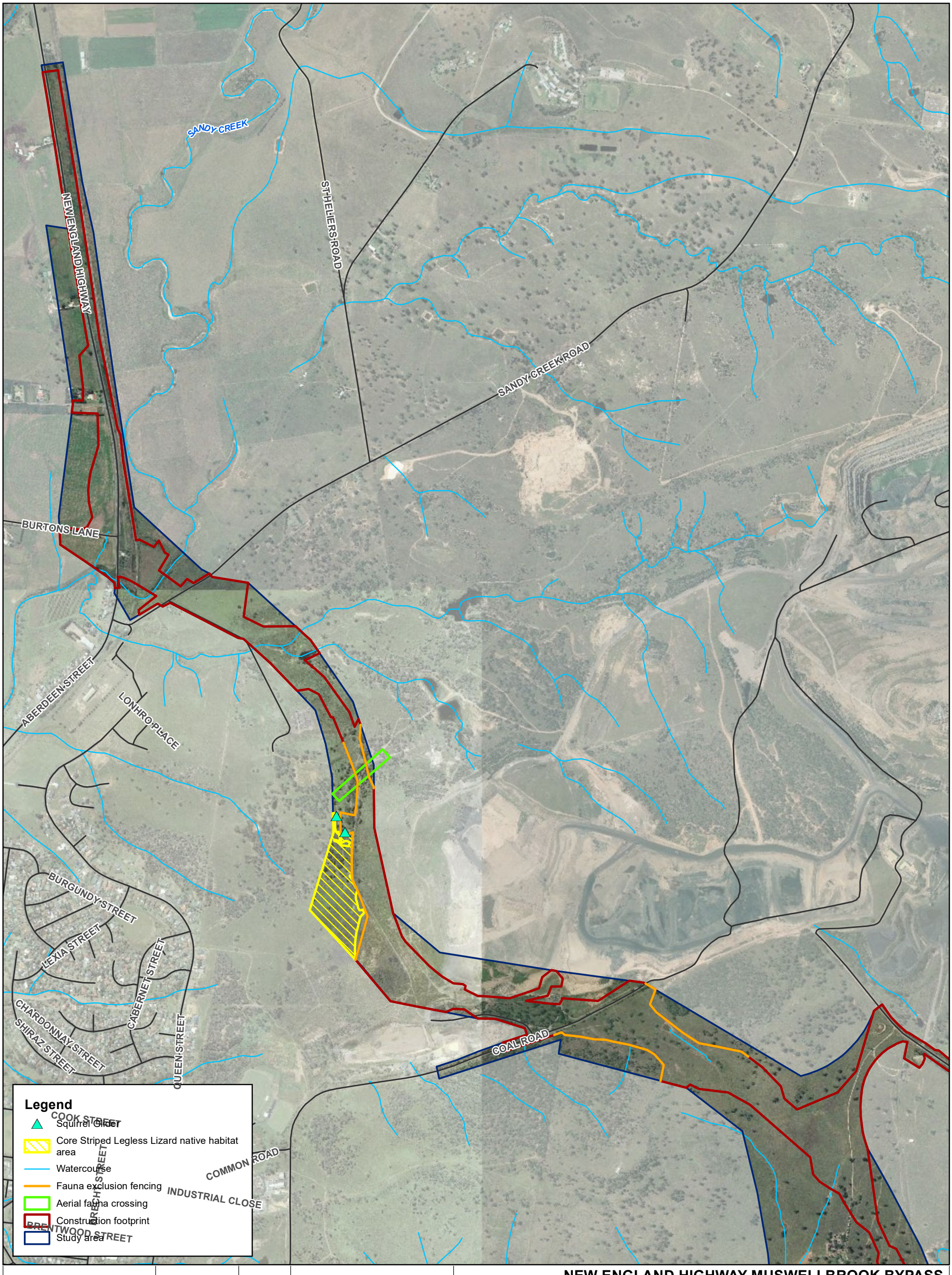
Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Removal of threatened plants	Habitat removal to be avoided through detailed design.	Detailed design	Effective	Although construction works would be in proximity to an Endangered Population no residual impacts are anticipated.
	Exclusion zones would be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011).	During construction	Effective	
	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011) if threatened flora species, not assessed in the biodiversity assessment, are identified in the construction footprint.	During construction	Proven	
Removal of threatened species habitat and habitat features	Habitat removal to be minimised through detailed design.	Detailed design	Effective	The predicted residual impact to native vegetation species habitat is estimated at up to 97.92ha (including 75.66ha of DNG and 22.26ha of remnant vegetation). Removal of 42 hollow-bearing trees and areas of impacts to areas containing bush rock.
	Exclusion zones would be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011).	During construction	Effective	
	Habitat removal would be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011). This would include a two-staged clearing program for the removal of hollow-bearing trees. Final hollow resource impacts would be determined during this process.	During construction	Effective	
	Habitat would be replaced or re-instated in accordance with *Guide 5: Re-use of woody debris and bushrock* and *Guide 8: Nest boxes* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011).	During construction	Proven	

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
	Establishment of native grassland habitat along new road verge within proximity to known Striped Legless Lizard habitat in accordance with *Guide 3: Re-establishment of native vegetation* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011) to minimise weed encroachment (in particular perennial grass species).	Post construction	Effective	
	Provide site personnel working within proximity of Striped Legless Lizard habitat with an information sheet and/or induction.	Prior to and during construction	Proven	
	Exclusion zone would be set up around known Striped Legless Lizard habitat during construction in accordance with the *Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011).	During construction	Effective	
	A Nest Box Strategy would be developed in accordance with *Guide 8: Nest boxes* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011). The Nest Box Strategy would primarily target the replacement of hollow resources being removed by the proposal on the Squirrel Glider. Final hollow resource impacts and subsequent nest boxes required would be informed by the tree clearing program.	Prior to construction	Proven	
Aquatic impacts	Aquatic habitat would be protected in accordance with Guide 10: Aquatic habitats and riparian zones of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011) and *Section 3.3.2 Standard precautions and mitigation measures* of the *Policy and guidelines for fish habitat conservation and management Update 2013* (Department of Primary Industries, 2013).	During construction	Effective	Minor, localised, modifications to already disturbed aquatic habitat.

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Injury and mortality of fauna and fragmentation of identified habitat corridors	Fauna would be managed in accordance with *Guide 9: Fauna handling* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011).	During construction	Effective	The mitigation measures should be effective, but injury or death may still occur. Minor loss of adjacent vegetation due to road widening or integration and implementation of construction.
	Habitat removal would be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011).	During construction	Effective	
	The unexpected species find procedure is to be followed under *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011) if threatened fauna, not assessed in the biodiversity assessment, are identified in the proposal footprint.	During construction	Proven	
	Road-kill and connectivity impacts would be minimised via: • Transport would install one aerial fauna crossing structure to retain fauna connectivity in the vicinity of where Squirrel Gliders have been recorded (indicative location provided in Figure 5.1). The final location, design and types of structure would be determined during detailed design • Transport would install one bridge over Muscle Creek which would provide an underpass crossing for terrestrial fauna species (indicative location provided in Figure 5.1) • Transport would consider installing appropriate fauna exclusion fencing in areas where fauna crossing structures are proposed and near known habitat for Striped Legless Lizard (indicative location provided in Figure 5.1). The final location, design and type of fencing would be determined during future detailed design pending design features and specifications • Installation of 'Koala Warning Signs' or 'Injured Native Wildlife Signs' in areas of potential wildlife conflict areas or crossing points.	Detailed design, construction and post construction	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Edge effects on adjacent native vegetation and habitat	Exclusion zones would be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011).	During construction	Effective	No residual impact is anticipated.
	Transport would install appropriate fauna exclusion fencing near known Striped Legless Lizard habitat in proximity to the new road (Figure 5.1) to reduce potential edge effects on habitat for example invasion and spread of exotic perennial grasses. Final location, design and type of fencing would be determined during detailed design.	Detailed design and during construction	Effective	
Invasion and spread of weeds and pests	Priority Weeds (refer to Table 3.10) would be managed in accordance with *Guide 6: Weed management* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011) and the Biosecurity Act .	During construction	Effective	Minor proliferation of weeds may occur at edges of construction footprint during the operational phase.
	Implement hygiene procedures for the use of vehicles and the importation of materials to the proposal footprint in accordance with *Guide 7: Pathogen management* and *Guide 6: Weed Management* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011) to reduce the chances of introducing or spreading new weeds or pests into the construction footprint.	During construction	Effective	
Invasion and spread of pathogens and disease	Implement hygiene procedures for the use of vehicles and the importation of materials to the proposal footprint in accordance with *Guide 7: Pathogen management* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011).	During construction	Effective	Minimal. With the implementation of these procedures, the risk of introducing pathogens would be greatly reduced.
	If areas containing pathogens or disease are identified best practice hygiene protocols would be implemented to prevent or minimise the introduction and spread of the pathogen within and outside of the construction footprint in accordance with *Guide 7: Pathogen management* of the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (Roads and Traffic Authority, 2011) or other relevant resource as appropriate.	During construction	Effective	

Impact	Mitigation measures	Timing and duration	Likely efficacy of mitigation	Residual impacts anticipated
Groundwater dependant ecosystems	Interruptions to water flows associated with GDEs would be minimised through detailed design.	Detailed design	Effective	Impacts associated with PCT 42, PCT 485 and PCT 1693.
Changes to hydrology	Changes to existing surface water flows would be minimised through detailed design.	Detailed deign	Effective	Minor alteration to surface water flows and as per impacts to PCTs.
	Construction to be completed in accordance with 'Managing urban stormwater: Soils and construction, Volume 2D: Main Road Construction, Sydney' (Blue Book) (Department of Environment and Climate Change, 2008).	During construction	Effective	
Biodiversity offsets	A Biodiversity Offset Strategy or Biodiversity Offset Report would be prepared for the proposal in accordance with Transport's Guidelines for Biodiversity Offsets (Roads and maritime Services, 2016).	Prior to construction	Effective	Residual impacts to be compensated as ratios specified in the offset guideline



Map: PS114532_BDAR_009_A3	Author: V.Lau
Date: 27/08/2021	Approved by: - T.Bangel

0 0.25 0.5 km

1:15,000

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

Data source: © Department of Customer Service 2020
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri

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NEW ENGLAND HIGHWAY MUSWELLBROOK BYPASS BIODIVERSITY ASSESSMENT REPORT

Figure 5.1a
Indicative locations of fauna crossing structures

COAL ROAD
MUSCLE CREEK
MUSCLE CREEK ROAD
BABBLER CRESCENT
WOODLAND RIDGE ROAD
ROSELLA CLOSE
TOP KNOT PLACE
KINGFISHER COURT
SILVER EYE ROAD
JEANS STREET
HENRY DANGAR DRIVE
MILPERA DRIVE
NEW ENGLAND HIGHWAY

Legend

- Koala scats
- Squirrel Glider
- Watercourse
- Fauna exclusion fencing
- Fauna underpass beneath Muscle Creek
- Construction footprint
- Study area

Map: PS114532_BDAR_009_A3	Author: V.Lau
Date: 27/08/2021	Approved by: - T.Bangel

0 0.25 0.5 km

1:15,000

Coordinate system: GDA 1994 MGA Zone 56

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Figure 5.1b
Indicative locations of fauna crossing structures

6 Offset strategy

6.1 Quantification of impacts

The need for biodiversity offsets is founded in the theory of 'avoid, minimise and mitigate' the impacts of proposals. The accepted approach to environmental assessment requires that, in the first instance, environmental impacts are avoided or minimised as far as possible and subsequently reduced to acceptable levels through appropriate mitigation techniques. Where measures to avoid and mitigate impacts are not feasible or cost effective, then offset strategies can be used to compensate the residual impacts of the development on biodiversity.

Although efforts have been made to avoid, minimise and mitigate ecological impacts associated with the proposal, some residual impacts would occur. This biodiversity assessment identified that the proposal is not likely to have a significant impact on any threatened biodiversity listed under the BC Act or EPBC Act (section 4.4 (Assessments of significance) and Appendix D). In this instance, and due to the Strategic Assessment, the EPBC Act environmental offsets policy does not apply to the proposal.

Transport for NSW would provide biodiversity offsets or where offsets are not reasonable or feasible, supplementary measures for impacts that exceed the thresholds in the Transport for NSW's *'Guideline for Biodiversity Offsets'* (Roads and Maritime Services, 2016). A comparison of the proposal's residual impacts against the predetermined thresholds is provided in Table 6.1. The assessment indicates that offsets would be required for this proposal as the impacts exceed biodiversity offset thresholds.

An estimate of the quantum of offsets required in accordance with the simplified offset ratios within Table 2 of the Transport for NSW's '*Guideline for Biodiversity Offsets'* (Roads and Maritime Services, 2016) is provided in Table 6.2.

Table 6.1 Transport for NSW offset thresholds

Description of activity or impact	Consider offsets or supplementary measures	Does the proposal trigger an offset
Activities in accordance with Transport for NSW Services Environmental assessment procedure: Routine and Minor Works (RTA 2011)	No	No
Works on cleared land, plantations, exotic vegetation where there are no threatened species or habitat present	No	No
Works involving clearing of vegetation planted as part of a road corridor landscaping program (this includes where threatened species or species comprising listed ecological communities have been used for landscaping purposes)	No	No
Works involving clearing of national or NSW listed critically endangered ecological communities (CEEC)	Where there is any clearing of a CEEC in moderate to good condition	Yes, areas of vegetation in moderate to good condition consistent with two CEECs would be impacted upon including: • 5.74ha of White box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland listed as CEEC under BC Act (of which 0.58ha is consistent with equivalent EPBC Act CEEC) • 8.88ha of Central Hunter eucalypt forest and woodland (CEEC under EPBC Act only).

Description of activity or impact	Consider offsets or supplementary measures	Does the proposal trigger an offset
Works involving clearing of nationally listed threatened ecological community (TEC) or nationally listed threatened species habitat	Where clearing >1ha of a TEC or habitat in moderate to good condition	Yes, 8.88ha of a nationally listed TEC in moderate to good condition (i.e. Central Hunter Valley eucalypt forest and woodland) would be directly impacted upon by the proposal – as specified in the above section. The proposal would also remove up to 22.26ha of habitat for the following nationally listed threatened species including: • Koala • Regent Honeyeater • Large-eared Pied Bat (foraging only) • Spotted-tailed Quoll • Painted Honeyeater • White-throated Needletail • Swift Parrot (foraging only) • Corben's Long-eared Bat • Grey-headed Flying-fox (no camps).
Works involving clearing of NSW endangered or vulnerable ecological community	Where clearing > 5ha or where the ecological community is subject to an SIS	Yes, 13.81ha of Central Hunter Grey Box – Ironbark Woodland EEC in moderate to good condition would require removal. Vegetation clearing of the remaining BC Act listed TECs would be <5ha or are listed as CEECs and considered in the above sections.
Works involving clearing of NSW listed threatened species habitat where the species is a species credit species as defined in the OEH Threatened Species Profile Database (TSPD)	Where clearing > 1ha or where the species is the subject of an SIS	Yes – up to 22.26ha of habitat in moderate to good condition for the following species credit species: • 22.26ha of Squirrel Glider habitat (containing hollows) • 22.26ha of habitat for the Koala • 12.27ha of habitat for the Southern Myotis.

Description of activity or impact	Consider offsets or supplementary measures	Does the proposal trigger an offset
Works involving clearing of NSW listed threatened species habitat and the species is an ecosystem credit species as defined in OEH's Threatened Species Profile Database (TSPD)	Where clearing > 5ha or where the species is the subject of an SIS	Yes, up to 22.26ha of NSW listed threatened species habitat in moderate to good condition for 37 ecosystem credit species would be impacted including Barking Owl, Powerful Owl, Masked Owl, Spotted Harrier, Black Falcon, Little Eagle, Square-tailed Kite, Black-chinned Honeyeater, Swift Parrot, Regent Honeyeater, Little Lorikeet, Painted Honeyeater, Brown Treecreeper, Dusky Woodswallow, Diamond Firetail, Flame Robin, Scarlet Robin, Grey-crowned Babbler (eastern subspecies), Hooded Robin, Speckled Warbler, Turquoise Parrot, Varied Sittella, Gang-Gang Cockatoo, Corben's Long-eared Bat, Eastern Cave Bat, Eastern Coastal Freetail Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat, Large-eared Pied-bat, Large Bent-winged Bat, Little Bent-wing Bat, Yellow-bellied Sheathtail-bat, Grey-headed Flying-fox, Koala, Spotted-tailed Quoll and White-bellied Sea-eagle.
Type 1 or Type 2 key fish habitats (as defined by NSW Fisheries)	Where there is any net loss of habitat	Yes, Type 1 sensitive key fish habitat would be impacted by the proposal. Impacts would be minor and restricted to where the proposal crossed Muscle Creek (about 0.08ha). This is based on the assumption that Muscle Creek is about 5m wide and the full length of the creek within the construction footprint (163.67m) would be impacted upon.

Table 6.2 Offset quantum based on REF proposal offset ratios

Type of impact	Offset ratio	Proposal impact	Potential offset obligation
Loss of threatened ecological community	Offset at a ratio of 4:1 where the offset sites are in moderate to good condition Offset at a ratio of 8:1 where the offset sites are in poor condition including rehabilitation sites	Impacts to TECs requiring offsets include: • 5.74ha of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CEEC under BC Act). This area includes 0.58ha consistent with the EPBC Act CEEC listing • 13.81ha of Central Hunter Grey Box – Ironbark Woodland (EEC under BC Act). This area includes 8.88ha of Central Hunter eucalypt forest and woodland listed as a CEEC under EPBC Act.	White box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland equivalent to: • 22.96ha in moderate to good condition • 45.92ha in poor condition. Central Hunter Grey Box – Ironbark Woodland/Central Hunter Valley eucalypt forest and woodland TECs equivalent to: • 55.24ha in moderate to good condition (at least 35.52ha consistent with EPBC Act listing) • 110.48ha in poor condition (at least 71.04ha consistent with EPBC Act listing).
Loss of threatened fauna species	Offset area of habitat lost at a ratio of 3:1	Up to 22.26ha of nationally listed threatened fauna species and NSW listed threatened species and ecosystem species habitat in moderate to good condition.	66.78ha of habitat for nationally listed threatened fauna species and NSW listed threatened ecosystem credit species. Following NSW listed threatened species credit habitat: • 66.78ha of habitat for the Squirrel Glider and Koala • 36.81ha for Southern Myotis.
Loss of threatened flora species	Offset individuals lost at a ratio of 3:1	No impacts on threatened flora species.	No offset obligation.
Loss of key fish habitat	Offset area of habitat loss at a ratio of 2:1 (Department of Primary Industries, 2013)	About 0.08ha (818.35m^2) of Type 1 key fish habitat would be impacted by the proposal.	0.16ha (11,400m^2)

7 Conclusion

This Biodiversity Assessment Report has been prepared to support a Review of Environmental Factors for the proposed Muswellbrook Bypass at Muswellbrook in NSW (the proposal).

The field surveys confirmed the presence of four threatened ecological communities listed under the BC Act within the study area, these included:

- Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered)
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions (Endangered)
- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands (Critically Endangered)
- Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions (Endangered).

Two of the above BC Act listed threatened ecological communities are also consistent with two EPBC Act listed threatened ecological communities being:

- Central Hunter Valley eucalypt forest and woodland (Critically Endangered)
- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands (Critically Endangered).

One threatened flora species, *Eucalyptus camaldulensis* (River Red Gum), listed as an Endangered Population within the Hunter catchment under the BC Act was recorded. About 12 naturally occurring *Eucalyptus camaldulensis* (River Red Gum) individuals were occur within the study area, all individuals would be avoided and not affected by the proposal.

Field surveys recorded 11 threatened fauna species including:

- Varied Sittella (*Daphoenositta chrysoptera*) listed as Vulnerable under the BC Act
- Little Lorikeet (*Glossopsitta pusilla*) listed as Vulnerable under the BC Act
- White-bellied Sea-eagle (*Haliaeetus leucogaster*) listed as Vulnerable under the BC Act
- Dusky Woodswallow (*Artamus cyanopterus cyanopterus*) listed as Vulnerable under the BC Act
- Speckled Warbler (*Chthonicola sagittata*) listed as Vulnerable under the BC Act
- Little Eagle (*Hieraaetus morphnoides*) listed as Vulnerable under the BC Act
- Southern Myotis (*Myotis macropus*) listed as Vulnerable under the BC Act
- Squirrel Glider (*Petaurus norfolcensis*) listed as Vulnerable under the BC Act
- Koala (Phascolarctos cinereus) listed as Vulnerable under the BC Act and EPBC Act
- Grey-headed Flying-fox (*Pteropus poliocephalus*) listed as Vulnerable under the BC Act and EPBC Act
- Striped Legless Lizard (*Delma impar*) listed as Vulnerable under the BC Act and EPBC Act.

Likelihood of occurrence assessments identified an additional 31 threatened fauna species of having a moderate or high likelihood of occurrence within the study area and therefore likely to be impacted by the proposal. These species include:

- 12 woodland birds
- Three waterfowls
- Three forest owls
- Three predatory birds; and
- Ten mammal species.

The key impact on biodiversity associated with the proposal would involve the direct removal of up to 97.92ha of native vegetation and associated habitats, including the removal of about 42 hollow-bearing trees. Of this native vegetation, 75.66ha consists of DNG and 22.26ha consists of low to moderate condition remnant native vegetation.

It is noted that this area of clearing represents a worst-case scenario as the construction footprint includes some additional areas which would not likely be impacted upon by the proposal. These additional areas have been included in this assessment to allow flexibility during design and construction to accommodate temporary structures ancillary features such as access tracks, site compounds and laydown areas.

A summary of native vegetation removal required is presented in the table below:

Plant community type (PCT)	Condition class	BC Act	EPBC Act	Percent cleared in NSW	Construction footprint (ha)
PCT 1691 Narrow-leaved Ironbark – Grey Box grassy woodland of the central and upper Hunter	Moderate	Endangered[1]	Critically Endangered[5]	77%	8.82
	Low (Remnant)		–		4.93
	Low (DNG)		–		38.39
PCT 1604 Narrow-leaved Ironbark – Grey Box – Spotted Gum shrub – grass woodland of the central and lower Hunter	Low (Remnant)	Endangered[2]	–	71%	0.67
PCT 1605 Narrow-leaved Ironbark – Native Olive shrubby open forest of the central and upper Hunter	Moderate	Endangered[1]	Critically Endangered[5]	32%	0.06
PCT 1607 Blakely's Red Gum – Narrow-leaved Ironbark – Rough-barked Apple shrubby woodland of the upper Hunter	Good	Critically Endangered[3]	Critically Endangered[6]	51%	0.56
	Low (Remnant)		–		0.09
	Low (DNG)		–		1.02
PCT 1693 Yellow Box – Rough-barked Apple grassy woodland of the upper Hunter and Liverpool Plains	Good	Critically Endangered[3]	Critically Endangered[6]	64%	–
	Moderate				0.02
	Low (Remnant)		–		5.07
	Low (DNG)		–		31.19
PCT 42 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Low (Remnant)	Endangered[4]	–	95%	0.08
	Low (DNG)		–		3.38

Plant community type (PCT)	Condition class	BC Act	EPBC Act	Percent cleared in NSW	Construction footprint (ha)
PCT 485 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)	Moderate	–	–	50%	1.78
	Low (Remnant)	–	–		0.18
	Low (DNG)	–	–		1.68
Total area of DNG					**75.66**
Total area of remnant vegetation					**22.26**
Total native vegetation impacted					**97.92**

1. Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions (Central Hunter Grey Box-Ironbark Woodland) – listed as Endangered under BC Act
2. Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions (Central Hunter Ironbark - Spotted Gum -Grey Box Forest) – listed as Endangered under the BC Act
3. White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions (White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland) – listed as Critically Endangered under the BC Act
4. Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions (Hunter Floodplain Red Gum Woodland) – listed as Endangered under the BC Act
5. Central Hunter Valley eucalypt forest and woodland – listed as Critically Endangered under the EPBC Act
6. White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland – listed as Critically Endangered under the EPBC Act.

Fauna injury or death is another key impact associated with the proposal as it would involve the construct of a new barrier (i.e. a nine kilometre new highway with a single lane in each direction and a one meter wide linemarked centreline). This new barrier which would reduce fauna movement within the immediate locality of the proposal, especially for less-mobile mammal species such as the Koala and Spotted-tailed Quoll. Indirect/operational impacts including an increase in habitat isolation. Invasion and spread of weeds, invasion and spread of pests, and invasion and spread of pathogens and disease are a risk with a proposal of this type. Noise, light and vibration would be increased during construction and operation.

The overall outcome of the tests of significance and EPBC Act assessments of significance (see Appendix D) indicate that the impacts to threatened biodiversity are unlikely to be significant. Given the proposal is not considered likely to lead to a significant impact on threatened species, populations, ecological communities or their habitats, a Species Impact Statement (SIS) is not required under the BC Act to support this proposal. In respect to Matters of National Environmental Significance (MNES) including threatened flora, fauna and communities, a referral of this proposal for consideration as a controlled action under the EPBC Act is not required.

Minimisation of biodiversity impacts would occur at the detailed design phase. However, mitigation measures would need to be implemented during the construction and operational phases to further lessen the potential ecological impacts of the proposal. The '*Roads and Maritime Biodiversity Guidelines: Protecting and managing biodiversity of RTA projects*' (Roads and Traffic Authority, 2011) identifies a range of mitigation techniques to be applied and these techniques must be implemented during construction. Due to the presence of an four threatened ecological communities, known Endangered Population of plant (*Eucalyptus camaldulensis*) and habitat present for many threatened fauna species (including a population of Striped Legless Lizard immediately within and adjacent the construction footprint), exclusion zones would be established to delineate the works limit boundary to ensure no accidental impacts occur.

Additional mitigation measures should be implemented to address potential impacts on wildlife movement for fauna such as the Koala, Squirrel Glider and Spotted-tailed Quoll. These additional mitigation measures include implementation of an aerial fauna crossing to the north and the construction of a large-spanned bridge over Muscle Creek which would minimise impacts on wildlife movement. With the implementation of the recommended mitigation measures proposed it is unlikely that residual impact of the proposal would result in a significant impact to biodiversity within the locality.

Although efforts have been made to avoid, minimise and mitigate potential ecological impacts from the proposal, some residual impacts would occur. This biodiversity assessment identified that the proposal is not likely to have a significant impact on any threatened biodiversity listed under the BC Act or EPBC Act. In this instance, and due to the Strategic Assessment, the EPBC Act environmental offsets policy does not apply.

It is however Transport for NSW's policy that biodiversity offsets (or where offsets are not reasonable or feasible, supplementary measures) would be provided for impacts that exceed predetermined thresholds. The Transport for NSW's '*Guidelines for Biodiversity Offsets'* (November 2016) indicates that the following offsets would be required by the proposal given residual impacts associated with the current development footprint exceed the predetermined thresholds as specified in the guideline:

- 22.96ha of White box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC in moderate to good condition
- 55.24ha of Central Hunter Valley Grey Box – Ironbark Woodland TEC in moderate to good condition (at least 35.52ha consistent with EPBC Act listing for Central Hunter Valley eucalypt forest and woodland)
- 66.78ha of habitat for national and NSW listed threatened fauna species (including 66.78ha of species credit habitat for the Squirrel Glider and Koala)
- 36.81ha of habitat for Southern Myotis
- 0.16ha of Type 1 key fish habitat.

A Biodiversity Offset Strategy would be developed to identify biodiversity credits and/or supplementary measures for those entities impacted.

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Appendix A – Habitat assessment tables

Likelihood of occurrence criteria

Likelihood	Criteria
Recorded	The species was observed in the study area during the current survey.
High	It is highly likely that a species inhabits the study area and is dependent on identified suitable habitat (i.e. for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the locality (10 kilometre) and is known or likely to maintain resident populations in the study area. Also, includes species known or likely to visit the study area during regular seasonal movements or migration.
Moderate	Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on habitat within the study area, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
Low	It is unlikely that the species inhabits the study area and has not been recorded recently in the locality (10 kilometre). It may be an occasional visitor, but habitat similar to the study area is widely distributed in the local area, meaning that the species is not dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the study area or the species are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded.
None	Suitable habitat is absent from the study area.

Habitat assessment table – threatened flora

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Acacia bynoeana	Bynoes Wattle	V	E1	Occurs south of Dora Creek-Morisset area to Berrima and the Illawarra region and west to the Blue Mountains. It grows mainly in heath and dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with *Corymbia gummifera, Eucalyptus haemastoma, E. gummifera, E. parramattensis, E. sclerophylla, Banksia serrata* and *Angophora bakeri.*	BioNet (Hunter)	Low – although an associated vegetation type was recorded, it was in poor condition and is unlikely to provide habitat for the species. Furthermore, the study area is outside the species current known distribution range (nearest record at Branxton).	No – species is considered unlikely to occur within the study area.
Acacia pendula	Weeping Myall, Boree	-	E2	Within the Hunter catchment the species typically occurs on heavy soils, sometimes on the margins of small floodplains, but also in more undulating locations. This population is known to occur naturally as far east as Warkworth, and extends northwest to Muswellbrook and to the west of Muswellbrook at Wybong. It has only been recorded at six locations: Jerrys Plains, Edderton, Wybong, Appletree Creek, Warkworth and Appletree Flat. The stand at Jerrys Plains is part of the Weeping Myall - Coobah - Scrub Wilga Shrubland of the Hunter Valley, listed under EPBC Act as a Critically Endangered Ecological Community.	BioNet (35 records), BioNet (Hunter)	**Moderate** – associated vegetation types occur and the species has been recorded frequently in the locality.	No – although a candidate species, it was not recorded naturally occurring in the study area during targeted surveys and is therefore considered unlikely to occur or be affected by the proposal. Note: planted individuals were identified within 'native planting' miscellaneous ecosystem; these do not form part of the listing for this Endangered Population.
Angophora inopina	Charmhaven Apple	V	V	Restricted to the Charmhaven - Wyee area where it grows in open dry sclerophyll woodland of *Eucalyptus haemastoma* and *Corymbia gummifera* with a dense shrub understorey. Occurs on deep white sandy soils over sandstone, often with some gravelly laterite.	BioNet (Hunter)	Low - no associated vegetation types recorded within the study area. Furthermore, study area is outside the species current known distribution range (nearest record east of Singleton).	No – species is considered unlikely to occur within the study area.
Asperula asthenes	Trailing Woodruff	V	V	This small herb occurs only in NSW in scattered locations from Bulahdelah north to near Kempsey, with several records from the Port Stephens/Wallis Lakes area. It grows in damp sites, often along river banks.	BioNet (Hunter)	Low – no associated vegetation types which provide habitat for the species were recorded within the study area.	No – species is considered unlikely to occur within the study area.

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Callistemon linearifolius	Netted Bottle Brush	–	V	Occurs chiefly from Georges to the Hawkesbury River where it grows in dry sclerophyll forest, open forest, scrubland or woodland on sandstone. Found in damp places, usually in gullies. Within the Sydney region, recent records are limited to the Hornsby Plateau area near the Hawkesbury River.	BioNet (Hunter)	Low – although an associated vegetation type was recorded, the species is not cryptic in nature and was not recorded during surveys. Furthermore, the study area is outside the species current known distribution range (nearest record near Cessnock).	No – species is considered unlikely to occur within the study area.
Chamaesyce psammogeton	Sand Spurge	–	E1	Occurs in coastal regions of NSW where it grows on sand dunes near the sea. Grows on fore-dunes and exposed headlands, often with Spinifex (*Spinifex sericeus*).	BioNet (Hunter)	Low – no associated vegetation types which provide habitat for the species were recorded (species is restricted to sand dunes on the coast).	No – species is considered unlikely to occur within the study area.
Commersonia procumbens		V	V	Occurs south of Picton lakes where it mainly grows in gullies along the escarpment, south from Picton Lakes, on the Southern Tablelands (one plant at Penrose State Forest, one plant at Rowes Lagoon and one plant at Tallong) and on the North Coast (less than 100 plants at the Tomago sandbeds north of Newcastle). It occurs on sandy, sometimes peaty soils in a wide variety of habitats: Snow Gum (*Eucalyptus pauciflora*) Woodland at Rose Lagoon; Blue leaved Stringybark (*E. agglomerata*) Open Forest at Tallong; and in Brittle Gum (*E. mannifera*) Low Open Woodland at Penrose; Scribbly Gum (*Eucalyptus haemostoma*)/ Swamp Mahogany (*E. robusta*) Ecotonal Forest at Tomago. Associated native species may include *Imperata cylindrica, Empodisma minus* and *Leptospermum continentale*.	PMST	Low – no associated vegetation types which provide potential habitat for the species were recorded. Furthermore, the study area is outside the species current known distribution range (nearest record on the Tomago sand beds at Williamtown).	No – species is considered unlikely to occur within the study area.
Commersonia rosea		E	E1	*Commersonia rosea* is only known from four localities in the Sandy Hollow district of the upper Hunter Valley, New South Wales, all within an 8 km radius of Sandy Hollow. *Commersonia rosea* occupies relatively small areas at its known sites and has a total population of less than 200 plants (Bell and Copeland 2004). No populations are within a conservation reserve. Vegetation surveys in the nearby Manobalai Nature Reserve, Goulburn River National Park, Myambat Logistics Company site Department of Defence, Wollemi National Park and other Crown Lands have failed to locate further plants. The habitat of this species is scrub and heathlands on skeletal sandy soils, with some sparse overstorey of *Eucalyptus crebra, Callitris endlicheri* or *Eucalyptus caleyi subsp. caleyi*.	BioNet (Hunter), PlantNet	Low – although an associated vegetation type which provides potential habitat for the species was recorded, the species known distribution is limited to within 8 km of Sandy Hollow. Vegetation within the study area does not align with the species preferred habitat and occurs outside the species current known distribution range.	No – species is considered unlikely to occur within the study area.
Corybas dowlingii	Red Helmet Orchid	-	E1	*Corybas dowlingii* is a tuberous orchid, forming clonal colonies. It commonly occurs in gullies of tall open forest, typically between 10 and 200m elevation and on well-drained gravelly soil.	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded. Furthermore, the study area is outside the species current known distribution range (nearest record near Raymond Terrace).	No – species is considered unlikely to occur within the study area.
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Occurs south from the Gibraltar Range, chiefly in coastal districts but also extends on to tablelands. Grows in swamp-heath and drier forest on sandy soils on granite & sandstone. Occurs in small, localised colonies most often on the flat plains close to the coast but also known from some mountainous areas growing in moist depressions and swampy habitats.	BioNet (Hunter)	Low – although associated vegetation types which provides potential habitat for the species were recorded, the study area occurs outside the species current known distribution range (nearest record near Awaba >70 km away).	No – species is considered unlikely to occur within the study area.

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Cymbidium canaliculatum	Tiger Orchid	–	E2	In the Hunter Catchment, the endangered population of this species grows singularly or in clumps in tree hollows, commonly between two to six metres above the ground. Found in woodlands and dry sclerophyll forests dominated by *Eucalyptus albens*, and less commonly found on *E. dawsonii, E. crebra, E. moluccana, Angophora floribunda* and *Acacia salicina*. Scattered, non-endangered populations of this species exist across northern Australia, from NSW to Western Australia.	BioNet (8 records), BioNet (Hunter)	**Moderate –** associated vegetation types which provide potential habitat for the species were recorded and the species has been recorded infrequently within the locality.	No – although a candidate species, it was not recorded in the study area during targeted surveys and is therefore considered unlikely to occur or be affected by the proposal.
Cynanchum elegans	White-flowered Wax Plant	E	E1	Occurs from the Gloucester district to the Wollongong area and inland to Mt Dangar where it grows in rainforest gullies, scrub and scree slopes. This species typically occurs at the ecotone between dry subtropical forest/woodland communities.	BioNet (Hunter), PlantNet, PMST	Low – although associated vegetation types which provide potential habitat were recorded, no preferred habitat was identified within the study area. The species has not been recorded in the locality (nearest record at Martindale). Records in the broader locality occur in higher quality remnants.	No – species is considered unlikely to occur within the study area.
Darwinia peduncularis		–	V	Occurs from Hornsby to Hawkesbury River and west to Glen Davies where it grows in dry sclerophyll forest on sandstone hillsides and ridges. Known to occur along watercourses. Usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone.	PlantNet	Low – no associated vegetation types which provide potential habitat for the species were recorded. Furthermore, the study area is outside the species current known distribution range (nearest record east of Rylstone).	No – species is considered unlikely to occur within the study area.
Veronica blakelyi		–	V	Restricted to the western Blue Mountains, from Clarence to Peel River and Coricudgy Range, near Mt Horrible and on Nullo Mountain. Grows in eucalypt forest, 650-950 m altitude, often in moist areas. Known locations all have small population sizes.	PlantNet	Low – no associated vegetation types which provide potential habitat for the species were recorded. Furthermore, the study area is outside the species current known distribution range (nearest record east of Rylstone).	No – species is considered unlikely to occur within the study area.
Dichanthium setosum	Bluegrass	V	V	Grows in woodland and grassland. On the New England Tablelands and North West Slopes it grows on stony red-brown hard-setting soils over basalt, or on black soil.	PMST	Low **–** although associated vegetation types which provide potential habitat for the species were recorded, the species is not known to occur within the Sydney Basin Bioregion (nearest BioNet records north of Scone).	No – species is considered unlikely to occur within the study area.
Dillwynia tenuifolia		–	V	Occurs on the Cumberland Plain from the Blue Mountains to Howes Valley area where it grows in dry sclerophyll woodland on sandstone, shale or laterite. Specifically, occurs within Castlereagh woodlands, particularly in shale gravel transition forest. Associated species include *Eucalyptus fibrosa, E. sclerophylla, Melaleuca decora, Daviesia ulicifolia, Dillwynia juniperina* and *Allocasuarina littoralis*.	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded. Furthermore, the study area is outside the species current known distribution range (nearest record south of Bulga which is a disjunct population).	No – species is considered unlikely to occur within the study area.
Diuris praecox	Rough Doubletail	V	V	Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey.	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded. Species is generally restricted in coastal districts.	No – species is considered unlikely to occur within the study area.

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Diuris tricolor	Pine Donkey Orchid, Painted Diuris	–	V, E2	Grows in sclerophyll forest among grass, often with Callitris, or in grassy Callitris woodland. 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. Soils include gritty orange-brown loam on granite, shallow red loamy sand on stony porphyry, skeletal lateritic soil and alluvial grey silty loam. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats. Within the Upper Hunter it is known to occur in *Eucalyptus albens/Eucalyptus crebra/Eucalyptus blakelyi/Corymbia maculata* woodland complexes and grasslands.	BioNet (25 records), BioNet (Hunter), PlantNet	**Moderate –** associated vegetation types which provide potential habitat for the species were recorded and the species has been recorded frequently within the locality.	No – although a candidate species, it was not recorded in the study area during targeted surveys and is therefore considered unlikely to occur or be affected by the proposal.
Eucalyptus camaldulensis	River Red Gum	–	E2	Occurs in the western slopes, western plains, far western plains and in the North Coast (Hunter Catchment). It is typically dominant, occurring within grassy woodland or forest on deep rich alluvial soils adjacent to large permanent water bodies. In the endangered Hunter population it may occur with *Eucalyptus tereticornis, Eucalyptus melliodora, Casuarina cunninghamiana subsp. cunninghamiana* and *Angophora floribunda*.	BioNet (29 records), BioNet (Hunter)	**Recorded –** vegetation associations which provide potential habitat for the species were recorded and the species has been recorded frequently in the locality. A small population of potentially naturally occurring individuals were recorded within the study are.	Yes – species identified within the study area although not directly impacted upon Endangered Population occurs on the edge of the construction footprint and indirect impacts may occur. Note: planted individuals were also identified within the 'native planting' miscellaneous ecosystem; these do not form part of the listing for this Endangered Population.
Eucalyptus camfieldii	Heart-leaved Stringybark	V	V	Occurs in scattered locations within a restricted distribution in a narrow band with the most northerly records in the Raymond Terrace area south to Waterfall. Grows in poor coastal country in shallow sandy soils overlying Hawkesbury sandstone, in coastal heath mostly on exposed sandy ridges. Occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas. Associated species frequently include Brown Stringybark (*E. capitellata*), Scribbly Gum (*E. haemastoma*), Narrow-leaved Stringybark (*E. oblonga*), Silvertop Ash (*E. sieberi*), Smooth-barked Apple (*Angophora costata*), Dwarf Apple (*A. hispida*), Red Bloodwood (*Corymbia gummifera*), Scrub She-oak (*Allocasuarina distyla*), Slender Tea Tree (*Leptospermum trinervium*), and Fern-leaved Banksia (*Banksia oblongifolia*).	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded. Furthermore, the study area occurs outside the species known current distribution limit (distribution is scattered along the coast, nearest record at Raymond Terrace).	No – species is considered unlikely to occur within the study area.
Eucalyptus castrensis	Singleton Mallee	–	E1	Known only from a single dense stand of about 10ha (near Broken Back repeater station in Singleton Training Area), and a number of smaller outlying stands over a 2.5km range, near Singleton in the lower Hunter Valley in the North Coast bioregion.	BioNet (Hunter)	Low – although an associated vegetation type which provides potential habitat for the species recorded, the species is not cryptic in nature and was not recorded. Furthermore, the species is restricted to a single population in Singleton.	No – species is considered unlikely to occur within the study area.
Eucalyptus corticosa		–	V	Occurs within a small area on the Central Tablelands, specifically, close to Mount Coricudgy near Rylstone. This species grows in sclerophyll woodland, often dominated by *Eucalyptus rossii*, where the woodland exists on sandstone ridges with shallow infertile soils along the upper Cudegong River. It may be locally frequent, and is often associated with *Eucalyptus rossii.*	PlantNet	Low – no associated vegetation types which provide potential habitat for the species were recorded, the study area occurs outside the species known current distribution limit.	No – species is considered unlikely to occur within the study area.

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Eucalyptus fracta	Broken Back Ironbark	–	V	Known only from State Forests on parts of the northern escarpment of the Broken Back Range, near Cessnock, where it is locally frequent. It is restricted to shallow soils along the upper escarpment of a steep sandstone range.	BioNet (Hunter), PlantNet	Low – no associated vegetation types which provide potential habitat for the species were recorded, the study area occurs outside the species known current distribution limit (nearest record at Cessnock).	No – species is considered unlikely to occur within the study area.
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	This species is sparsely distributed but widespread on the New England Tablelands from Nundle to north of Tenterfield, being most common in central portions of its range. Found largely on private property and roadsides, and occasionally in conservation reserves. Planted as urban trees, windbreaks and corridors.	Recorded on site	Low – no naturally occurring individuals are considered likely to occur as the species is not known to occur naturally within the Sydney Basin and no associated vegetation types which provide potential habitat for the species were recorded.	No – species is considered unlikely to naturally occur within the study area. Note: planted individuals were identified within the study area; these do not form part of the listing for this Endangered Population.
Eucalyptus scoparia	Wallangarra White Gum	V	E	In NSW it is known from only three locations near Tenterfield, including Bald Rock National Park. In Queensland it is equally rare, occurring at three sites on the Stanthorp Plateau including one population in Girrawween National Park. Only one Queensland population has more than a dozen trees.	Recorded on site	Low –no naturally occurring individuals are considered likely to occur as the species is not known to occur naturally within the Sydney Basin and no associated vegetation types which provide potential habitat for the species were recorded.	No – species is considered unlikely to naturally occur within the study area. Note: planted individuals were identified within the study area; these do not form part of the listing for this Endangered Population.
Eucalyptus glaucina	Slaty Red Gum	V	V	Occurs from Taree to Broke where it is locally frequent but very sporadic and grows in grassy woodland on deep, moderately fertile and well-watered soil. Endemic on low coastal ranges and tablelands of central NSW, Taree to Broke, also near Casino.	BioNet (9 records), BioNet (Hunter), PMST	**Moderate –** associated vegetation types which provide potential habitat for the species were recorded and the species has been recorded infrequently in the locality.	No – although a candidate species, it was not recorded in the study area during targeted surveys and is therefore considered unlikely to occur or be affected by the proposal.
Eucalyptus parramattensis subsp. *decadens*		V	V	Locally frequent, grows in dry sclerophyll woodland on sandy soils in low, often wet sites.	BioNet (Hunter)	Low – although an associated vegetation type was recorded, the study area occurs outside the species known current distribution range (nearest record near Branxton). Furthermore, species was not recorded from within the associated vegetation type on site.	No – species is considered unlikely to occur within the study area.
Eucalyptus pumila	Pokolbin Mallee	V	V	Now only known from a single stand near Pokolbin where it grows in sclerophyll shrubland on skeletal soil on sloping sandstone. Previously recorded from Muswellbrook and Wyong.	BioNet (Hunter)	Low – although an associated vegetation type was recorded, the study area occurs outside the species known current distribution range (restricted to a single stand of trees at Pokolbin).	No – species is considered unlikely to occur within the study area.
Euphrasia arguta		CE	CE	Rediscovered in the Nundle area of the NSW north western slopes and tablelands in 2008, it had not been collected for 100 years. Historically, it was recorded from relatively few places within an area extending from Sydney to Bathurst and north to Walcha. Ecological information from historical records is scarce including, 'in the open forest country around Bathurst in sub humid places', 'on the grassy country near Bathurst', 'in meadows near rivers'. The populations that are currently known are located in the Nundle State Forest and on nearby private land, in eucalypt forest with a mixed grass and shrub understorey.	PMST	Low **–** species is not known to occur within the Sydney Basin (i.e. study area occurs outside the species known distribution range).	No – species is considered unlikely to occur within the study area.

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	V	V	Mainly known from the Prospect area (but now extinct there) and lower Georges River to Camden, Appin and Cordeaux Dam areas, with a disjunct populations near Putty, Cessnock and Cooranbong. Grows in heath or shrubby woodland in sandy or light clay soils usually over thin shales.	BioNet (Hunter)	Low – although an associated vegetation type was recorded it was in low condition and the study area occurs outside the species known current distribution range (nearest record east of Branxton).	No – species is considered unlikely to occur within the study area.
Homoranthus darwinioides		V	V	Grows in in various woodland habitats with shrubby understoreys, usually in gravely sandy soils. Landforms the species has been recorded growing on include flat sunny ridge tops with scrubby woodland, sloping ridges, gentle south-facing slopes, and a slight depression on a roadside with loamy sand. Associated species include *Callitris endlicheri, Eucalyptus crebra, E. fibrosa, E. trachyphloia, E. beyeri subsp. illaquens, E. dwyeri, E. rossii, Leptospermum divaricatum, Melaleuca uncinata, Calytrix tetragona, Allocasuarina spp*. and *Micromyrtus spp.*	PlantNet	Low – although an associated vegetation type which provides potential habitat for the species was recorded, the study area occurs outside the species known current distribution limit and the study area doesn't contain preferred habitat.	No – species is considered unlikely to occur within the study area.
Kennedia retrorsa		V	V	Found in a variety of habitats from mountainsides to riparian zones, from sheltered forest to steep, exposed rocky ridgelines. Believed to be restricted to the Mount Dangar area and the adjacent Goulburn River catchment, within the Muswellbrook and adjacent Merriwa local government areas.	PlantNet	Low – no associated vegetation types which provide potential habitat for the species were recorded and the study area occurs outside the species known current distribution limit.	No – species is considered unlikely to occur within the study area.
Lasiopetalum longistamineum		V	V	Grows in rich alluvial deposits in the Gungal - Mt Dangar area. The species is known to occur in grassy woodlands and dry (sclerophyll) forests and rainforests on rich alluvial deposits. Associated species include Bottlebrush (*Callistemon sp*.) and Tea Tree (*Leptospermum sp.*) The species' habitat overlaps with that of the EPBC Act listed White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland threatened ecological community.	PlantNet	Low – although associated vegetation types which provide potential habitat for the species were recorded the study area occurs outside the species known current distribution range (restricted to the Mt Dangar and Gungal area).	No – species is considered unlikely to occur within the study area.
Leionema lamprophyllum subsp. *obovatum*		–	E2	Grows south from Tidbinbilla, in heath on exposed ridges at higher altitudes. Also recorded near Pokolbin, where it is listed as an Endangered population in Pokolbin State Forest, part of the Singleton Local Government Area in the Hunter Catchment.	BioNet (Hunter)	Low – no associated vegetation types which provide habitat for the species were recorded. Furthermore, the study area occurs outside the species current known distribution range.	No – species is considered unlikely to occur within the study area.
Maundia triglochinoides	–	–	V	Occurs north from Sydney. Grows in swamps, creeks or shallow freshwater 30 to 60cm deep on heavy clay, low nutrients. Associated with wetland species such as *Triglochin procerum.*	BioNet (Hunter)	Low – no associated vegetation types which provide habitat for the species were recorded. Furthermore, the study area occurs outside the species current known distribution range (restricted to coastal regions).	No – species is considered unlikely to occur within the study area.
Melaleuca biconvexa	Biconvex Paperbark	V	V	Occurs as disjunct populations in coastal New South Wales from Jervis Bay to Port Macquarie, with the main concentration of records is in the Gosford/Wyong area. Grows in damp places, often near streams, or low-lying areas on alluvial soils of low slopes or sheltered aspects.	BioNet (Hunter)	Low – no associated vegetation types which provide habitat for the species were recorded. Furthermore, the study area occurs outside the species current known distribution range (generally restricted to coastal regions).	No – species is considered unlikely to occur within the study area.

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Melaleuca groveana	Groves Paperbark	–	V	Widespread, scattered populations in coastal districts north of Yengo National Park to southeast Queensland. Also found as a disjunct population near Torrington on the northern tablelands. It grows in heath and shrubland, often in exposed sites, in low coastal hills, escarpment ranges and tablelands on outcropping granite, rhyolite and sandstone on rocky outcrops and cliffs. It also occurs in dry shrubby open forest and woodlands.	BioNet (Hunter)	Low – no associated vegetation types which provide habitat for the species were recorded. Furthermore, the study area occurs outside the species current known distribution range (nearest record south of Denman).	No – species is considered unlikely to occur within the study area.
Monotaxis macrophylla		–	E1	*Monotaxis macrophylla* is a fire ephemeral species where germination is stimulated only by fire. This species has a short life span (don't persist longer than 6 months) with flowering occurs in August and within 2 to 3 months after germination. Many hundreds of plants have been observed growing with *Muehlenbeckia costata* on recently burnt rock outcrops. Plants are recorded as common but localised in populations. In the northern NSW sites, *Monotaxis macrophylla* was locally abundant on outcrops especially where burnt. Grows on rocky ridges and hillsides. There is a great diversity in the associated vegetation within NSW, encompassing coastal heath, arid shrubland, forests and montane heath from almost sea level to 1300m altitude.	BioNet (Hunter), PlantNet	Low – although associated vegetation types were recorded, the study area occurs outside the species current known distribution range (nearest record >20km south in higher quality vegetation) and preferred habitat i.e. rocky ridges was not recorded.	No – species is considered unlikely to occur within the study area.
Ozothamnus tesselatus		V	V	This species distribution is from Ryalstone north to the upper Hunter Valley. Grows in eucalypt woodland and often occurs in White Box Woodlands and Central Hunter Grey Box Ironbark Woodland in the Hunter Valley near Singleton.	BioNet (Hunter), PlantNet	**Moderate** – associated vegetation types which provide potential habitat for the species were recorded and the species has been recorded in the broader locality.	No – although a candidate species, it was not recorded in the study area during targeted surveys and is therefore considered unlikely to occur or be affected by the proposal.
Persicaria elatior	Tall Knotweed	V	V	Occurs infrequently in coastal regions where it grows in damp places especially beside streams and lakes. Also occasionally occurs in swamp forest or associated with disturbance.	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded, the study area occurs outside the species known current distribution limit.	No – species is considered unlikely to occur within the study area.
Persoonia pauciflora	North Rothbury Persoonia	CE	CE	Known distribution extremely restricted . All known individuals occur within 2.5km of the original or type specimen, which was recorded near North Rothbury in the Cessnock Local Government Area. Occurs in dry open-forest or woodland habitats, generally with a projected foliage cover ranging between 10 to 40% and tree height range of between 6 to 18 metres. The lower strata usually comprises of a moderate to sparsely distributed shrub layer, with a high percentage of groundcover species, particularly grasses. Vegetation communities are dominated by Spotted Gum (*Corymbia maculata*), Broad-leaved Ironbark (*Eucalyptus fibrosa*), and/or Narrow-leaved Ironbark (*E. crebra*). Sub-dominant species include Grey Gum (*E. punctata*) and Grey Box (*E. mollucana*). Common understorey shrubs include *Acacia parvipinnula, Daviesia ulicifolia* and *Bursaria spinosa*. The majority of the population is known to occur on silty sandstone soils derived from the "Farley Formation".	BioNet (Hunter)	Low – although an associated vegetation type was recorded, the species is restricted to North Rothbury in the Cessnock LGA.	No – species is considered unlikely to occur within the study area.

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Philotheca ericifolia	–	V	–	Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies, in the upper Hunter Valley and Pilliga to Peak Hill district. It has been collected from a variety of habitats including heath, open woodland, dry sandy creek beds, and rocky ridge and cliff tops. Associated species include *Melaleuca uncinata, Eucalyptus crebra, E. rossii, E. punctata, Corymbia trachyphloia, Acacia triptera, A. burrowii, Beyeria viscosa, Philotheca australis, Leucopogon muticus* and *Calytrix tetragona*. Noted as being a moisture-loving plant, with plants common on the sides of a particular spur of the Hervey Ranges where soakage from the high background provides sufficient moisture for the plants.	PlantNet, PMST	Low – no associated vegetation types which provide potential habitat for the species were recorded, the study area occurs outside the species known current distribution limit (eastern most records occur west of Denman and Wingen).	No – species is considered unlikely to occur within the study area.
Pomaderris bodalla		–	V	*Pomaderris bodalla* is endemic to NSW and is currently known to occur on the south coast between Bodalla and Merimbula, and in the upper Hunter valley near Muswellbrook. On the south coast, it occurs in moist open forest along sheltered gullies or along stream banks. In the upper Hunter valley, it occurs in open forest or woodland on open slopes. There are ten populations of *Pomaderris bodalla* currently known, and a further two imprecisely described locations from which the species was collected about 40 years ago. The majority of populations are small with seven of the populations having estimates of less than a hundred plants each. All populations have locally restricted distributions. The largest known population is in Wollemi National Park and is unlikely to include more than one thousand plants.	BioNet (Hunter)	Low – although recorded in the broader locality, no associated vegetation types which provide potential habitat for the species were recorded in the study area.	No – species is considered unlikely to occur within the study area.
Pomaderris queenslandica	Scant Pomaderris	E1	-	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. It grows in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	BioNet (Hunter), PlantNet	**Moderate –** associated vegetation types which provide potential habitat for the species recorded and species recorded in the broader locality.	No – although a candidate species, it was not recorded in the study area during targeted surveys and is therefore considered unlikely to occur or be affected by the proposal.
Pomaderris reperta	Denman Pomaderris	CE	CE	Recorded from a small number of sites along a single ridgeline near Denman in the upper Hunter Valley (Muswellbrook Local Government Area). Occupies woodland in association with *Eucalyptus crebra, E. blakelyi, Notelaea microcarpa*, and *Allocasuarina littoralis.*	BioNet (Hunter), PlantNet	Low – preferred habitat not recorded within the study area. Species is restricted to a single population near Denman.	No – species is considered unlikely to occur within the study area.
Prasophyllum petilum	Tarengo Leek Orchid	E	E (refer below to *Prasophyllum sp. 'Wybong'*)	Natural populations are known from a total of five sites in NSW. These area at Boorowa, Captains Flat, Ilford, Delegate and a newly recognised population c.10 k SE of Muswellbrook. It also occurs at Hall in the Australian Capital Territory. Grows in open sites within Natural Temperate Grassland at the Boorowa and Delegate sites. Also grows in grassy woodland in association with River Tussock *Poa labillardieri*, Black Gum *Eucalyptus aggre*gata and tea-trees Leptospermum spp. at Captains Flat and within the grassy groundlayer dominated by Kangaroo Grass under Box-Gum Woodland at Ilford (and Hall, ACT). Highly susceptible to grazing, being retained only at little-grazed travelling stock reserves (Boorowa & Delegate) and in cemeteries (Captains Flat, Ilford and Hall).	PlantNet	**Moderate** – *Prasophyllum sp.* 'Wybong' is considered a synonym of *Prasophyllum petilum* under the BC Act however treated separately under the EPBC Act. *Prasophyllum sp. 'Wybong'* has been recorded within the broader locality and potential habitat occurs within the study area.	No – although a candidate species, it was not recorded in the study area during targeted surveys and is therefore considered unlikely to occur or be affected by the proposal.

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Prasophyllum sp. 'Wybong' (synonym of Prasophyllum petilum under BC Act)	A Leek Orchid	CE	–	*Prasophyllum sp. Wybong* (C. Phelps ORG 5269) is known from seven populations in open eucalypt woodland and grassland in NSW. The species' area of occupancy is estimated to be 1.5km^2 with an estimated population size based on surveys in 2006 of 460 mature individuals. This species occurs within the Sydney Basin, New England Tablelands, Brigalow Belt South and NSW South Western Slopes IBRA Bioregions and the Border Rivers-Gwydir, Namoi, Hunter-Central Rivers and Central West Natural Resource Management Regions. The distribution of this species overlaps with the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act-listed threatened ecological community.	PMST		
Prostanthera cineolifera	Singleton Mint Bush	V	V	Thought to occur in north coast and central coast botanical subdivisions where it apparently grows in sclerophyll forest. The distribution of this taxon is uncertain.	BioNet (Hunter)	Low – although a single associated vegetation formation which provides habitat was recorded it was highly degraded, the species is not cryptic in nature and was not recorded within this vegetation type.	No – species is considered unlikely to occur within the study area.
Prostanthera cryptandroides subsp. cryptandroides		V	V	Range extends from Lithgow to Queensland, however occurrence is disjunct within this range. Habitat is specific at each location, for example: Open forest dominated by *Eucalyptus fibrosa* at Glen Davis; variety of communities along rocky ridgelines on Narrabeen group Sandstones at Denman-Gungal and Widden-Baerami Valley such as rocky heath, Acacia woodland, exposed woodland, open heathland of *Calytrix tetragona, leptospermum parviflorum* and *Isopogon dawsonii* and open scrubland of *Eucalyptus dwyeri, Baeckea densifolia, Dillwynia floribunda, Aotus ericoides* and *Hemigenia cunefolia.*	BioNet (Hunter), PlantNet	Low – preferred habitat was not recorded within the study area, nearest record south of Denman.	No – species is considered unlikely to occur within the study area.
Prostanthera discolor		V	V	Grows in dry sclerophyll forest in rocky gullies; in the Sandy Hollow-Merriwa district.	PlantNet	Low – no preferred habitat recorded and the study area occurs outside the species known current distribution limit (nearest record south of Kerrabee).	No – species is considered unlikely to occur within the study area.
Prostanthera stricta		V	V	Grows in areas of both skeletal soil and on deeper, well-drained soil profiles in areas characterised by steep rocky sideslopes, cliff lines, sandstone platforms, or gentle slopes with exposed sandstone outcroppings. Most known sites are within the riparian zone. *Prostanthera stricta* is often a locally dominant undershrub in heath or scrub communities along cliff edges, or as an understorey species within a range of open forest or tall open forest types, or in adjacent transitional communities. Associated vegetation includes *Eucalyptus blaxlandii, Eucalyptus cannonii* and *Eucalyptus viminalis.*	PlantNet	Low – although an associated vegetation types which provides potential habitat for the species was recorded, the study area occurs outside the species known current distribution limit (occurs between Mt Vincent to Genowlan Mountain).	No – species is considered unlikely to occur within the study area.
Pterostylis chaetophora		–	V	Within Queensland the species is known to occur from four sparsely distributed locations, from Tamborine Mountain in the south, to Toolara State Forest in the north, and inland to Gayndah to the far west. Preferred habitat of *Pterostylis chaetophora* is seasonally moist, dry sclerophyll forest with a grass and shrub understorey.	BioNet (Hunter)	**Moderate –** potential habitat recorded within the study area and the species has been recorded in the broader locality.	No – although a candidate species, it was not recorded in the study area during targeted surveys and is therefore considered unlikely to occur or be affected by the proposal.

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Pterostylis gibbosa		E	E1	Occurs in the southern part of the Central Coast region with a disjunct population in the Hunter Valley. Grows among grass in sclerophyll forest. In the Illawarra it grows in Coastal Grassy Red Gum Forest and in Lowland Woolybutt-Melaleuca forest.	BioNet (Hunter), PMST	Low – no associated vegetation types which provide potential habitat for the species were recorded in the study area. Study area occurs outside the species known current distribution limit (isolated Hunter population at Mibrodale closest record).	No – species is considered unlikely to occur within the study area.
Pterostylis saxicola	Sydney Plains Greenhood	E	E1	Known now only from Freemans Reach to Picton district. Grows in Sydney Sandstone Gully Forest in shallow or skeletal soils over sandstone shelves, often near streams.	PlantNet	Low – no associated vegetation types which provide potential habitat for the species were recorded in the study area. Study area occurs outside the species known current distribution limit (nearest record south of Kurrajong).	No – species is considered unlikely to occur within the study area.
Pultenaea glabra	Smooth Bush-pea	V	V	Restricted to the higher Blue Mountains, it has been recorded from the Katoomba-Hazelbrook and Mount Victoria areas, with unconfirmed sightings in the Mount Wilson and Mount Irvine areas. All known populations occur within the Blue Mountains Local Government Area. It grows on swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath on sandstone.	PlantNet	Low – no associated vegetation types which provide potential habitat for the species were recorded in the study area. Study area occurs outside the species known current distribution limit (nearest record in Wollemi NP).	No – species is considered unlikely to occur within the study area.
Pultenaea maritima		–	V	*Pultenaea maritima* occurs in New South Wales and Queensland and is restricted to grasslands on exposed coastal headlands. Within NSW, the species has been recorded from Newcastle north to Byron Bay.	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded in the study area. Species is generally restricted to headlands in coastal areas.	No – species is considered unlikely to occur within the study area.
Pultenaea setulosa		V	–	Occurs in central coast, central and northern tablelands and western slopes bioregions west to Gilgandra district. It grows in dry sclerophyll forest.	PlantNet	Low – species is only threatened when found in the Marlborough district and south to Rockhampton and Mt Fairview in QLD (SPRAT profile).	No – species is considered unlikely to occur within the study area.
Rhodamnia rubescens	Scrub Turpentine	–	CE	Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils. Occurs in coastal districts north from Batemans Bay in New South Wales, about 280km south of Sydney, to areas inland of Bundaberg in Queensland. Populations of *R. rubescens* typically occur in coastal regions and occasionally extend inland onto escarpments up to 600m a.s.l. in areas with rainfall of 1,000–1,600mm.	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded in the study area.	No – species is considered unlikely to occur within the study area.
Rhodomyrtus psidioides	Native Guava	–	CE	Pioneer species found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest often near creeks and drainage lines. Occurs from Broken Bay, approx. 90km north of Sydney, NSW, to Maryborough in Queensland. Populations are typically restricted to coastal and sub-coastal areas of low elevation however the species does occur up to c. 120km inland in the Hunter and Clarence River catchments and along the Border Ranges in NSW.	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded in the study area. Furthermore, study area occurs outside the species current known distribution (nearest record near Barrington Tops).	No – species is considered unlikely to occur within the study area.

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Rutidosis heterogama	Heath Wrinklewort	V	V	Occurs in coastal districts from Maclean to the Hunter Valley and inland to the Torrington region. Grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides.	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded in the study area. Furthermore, study area occurs outside the species current known distribution (nearest record near Branxton).	No – species is considered unlikely to occur within the study area.
Senecio linearifolius var. dangarensis		–	E1	Restricted to Goulburn River National park, where this species exists as a single population over 20 hectares. The habitat is open scree slope, woodland and rainforest on basalt soils.	PlantNet	Low – although a vegetation types which provides habitat for the species was recorded, the species is restricted to a single population in Goulburn National Park and therefore considered unlikely to occur.	No – species is considered unlikely to occur within the study area.
Syzygium paniculatum	Magenta Lilly Pilly	V	E1	Occurs between Bulahdelah and St Georges Basin where it grows in subtropical and littoral rainforest on sandy soils or stabilized dunes near the sea. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded in the study area. If the species were to occur in the study area it would likely be a planted specimen.	No – species is considered unlikely to occur within the study area.
Tetratheca juncea	Black-eyed Susan	V	V	Occurs in coastal districts from Bulahdelah to Port Macquarie where it grows in dry sclerophyll forest and occasionally swampy heath in sandy, low nutrient soils with a dense understorey of grasses. Specifically it is known to occur within Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland.	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded in the study area. Furthermore, the study area occurs outside the species known current distribution limit (nearest records near Kurri Kurri).	No – species is considered unlikely to occur within the study area.
Thesium australe	Austral Toadflax	V	V	Grows in grassland or woodland often in damp sites. It is a semi-parasitic herb and hosts are likely to be Themeda australis and Poa spp.	BioNet (Hunter), PMST	**Moderate –** potential habitat recorded within the study area.	No – although a candidate species, it was not recorded in the study area during targeted surveys and is therefore considered unlikely to occur or be affected by the proposal.
Tylophora linearis		E	V	Majority of records occur in the central western region. Records from Goonoo, Pillaga West, Pillaga East, Bibblewindi, Cumbil and Eura State Forests, Coolbaggie NR, Goobang NP and Beni SCA. Also has been recorded Hiawatha State Forest near West Wyalong in the south and there are old records as far north as Crow Mountain near Barraba and near Glenmorgan in the western Darling Downs. Grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa, Eucalyptus sideroxylon, Eucalyptus albens, Callitris endlicheri, Callitris glaucophylla* and *Allocasuarina luehmannii*. Also grows in association with *Acacia hakeoides, Acacia lineata, Melaleuca uncinata, Myoporum species* and *Casuarina species*. Flowers in spring, with flowers recorded in November or May with fruiting probably 2 to 3 months later.	PlantNet, PMST	Low – no associated vegetation types which provide potential habitat for the species were recorded in the study area. Furthermore, the study area occurs outside the species known current distribution limit.	No – species is considered unlikely to occur within the study area.

Scientific name	Common name	BC Act[1]	EPBC Act[2]	Habitat requirements[3]	Source[4]	Likelihood of occurrence	Significant impact assessment required?
Zannichellia palustris	–	–	E1	Grows in fresh or slightly saline stationary or slowly flowing water.	BioNet (Hunter)	Low – no associated vegetation types which provide potential habitat for the species were recorded in the study area. Furthermore, the study area occurs outside the species current known distribution range (largely restricted to coastal regions, nearest record near Cessnock).	No – species is considered unlikely to occur within the study area.

1. Listed under the NSW *Biodiversity Conservation Act 2016* – CE = Critically Endangered, E1 = Endangered Species, E2 = Endangered Population, V = Vulnerable.
2. Listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* – X = Extinct, CE = Critically Endangered, E = Endangered, V = Vulnerable
3. Habitat descriptions sourced from EES Group species profiles (2020b) and DPE SPRAT website (2020b) for each species
4. BioNet = OEH BioNet Atlas of NSW Wildlife, EPBC Protected Matters Search Tool = Department of Agriculture, Water and the Environment's EPBC Protected Matters Search Tool and PlantNet = Royal Botanic Gardens PlantNet Spatial Search

Habitat assessment table – threatened fauna

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Amphibians								
Crinia tinnula	Wallum Froglet	–	V	–	Occurs along coast from south-eastern Queensland to Sydney. Mostly associated with swamps, dams and flooded roadside ditches, usually in heathland, where it is confined to acid, paperbark swamps and sedge swamps of the 'wallum' country. Males call any time of year. Breed in late winter.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Heleioporus australiacus	Giant Burrowing Frog	V	V	–	Found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. Spends more than 95% of its time in non-breeding habitat in areas up to 300m from breeding sites. While in non-breeding habitat it burrows below the soil surface or in the leaf litter. Breeding habitat of this species is generally soaks or pools within first or second order streams. Species is dependent on hanging swamps on the top of sandstone plateaus and deeply dissected gullies that occur as erosion features in the Sydney Basin.	BioNet (Hunter), PMST	Low – no preferred habitat recorded within the study area.	No
Litoria aurea	Green and Golden Bell Frog	V	E1	–	Since 1990 there have been about 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range, however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands. Previously known to inhabit marshes, dams and stream-sides, particularly those containing bullrushes (*Typha spp*.) or spikerushes (*Eleocharis spp*.), however the arrival fungal pathogens in Eastern Australia, have reduced its distribution to areas where salinity or toxic environments reduce fungal threats. Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available.	BioNet (Hunter, PMST	Low – no preferred habitat recorded within the study area.	
Litoria booroolongensis	Booroolong Frog	E	E1	–	Confined to mountain streams of the Great Dividing Range. Usually found on or under boulders and debris in and beside the rocky beds of mountain streams; breeds in summer.	PMST	Low – no preferred habitat recorded within the study area.	No
Litoria brevipalmata	Green-thighed Frog	–	V	–	Green-thighed Frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. Breeding occurs following heavy rainfall in late spring and summer, with frogs aggregating around grassy semi-permanent ponds and flood-prone grassy areas. The frogs are thought to forage in leaf-litter. Isolated localities along the coast and ranges from the NSW central coast to south-east Queensland.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	V	V	–	Has a distribution that includes the plateaus and eastern slopes of the Great Dividing Range from Watagan State Forest (90km north of Sydney) south to Buchan in Victoria. The majority of records are from within the Sydney Basin Bioregion with only scattered records south to the Victorian border and this species has not been recorded in southern NSW within the last decade. Records are isolated and tend to be at high altitude. This species breeds in the upper reaches of permanent streams and in perched swamps. Non-breeding habitat is heath based forests and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Pseudophryne australis	Red-crowned Toadlet	–	V	–	The Red-crowned Toadlet has a restricted distribution. It is confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains. Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter. Breeding congregations occur in dense vegetation and debris beside ephemeral creeks and gutters. Red-crowned Toadlets have not been recorded breeding in waters that are even mildly polluted or with a pH outside the range 5.5 to 6.5. Red-crowned Toadlets are quite a localised species that appear to be largely restricted to the immediate vicinity of suitable breeding habitat. Red-crowned Toadlets are usually found as small colonies scattered along ridges coinciding with the positions of suitable refuges near breeding sites.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Uperoleia mahonyi	Mahony's Toadlet	–	E	–	Inhabits ephemeral and semi-permanent swamps and swales on the coastal fringe of its range. Known records occur in heath or wallum habitats almost exclusively associated with leached (highly nutrient impoverished) white sand. Commonly associated with acid paperbark swamps, Mahony's Toadlet also is known to occur in wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney red gum woodland. Recent studies suggest intact vegetation adjacent to and within water bodies is an important habitat feature for this species. Known records are associated with shallow ephemeral/semi-permanent water bodies with limited flow of water. Aquatic vegetation at breeding sites includes sedges (*Shoenoplectus spp., Baumea spp. and Lepironia articulata*) and Broadleaf Cumbungi (*Typha orientalis*).	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Birds								
Actitis hypoleucos	Common Sandpiper	M	–	–	The Common Sandpiper frequents a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity. It is mostly encountered along muddy margins or rocky shores and rarely on mudflats. It has been recorded in estuaries and deltas of streams, banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The muddy margins utilised by the species are often narrow, and may be steep. The species is often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags. Roost sites are typically on rocks or in roots or branches of vegetation, especially mangroves. The species is known to perch on posts, jetties, moored boats and other artificial structures, and to sometimes rest on mud or 'loaf' on rocks.	PMST	Low – no preferred habitat recorded within the study area.	No
Anseranas semipalmata	Magpie Goose	–	V	–	Occurs in shallow wetlands such as large swamps and dams, especially with dense growth of rushes or sedges, and with permanent lagoons and grassland nearby. Feeds on seeds, tubers and green grass. Form large nesting colonies during the wet season. During the dry season this species migrates hundreds of kilometres to perennial swamps.	BioNet (1), BioNet (Hunter)	**Moderate –** marginal quality habitat recorded within the study area. May occur sporadically to forage, has been recorded in the locality.	Yes
Anthochaera phrygia (syn. Xanthomyza phrygia)	Regent Honeyeater	CEM	CE	–	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. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. It inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. It feeds mainly on the nectar from a relatively small number of eucalypts that produce high volumes of nectar. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany.	BioNet (1), BioNet (Hunter), PMST	**Moderate** – potential habitat occurs within the study area and the species has been recorded in the locality.	Yes
Artamus cyanopterus cyanopterus	Dusky Woodswallow	–	V	–	Dusky woodswallows are widespread in eastern, southern and south western Australia. The species occurs throughout most of New South Wales, but is sparsely scattered in, or largely absent from, much of the upper western region. Most breeding activity occurs on the western slopes of the Great Dividing Range. Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland.	BioNet (4), BioNet (Hunter)	**Recorded –** individuals were recorded within the study area and suitable habitat for the species was recorded on site.	Yes
Botaurus poiciloptilus	Australasian Bittern	E	E1	–	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. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha spp*.) and spikerushes (*Eleocharis spp*.). Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with prey remains. Breeding occurs in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds.	BioNet (Hunter), PMST	Low – no preferred habitat recorded within the study area.	No
Burhinus grallarius	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. Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Calidris acuminata	Sharp-tailed Sandpiper	M	–	–	Occurs in a variety of habitats: tidal mudflat, mangrove swamps, saltmarshes, shallow fresh, brackish, salt inland swamps and lakes; flooded and irrigated paddocks, sewage farms and commercial saltfields.	PMST	Low – no preferred habitat recorded within the study area.	No
Calidris ferruginea	Curlew Sandpiper	CEM	E1	–	Occurs in inter-tidal mudflats of estuaries, lagoons, mangrove channels and also around lakes, dams, floodwaters and flooded saltbush surrounding inland lakes.	BioNet (Hunter), PMST	Low – no preferred habitat recorded within the study area.	No
Calidris melanotos	Pectoral Sandpiper	M	–	–	In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species frequents coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. It is usually found in coastal or near coastal habitat but occasionally further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. It has also been recorded in swamp overgrown with lignum. They forage in shallow water or soft mud at the edge of wetlands.	PMST	Low – no preferred habitat recorded within the study area.	No
Calidris tenuirostris	Great Knot	CEM	V	–	Generally a coastal species found on tidal mudflats and sandy ocean shores. A migratory species visiting Australian waters between September and March.	BioNet (Hunter)	Low – an estuarine species, no habitat in study area.	No
Callocephalon fimbriatum	Gang-gang Cockatoo	–	V	–	The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee. In spring and summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In autumn and winter, the species often moves to lower altitudes in drier more open eucalypt forests and woodlands, particularly box-gum and box-ironbark assemblages, or in dry forest in coastal areas and often found in urban areas. May also occur in sub-alpine Snow Gum (*Eucalyptus pauciflora*) woodland and occasionally in temperate rainforests. Favours old growth forest and woodland attributes for nesting and roosting. Nests are located in hollows that are 10cm in diameter or larger and at least 9m above the ground in eucalypts.	BioNet (Hunter)	**Moderate –** marginal quality habitat recorded within the study area.	Yes
Calyptorhynchus lathami	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. Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (*Allocasuarina littoralis*) and Forest Sheoak (*A. torulosa*) are important foods. Inland populations feed on a wide range of sheoaks, including Drooping Sheoak, *Allocasuarina diminuta*, and *A. gymnathera*. Belah is also utilised and may be a critical food source for some populations. In the Riverina, birds are associated with hills and rocky rises supporting Drooping Sheoak, but also recorded in open woodlands dominated by Belah (*Casuarina cristata*). Feeds almost exclusively on the seeds of several species of she-oak (*Casuarina* and *Allocasuarina species*), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites.	BioNet (1), BioNet (Hunter)	Low **–** no suitable feed tree species within the study area, although this species occurs in the wider locality.	No
Charadrius leschenaultii	Greater Sand Plover	VM	V	–	Entirely coastal in NSW foraging on intertidal sand and mudflats in estuaries, and roosting during high tide on sand beaches or rocky shores. A migratory species it is found in New South Wales generally during the summer months.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Charadrius mongolus	Lesser Sand Plover	EM	V	–	Migratory bird that migrates from the northern hemisphere to coastal areas of northern and east coast of Australia. The species is almost strictly coastal during the non-breeding season, preferring sandy beaches, mudflats of coastal bays and estuaries, sand-flats and dunes near the coast, occasionally frequenting mangrove mudflats (IUCN Redlist entry).	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Chthonicola sagittata (syn. Pyrrholaemus sagittatus)	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. Lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees.	BioNet (13), BioNet (Hunter)	**Recorded –** individuals were recorded within the study area and suitable habitat for the species was recorded on site.	Yes

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Circus assimilis	Spotted Harrier	–	V	–	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. 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. Preys on terrestrial mammals (e.g. bandicoots, bettongs, and rodents), birds and reptile, occasionally insects and rarely carrion.	BioNet (1), BioNet (Hunter)	**Moderate –** suitable habitat recorded within the study area.	Yes
Climacteris picumnus victoriae	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. Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; 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 River Red Gum (Eucalyptus camaldulensis) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains. Sedentary, considered to be resident in many locations throughout its range; present in all seasons or year-round at many sites; territorial year-round, though some birds may disperse locally after breeding.	BioNet (5), BioNet (Hunter)	**Moderate –** suitable habitat recorded within the study area.	Yes
Daphoenositta chrysoptera	Varied Sittella	–	V	–	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy.	BioNet (4), BioNet (Hunter)	**Recorded -** individuals were recorded within the study area and suitable habitat for the species was recorded on site.	Yes
Dromaius novaehollandiae	Emu	–	E2	–	Widespread throughout Aust. mainland in a variety of habitats from timbered areas to open country. Found from tropical monsoonal to temperate regions and at all altitudes from coasts to above winter snow-line in Great Dividing Range. Mostly found in flat undulating lands but also on timbered ridges, tablelands and moderately hilly terrain, also recorded on ocean beaches, wading in shallow estuarine inlets, mudflats, saltmarshes. Other coastal habitats include sandplains, sand-dunes, heathlands and low foothills. Tends to nest in areas of extensive cover where disturbance is infrequent and tend to avoid areas frequently disturbed by human activity.	BioNet (Hunter)	Low – study area does not occur within the North Coast Bioregion or Port Stephens Local Government Area.	No
Ephippiorhynchus asiaticus	Black-necked Stork	–	E1	–	Widespread in coastal and subcoastal northern and eastern Australia, as far south as central NSW (although vagrants may occur further south or inland, well away from breeding areas). In NSW, the species becomes increasingly uncommon south of the Clarence Valley, and rarely occurs south of Sydney. Since 1995, breeding has been recorded as far south as Buladelah. Floodplain wetlands (swamps, billabongs, watercourses and dams) of the major coastal rivers are the key habitat in NSW for the Black-necked Stork. Secondary habitat includes minor floodplains, coastal sandplain wetlands and estuaries. Usually forage in water 5–30cm deep for vertebrate and invertebrate prey. Eels regularly contribute the greatest biomass to their diet, but they feed on a wide variety of animals, including other fish, frogs and invertebrates (such as beetles, grasshoppers, crickets and crayfish).	BioNet (2), BioNet (Hunter)	**Moderate** – marginal quality habitat recorded within the study area. May occur sporadically to forage.	Yes
Epthianura albifrons	White-fronted Chat	–	E2, V	–	The White-fronted Chat is found across the southern half of Australia, from southernmost Queensland to southern Tasmania, and across to Western Australia as far north as Carnarvon. Found mostly in temperate to arid climates and very rarely sub-tropical areas, it occupies foothills and lowlands up to 1000m 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 western part of the state. Along the coastline, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas. Two isolated sub-populations of White-fronted Chats are currently known from the Sydney Metropolitan Catchment Management Authority (CMA) area; one at Newington Nature Reserve on the Parramatta River and one at Towra Point Nature Reserve in Botany Bay. These sub-populations are separated from each other by 25km of urbanised land, across which the Chats are unlikely to fly. The nearest extant populations outside Sydney Metropolitan CMA are at Ash Island north of Newcastle and Lake Illawarra, south of Wollongong. White-fronted Chats were previously recorded at Penrith Lakes (2001), Hawkesbury Swamps (2002), Tuggerah Lake (1997) and Lake Macquarie (1998).	BioNet (Hunter)	Low – study area does not occur in the Sydney Metropolitan Catchment Management Authority area. There are no records from within the study are or wider locality although occasional occurrences cannot be entirely discounted.	No
Erythrotriorchis radiatus	Red Goshawk	VM	CE	–	Lives in coastal and sub-coastal tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers and along edges of rainforest. Nests are only built in trees taller than 20 metres which occur within 1 kilometre of a watercourse or wetland. Has a home range of 200 square kilometres and hunts for medium to large birds in open forests and gallery forest.	BioNet (Hunter), PMST	Low – no preferred habitat recorded within the study area.	No

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Falco subniger	Black Falcon	–	V	–	Widely, but sparsely, distributed in New South Wales, mostly occurring woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees. It is usually associated with streams or wetlands, visiting them in search of prey and often using standing dead trees as lookout posts. Habitat selection is generally influenced more by prey densities than by specific aspects of habitat floristics or condition, although in agricultural landscapes it tends to nest in healthy, riparian woodland remnants with a diverse avi-fauna.	BioNet (1), BioNet (Hunter)	**Moderate –** suitable habitat recorded within the study area, and recorded in the wider locality.	Yes
Gallinago hardwickii	Latham's Snipe	M	–	–	Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed.	PMST	**Moderate** – marginal quality habitat recorded within the study area. May occur sporadically to forage.	Yes
Glossopsitta pusilla	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. Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species. Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards.	BioNet (9), BioNet (Hunter)	**Recorded –** several individuals were recorded flying over the study area and suitable habitat for the species was recorded on site.	Yes
Grantiella picta	Painted Honeyeater	V	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 Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits Boree/ Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) and Box-Gum Woodlands and Box-Ironbark Forests (Oliver et al., 2003). A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.	BioNet (Hunter), PMST	**Moderate –** potential habitat recorded within the study area.	Yes
Haematopus fuliginosus	Sooty Oystercatcher	–	V	–	The Sooty Oystercatcher is found on rocky headlands, rock shelves, exposed reefs with rock pools, beaches and muddy estuaries. The species forages on exposed intertidal rocky shorelines at low tide. It breeds almost exclusively on offshore islands, and occasionally on isolated promontories during spring and summer. They nest on the ground in amongst rocks, seaweed, shells and pebbles.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Haematopus longirostris	Australian Pied Oystercatcher	–	E1	–	The species is distributed around the entire Australian coastline, although it is most common in coastal Tasmania and parts of Victoria, such as Corner Inlet. In NSW the species is thinly scattered along the entire coast, with fewer than 200 breeding pairs estimated to occur in the state. Favours intertidal flats of inlets and bays, open beaches and sandbanks. Forages on exposed sand, mud and rock at low tide, for molluscs, worms, crabs and small fish. Nests mostly on coastal or estuarine beaches although occasionally they use saltmarsh or grassy areas.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Haliaeetus leucogaster	White-bellied Sea-Eagle	–	V	–	The White-bellied Sea-eagle is distributed around the Australian coastline, including Tasmania, and well inland along rivers and wetlands of the Murray Darling Basin. In New South Wales it is widespread along the east coast, and along all major inland rivers and waterways. Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. Occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest). Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts'. Feed mainly on fish and freshwater turtles, but also waterbirds, reptiles, mammals and carrion.	BioNet (4)	**Recorded –** potential habitat recorded within the study area.	Yes
Hamirostra melanosternon	Black-breasted Buzzard	–	V	–	Distributed throughout most of inland Australia and prefers arid scrubland, and open woodlands. Feeds on small mammals and birds.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Hieraaetus morphnoides	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. Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. Preys on birds, reptiles and mammals, occasionally adding large insects and carrion.	BioNet (1), BioNet (Hunter)	**Recorded –** individual was recorded flying over study area on three occasions and suitable habitat for the species was recorded on site.	Yes
Hirundapus caudacutus	White-throated Needletail	M, V	–	–	Widespread in eastern and south-eastern Australia. In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. It is almost exclusively aerial, from heights of less than 1m up to more than 1000m 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.	BioNet (1), PMST	**Recorded –** utilising air space above study area to forage, but unlikely to use terrestrial habitats.	Yes
Irediparra gallinacea	Comb-crested Jacana	–	V	–	Occurs in floating vegetation of permanent well-vegetated wetlands and dams. Walks on floating plants. Occasionally feeds along muddy wetland margins on east coast of NSW.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Ixobrychus flavicollis	Black Bittern	–	V	–	The Black Bittern has a wide distribution, from southern NSW north to Cape York and along the north coast to the Kimberley region. The species also occurs in the south-west of Western Australia. In NSW, records of the species are scattered along the east coast, with individuals rarely being recorded south of Sydney or inland. Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves. Feeds on frogs, reptiles, fish and invertebrates, including snails, dragonflies, shrimps and crayfish, with most feeding done at dusk and at night. During the day, roosts in trees or on the ground amongst dense reeds.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area and no records locally.	No
Lathamus discolor	Swift Parrot	CE	CE	–	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 mostly occurs on the coast and south west slopes. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum Corymbia maculata, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Inland Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis*.	BioNet (6), BioNet (Hunter), PMST	**Moderate –** potential habitat within the study area.	Yes
Limicola falcinellus	Broad-billed Sandpiper	M	V	–	A migratory species that breeds in the northern hemisphere between June and August. Individuals feed both on exposed mudflats and while wading in water.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Limosa limosa	Black-tailed Godwit	M	V	–	A coastal species found on tidal mudflats, swamps, shallow river margins and sewage farms. Also found inland on larger shallow fresh or brackish waters. A migratory species visiting Australia between September and May.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Lophoictinia isura	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 the species 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, arriving in September and leaving by March. Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland. Is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage.	BioNet (1), BioNet (Hunter)	**Moderate –** potential habitat recorded within the study area.	Yes

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Macronectes giganteus	Southern Giant-Petrel	EM	E1	–	A partly nomadic marine species that forages off the coast of New South Wales.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Melanodryas cucullata cucullata	Hooded Robin (South-Eastern)	–	V	–	Found in south-eastern Australia, generally east of the Great Dividing Range. Found in eucalypt woodland and mallee and acacia shrubland. This is one of a suite of species that has declined in woodland areas in south-eastern Australia. The species appears unable to survive in remnants smaller than 100–200ha.	BioNet (1), BioNet (Hunter)	**Moderate –** potential habitat within the study area.	Yes
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	–	V	–	The eastern subspecies extends south from central Queensland, through NSW, Victoria into south eastern South Australia, though it is very rare in the last state. 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, though it is very rare in the latter. Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) and Forest Red Gum (*E. tereticornis*). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks, river sheoaks (nesting habitat) and tea-trees.	BioNet (Hunter)	**Moderate –** potential habitat within the study area.	Yes
Monarcha melanopsis	Black-faced Monarch	M	–	–	Occurs in rainforests, eucalypt woodlands, coastal scrubs, damp gullies in rainforest, eucalypt forest and in more open woodland when migrating.	PMST	**Moderate –** potential habitat recorded within the study area. May use resources in the study area sporadically when migrating.	No
Motacilla flava	Yellow Wagtail	M	–	–	This species occurs in a range of habitats including estuarine habitats such as sand dunes, mangrove forests and coastal saltmarshes. This species also occurs in open grassy areas including disturbed sites such as sports grounds and has been recorded on the edges of wetlands, swamps, lakes and farm dams. This species migrates from Asia to Australia in spring-summer. It has been recorded in the estuarine areas of the Hunter River in Newcastle NSW and in QLD and the north of NT and WA.	PMST	Low – no preferred habitat recorded within the study area.	No
Myiagra cyanoleuca	Satin Flycatcher	M	–	–	Widespread in eastern Australia. In Queensland, it is widespread but scattered in the east. 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. In Victoria, the species is widespread in the south and east, in the area south of a line joining Numurkah, Maldon, the northern Grampians, Balmoral and Nelson. 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. Satin Flycatchers mainly inhabit eucalypt forests, often near wetlands or watercourses. They generally occur in moister, taller forests, often occurring in gullies. They also occur in eucalypt woodlands with open understorey and grass ground cover, and are generally absent from rainforest. In south-eastern Australia, they occur at elevations of up to 1400m above sea level, and in the ACT, they occur mainly between 800m above sea level and the tree-line.	PMST	**Moderate –** potential habitat recorded within the study area. May use resources in the study area sporadically when migrating.	No
Neophema pulchella	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. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	BioNet (Hunter)	**Moderate –** potential habitat recorded within the study area. May use resources in the study area sporadically.	Yes

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Ninox connivens	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 and in some northeast coastal and escarpment forests. Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey on these fertile riparian soils. Preferentially hunts small arboreal mammals such as Squirrel Gliders and Common Ringtail Possums, but when loss of tree hollows decreases these prey populations the owl becomes more reliant on birds, invertebrates and terrestrial mammals such as rodents and rabbits. Requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats.	BioNet (Hunter)	**Moderate –** potential habitat within the study area.	Yes
Ninox strenua	Powerful Owl	–	V	–	The Powerful Owl 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 to tablelands, with scattered records on the western slopes and plains suggesting occupancy prior to land clearing. Now at low densities throughout most of its eastern range, rare along the Murray River and former inland populations. It inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. It requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine *Syncarpia glomulifera,* Black She-oak *Allocasuarina littoralis*, Blackwood *Acacia melanoxylon,* Rough-barked Apple *Angophora floribunda*, Cherry Ballart *Exocarpus cupressiformis* and a number of eucalypt species. The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider.	BioNet (Hunter)	**Moderate –** potential habitat within the study area.	Yes
Numenius madagascariensis	Eastern Curlew	CEM	-	–	Inhabits coastal estuaries, mangroves, mud flats and sand pits. It is a migratory shorebird which generally inhabits sea and lake shore mud flats, deltas and similar areas, where it forages for crabs and other crustaceans, clam worms and other annelids, molluscs, insects and other invertebrates. Its migration route ranges from its wintering grounds in Australia to its breeding grounds in northern China, Korea and Russia.	PMST	Low – no preferred habitat recorded within the study area.	No
Oxyura australis	Blue-billed Duck	–	V	–	Relatively sparse throughout species range. Regularly found breeding in south-east Queensland, north-east South Australia and throughout New South Wales. Found on temperate, fresh to saline, terrestrial wetlands, and occupies artificial wetlands. Prefers deep permanent open water, within or near dense vegetation. Nest in rushes, sedge, Lignum *Muehlenbeckia cunninghamii* and paperbark Melaleuca.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Pachycephala olivacea	Olive Whistler	–	V	–	Distributed from Queensland to South Australia, and occurs across the altitudinal range from coastal to alpine areas. In NSW, found north of the Hunter River, NSW, extending just into the Lamington Plateau in far south-east Queensland. There are isolated populations in the Macpherson Range, New England NP, Mt. Boss and Barrington Tops areas, and possibly in the Gibraltar Range and Walcha-Nundle areas. Occurs in tall wet sclerophyll forest, rainforest, woodland, alpine heaths. In NE NSW, occurs in cool temperate rainforest and cool, moist sclerophyll forest at elevations of >=800 metres asl. Also recorded in warm temperate and sub-tropical rainforests. South of Sydney, the species inhabits rainforest, moist eucalypt forest, coastal, moist thickets and mountain scrubs. Microhabitat is areas with a dense, moist understorey.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Pandion cristatus (syn. P. haliaetus)	Eastern Osprey	M	V	–	Eastern Ospreys are found right around the Australian coast line, except for Victoria and Tasmania. They are common around the northern coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south-eastern Australia. There are a handful of records from inland areas. Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water.	BioNet (Hunter), PMST	Low – no preferred habitat recorded within the study area.	No
Petroica boodang	Scarlet Robin	–	V	–	The Scarlet Robin is found from south east Queensland to south east South Australia and also in Tasmania and south west 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 lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat. The Scarlet Robin breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 metres in altitude.	BioNet (Hunter)	**Moderate –** potential habitat recorded within the study area.	Yes

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Petroica phoenicea	Flame Robin	–	V	–	In NSW the Flame Robin breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats. In winter lives in dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees. In winter, occasionally seen in heathland or other shrublands in coastal areas. Occasionally occurs in temperate rainforest, and also in herb fields, heathlands, shrublands and sedgelands at high altitudes. The Flame Robin forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other woody debris. The robin builds an open cup nest of plant fibres and cobweb, which is often near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank.	BioNet (Hunter)	**Moderate -** potential habitat recorded within the study area. May use resources in the study area sporadically during winter.	Yes
Pomatostomus temporalis temporalis	Grey-Crowned Babbler (Eastern subspecies)	–	V	–	The eastern form of the species formerly ranged throughout eastern Australia from South Australia, through Victoria and broadly through NSW and central Queensland but is now extinct in South Australia, coastal Victoria and the ACT. In NSW, it occurs on the western slopes and plains but is less common at the higher altitudes of the tablelands. Isolated populations are known from coastal woodlands on the North Coast, in the Hunter Valley and from the South Coast near Nowra. Grey-crowned Babblers occupy open woodlands dominated by mature eucalypts, with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs. The species builds conspicuous dome-shaped nests and breeds co-operatively in sedentary family groups of 2-13 birds. Grey-crowned Babblers are insectivorous and forage in leaf litter and on bark of trees.	BioNet (5), BioNet (Hunter)	**High –** potential habitat within study area and species recorded frequently in the locality.	Yes
Pterodroma solandri	Providence Petrel	–	V	–	A marine species that breeds at Norfolk island and breeds within earth burrows often within rainforest. Occurs across the western Tasman Sea and the entire north Pacific Ocean.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Ptilinopus magnificus	Wompoo Fruit-Dove	–	V	–	Occurs in rainforests, monsoon forests, adjacent eucalypt forests, fruiting trees on scrubby creeks or in open country.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Ptilinopus regina	Rose-crowned Fruit-Dove	–	V	–	Occurs in subtropical and dry rainforests and occasionally in moist eucalypt forests and swamp forests where fruit is plentiful. They are thought to move locally as they follow the ripening fruit.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Ptilinopus superbus	Superb Fruit-Dove	–	V	–	The Superb Fruit-dove occurs principally from north-eastern in Queensland to north-eastern NSW. It is much less common further south, where it is largely confined to pockets of suitable habitat as far south as Moruya. There are records of vagrants as far south as eastern Victoria and Tasmania. Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees. Part of the population is migratory or nomadic.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Rhipidura rufifrons	Rufous Fantail	M	–	–	Occurs in a range of habitats including the undergrowth of rainforests/wetter eucalypt forests/gullies, monsoon forests paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks and gardens. When migrating they may also be recorded on farms, streets and buildings. Migrates to SE Australia in October-April to breed, mostly in or on the coastal side of the Great Dividing Range.	PMST	**Moderate –** potential habitat recorded within the study area. May use resources in the study area sporadically when migrating.	No
Rostratula australis (syn. R. benghalensis)	Australian Painted Snipe (Painted Snipe)	E	E1	–	The Australian Painted Snipe is restricted to Australia. Most records are from the south east, particularly the Murray Darling Basin, with scattered records across northern Australia and historical records from around the Perth region in Western Australia. In NSW, many records are from the Murray-Darling Basin including the Paroo wetlands, Lake Cowal, Macquarie Marshes, Fivebough Swamp and more recently, swamps near Balldale and Wanganella. Other important locations with recent records include wetlands on the Hawkesbury River and the Clarence and lower Hunter Valleys. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	BioNet (Hunter), PMST	**Moderate** – marginal habitat recorded within the study area although may occur under suitable climatic conditions.	Yes
Stagonopleura guttata	Diamond Firetail	–	V	–	Distributed through central and eastern NSW, extending north into southern and central Queensland and south through Victoria to the Eyre Peninsula, South Australia. In NSW, the species occurs predominantly west of the Great Dividing Range, although populations are known from drier coastal areas. Occurs in a range of eucalypt dominated communities with a grassy understorey including woodland, forest and mallee. Most populations occur on the inland slopes of the dividing range. Firetails nest in trees and bushes, and forage on the ground, largely for grass seeds and other plant material, but also for insects.	BioNet (2), BioNet (Hunter)	**Moderate** – suitable habitat recorded within the study area and the species has been recorded infrequently in the locality.	Yes

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Sterna albifrons	Little Tern	M	E1	–	Little Terns inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets. They nest on sand-spits, sandbanks, ridges or islets in these habitats or gently sloping sandy ocean beaches and occasionally in sand-dunes.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Stictonetta naevosa	Freckled Duck	–	V	–	In most years this species appear to be nomadic between ephemeral inland wetlands. In dry years they congregate on permanent wetlands while in wet years they breed prolifically and disperse widely, generally towards the coast. In inland eastern Australia, they generally occur in brackish to hyposaline wetlands that are densely vegetated with Lignum (*Muehlenbeckia cunninghamii*) within which they build their nests.	BioNet (Hunter)	Low – although marginal quality habitat was recorded immediately outside the construction footprint none occurred within.	Yes
Sula dactylatra	Masked Booby	M	V	–	Seabird throughout tropical and subtropical seas, with a breeding population on Lord Howe Island.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Tringa nebularia	Common Greenshank	M	–	–	Occurs in a range of inland and coastal environments. Inland, it occurs in both permanent and temporary wetlands, billabongs, swamps, lakes floodplains, sewage farms, saltworks ponds, flooded irrigated crops. On the coast, it occurs in sheltered estuaries and bays with extensive mudflats, mangrove swamps, muddy shallows of harbours and lagoons, occasionally rocky tidal ledges. It generally prefers wet and flooded mud and clay rather than sand.	PMST	Low – no preferred habitat recorded within the study area.	No
Tyto longimembris longimembris	Eastern Grass Owl	–	V	–	Typically found in tussock-grasslands but also occur in heathland, swamps, coastal dunes, tree-lined creeks, treeless plains, grassy gaps between trees and crops. Nest on the ground generally under tussocks. They generally feed on rodents but will also eat insects.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Tyto novaehollandiae novaehollandiae	Masked Owl (southern mainland)	–	V	–	Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within about 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution. Lives in dry eucalypt forests and woodlands from sea level to 1100m. A forest owl, but often hunts along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially rats. Pairs have a large home-range of 500 to 1000 hectares.	BioNet (Hunter)	**Moderate –** potential habitat within study area.	Yes
Tyto tenebricosa	Sooty Owl	–	V	–	Occupies the easternmost one-eighth of NSW, occurring on the coast, coastal escarpment and eastern tablelands. Territories are occupied permanently. Occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the Common Ringtail Possum (*Pseudocheirus peregrinus*) or Sugar Glider (*Petaurus breviceps*). Nests in very large tree-hollows.	BioNet (1), BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Xenus cinereus	Terek Sandpiper	M	V	–	In Australia widespread and common along north and east coasts than along south coastlines. It inhabits coastal areas, mostly saline intertidal mudflats in sheltered estuaries, embayments, harbours and lagoons; on islets, mudbanks or sandbanks and spits; often around mangroves.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Mammals								
Cercartetus nanus	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. Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Chalinolobus dwyeri	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. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years. Found in well-timbered areas containing gullies.	BioNet (3), BioNet (Hunter), PMST	**Moderate –** potential foraging habitat recorded and the species has been recorded in the locality.	Yes

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Dasyurus maculatus maculatus	Spotted-Tailed Quoll (Southern Subspecies)	E	V	–	Found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares. Are known to traverse their home ranges along densely vegetated creeklines.	BioNet (7), BioNet (Hunter), PMST	**Moderate** – records exist along drainage line in the central Hunter Valley and transitory occurrences cannot be discounted.	Yes
Falsistrellus tasmaniensis	Eastern False Pipistrelle	–	V	–	The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania. Prefers moist habitats, with trees taller than 20m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	BioNet (5), BioNet (Hunter)	**High –** potential foraging and roosting habitat recorded and the species has been recorded frequently in the locality.	Yes
Miniopterus australis	Little Bent-winged Bat	–	V	–	Found along east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats. Only five nursery sites/maternity colonies are known in Australia.	BioNet (3), BioNet (Hunter)	**High –** potential foraging and roosting habitat recorded and the species has been recorded frequently in the locality.	Yes
Miniopterus schreibersii oceanensis	Large Bent-winged Bat	–	V	–	Eastern Bentwing-bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Populations disperse within about 300km range of maternity caves. Hunt in forested areas, catching moths and other flying insects above the tree tops.	BioNet (15), BioNet (Hunter)	**High –** potential foraging and roosting habitat recorded and the species has been recorded frequently in the locality.	Yes
Micronomus norfolkensis	Eastern Coast Free-tail Bat	–	V	–	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures.	BioNet (10), BioNet (Hunter)	**High –** potential foraging and roosting habitat recorded and the species has been recorded frequently in the locality.	Yes
Myotis macropus	Southern Myotis, Large-footed Myotis	–	V	–	The Southern 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.	BioNet (5), BioNet (Hunter)	**Recorded –** observed sheltering in concrete box culvert under Muscle Creek Road and foraging in woodland habitat to the north.	Yes
Nyctophilus corbeni (syn. N. timoriensis)	South-eastern Long-eared Bat (Corben's Long-eared Bat & Greater Long-eared Bat)	V	V	–	Overall, the distribution of the south eastern form coincides about with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. Inhabits a variety of vegetation types, including mallee, bulloke (*Allocasuarina leuhmanni*) 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. Roosts in tree hollows, crevices, and under loose bark.	BioNet (Hunter), PMST	**Moderate –** potential foraging habitat recorded within the study area.	Yes
Petauroides volans	Greater Glider	V	–	–	The Greater Glider has a restricted distribution in eastern Australia, from the Windsor Tableland in north Queensland to central Victoria, with an elevated range from sea level to 1200m above sea level. The species is largely restricted to eucalypt forests and woodlands, feeds exclusively on eucalypt leaves, buds, flowers and mistletoe. It is found in abundance in montane eucalypt forest with relatively old trees and an abundance of hollows. It also favours forests with a diversity of eucalypts to cater for seasonal variation in food abundance.	PMST	**Moderate –** potential habitat within the study area and the species has been recorded in the locality.	No – targeted surveys (spotlighting & arboreal and cage trapping) completed and species not recorded.

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Petaurus australis	Yellow-bellied Glider	–	V	–	The Yellow-bellied Glider is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland to Victoria. Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein. Extract sap by incising (or biting into) the trunks and branches of favoured food trees, often leaving a distinctive 'V'-shaped scar. Very mobile and occupy large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Petaurus norfolcensis	Squirrel Glider	–	V	–	The species is widely though sparsely distributed in eastern Australia, from northern Queensland to western Victoria. Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.	BioNet (2), BioNet (Hunter)	**Recorded –** individuals recorded across the study area in suitable habitat.	Yes
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	–	The range of the Brush-tailed Rock-wallaby extends from south-east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range. However the distribution of the species 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. Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night. Highly territorial and have strong site fidelity with an average home range size of about 15ha.	BioNet (Hunter), PMST	Low – no preferred habitat recorded within the study area.	No
Phascogale tapoatafa	Brush-tailed Phascogale	–	V	–	Largely arboreal it occurs in a range of habitats which have reliable rainfall (500–2000mm), but has preference for open dry sclerophyll forest on ridges (up to 600m alt) with little/sparse ground cover. It nests in tree hollows and feeds at dusk on arthropods and small vertebrates.	BioNet (2), BioNet (Hunter)	**Moderate –** potential habitat within the study area and the species has been recorded in the locality.	No – targeted surveys (spotlighting & arboreal and cage trapping) completed and species not recorded.
Phascolarctos cinereus	Koala (NSW, ACT & QLD - excluding SE QLD)	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. Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Some preferred species include Forest Red Gum, Grey Gum. In coastal areas, Tallowwood and Swamp Mahogany are important food species, while in inland areas White Box, Bimble Box and River Red Gum are favoured. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size.	BioNet (7), BioNet (Hunter), PMST	**Recorded –** scats recorded and potential habitat occurs within the study area.	Yes
Planigale maculata	Common Planigale	–	V	–	Occurs in a range of habitats from rainforest, sclerophyll forest, grasslands, marshlands and rocky areas, usually where there is ground cover and close to water. Builds small saucer-shaped nests of grass and bark.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland)	V	V	–	The long-nosed potoroo is found on the south-eastern coast of Australia, from Queensland to eastern Victoria and Tasmania, including some of the Bass Strait islands. There are geographically isolated populations in western Victoria. In NSW it is generally restricted to coastal heaths and forests east of the Great Dividing Range, with an annual rainfall exceeding 760mm. Inhabits coastal heaths and dry and wet sclerophyll forests. Dense understorey with occasional open areas is an essential part of habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. The fruit-bodies of hypogeous (underground-fruiting) fungi are a large component of the diet of the Long-nosed Potoroo. They also eat roots, tubers, insects and their larvae and other soft-bodied animals in the soil. Individuals are mainly solitary, non-territorial and have home range sizes ranging between 2–5ha.	PMST	Low – no preferred habitat recorded within the study area.	No
Pseudomys novaehollandiae	New Holland Mouse	V	–	–	The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Genetic evidence indicates that the New Holland Mouse once formed a single continuous population on mainland Australia and the distribution of recent subfossils further suggest that the species has undergone a large range contraction since European settlement. Total population size of mature individuals is now estimated to be less than 10,000 individuals although, given the number of sites from which the species is known to have disappeared between 1999 and 2009, it is likely that the species' distribution is actually smaller than current estimates. Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes.	PMST	Low – no preferred habitat recorded within the study area.	No
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	–	Grey-headed Flying-foxes are generally found within 200km of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia. Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Can travel up to 50km from the camp to forage; commuting distances are more often <20km. Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines.	BioNet (23), BioNet (Hunter), PMST	**Recorded –** foraging individuals recorded within the study area. No camp sites recorded within the study area.	Yes
Saccolaimus flaviventris	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. Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	BioNet (2), BioNet (Hunter)	**Moderate –** potential foraging and roosting habitat recorded.	Yes
Scoteanax rueppellii	Greater Broad-nosed Bat	–	V	–	The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500m. Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3–6m.	BioNet (3), BioNet (Hunter)	**Moderate –** potential foraging and roosting habitat recorded and the species has been recorded in the locality.	Yes
Vespadelus troughtoni	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. A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals. Occasionally found along cliff-lines in wet eucalypt forest and rainforest.	BioNet (9), BioNet (Hunter)	**Moderate –** potential foraging habitat recorded and the species has been recorded frequently in the locality.	Yes
Reptiles								
Aprasia parapulchella	Pink-tailed Worm Lizard (syn. Pink-tailed Legless Lizard)	V	V	–	This lizard is known from four sites in eastern Australia: near Canberra in the ACT, Tarcutta and Bathurst in NSW, and near Bendigo in Vic. In general, lizards occur in open grassland habitats that have a substantial cover of small rocks. Lizards also show a preference for sunny aspects, avoiding S facing slopes. Some specimens have been collected from grassland sites that appear not to support any native grasses and several animals have been found on the edge of *Callitris enlicheri* woodland and *Eucalyptus macrorhyncha* woodland. A burrowing species, it is usually found under rocks on well-drained soil and in ant nests, occasionally with several individuals found under the same rock.	PMST	Low – study area outside the species likely known habitat or predicted distribution area (SPRAT profile).	No

Scientific name	Common name	EPBC Act[1]	BC Act[2]	FM Act[3]	Habitat[4]	Data source[5]	Likelihood of occurrence	Significant impact assessment required?
Delma impar	Striped Legless Lizard	V	V	–	The Striped Legless Lizard occurs in the Southern Tablelands, the South West Slopes and possibly on the Riverina. Populations are known in the Goulburn, Yass, Queanbeyan, Cooma and Tumut areas. Also occurs in the ACT, Victoria and south-eastern South Australia. Found mainly in Natural Temperate Grassland but has also been captured in grasslands that have a high exotic component. Also found in secondary grassland near Natural Temperate Grassland and occasionally in open Box-Gum Woodland. Habitat is where grassland is dominated by perennial, tussock-forming grasses such as Kangaroo Grass Themeda australis, spear-grasses Austrostipa spp. and poa tussocks *Poa* spp., and occasionally wallaby grasses *Rytidosperma* spp. Sometimes present in modified grasslands with a significant content of exotic grasses. Also sometimes found in grasslands with significant amounts of surface rocks, which are used for shelter.	BioNet (5), BioNet (Hunter), PMST	**Recorded –** individuals recorded within the study area.	Yes
Hoplocephalus bitorquatus	Pale-headed Snake	–	V	–	A patchy distribution from north-east Queensland to the north-eastern quarter of NSW. In NSW it has historically been recorded from as far west as Mungindi and Quambone on the Darling Riverine Plains, across the north west slopes, and from the north coast from Queensland to Sydney. A small number of historical records are known for the New England Tablelands from Glenn Innes and Tenterfield; however, the majority of records appear to be from sites of relatively lower elevation. Although the Pale-headed snake distribution is very cryptic, it now appears to have contracted to a patchy and fragmented distribution. The Pale-headed Snake is a highly cryptic species that can spend weeks at a time hidden in tree hollows. Found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest. In drier environments, it appears to favour habitats close to riparian areas. Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees.	BioNet (Hunter)	**Moderate –** potential habitat recorded within the study area.	No – species not recorded during targeted surveys in optimal conditions, species unlikely to be affected
Hoplocephalus stephensii	Stephen's Banded Snake	–	V	–	Found in coastal areas from Gosford district to southern QLD. Arboreal snake usually encountered in the wetter sclerophyll or rainforests which occur within its range.	BioNet (Hunter)	Low – no preferred habitat recorded within the study area.	No
Fish								
Craterocephalus amniculus	Darling River Hardyhead	–	E2	–	The species is most commonly found in the north-east part of the Murray-Darling Basin, especially in the MacIntyre, Namoi other border rivers. The Hunter River population is the only known occurrence of the species in an eastward flowing river. They are usually found in slow flowing, clear, shallow waters or in aquatic vegetation at the edge of such waters. The species has also been recorded from the edge of fast flowing habitats such as the runs at the head of pools.	DPI	Low **–** degraded habitat along Muscle Creek is unlikely to be used by the species and low number of recent records in the region.	No
Mogurnda adspersa	Purple Spotted Gudgeon	–	–	E1	There are two populations of this species; an eastern population in coastal catchments north of the Clarence River and a western population found throughout the Murray-Darling Basin. Species prefers a variety of habitat types such as rivers, creeks and billabongs with slow-moving or still waters in streams with low turbidity. Cover in the form of aquatic vegetation, overhanging vegetation from river banks, leaf litter, rocks or snags are important.	DPI	Low **–** degraded habitat along Muscle Creek is unlikely to be used by the species and low number of recent records in the region.	No

1. Listed under the Commonwealth *Environment Protection and Biodiversity Act 1999* - CE = Critically Endangered, E= Endangered, V= Vulnerable, M= Migratory, Ma=Marine
2. Listed under the NSW *Biodiversity Conservation Act 2016* – CE = Critically Endangered, E1= Endangered, E2= Endangered Population, V= Vulnerable
3. Listed under the NSW *Fisheries* Management Act 1994 – E1= Endangered, E2= Endangered Population, V= Vulnerable
4. Habitat descriptions sourced from EES Group species profiles (2020b) and DPE SPRAT website (2020b) for each species
5. BioNet search = OEH BioNet Atlas of NSW Wildlife (records within 10km of the study area/regional search); PMST= Department of Environment and Energy's EPBC Protected Matters Search Tool; DPI = NSW Department of Primary Industries (Fishing and Aquaculture) spatial data.

Appendix B – Flora and fauna species recorded

B1 – Recorded flora

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Exotic species recorded				
Agavaceae	*Yucca aloifolia**	Yucca		
Aizoaceae	*Galenia pubescens var. pubescens**	Galenia		
Alliaceae	*Nothoscordum gracile**	Onion Weed		
Amaranthaceae	*Alternanthera pungens**	Khaki Weed		
Amaranthaceae	*Gomphrena celosioides**	Gomphrena Weed		
Anacardiaceae	*Schinus molle var. areira**	Peppercorn Tree		
Apiaceae	*Cyclospermum leptophyllum**	Slender Celery		
Apiaceae	*Foeniculum vulgare**	Fennel		
Apocynaceae	*Gomphocarpus fruticosus**	Narrow-leaved Cotton Bush		
Asphodelaceae	*Aloe vera*	Aloe Vera		
Asteraceae	*Arctotheca calendula**	Capeweed		
Asteraceae	*Argemone ochroleuca subsp. ochroleuca**	Mexican Poppy		
Asteraceae	*Bidens pilosa**	Cobblers Pegs		
Asteraceae	*Bidens subalternans**	Greater Beggars Ticks		
Asteraceae	*Carduus pycnocephalus**	Slender Thistle		
Asteraceae	*Carduus tenuiflorus**	Winged Slender Thistle		
Asteraceae	*Carthamus lanatus**	Saffron Thistle		
Asteraceae	*Centaurea melitensis**	Maltese Thistle		
Asteraceae	*Chondrilla juncea**	Skeleton Weed		
Asteraceae	*Cirsium vulgare**	Spear Thistle		
Asteraceae	*Conyza bonariensis**	Flaxleaf Fleabane		
Asteraceae	*Cyanthillium cinereum*	–		
Asteraceae	*Facelis retusa**	Annual Trampweed		
Asteraceae	*Gamochaeta americana**	American Cudweed		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Asteraceae	*Gamochaeta purpurea**	Purple Cudweed		
Asteraceae	*Gamochaeta calviceps**	Cudweed		
Asteraceae	*Hypochaeris radicata**	Catsear		
Asteraceae	*Lactuca serriola**	Prickly Lettuce		
Asteraceae	*Leontodon rhagadioloides**	Cretan Weed		
Asteraceae	*Schkuhria pinnata**	Dwarf Marigold		
Asteraceae	*Senecio madagascariensis**	Fireweed		
Asteraceae	*Silybum marianum**	Variegated Thistle		
Asteraceae	*Soliva sessilis**	Jo-jo		
Asteraceae	*Sonchus oleraceus**	Common Sowthistle		
Asteraceae	*Tolpis barbata**	Yellow Hawkweed		
Asteraceae	*Tragopogon porrifolius**	Salsify		
Asteraceae	*Xanthium spinosum**	Bathurst Burr		
Boraginaceae	*Echium plantagineum**	Pattersons Curse		
Boraginaceae	*Heliotropium amplexicaule**	Blue Heliotrope		
Brassicaceae	*Capsella bursa-pastoris**	Shepherds Purse		
Brassicaceae	*Cardamine hirsuta**	Common Bittercress		
Brassicaceae	*Hirschfeldia incana**	Hairy Brassica		
Brassicaceae	*Lepidium africanum**	Common Peppercress		
Brassicaceae	*Lepidium bonariense**	–		
Brassicaceae	*Lepidium didymum**	Lesser Swinecress		
Brassicaceae	*Rapistrum rugosum**	Turnip Weed		
Brassicaceae	*Sisymbrium irio**	London Rocket		
Cactaceae	*Opuntia aurantiaca**	Tiger Pear		
Cactaceae	*Opuntia stricta**	Prickly Pear		
Caryophyllaceae	*Cerastium glomeratum**	Mouse-ear Chickweed		
Caryophyllaceae	*Paronychia brasiliana**	Chilean Whitlow Wort		
Caryophyllaceae	*Petrorhagia nanteuilii**	Childling Pink		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Caryophyllaceae	*Polycarpon tetraphyllum**	Four-leaved Allseed		
Caryophyllaceae	*Saponaria officinalis*	Soapwort		
Caryophyllaceae	*Silene gallica var. gallica**	French Catchfly		
Caryophyllaceae	*Silene nocturna**	Mediterranean Catchfly		
Caryophyllaceae	*Stellaria media**	Common Chickweed		
Chenopodiaceae	*Chenopodium murale**	Nettle-leaf Goosefoot		
Chenopodiaceae	*Dysphania ambrosioides**	Mexican Tea		
Crassulaceae	*Bryophyllum x houghtonii**	-		
Euphorbiaceae	*Euphorbia peplus**	Petty Spurge		
Fabaceae (Faboideae)	*Medicago arabica**	Spotted Burr Medic		
Fabaceae (Faboideae)	*Medicago minima**	Woolly Burr Medic		
Fabaceae (Faboideae)	*Medicago orbicularis**	Button Medic		
Fabaceae (Faboideae)	*Medicago polymorpha**	Burr Medic		
Fabaceae (Faboideae)	*Medicago sativa**	Lucerne		
Fabaceae (Faboideae)	*Medicago truncatula**	Barrel Medic		
Fabaceae (Faboideae)	*Melilotus indica**	Hexham Scent		
Fabaceae (Faboideae)	*Trifolium angustifolium**	Narrow-leaved Clover		
Fabaceae (Faboideae)	*Trifolium arvense**	Harsefoot Clover		
Fabaceae (Faboideae)	*Trifolium glomeratum**	Clustered Clover		
Fabaceae (Faboideae)	*Trifolium repens**	White Clover		
Fabaceae (Faboideae)	*Trifolium tomentosum**	Woolly Clover		
Fabaceae (Faboideae)	*Trifolium campestre**	Hop Clover		
Fabaceae (Mimosoideae)	*Acacia nesophila**	–		
Fabaceae (Mimosoideae)	*Acacia saligna**	Golden Wreath Wattle		
Fumariaceae	*Fumaria densiflora**	Dense-flowered Fumitory		
Fumariaceae	*Fumaria parviflora**	Small-flowered Fumitory		
Iridaceae	*Romulea rosea**	Onion Grass		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Iridaceae	*Sisyrinchium rosulatum**	Scourweed		
Juncaceae	*Juncus acutus subsp. acutus**	Sharp Sedge		
Lamiaceae	*Lamium amplexicaule*	Henbit		
Lamiaceae	*Lavandula stoechas**	Lavender		
Lamiaceae	*Marrubium vulgare**	Horehound		
Lamiaceae	*Stachys arvensis**	Stagger Weed		
Linaceae	*Linum trigynum**	French Flax		
Malvaceae	*Malva parviflora**	Small-flowered Mallow		
Malvaceae	*Modiola caroliniana**	Red-flowered Mallow		
Malvaceae	*Pavonia hastata**	–		
Malvaceae	*Sida rhombifolia**	Paddys Lucerne		
Myrtaceae	*Corymbia citriodora**	Lemon-scented Gum		
Orobanchaceae	*Parentucellia latifolia**	Red Bartsia		
Oxalidaceae	*Oxalis corniculata**	–		
Papaveraceae	*Papaver somniferum**	Opium Poppy		
Phytolaccaceae	*Phytolacca octandra**	Ink Weed		
Plantaginaceae	*Linaria pelisseriana**	Pelisser's Toadflax		
Plantaginaceae	*Misopates orontium**	Lesser Snapdragon		
Plantaginaceae	*Nuttallanthus canadensis**	Blue Toadflax		
Plantaginaceae	*Plantago lanceolata**	Lambs Tongues		
Plantaginaceae	*Plantago myosuros subsp. myosuros**	–		
Poaceae	*Avena fatua**	Wild Oats		
Poaceae	*Briza minor**	Shivery Grass		
Poaceae	*Bromus catharticus**	Prairie Grass		
Poaceae	*Bromus diandrus**	Great Brome		
Poaceae	*Bromus molliformis**	Soft Brome		
Poaceae	*Cenchrus ciliaris**	Buffel Grass		
Poaceae	*Cenchrus clandestinus**	Kikuyu Grass		
Poaceae	*Chloris gayana**	Rhodes Grass		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Poaceae	*Desmazeria rigida**	Rigid Festcue		
Poaceae	*Ehrharta erecta**	Panic Veldtgrass		
Poaceae	*Eleusine tristachya**	Goose Grass		
Poaceae	*Eragrostis cilianensis**	Stinkgrass		
Poaceae	*Eragrostis curvula**	African Lovegrass		
Poaceae	*Hordeum leporinum**	Barley Grass		
Poaceae	*Hyparrhenia hirta**	Coolatai Grass		
Poaceae	*Lolium perenne**	Perennial Ryegrass		
Poaceae	*Megathyrsus maximus**	Guinea Grass		
Poaceae	*Melinis repens**	Red Natal Grass		
Poaceae	*Paspalum dilatatum**	Paspalum		
Poaceae	*Polypogon monspeliensis**	Annual Beardgrass		
Poaceae	*Setaria parviflora**	Slender Pigeon Grass		
Poaceae	*Setaria sphacelata**	South African Pigeon Grass		
Poaceae	*Vulpia bromoides**	Squirrel Tail Fescue		
Poaceae	*Vulpia muralis**	–		
Polygonaceae	*Polygonum aviculare**	Wireweed		
Polygonaceae	*Rumex crispus**	Curled Dock		
Polygonaceae	*Rumex hypogaeus**	Spiny Emex		
Primulaceae	*Lysimachia arvensis**	Scarlet/Blue Pimpernel		
Rosaceae	*Rubus fruticosus species aggregate**	Blackberry		
Rubiaceae	*Galium aparine**	Goosegrass		
Salicaceae	*Salix sp.**	Willow		
Solanaceae	*Datura stramonium**	Common Thornapple		
Solanaceae	*Lycium ferocissimum**	African Boxthorn		
Solanaceae	*Solanum nigrum**	Black-berry Nightshade		
Solanaceae	*Solanum seaforthianum**	Brazilian Nightshade		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Tamaricaceae	*Tamarix aphylla**	Athel Tree		
Verbenaceae	*Verbena bonariensis**	Purpletop		
Verbenaceae	*Verbena rigida**	Veined Verbena		
Native species recorded				
Acanthaceae	*Brunoniella australis*	Blue Trumpet		
Acanthaceae	*Rostellularia adscendens subsp. adscendens*	–		
Adiantaceae	*Adiantum aethiopicum*	Common Maidenhair		
Adiantaceae	*Cheilanthes austrotenuifolia*	Rock Fern		
Adiantaceae	*Cheilanthes distans*	Bristly Cloak Fern		
Adiantaceae	*Cheilanthes sieberi subsp. sieberi*	Poison Rock Fern		
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed		
Anthericaceae	*Arthropodium milleflorum*	Vanilla Lily		
Anthericaceae	*Arthropodium minus*	–		
Anthericaceae	*Arthropodium sp. B*	–		
Anthericaceae	*Dichopogon fimbriatus*	Chocolate Nodding Lily		
Apiaceae	*Daucus glochidiatus*	Native Carrot		
Apiaceae	*Hydrocotyle laxiflora*	Stinking Pennywort		
Asclepiadaceae	*Tylophora barbata*	Bearded Tylophora		
Aspleniaceae	*Asplenium flabellifolium*	Necklace Fern		
Asteraceae	*Calotis hispidula*	Bogan Flea		
Asteraceae	*Calotis lappulacea*	Yellow Burr-daisy		
Asteraceae	*Cassinia quinquefaria*	–		
Asteraceae	*Cassinia sifton*	Sifton Bush		
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting		
Asteraceae	*Cotula australis*	Common Cotula		
Asteraceae	*Euchiton sphaericus*	–		
Asteraceae	*Glossocardia bidens*	Cobbler's Tack		
Asteraceae	*Lagenophora stipitata*	Blue Bottle-daisy		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Asteraceae	*Leiocarpa panaetioides*	Woolly Buttons		
Asteraceae	*Minuria leptophyllum*	–		
Asteraceae	*Ozothamnus diosmifolius*	White Dogwood		
Asteraceae	*Pseudognaphalium luteoalbum*	Jersey Cudweed		
Asteraceae	*Senecio quadridentatus*	Cotton Firewee		
Asteraceae	*Sigesbeckia australiensis*	–		
Asteraceae	*Triplodiscus pygmeaus*	Common Sunray		
Asteraceae	*Vittadinia cuneata var. cuneata*	Fuzzweed		
Asteraceae	*Vittadinia muelleri*	–		
Asteraceae	*Vittadinia pustulata*	–		
Asteraceae	*Xerochrysum bracteatum*	Golden Everlasting		
Campanulaceae	*Wahlenbergia communis*	Tufted Bluebell		
Campanulaceae	*Wahlenbergia gracilis*	Sprawling Bluebell		
Campanulaceae	*Wahlenbergia luteola*	–		
Campanulaceae	*Wahlenbergia sp.*	Bluebell		
Casuarinaceae	*Allocasuarina luehmannii*	Bulloak		
Casuarinaceae	*Allocasuarina torulosa*	Forest Oak		
Casuarinaceae	*Casuarina cunninghamiana subsp. cunninghamiana*	River Oak, River Sheoak		
Casuarinaceae	*Casuarina glauca*	Swamp Oak		
Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush		
Chenopodiaceae	*Dysphania carinata*	Keeled Goosefoot		
Chenopodiaceae	*Dysphania pumilio*	Small Crumbweed		
Chenopodiaceae	*Einadia hastata*	Berry Saltbush		
Chenopodiaceae	*Einadia nutans subsp. linifolia*	Climbing Saltbush		
Chenopodiaceae	*Einadia nutans subsp. nutans*	Climbing Saltbush		
Chenopodiaceae	*Einadia polygonoides*	–		
Chenopodiaceae	*Einadia trigonos*	Fishweed		
Chenopodiaceae	*Enchylaena tomentosa*	Ruby Saltbush		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Chenopodiaceae	*Maireana enchylaenoides*	Wingless Bluebush		
Chenopodiaceae	*Maireana microphylla*	Small-leaf Bluebush		
Commelinaceae	*Commelina cyanea*	Native Wandering Jew		
Convolvulaceae	*Convolvulus angustissima*	–		
Convolvulaceae	*Convolvulus erubescens*	Blushing Bindweed		
Convolvulaceae	*Convolvulus graminetinus*	–		
Convolvulaceae	*Dichondra repens*	Kidney Weed		
Convolvulaceae	*Dichondra sp. Inglewood (J.M.Dalby 86/93) QLD Herbarium*	Kidney Weed		
Convolvulaceae	*Evolvulus alsinoides var. decumbens*	–		
Convolvulaceae	*Polymeria calycina*	–		
Crassulaceae	*Crassula colorata*	Dense Crassula		
Crassulaceae	*Crassula sieberiana*	Australian Stonecrop		
Cyperaceae	*Bolboschoenus caldwellii*	Salt Club-sedge		
Cyperaceae	*Carex inversa*	Knob Sedge		
Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge		
Cyperaceae	*Eleocharis plana*	Flat Spike-sedge		
Cyperaceae	*Scleria mackaviensis*	–		
Dilleniaceae	*Hibbertia obtusifolia*	Grey Guinea-flower		
Euphorbiaceae	*Euphorbia drummondii*	Caustic Weed		
Fabaceae (Faboideae)	*Desmodium varians*	Slender Tick-trefoil		
Fabaceae (Faboideae)	*Glycine clandestina*	–		
Fabaceae (Faboideae)	*Glycine tabacina*	–		
Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla		
Fabaceae (Faboideae)	*Hardenbergia violacea*	False Sarsaparilla		
Fabaceae (Faboideae)	*Indigofera australis*	Austral Indigo		
Fabaceae (Faboideae)	*Oxytes brachypoda*	Large Tick-trefoil		
Fabaceae (Faboideae)	*Swainsona galegifolia*	Smooth Darling-pea		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Fabaceae (Faboideae)	*Swainsona monticola*	Notched Swainsona-pea		
Fabaceae (Faboideae)	*Templetonia stenophylla*	Leafy Templetonia		
Fabaceae (Faboideae)	*Zornia dyctiocarpa var. dyctiocarpa*	Zornia		
Fabaceae (Mimosoideae)	*Acacia baileyana*	Cootamundra Wattle		
Fabaceae (Mimosoideae)	*Acacia deanei subsp. deanei*	Deane's Wattle		
Fabaceae (Mimosoideae)	*Acacia decora*	Western Golden Wattle		
Fabaceae (Mimosoideae)	*Acacia falcata*	Hickory Wattle		
Fabaceae (Mimosoideae)	*Acacia implexa*	Hickory Wattle		
Fabaceae (Mimosoideae)	*Acacia macradenia*	Zig Zag Wattle		
Fabaceae (Mimosoideae)	*Acacia paradoxa*	Kangaroo Thorn		
Fabaceae (Mimosoideae)	*Acacia pendula*[3]	Weeping Myall, Boree	E2	
Fabaceae (Mimosoideae)	*Acacia podalyriifolia*	Queensland Silver Wattle		
Fabaceae (Mimosoideae)	*Acacia salicina*	Cooba		
Fabaceae (Mimosoideae)	*Acacia sp.*	Wattle		
Fabaceae (Mimosoideae)	*Acacia spectabilis*	Mudgee Wattle		
Geraniaceae	*Erodium crinitum*	Blue Storksbill		
Geraniaceae	*Geranium solanderi*	Native Geranium		
Geraniaceae	*Geranium sp.*	–		
Goodeniaceae	*Goodenia glauca*	–		
Goodeniaceae	*Goodenia pinnatifida*	–		
Juncaceae	*Juncus continuus*	–		
Juncaceae	*Juncus usitatus*	–		
Juncaginaceae	*Cycnogeton procerum*	Water Ribbons		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Linaceae	*Linum marginale*	Native Flax		
Lobeliaceae	*Lobelia concolor*	Poison Pratia		
Lobeliaceae	*Lobelia purpurascens*	Whiteroot		
Lomandraceae	*Lomandra confertifolia*	Mat-rush		
Lomandraceae	*Lomandra filiformis subsp. coriacea*	Wattle Mat-rush		
Lomandraceae	*Lomandra filiformis subsp. filiformis*	Wattle Mat-rush		
Lomandraceae	*Lomandra multiflora subsp. multiflora*	Many-flowered Mat-rush		
Loranthaceae	*Amyema miquelii*	Box Mistletoe		
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry		
Malvaceae	*Abutilon oxycarpum*	Straggly Lantern-bush		
Malvaceae	*Sida corrugata*	Corrugated Sida, Variable Sida		
Malvaceae	*Sida hackettiana*	Golden Rod		
Malvaceae	*Sida spinosa*	–		
Meliaceae	*Melia azedarach*	White Cedar		
Montoaceae	*Calandrinia eremaea*	–		
Myoporaceae	*Eremophila debilis*	Amulla		
Myrtaceae	*Angophora floribunda*	Rough-barked Apple		
Myrtaceae	*Corymbia maculata*	Spotted Gum		
Myrtaceae	*Eucalyptus blakelyi*	Blakelys Red Gum		
Myrtaceae	*Eucalyptus blakelyi x tereticornis*	–		
Myrtaceae	*Eucalyptus camaldulensis*	River Red Gum	E2	
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark		
Myrtaceae	*Eucalyptus dawsonii*	Slaty Gum		
Myrtaceae	*Eucalyptus melanophloia*	Silver-leaved Ironbark		
Myrtaceae	*Eucalyptus melliodora*	Yellow Box		
Myrtaceae	*Eucalyptus moluccana*	Grey Box		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Myrtaceae	*Eucalyptus nicholii*[3]	Narrow-leaved Black Peppermint	V	V
Myrtaceae	*Eucalyptus scoparia*[3]	Wallangarra White Gum	E	V
Myrtaceae	*Eucalyptus tereticornis*	River Red Gum		
Nyctaginaceae	*Boerhavia dominii*	Tarvine		
Oleaceae	*Notelaea microcarpa var. microcarpa*	Native Olive		
Oxalidaceae	*Oxalis perennans*	Grassland Wood-sorrel		
Oxalidaceae	*Oxalis radicosa*	–		
Phormiaceae	*Dianella caerulea var. cinerascens*	Blue Flax-lily		
Phormiaceae	*Dianella longifolia*	Blueberry Lily		
Phormiaceae	*Dianella revoluta var. revoluta*	Blueberry Lily		
Phormiaceae	*Stypandra glauca*	Nodding Blue Lily		
Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush		
Phyllanthaceae	*Phyllanthus virgatus*	Wiry Spurge		
Pittosporaceae	*Bursaria spinosa subsp. spinosa*	Native Blackthorn		
Plantaginaceae	*Plantago debilis*	–		
Poaceae	*Amphibromus nervosus*	–		
Poaceae	*Anthosachne scabra*	Wheatgrass		
Poaceae	*Aristida ramosa*	Cane Wire-grass		
Poaceae	*Aristida vagans*	Threeawn Speargrass		
Poaceae	*Austrostipa scabra*	Speargrass		
Poaceae	*Austrostipa setacea*	Corkscrew Grass		
Poaceae	*Austrostipa verticillata*	Slender Bamboo grass		
Poaceae	*Bothriochloa macra*	Red Grass		
Poaceae	*Chloris truncata*	Windmill Grass		
Poaceae	*Chloris ventricosa*	Tall Chloris		
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Poaceae	*Cynodon dactylon*	Common Couch		
Poaceae	*Dichanthium sericeum*	Queensland Bluegrass		
Poaceae	*Digitaria brownii*	Cotton Panic Grass		
Poaceae	*Digitaria diffusa*	Open Summer-grass		
Poaceae	*Digitaria divaricatissima*	Umbrella Grass		
Poaceae	*Echinopogon caespitosus var. caespitosus*	Tufted Hedgehog Grass		
Poaceae	*Echinopogon ovatus*	Forest Hedgehog Grass		
Poaceae	*Enneapogon gracilis*	Slender Bottle-washers		
Poaceae	*Enteropogon acicularis*	Spider Grass		
Poaceae	*Eragrostis brownii*	Browns Lovegrass		
Poaceae	*Eragrostis elongata*	Clustered Lovegrass		
Poaceae	*Eragrostis leptostachya*	Paddock Lovegrass		
Poaceae	*Eragrostis megalosperma*	–		
Poaceae	*Eriochloa pseudoacrotricha*	Early Spring Grass		
Poaceae	*Eulalia aurea*	Silky Browntop		
Poaceae	*Microlaena stipoides var. stipoides*	Weeping Grass		
Poaceae	*Panicum effusum*	Poison or Hairy Panic		
Poaceae	*Panicum queenslandicum var. queenslandicum*	Coolibah Grass		
Poaceae	*Paspalidium aversum*	–		
Poaceae	*Paspalidium criniforme*	–		
Poaceae	*Paspalidium gracile*	Slender Panic		
Poaceae	*Phragmites australis*	Common Reed		
Poaceae	*Rytidosperma fulvum*	Copper-awned Wallaby-grass		
Poaceae	*Rytidosperma monticola*	–		
Poaceae	*Rytidosperma racemosum var. obtusatum*	–		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Poaceae	*Rytidosperma setaceum*	Bristly Wallaby-grass		
Poaceae	*Sporobolus caroli*	Fairy Grass		
Poaceae	*Sporobolus creber*	Slender Rats Tail Grass		
Poaceae	*Themeda triandra*	Kangaroo Grass		
Polygonaceae	*Rumex brownii*	Swamp Dock		
Portulacaceae	*Portulaca oleracea*	Pigweed		
Proteaceae	*Persoonia sp.*	–		
Ranunculaceae	*Clematis aristata*	Mountain Clematis		
Ranunculaceae	*Ranunculus lappaceus*	Common Buttercup		
Rosaceae	*Acaena agnipila*	–		
Rubiaceae	*Asperula conferta*	Common Woodruff		
Rubiaceae	*Galium sp.*	–		
Rubiaceae	*Opercularia diphylla*	–		
Rubiaceae	*Psydrax odorata subsp. australiana*	Shiny-leaved Canthium		
Rutaceae	*Geijera parviflora*	Wilga		
Rutaceae	*Geijera salicifolia*	Brush Wilga		
Santalaceae	*Exocarpos cupressiformis*	Native Cherry		
Sapindaceae	*Dodonaea viscosa subsp. spatulata*	Sticky Hop-bush		
Scrophulariaceae	*Veronica plebeia*	Trailing Speedwell		
Solanaceae	*Solanum brownii*	Violet Nightshade		
Solanaceae	*Solanum cinereum*	Narrawa Burr		
Stackhousiaceae	*Stackhousia muricata*	Western Stackhousia		
Stackhousiaceae	*Stackhousia viminea*	Slender Stackhousia		
Sterculiaceae	*Brachychiton populneus subsp. populneus*	Kurrajong		
Typhaceae	*Typha domingensis*	Narrow-leaved Cumbungi		
Urticaceae	*Urtica incisa*	Stinging Nettle		

Family	Scientific name	Common name	BC Act status[1]	EPBC Act status[2]
Verbenaceae	*Verbena gaudichaudii*	–		
Vitaceae	*Clematicissus opaca*	Pepper Vine		

1. Listed as Vulnerable (V), Endangered (E) or Endangered Population (E2) under the NSW *Biodiversity Conservation Act 2016* (BC Act)
2. Listed as Vulnerable (V) or Endangered (E) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
3. *Eucalyptus scoparia, Eucalyptus nicholii* and *Acacia pendula* individuals recorded within the study area were planted cultivars generally restricted to 'native plantings' or urban/exotic areas.

B2 – Vegetation integrity plot data

Q1

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20170224. 1531			46	38	4	5	11	13	1	4	8	3
PCT 1691 - Moderate condition (Q1)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	Cover	Abundance	100.5	97.4	43.2	8.1	40.2	3.4	0.2	2.3	3.1	2.3
Eucalyptus crebra	35	30	TG		35							
Geijera parviflora	5	1	SG			5						
Notelaea microcarpa var. microcarpa	3	2	TG		3							
Allocasuarina luehmannii	5	10	TG		5							
Enchylaena tomentosa	2	50	SG			2						
Aristida ramosa	10	100	GG				10					
Glycine tabacina	0.1	10	OG							0.1		
Sida hackettiana	2	40	FG					2				
Eragrostis leptostachya	0.3	10	GG				0.3					
Cymbopogon refractus	1	20	GG				1					
Digitaria divaricatissima	0.3	20	GG				0.3					
Calotis lappulacea	0.3	20	FG					0.3				
Sida corrugata	0.1	10	FG					0.1				
Einadia nutans	0.1	10	FG					0.1				
Bothriochloa macra	5	60	GG				5					
Eremophila debilis	0.5	10	SG			0.5						
Galenia pubescens var. pubescens	2	20	HT									2
Opuntia stricta	0.1	1	EX								0.1	
Stackhousia viminea	0.1	3	FG					0.1				
Chrysocephalum apiculatum	0.1	2	FG					0.1				
Wahlenbergia sp.	0.1	10	FG					0.1				
Clematicissus opaca	0.1	1	OG							0.1		
Austrostipa scabra	0.8	30	GG				0.8					
Convolvulus erubescens	0.1	1	OG							0.1		
Brunoniella australis	0.1	20	FG					0.1				
Amyema miquelii	2	2	OG							2		
Maireana enchylaenoides	0.1	10	FG					0.1				
Lycium ferocissimum	0.2	5	HT									0.2
Einadia hastata	0.1	20	FG					0.1				
Lomandra filiformis subsp. filiformis	0.2	20	GG				0.2					
Cyperus gracilis	0.1	5	GG				0.1					
Cheilanthes sieberi subsp. sieberi	0.2	50	EG						0.2			
Cyanthillium cinereum	0.4	3	EX								0.4	
Phyllanthus virgatus	0.1	3	FG					0.1				
Enteropogon acicularis	2	20	GG				2					
Lepidium africanum	0.1	5	EX								0.1	
Senecio madagascariensis	0.1	1	HT									0.1

Easting	303524
Northing	6430321
Orientation	350
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	
30-49	Yes
20-29	Yes
10-19	Yes
5-9	Yes
<5	Yes
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	72
Bare Ground (%)	8
Vegetation (%)	16
Rock (%)	0
Cryptogram (%)	4

Portulaca oleracea	0.1	1	FG					0.1							
Austrostipa verticillata	20	1	GG				20								
Maireana microphylla	0.1	1	SG			0.1									
Psydrax odorata	0.5	1	SG			0.5									
Nothoscordum gracile	0.1	10	EX								0.1				
Sida rhombifolia	0.1	1	EX								0.1				
Dianella longifolia	0.1	1	FG					0.1							
Acacia salicina	0.2	1	TG		0.2										
Chloris ventricosa	0.5	10	GG				0.5								

Q2

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20170224.1531			37	28	3	5	15	4	0	1	9	5
PCT 1691 - Low (remnant) (Q2)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	105.4	78.5	65.3	6.5	5.9	0.6	0	0.2	26.9	26.2
Eucalyptus crebra	65	38	TG		65							
Geijera parviflora	3	1	SG			3						
Lycium ferocissimum	2	5	HT									2
Megathyrsus maximus	14	50	HT									14
Galenia pubescens var. pubescens	10	40	HT									10
Enchylaena tomentosa	3	30	SG			3						
Sida hackettiana	0.1	1	FG					0.1				
Enteropogon acicularis	0.4	20	GG				0.4					
Solanum cinereum	0.1	1	SG			0.1						
Eremophila debilis	0.2	3	SG			0.2						
Glycine tabacina	0.2	30	OG							0.2		
Cyperus gracilis	0.1	1	GG				0.1					
Calotis lappulacea	0.2	30	FG					0.2				
Digitaria diffusa	0.2	15	GG				0.2					
Austrostipa scabra	0.2	15	GG				0.2					
Melinis repens	0.1	5	EX								0.1	
Paspalidium criniforme	0.3	20	GG				0.3					
Cymbopogon refractus	0.1	5	GG				0.1					
Aristida ramosa	0.5	20	GG				0.5					
Digitaria brownii	0.4	20	GG				0.4					
Einadia nutans	0.2	10	FG					0.2				
Lomandra multiflora subsp. multiflora	0.1	5	GG				0.1					
Bothriochloa macra	0.5	20	GG				0.5					
Opuntia aurantiaca	0.1	1	EX								0.1	
Cynodon dactylon (exotic)	0.4	20	EX								0.4	
Maireana enchylaenoides	0.1	10	FG					0.1				
Chloris ventricosa	0.5	20	GG				0.5					
Austrostipa verticillata	2	10	GG				2					
Digitaria divaricatissima	0.2	10	GG				0.2					
Panicum queenslandicum var. queenslandicum	0.3	10	GG				0.3					
Notelaea microcarpa var. microcarpa	0.2	1	TG		0.2							
Acacia salicina	0.1	1	TG		0.1							
Maireana microphylla	0.2	1	SG			0.2						
Solanum seaforthianum	0.1	1	HT									0.1
Rytidosperma setaceum	0.1	3	GG				0.1					
Sida rhombifolia	0.1	1	EX								0.1	
Chloris gayana	0.1	1	HT									0.1

Easting	303377
Northing	6429860
Orientation	150
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	2
30-49	Yes
20-29	Yes
10-19	Yes
5-9	Yes
<5	Yes
Hollows	2
Length logs (m)	0.8
BAM Attributes 1x1 plot (%)	
Litter (%)	76
Bare Ground (%)	4
Vegetation (%)	17
Rock (%)	0
Cryptogram (%)	1

Q3

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20170224.1531			53	39	0	2	21	13	2	1	14	3
PCT 1691 - Low (DNG) (Q3)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	102.3	97.1	0	2.1	86.6	8	0.2	0.2	5.2	2.1
Cymbopogon refractus	10	200	GG				10					
Dichanthium sericeum	4	50	GG				4					
Aristida ramosa	10	200	GG				10					
Digitaria brownii	3	50	GG				3					
Plantago lanceolata	2	30	EX								2	
Chrysocephalum apiculatum	2	50	FG					2				
Digitaria divaricatissima	7	100	GG				7					
Nothoscordum gracile	0.1	5	EX								0.1	
Carthamus lanatus	1	40	HT									1
Glycine tabacina	0.2	30	OG							0.2		
Sida hackettiana	3	40	FG					3				
Enchylaena tomentosa	2	40	SG			2						
Sida rhombifolia	0.2	30	EX								0.2	
Cyperus gracilis	0.1	1	GG				0.1					
Carex inversa	0.1	10	GG				0.1					
Rytidosperma setaceum	2	30	GG				2					
Panicum queenslandicum var. queenslandicum	5	20	GG				5					
Medicago polymorpha	0.1	50	EX								0.1	
Austrostipa scabra	5	50	GG				5					
Wahlenbergia communis	0.1	2	FG					0.1				
Brunoniella australis	2	60	FG					2				
Eriochloa pseudoacrotricha	6	60	GG				6					
Enteropogon acicularis	6	70	GG				6					
Eragrostis leptostachya	4	50	GG				4					
Sonchus oleraceus	0.1	1	EX								0.1	
Chloris truncata	2	20	GG				2					
Sporobolus creber	5	50	GG				5					
Chloris ventricosa	5	60	GG				5					
Chloris gayana	1	5	HT									1
Lagenophora stipitata	0.1	10	FG					0.1				
Lysimachia arvensis	0.1	10	EX								0.1	
Enteropogon acicularis	5	80	GG				5					
Lomandra multiflora subsp. multiflora	0.2	10	GG				0.2					
Galenia pubescens var. pubescens	0.1	1	HT									0.1
Setaria parviflora	0.1	1	EX								0.1	
Cheilanthes sieberi subsp. sieberi	0.1	10	EG						0.1			
Erodium crinitum	0.1	10	FG					0.1				
Bothriochloa macra	5	60	GG				5					
Cheilanthes distans	0.1	1	EG						0.1			
Panicum effusum	2	15	GG				2					

Easting	303425
Northing	6429700
Orientation	155
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	
30-49	
20-29	None
10-19	
5-9	
<5	
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	17
Bare Ground (%)	12
Rock (%)	0
Vegetation (%)	70
Cryptogram (%)	1

Einadia nutans	0.1	3	FG					0.1							
Gomphrena celosioides	0.1	1	EX								0.1				
Opuntia stricta	0.1	1	EX								0.1				
Sida corrugata	0.1	2	FG					0.1							
Lomandra filiformis subsp. filiformis	0.2	10	GG				0.2								
Calotis lappulacea	0.1	3	FG					0.1							
Opuntia aurantiaca	0.1	1	EX								0.1				
Boerhavia dominii	0.1	1	FG					0.1							
Vittadinia cuneata var. cuneata	0.1	1	FG					0.1							
Gomphocarpus fruticosus	0.1	1	EX								0.1				
Rostellularia adscendens	0.1	3	FG					0.1							
Eremophila debilis	0.1	1	SG			0.1									
Stackhousia viminea	0.1	1	FG					0.1							

Q4

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20170324.1531			51	34	5	5	14	8	1	1	17	7
PCT 1607 – Good condition (Q4)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	118.7	98.8	61	11.7	23.1	2.8	0.1	0.1	19.9	17.4
Eucalyptus blakelyi	45	10	TG		45							
Notelaea microcarpa var. microcarpa	10	30	TG		10							
Brachychiton populneus subsp. populneus	4	2	TG		4							
Lycium ferocissimum	5	10	HT									5
Austrostipa verticillata	8	50	GG				8					
Acacia implexa	10	50	SG			10						
Chloris ventricosa	5	60	GG				5					
Galenia pubescens var. pubescens	5	50	HT									5
Eriochloa pseudoacrotricha	0.2	20	GG				0.2					
Sida hackettiana	0.1	20	FG					0.1				
Sida rhombifolia	0.1	2	EX								0.1	
Erodium crinitum	0.1	1	FG					0.1				
Cyperus gracilis	0.1	20	GG				0.1					
Einadia hastata	2	40	FG					2				
Chloris truncata	0.5	20	GG				0.5					
Microlaena stipoides	5	80	GG				5					
Magathyrsus maximus	2	30	HT									2
Setaria parviflora	1	30	EX								1	
Eragrostis leptostachya	0.8	20	GG				0.8					
Dichondra repens	0.2	50	FG					0.2				
Asparagus asparagoides	0.2	1	HT									0.2
Ehrharta erecta	5	100	HT									5
Geranium sp.	0.2	1	EX								0.2	
Acacia decora	1	3	SG			1						
Fumaria densiflora	0.1	2	EX								0.1	
Acacia paradoxa	0.5	1	SG			0.5						
Rytidosperma setaceum	2	40	GG				2					
Dichanthium sericeum	0.2	10	GG				0.2					
Enchylaena tomentosa	0.1	1	SG			0.1						
Cymbopogon refractus	0.1	2	GG				0.1					
Opuntia stricta	0.1	1	EX								0.1	
Opuntia aurantiaca	0.1	2	EX								0.1	
Chloris gayana	0.1	2	HT									0.1
Aristida ramosa	0.5	20	GG				0.5					
Melinis repens	0.2	10	EX								0.2	
Einadia nutans	0.1	2	FG					0.1				
Enteropogon acicularis	0.5	10	GG				0.5					
Wahlenbergia communis	0.1	1	FG					0.1				
Eucalyptus crebra	1	2	TG		1							
Calotis lappulacea	0.1	4	FG					0.1				
Melia azedarach	1	1	TG		1							
Lomandra filiformis subsp. filiformis	0.1	3	GG				0.1					
Senecio madagascariensis	0.1	5	HT									0.1
Cheilanthes sieberi	0.1	1	EG						0.1			
Convolvulus erubescens	0.1	1	OG							0.1		
Enemophila debilis	0.1	1	SG			0.1						
Lysimachia arvensis	0.1	10	EX								0.1	
Medicago polymorpha	0.1	1	EX								0.1	
Sida corrugata	0.1	1	FG					0.1				
Cynodon dactylon (exotic)	0.5	20	EX								0.5	
Rytidosperma fulvum	0.1	1	GG				0.1					

Easting	304328
Northing	6429173
Orientation	280
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	1
30–49	Yes
20–29	Yes
10–19	Yes
5–9	Yes
<5	Yes
Hollows	1
Length logs (m)	6

BAM Attributes 1x1 plot (%)	
Litter (%)	62
Bare Ground (%)	16
Rock (%)	20
Cryptogram (%)	2

Q5

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	ighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20170324.1531			41	31	2	6	11	9	1	2	10	5
PCT 1691 – Moderate condition (Q5)			Sum cove	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundanc**	119.3	99.3	42	27.4	20.6	8.9	0.1	0.3	20	16.3
Eucalyptus crebra	37	25	TG		37							
Notelaea microcarpa var. microcarpa	5	30	TG		5							
Dodonaea viscosa subsp. spatulata	25	50	SG			25						
Austrostipa verticillata	10	50	GG				10					
Galenia pubescens var. pubescens	15	100	HT									15
Opuntia stricta	0.1	1	EX								0.1	
Calotis lappulacea	3	100	FG					3				
Enchylaena tomentosa	0.1	2	SG			0.1						
Cynodon dactylon (exotic)	0.2	20	EX								0.2	
Einadia hastata	5	100	FG					5				
Senecio madagascariensis	0.1	2	HT									0.1
Aristida ramosa	5	80	GG				5					
Abutilon oxycarpum	0.1	1	SG			0.1						
Einadia nutans	0.1	10	FG					0.1				
Eremophila debilis	0.2	2	SG			0.2						
Cyperus gracilis	0.5	50	GG				0.5					
Sida hackettiana	0.2	20	FG					0.2				
Portulaca oleracea	0.1	1	FG					0.1				
Cheilanthes sieberi subsp. sieberi	0.1	3	EG						0.1			
Digitaria diffusa	0.5	20	GG				0.5					
Glycine tabacina	0.1	3	OG							0.1		
Cymbopogon refractus	0.2	10	GG				0.2					
Austrostipa scabra	0.4	20	GG				0.4					
Lomandra multiflora subsp. multiflora	0.1	1	GG				0.1					
Wahlenbergia sp.	0.1	1	FG					0.1				
Eragrostis leptostachya	2	50	GG				2					
Lomandra filiformis subsp. filiformis	0.5	20	GG				0.5					
Aloe vera	3	10	EX								3	
Chrysocephalum apiculatum	0.1	2	FG					0.1				
Eragrostis curvula	0.3	5	HT									0.3
Acacia paradoxa	1	3	SG			1						
Chloris ventricosa	0.6	20	GG				0.6					
Megathyrsus maximus	0.8	15	HT									0.8
Rytidosperma setaceum	0.8	30	GG				0.8					
Medicago polymorpha	0.3	5	EX								0.3	
Clematis aristata	0.2	1	OG							0.2		
Acacia implexa	1	5	SG			1						
Dichondra repens	0.2	50	FG					0.2				
Opuntia aurantiaca	0.1	1	EX								0.1	
Cenchrus ciliaris	0.1	1	HT									0.1
Vittadinia cuneata var. cuneata	0.1	20	FG					0.1				

Easting	304191
Northing	6429144
Orientation	110
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	Yes
20–29	Yes
10–19	Yes
5–9	Yes
<5	Yes
Hollows	0
ength logs (n	2
BAM Attributes 1x1 plot (%)	
Litter (%)	50
Bare Ground	8
Rock (%)	0
Vegetation (:	40
Cryptogram (	2

Q6

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	ighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20170224.1531			53	38	3	4	15	14	0	2	15	4
PCT 1691 – Moderate condition (Q6)			Sum cove	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**bundanc**	94.2	68	25	1.6	39.2	1.9	0	0.3	26.2	18.2
Eucalyptus moluccana	16	4	TG		16							
Geijera salicifolia	3	1	TG		3							
Notelaea microcarpa var. microcarpa	6	8	TG		6							
Lycium ferocissimum	5	8	HT									5
Chloris truncata	10	200	GG				10					
Sida rhombifolia	0.3	30	EX								0.3	
Opuntia stricta	0.2	4	EX								0.2	
Austrostipa verticillata	6	40	GG				6					
Galenia pubescens var. pubescens	12	200	HT									12
Plantago lanceolata	0.5	30	EX								0.5	
Sida corrugata	0.1	15	FG					0.1				
Aristida ramosa	4	50	GG				4					
Sida spinosa	0.2	40	EX								0.2	
Marrubium vulgare	2	50	EX								2	
Chloris truncata	5	60	GG				5					
Erodium crinitum	0.1	2	FG					0.1				
Austrostipa scabra	1	30	GG				1					
Lomandra multiflora subsp. multiflora	0.1	2	GG				0.1					
Asperula conferta	0.4	60	FG					0.4				
Senecio madagascariensis	0.2	20	HT									0.2
Euphorbia drummondii	0.1	1	FG					0.1				
Phyllanthus virgatus	0.1	2	FG					0.1				
Cymbopogon refractus	0.1	2	GG				0.1					
Pyrrhosperma sp.	3	100	GG				3					
Bothriochloa macra	3	50	GG				3					
Lysimachia arvensis	0.2	50	EX								0.2	
Cirsium vulgare	0.2	10	EX								0.2	
Carthamus lanatus	1	40	HT									1
Glycine tabacina	0.2	20	OG							0.2		
Panicum queenslandicum var. queenslandicum	0.3	10	GG				0.3					
Dichanthium sericeum	3	50	GG				3					
Cynodon dactylon (exotic)	4	50	EX								4	
Enchylaena tomentosa	0.2	15	SG			0.2						
Einadia nutans	0.2	20	FG					0.2				
Oxalis sp.	0.1	3	FG					0.1				
Dichondra repens	0.2	30	FG					0.2				
Eremophila debilis	1	20	SG			1						
Rostellularia adscendens var. adscendens	0.1	10	FG					0.1				
Opuntia aurantiaca	0.1	1	EX								0.1	
Lomandra filiformis subsp. filiformis	0.3	10	GG				0.3					
Cyperus gracilis	3	100	GG				3					
Carex inversa	0.3	20	GG				0.3					
Vittadinia cuneata var. cuneata	0.1	20	FG					0.1				
Sonchus oleraceus	0.2	20	EX								0.2	
Abutilon oxycarpum	0.1	1	SG			0.1						

Easting	304942
Northing	6428714
Orientation	80
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	Yes
20–29	
10–19	Yes
5–9	
<5	Yes
Hollows	4
Length logs (m)	24

BAM Attributes 1x1 plot (%)	
Litter (%)	15
Bare Ground (%)	4
Rock (%)	0
Vegetation (%)	78
Cryptogram (%)	3

Wahlenbergia communis	0.1	1	FG					0.1							
Lagenifera stipitata	0.1	20	FG					0.1							
Solanum cinereum	0.3	20	SG			0.3									
Eustrephus latifolius	0.1	1	OG							0.1					
Modiola caroliniana	0.1	3	EX								0.1				
Arthropodium milleflorum	0.1	2	FG					0.1							
Calotis lappulacea	0.1	1	FG					0.1							
Digitaria brownii	0.1	5	GG				0.1								

Q7

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160907			43	31	1	1	13	13	2	1	12	2
PCT 1691 – Low (DNG) (Q7)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	83.7	81.1	0.1	0.2	76.8	3.5	0.4	0.1	2.6	0.4
Aristida ramosa	40	500	GG				40					
Lomandra multiflora subsp. multiflora	4	100	GG				4					
Lomandra filiformis subsp. filiformis	8	200	GG				8					
Cheilanthes sieberi subsp. sieberi	0.3	40	EG						0.3			
Stackhousia viminea	0.2	20	FG					0.2				
Sida rhombifolia	1	30	EX								1	
Sida hackettiana	2	40	FG					2				
Convolvulus erubescens	0.1	30	OG							0.1		
Hypochaeris radicata	0.1	1	EX								0.1	
Lysimachia arvensis	0.2	20	EX								0.2	
Modiola caroliniana	0.1	10	EX								0.1	
Chloris truncata	6	80	GG				6					
Eragrostis leptostachya	1	20	GG				1					
Calotis lappulacea	0.1	10	FG					0.1				
Austrostipa scabra	2	30	GG				2					
Rytidosperma setaceum	3	30	GG				3					
Einadia nutans	0.1	10	FG					0.1				
Cheilanthes distans	0.1	20	EG						0.1			
Digitaria brownii	3	40	GG				3					
Panicum effusum	3	40	GG				3					
Senecio madagascariensis	0.2	10	HT									0.2
Wahlenbergia communis	0.1	10	FG					0.1				
Stachys arvensis	0.1	20	EX								0.1	
Euphorbia drummondii	0.1	2	FG					0.1				
Sida corrugata	0.1	10	FG					0.1				
Erodium crinitum	0.3	40	FG					0.3				
Solanum cinereum	0.2	3	SG			0.2						
Zornia dyctiocarpa var. dyctiocarpa	0.1	2	FG					0.1				
Bothriochloa macra	5	80	GG				5					
Brunoniella australis	0.1	1	FG					0.1				
Notelaea microcarpa var. microcarpa	0.1	1	TG		0.1							
Cymbopogon refractus	1	30	GG				1					
Oxalis perennans	0.1	3	FG					0.1				
Einadia hastata	0.1	10	FG					0.1				
Galenia pubescens var. pubescens	0.2	1	HT									0.2
Opuntia stricta	0.1	1	EX								0.1	
Sonchus oleraceus	0.1	2	EX								0.1	
Chloris ventricosa	0.6	20	GG				0.6					
Chondrilla juncea	0.3	20	EX								0.3	
Digitaria divaricatissima	0.2	10	GG				0.2					
Sida spinosa	0.1	5	EX								0.1	
Malva parviflora	0.1	2	EX								0.1	
Daucus glochidiatus	0.1	2	FG					0.1				

Easting	304916
Northing	6428975
Orientation	245
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	
20–29	None
10–19	
5–9	
<5	
Hollows	0
Length logs (m)	18
BAM Attributes 1x1 plot (%)	
Litter (%)	3
Bare Ground (%)	36
Rock (%)	0
Vegetation (%)	61
Cryptogram (%)	0

Q8

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180807			47	35	2	2	16	11	2	2	12	4
PCT 1691 - Moderate condition (Q8)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	117.1	112	32	0.5	77.9	1.3	0.3	0.2	4.9	3.8
Eucalyptus crebra	25	24	TG		25							
Notelaea microcarpa var. microcarpa	7	40	TG		7							
Austrostipa verticillata	18	60	GG				18					
Lycium ferocissimum	3	6	HT									3
Chloris ventricosa	5	60	GG				5					
Aristida ramosa	30	200	GG				30					
Dichondra repens	0.1	20	FG					0.1				
Sida rhombifolia	0.3	30	EX								0.3	
Einadia nutans	0.1	3	FG					0.1				
Galenia pubescens var. pubescens	0.5	10	HT									0.5
Glycine tabacina	0.1	10	OG							0.1		
Cyperus gracilis	0.2	20	GG				0.2					
Senecio madagascariensis	0.2	40	HT									0.2
Cheilanthes distans	0.1	10	EG						0.1			
Wahlenbergia communis	0.1	5	FG					0.1				
Cheilanthes sieberi subsp. sieberi	0.2	20	EG						0.2			
Digitaria divaricatissima	3	50	GG				3					
Lomandra multiflora subsp. multiflora	0.2	10	GG				0.2					
Eragrostis leptostachya	6	80	GG				6					
Abutilon oxycarpum	0.2	20	SG			0.2						
Lomandra filiformis subsp. filiformis	0.6	30	GG				0.6					
Solanum cinereum	0.3	5	SG			0.3						
Rytidosperma setaceum	3	60	GG				3					
Sida hackettiana	0.1	2	FG					0.1				
Marrubium vulgare	0.1	1	EX								0.1	
Lagenifera stipitata	0.1	1	FG					0.1				
Oxalis perennans	0.1	2	FG					0.1				
Sida corrugata	0.1	5	FG					0.1				
Chloris truncata	4	60	GG				4					
Stachys arvensis	0.1	10	EX								0.1	
Calotis lappulacea	0.2	30	FG					0.2				
Panicum effusum	3	50	GG				3					
Paspalidium criniforme	0.5	10	GG				0.5					
Cymbopogon refractus	3	40	GG				3					
Glycine microphylla	0.1	1	OG							0.1		
Stackhousia viminea	0.1	10	FG					0.1				
Cyanthillium cinereum	0.1	1	EX								0.1	
Opuntia stricta	0.2	3	EX								0.2	
Sporobolus creber	0.5	20	GG				0.5					
Plantago lanceolata	0.1	3	EX								0.1	
Erodium crinitum	0.2	30	FG					0.2				
Einadia hastata	0.1	10	FG					0.1				
Bothriochloa macra	0.6	20	GG				0.6					
Eriochloa pseudoacrotricha	0.3	10	GG				0.3					
Lepidium africanum	0.1	5	EX								0.1	
Carthamus lanatus	0.1	2	HT									0.1
Lysimachia arvensis	0.1	10	EX								0.1	

Easting	304758
Northing	6423017
Orientation	300
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	2
30-49	
20-29	Yes
10-19	Yes
5-9	Yes
<5	Yes
Hollows	1
Length logs (m)	6

BAM Attributes 1x1 plot (%)	
Litter (%)	26
Bare Ground (%)	30
Rock (%)	0
Vegetation (%)	44
Cryptogram (%)	0

Q9

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic ligh	Threat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version 20100907			51	25	3	1	11	10	0	0	26	5
PCT 485 - Moderate condition (Q9)			Sum cove	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundanc**	143.2	111	45.1	0.1	62.3	3	0	0	32.7	23.2
Angophora floribunda	15	5	TG		15							
Casuarina cunninghamiana subsp. cunninghamiana	30	12	TG		30							
Juncus acutus	20	20	HT									20
Microlaena stipoides var. stipoides	25	200	GG				25					
Urtica incisa	0.8	30	FG					0.8				
Austrostipa verticillata	8	80	GG				8					
Sonchus oleraceus	0.2	20	EX								0.2	
Einadia trigonos	0.2	40	FG					0.2				
Lycium ferocissimum	0.1	1	HT									0.1
Cirsium vulgare	0.3	20	EX								0.3	
Modiola caroliniana	0.3	20	EX								0.3	
Plantago lanceolata	0.1	3	EX								0.1	
Eriochloa pseudoacrotricha	0.1	2	GG				0.1					
Galenia pubescens var. pubescens	2	20	HT									2
Notelaea microcarpa	0.1	1	TG		0.1							
Datura stramonium	0.1	2	EX								0.1	
Senecio madagascariensis	0.1	3	HT									0.1
Typha domingensis	0.1	1	GG				0.1					
Rumex brownii	1	30	FG					1				
Commelina cyanea	0.1	1	FG					0.1				
Bolboschoenus caldwellii	2	20	GG				2					
Euphorbia peplus	0.1	2	EX								0.1	
Dysphania ambrosioides	0.1	1	EX								0.1	
Cynodon dactylon	15	100	GG				15					
Sida rhombifolia	0.1	10	EX								0.1	
Setaria parviflora	2	30	EX								2	
Sporobolus creber	3	30	GG				3					
Fumaria parviflora	0.1	2	EX								0.1	
Trifolium repens	0.1	2	EX								0.1	
Stachys arvensis	0.1	3	EX								0.1	
Lysimachia arvensis	0.1	3	EX								0.1	
Ranunculus lappaceus	0.1	2	FG					0.1				
Isolepis prolifera	0.1	1	FG					0.1				
Aristida ramosa	5	80	GG				5					
Lobelia purpurascens	0.3	30	FG					0.3				
Paspalum dilatatum	1	10	HT									1
Silybum marianum	0.1	2	EX								0.1	
Capsella bursa-pastoris	0.1	2	EX								0.1	
Solanum cinereum	0.1	1	SG			0.1						
Paspalidium criniforme	0.1	10	GG				0.1					
Conyza bonariensis	0.2	5	EX								0.2	
Oxalis sp.	0.2	50	FG					0.2				
Chloris truncata	1	20	GG				1					
Cyperus gracilis	3	100	GG				3					
Echium plantagineum	5	40	EX								5	
Sida spinosa	0.1	3	EX								0.1	
Gamochaeta americana	0.1	10	EX								0.1	
Calotis lappulacea	0.1	5	FG					0.1				
Veronica plebeia	0.1	1	FG					0.1				
Marrubium vulgare	0.1	1	EX								0.1	
Salvia sessilis	0.1	3	EX								0.1	

Easting	305361
Northing	6426728
Orientation	5
Plot size	10x40 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	1
30-49	Yes
20-29	Yes
10-19	Yes
5-9	
<5	Yes
Hollows	1
ength logs (l	3

BAM Attributes 1x1 plot (%)	
Litter (%)	2
Bare Ground	6
Rock (%)	0
Vegetation	92
Cryptogram	0

Q10

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			24	9	0	1	5	3	0	0	15	3
PCT 42 Low (DNG) (Q10)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	84.7	58.5	0	0.1	58	0.4	0	0	26.2	15.2
Cynodon dactylon	45	500	GG				45					
Aristida ramosa	5	30	GG				5					
Galenia pubescens var. pubescens	15	70	HT									15
Echium plantagineum	5	40	EX								5	
Solva sessilis	5	100	EX								5	
Bothriochloa macra	4	80	GG				4					
Hypochaeris radicata	0.1	1	EX								0.1	
Rumex brownii	0.2	10	FG					0.2				
Lysimachia arvensis	0.1	10	EX								0.1	
Paronychia brasiliana	0.1	1	EX								0.1	
Erodium crinitum	0.1	1	FG					0.1				
Chloris truncata	3	40	GG				3					
Solanum cinereum	0.1	3	SG			0.1						
Sporobolus creber	1	20	GG				1					
Gamochaeta americana	0.1	10	EX								0.1	
Conyza bonariensis	0.1	1	EX								0.1	
Stachys arvensis	0.1	10	EX								0.1	
Oxalis sp.	0.1	10	FG					0.1				
Senecio madagascariensis	0.1	1	HT									0.1
Lepidium africanum	0.1	2	EX								0.1	
Sida spinosa	0.1	10	EX								0.1	
Alternanthera pungens	0.1	1	HT									0.1
Silybum marianum	0.1	2	EX								0.1	
Malva parviflora	0.1	5	EX								0.1	

Easting	305631
Northing	6426621
Orientation	195
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	
30-49	
20-29	None
10-19	
5-9	
<5	
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	0
Bare Ground (%)	4
Rock (%)	0
Vegetation (%)	96
Cryptogram (%)	0

Q11

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			26	13	0	1	7	3	0	2	13	3
PCT 1691 – Low (DNG) (Q11)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	49.4	23.5	0	6	17	0.3	0	0.2	25.9	18.1
Chloris truncata	15	200	GG				15					
Solanum cinereum	6	100	SG			6						
Galenia pubescens var. pubescens	15	200	HT									15
Stachys arvensis	3	100	EX								3	
Glycine tabacina	0.1	10	OG							0.1		
Carthamus lanatus	3	100	HT									3
Bothriochloa macra	1	20	GG				1					
Modiola caroliniana	0.2	30	EX								0.2	
Senecio madagascariensis	0.1	10	HT									0.1
Eriochloa pseudoacrotricha	0.5	10	GG				0.5					
Cynodon dactylon (exotic)	0.8	20	EX								0.8	
Sida spinosa	0.3	20	EX								0.3	
Erodium crinitum	0.1	2	FG					0.1				
Polygonum aviculare	0.1	3	EX								0.1	
Rytidosperma setaceum	0.1	5	GG				0.1					
Convolvulus erubescens	0.1	6	OG							0.1		
Lepidium africanum	0.1	2	EX								0.1	
Malva parviflora	0.1	2	EX								0.1	
Lobelia concolor	0.1	3	FG					0.1				
Eragrostis leptostachya	0.2	10	GG				0.2					
Cyperus gracilis	0.1	10	GG				0.1					
Einadia nutans	0.1	1	FG					0.1				
Plantago lanceolata	0.1	1	EX								0.1	
Sporobolus creber	0.1	2	GG				0.1					
Datura stramonium	0.1	1	EX								0.1	
Medicago polymorpha	3	200	EX								3	

Easting	305238
Northing	6428701
Orientation	160
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	
20–29	None
10–19	
5–9	
<5	
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	0
Bare Ground (%)	13
Rock (%)	0
Vegetation (%)	87
Cryptogram (%)	0

Q12

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160601			27	18	2	0	11	4	1	0	9	2
PCT 1693 – Low (remannt) (Q12)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	135.2	118.2	37	0	52.7	28.4	0.1	0	17	1.3
Eucalyptus melliodora	2	1	TG		2							
Eucalyptus blakelyi	35	9	TG		35							
Cynodon dactylon (exotic)	15	100	EX								15	
Aristida ramosa	30	200	GG				30					
Chrysocephalum apiculatum	28	30	FG					28				
Senecio madagascariensis	0.3	20	HT									0.3
Carex inversa	0.2	20	GG				0.2					
Sida rhombifolia	0.2	10	EX								0.2	
Galenia pubescens var. pubescens	1	20	HT									1
Lomandra filiformis subsp. filiformis	5	50	GG				5					
Digitaria brownii	3	50	GG				3					
Eragrostis brownii	0.1	10	GG				0.1					
Calotis lappulacea	0.2	10	FG					0.2				
Gomphrena celosioides	0.1	1	EX								0.1	
Cyperus gracilis	0.3	20	GG				0.3					
Stackhousia viminea	0.1	1	FG					0.1				
Digitaria divaricatissima	6	60	GG				6					
Digitaria diffusa	2	30	GG				2					
Paronychia brasiliana	0.1	1	EX								0.1	
Hypochaeris radicata	0.1	3	EX								0.1	
Bothriochloa macra	3	40	GG				3					
Cymbopogon refractus	0.1	2	GG				0.1					
Paspalidium criniforme	3	30	GG				3					
Cheilanthes sieberi subsp. sieberi	0.1	2	EG						0.1			
Phyllanthus virgatus	0.1	2	FG					0.1				
Opuntia stricta	0.1	1	EX								0.1	
Verbena rigida	0.1	1	EX								0.1	

Easting	305433
Northing	6425612
Orientation	120
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	
30-49	Yes
20-29	Yes
10-19	Yes
5-9	Yes
<5	Yes
Hollows	0
Length logs (m)	2

BAM Attributes 1x1 plot (%)	
Litter (%)	40
Bare Ground (%)	14
Rock (%)	0
Vegetation (%)	46
Cryptogram (%)	0

Q13

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180807			18	7	0	0	5	2	0	0	11	3
PCT 1693 – Low (DNG) (Q13)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	77.9	37.3	0	0	37.1	0.2	0	0	40.6	1.3
Cynodon dactylon (exotic)	35	200	EX								35	
Chloris truncata	28	200	GG				28					
Eragrostis leptostachya	0.1	1	GG				0.1					
Senecio madagascariensis	0.2	10	HT									0.2
Hypochaeris radicata	3	100	EX								3	
Eragrostis curvula	0.5	5	HT									0.5
Panicum effusum	1	15	GG				1					
Eleusine tristachya	0.1	1	EX								0.1	
Paspalum dilatatum	0.6	10	HT									0.6
Vittadinia cuneata var. cuneata	0.1	10	FG					0.1				
Soliva sessilis	0.1	10	EX								0.1	
Sporobolus creber	5	60	GG				5					
Bothriochloa macra	3	40	GG				3					
Plantago lanceolata	0.1	2	EX								0.1	
Setaria parviflora	0.6	10	EX								0.6	
Verbena bonariensis	0.2	5	EX								0.2	
Phyllanthus virgatus	0.1	1	FG					0.1				
Sonchus oleraceus	0.2	10	EX								0.2	

Easting	305200
Northing	6426087
Orientation	155
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	
30-49	
20-29	None
10-19	
5-9	
<5	
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	0
Bare Ground (%)	8
Rock (%)	0
Vegetation (%)	92
Cryptogram (%)	0

Q14

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180807			16	6	0	0	5	1	0	0	10	1
PCT 1693 - Low (DNG) (Q14)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	72.1	57.3	0	0	57.2	0.1	0	0	14.8	0.1
Chloris truncata	45	500	GG				45					
Sporobolus creber	8	80	GG				8					
Bothriochloa macra	3	40	GG				3					
Echium plantagineum	3	40	EX								3	
Sida spinosa	0.1	10	EX								0.1	
Soliva sessilis	0.3	30	EX								0.3	
Sonchus oleraceus	0.2	10	EX								0.2	
Eleusine tristachya	0.6	20	EX								0.6	
Plantago lanceolata	0.1	2	EX								0.1	
Vittadinia cuneata var. cuneata	0.1	1	FG					0.1				
Gamochaeta americana	0.3	40	EX								0.3	
Senecio madagascariensis	0.1	1	HT									0.1
Verbena bonariensis	0.1	5	EX								0.1	
Eragrostis leptostachya	1	20	GG				1					
Cyperus gracilis	0.2	20	GG				0.2					
Cynodon dactylon (exotic)	10	100	EX								10	

Easting	305399
Northing	6426291
Orientation	150
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	
30-49	
20-29	None
10-19	
5-9	
<5	
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	0
Bare Ground (%)	21
Rock (%)	0
Vegetation (%)	79
Cryptogram (%)	0

Q15

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			35	27	3	3	11	8	0	2	8	3
PCT 1691 – Moderate condition (Q15)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	67.4	65.5	41.1	0.5	20	3.5	0	0.4	1.9	1.2
Eucalyptus crebra	35	27	TG		35							
Notelaea microcarpa var. microcarpa	6	6	TG		6							
Austrostipa verticillata	6	50	GG				6					
Lomandra multiflora subsp. multiflora	1	20	GG				1					
Einadia hastata	2	80	FG					2				
Sida rhombifolia	0.2	20	EX								0.2	
Opuntia stricta	0.2	5	EX								0.2	
Galenia pubescens var. pubescens	1	30	HT									1
Digitaria divaricatissima	2	30	GG				2					
Einadia nutans	0.2	20	FG					0.2				
Calotis lappulacea	0.8	80	FG					0.8				
Enchylaena tomentosa	0.1	1	SG			0.1						
Glycine tabacina	0.3	40	OG							0.3		
Lomandra filiformis subsp. filiformis	0.3	30	GG				0.3					
Lysimachia arvensis	0.1	1	EX								0.1	
Microlaena stipoides var. stipoides	3	60	GG				3					
Soliva sessilis	0.1	20	EX								0.1	
Cyperus gracilis	0.2	20	GG				0.2					
Rytidosperma setaceum	3	40	GG				3					
Digitaria diffusa	0.5	20	GG				0.5					
Opuntia aurantiaca	0.1	1	EX								0.1	
Xanthium spinosum	0.1	1	HT									0.1
Desmodium varians	0.1	4	OG							0.1		
Chloris truncata	0.5	10	GG				0.5					
Oxalis perennans	0.1	1	FG					0.1				
Senecio madagascariensis	0.1	1	HT									0.1
Entenopogon acicularis	0.5	10	GG				0.5					
Abutilon oxycarpum	0.1	2	SG			0.1						
Vittadinia sp.	0.1	1	FG					0.1				
Aristida ramosa	3	40	GG				3					
Sida corrugata	0.1	1	FG					0.1				
Eremophila debilis	0.3	5	SG			0.3						
Stackhousia viminea	0.1	3	FG					0.1				
Oxytes brachypoda	0.1	1	FG					0.1				
Geijera salicifolia	0.1	1	TG		0.1							

Easting	305504
Northing	6427393
Orientation	165
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	1
30–49	
20–29	Yes
10–19	Yes
5–9	Yes
<5	
Hollows	1
Length logs (m)	11
BAM Attributes 1x1 plot (%)	
Litter (%)	53
Bare Ground (%)	38
Rock (%)	0
Vegetation (%)	7
Cryptogram (%)	2

Q16

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			45	36	4	5	11	13	2	1	9	3
PCT 1691 – Moderate condition (Q16)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	86.6	79.8	54	9.9	9.8	5.3	0.2	0.6	6.8	6.1
Eucalyptus moluccana	45	25	TG		45							
Geijera parviflora	9	3	SG			9						
Austrostipa verticillata	5	50	GG				5					
Einadia nutans	2	100	FG					2				
Solanum cinereum	0.3	10	SG			0.3						
Oxytes brachypoda	1	20	FG					1				
Lycium ferocissimum	2	6	HT									2
Notelaea microcarpa var. microcarpa	3	10	TG		3							
Galenia pubescens var. pubescens	4	50	HT									4
Glycine tabacina	0.6	50	OG							0.6		
Sida rhombifolia	0.2	30	EX								0.2	
Einadia hastata	1	40	FG					1				
Chloris truncata	0.2	20	GG				0.2					
Lysimachia arvensis	0.1	30	EX								0.1	
Solva sessilis	0.1	2	EX								0.1	
Sida corrugata	0.1	4	FG					0.1				
Calotis lappulacea	0.3	40	FG					0.3				
Eremophila debilis	0.2	30	SG			0.2						
Microlaena stipoides var. stipoides	3	50	GG				3					
Enchylaena tomentosa	0.3	20	SG			0.3						
Sonchus oleraceus	0.1	10	EX								0.1	
Opuntia stricta	0.1	2	EX								0.1	
Abutilon oxycarpum	0.1	5	SG			0.1						
Erodium crinitum	0.1	1	FG					0.1				
Lagenifera stipitata	0.1	1	FG					0.1				
Eucalyptus crebra	3	3	TG		3							
Opuntia aurantiaca	0.1	3	EX								0.1	
Cyperus gracilis	0.1	20	GG				0.1					
Oxalis perennans	0.1	1	FG					0.1				
Austrostipa scabra	0.3	10	GG				0.3					
Lomandra multiflora subsp. multiflora	0.1	5	GG				0.1					
Cheilanthes distans	0.1	1	EG						0.1			
Rytidosperma sp.	0.4	20	GG				0.4					
Cheilanthes sieberi subsp. sieberi	0.1	1	EG						0.1			
Lobelia purpurascens	0.2	20	FG					0.2				
Eragrostis leptostachya	0.2	5	GG				0.2					
Rostellularia adscendens var. adscendens	0.1	3	FG					0.1				
Wahlenbergia sp.	0.1	1	FG					0.1				
Senecio madagascariensis	0.1	1	HT									0.1
Chrysocephalum apiculatum	0.1	1	FG					0.1				
Rytidosperma racemosum var. obtusatum	0.2	20	GG				0.2					
Enteropogon acicularis	0.2	20	GG				0.2					
Digitaria brownii	0.1	5	GG				0.1					
Sida hackettiana	0.1	1	FG					0.1				
Brachychiton populneus subsp. populneus	3	1	TG		3							

Easting	305630
Northing	6427125
Orientation	345
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	1
30-49	Yes
20-29	Yes
10-19	Yes
5-9	yes
<5	
Hollows	1
Length logs (m)	32

BAM Attributes 1x1 plot (%)	
Litter (%)	55
Bare Ground (%)	8
Rock (%)	0
Vegetation (%)	31
Cryptogram (%)	6

Q17

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			43	23	0	1	11	10	1	0	20	4
PCT 1691 – Low (DNG) (Q17)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	43.1	38.2	0	0.2	36.4	1.4	0.2	0	4.9	1
Chloris truncata	5	50	GG				5					
Bothriochloa macra	10	200	GG				10					
Echium plantagineum	2	40	EX								2	
Aristida ramosa	3	40	GG				3					
Senecio madagascariensis	0.1	10	HT									0.1
Lysimachia arvensis	0.1	20	EX								0.1	
Soliva sessilis	0.2	50	EX								0.2	
Stachys arvensis	0.1	20	EX								0.1	
Geranium solanderi	0.1	1	FG					0.1				
Oxalis perennans	0.1	2	FG					0.1				
Hypochaeris radicata	0.2	40	EX								0.2	
Petrorhagia nanteuilii	0.1	10	EX								0.1	
Sporobolus creber	4	50	GG				4					
Chrysocephalum apiculatum	0.3	20	FG					0.3				
Romulea rosea	0.2	40	HT									0.2
Panicum effusum	4	60	GG				4					
Galenia pubescens var. pubescens	0.5	20	HT									0.5
Paspalidium criniforme	0.2	10	GG				0.2					
Eragrostis leptostachya	4	60	GG				4					
Plantago lanceolata	0.1	3	EX								0.1	
Cirsium vulgare	0.2	10	EX								0.2	
Daucus glochidiatus	0.1	1	FG					0.1				
Rapistrum rugosum	0.1	4	EX								0.1	
Sida spinosa	0.1	3	EX								0.1	
Cyperus gracilis	0.2	40	GG				0.2					
Crassula colorata	0.1	10	FG					0.1				
Erodium crinitum	0.1	10	FG					0.1				
Vittadinia sp.	0.1	10	FG					0.1				
Sonchus oleraceus	0.1	10	EX								0.1	
Sida rhombifolia	0.2	30	EX								0.2	
Verbena bonariensis	0.1	1	EX								0.1	
Sida hackettiana	0.3	40	FG					0.3				
Digitaria divaricatissima	2	30	GG				2					
Carthamus lanatus	0.2	20	HT									0.2
Solanum cinereum	0.2	6	SG			0.2						
Gomphrena celosioides	0.1	1	EX								0.1	
Setaria parviflora	0.1	5	EX								0.1	
Vittadinia cuneata var. cuneata	0.1	3	FG					0.1				
Chloris ventricosa	2	30	GG				2					
Cheilanthes sieberi subsp. sieberi	0.2	20	EG						0.2			
Digitaria brownii	2	20	GG				2					
Capsella bursa-pastoris	0.1	1	EX								0.1	
Calotis lappulacea	0.1	3	FG					0.1				

Easting	305613
Northing	6427017
Orientation	260
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	
30-49	
20-29	None
10-19	
5-9	
<5	
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	0
Bare Ground (%)	2
Rock (%)	0
Vegetation (%)	98
Cryptogram (%)	0

Q18

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version 20180807			56	44	6	6	13	12	3	4	12	2
PCT 1607 - Good condition (Q18)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	71.3	69.3	37.1	4.5	21	4	0.4	2.3	2	0.6
Eucalyptus molliodora	5	3	TG		5							
Eucalyptus blakelyi	12	5	TG		12							
Angophora floribunda	5	8	TG		5							
Eucalyptus crebra	5	4	TG		5							
Notelaea microcarpa var. microcarpa	10	20	TG		10							
Bursaria spinosa subsp. spinosa	3	10	SG			3						
Microlaena stipoides var. stipoides	6	100	GG				6					
Digitaria brownii	2	50	GG				2					
Glycine tabacina	2	50	OG							2		
Aristida ramosa	3	50	GG				3					
Eremophila debilis	0.2	20	SG			0.2						
Senecio madagascariensis	0.1	10	HT									0.1
Lomandra multiflora subsp. multiflora	0.1	10	GG				0.1					
Lysimachia arvensis	0.2	30	EX								0.2	
Galenia pubescens var. pubescens	0.5	30	HT									0.5
Arthropodium milleflorum	2	200	FG					2				
Einadia hastata	0.4	30	FG					0.4				
Plantago lanceolata	0.1	5	EX								0.1	
Stackhousia viminea	0.1	5	FG					0.1				
Lomandra filiformis subsp. filiformis	0.3	20	GG				0.3					
Desmodium varians	0.1	10	OG							0.1		
Cymbopogon refractus	2	30	GG				2					
Oxalis perennans	0.1	10	FG					0.1				
Indigofera australis	1	30	SG			1						
Rytidosperma fulvum	2	60	GG				2					
Solanum cinereum	0.1	3	SG			0.1						
Chrysocephalum apiculatum	0.1	2	FG					0.1				
Dichondra repens	0.1	10	FG					0.1				
Calotis lappulacea	0.1	1	FG					0.1				
Cheilanthes sieberi subsp. sieberi	0.1	10	EG						0.1			
Einadia nutans	0.6	50	FG					0.6				
Sonchus oleraceus	0.1	4	EX								0.1	
Eustrephus latifolius	0.1	2	OG							0.1		
Rytidosperma racemosum var. obtusatum	2	30	GG				2					
Cynanthillium cinereum	0.4	40	EX								0.4	
Cyperus gracilis	0.2	50	GG				0.2					
Eragrostis leptostachya	0.2	20	GG				0.2					
Lepidium africanum	0.1	1	EX								0.1	
Asplenium flabellifolium	0.2	20	EG						0.2			
Echinopogon caespitosus	3	50	GG				3					
Hardenbergia violacea	0.1	0.1	OG							0.1		
Lobelia purpurascens	0.2	0.2	FG					0.2				
Carex inversa	0.1	3	GG				0.1					
Opuntia aurantiaca	0.1	2	EX								0.1	
Opuntia stricta	0.1	2	EX								0.1	
Hydrocotyle laxiflora	0.1	10	FG					0.1				
Capsella bursa-pastoris	0.1	1	EX								0.1	
Geijera salicifolia	0.1	1	TG		0.1							
Enchylaena tomentosa	0.1	1	SG			0.1						
Rumex brownii	0.1	2	FG					0.1				
Cirsium vulgare	0.1	1	EX								0.1	
Soliva sessilis	0.1	1	EX								0.1	
Galium sp.	0.1	3	FG					0.1				
Chloris ventricosa	0.1	5	GG				0.1					
Adiantum aethiopicum	0.1	10	EG						0.1			
Acacia implexa	0.1	1	SG			0.1						

Easting	305546
Northing	6426852
Orientation	275
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	2
30-49	Yes
20-29	Yes
10-19	Yes
5-9	Yes
<5	Yes
Hollows	2
Length logs (m)	2

BAM Attributes 1x1 plot (%)	
Litter (%)	47
Bare Ground (%)	11
Rock (%)	15
Vegetation (%)	27
Cryptogram (%)	0

Q19

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			31	14	0	1	9	4	0	0	17	5
PCT 1693 – Low (DNG) (Q19)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	73	35.2	0	0.2	29.8	5.2	0	0	37.8	8.7
Chloris truncata	4	60	GG				4					
Sporobolus creber	10	150	GG				10					
Galenia pubescens var. pubescens	8	100	HT									8
Oxalis sp.	2	200	FG					2				
Sida spinosa	0.1	30	EX								0.1	
Modiola caroliniana	1	40	EX								1	
Sida rhombifolia	0.4	50	EX								0.4	
Echium plantagineum	4	60	EX								4	
Hypochaeris radicata	0.2	40	EX								0.2	
Panicum effusum	5	150	GG				5					
Sida hackettiana	3	50	FG					3				
Soliva sessilis	3	100	EX								3	
Setaria parviflora	10	200	EX								10	
Sonchus oleraceus	0.1	3	EX								0.1	
Aristida ramosa	0.4	10	GG				0.4					
Paspalidium criniforme	5	100	GG				5					
Cynodon dactylon (exotic)	10	100	EX								10	
Plantago lanceolata	0.1	1	EX								0.1	
Romulea rosea	0.2	40	HT									0.2
Solanum cinereum	0.2	6	SG			0.2						
Senecio madagascariensis	0.1	10	HT									0.1
Calotis lappulacea	0.1	1	FG					0.1				
Einadia hastata	0.1	2	FG					0.1				
Cyperus gracilis	0.3	10	GG				0.3					
Eragrostis leptostachya	2	30	GG				2					
Paspalum dilatatum	0.3	10	HT									0.3
Bothriochloa macra	3	30	GG				3					
Lomandra filiformis subsp. filiformis	0.1	5	GG				0.1					
Silybum marianum	0.1	1	EX								0.1	
Heliotropium amplexicaule	0.1	1	HT									0.1
Trifolium repens	0.1	1	EX								0.1	

Easting	305370
Northing	6426901
Orientation	180
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	
20–29	None
10–19	
5–9	
<5	
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	4
Bare Ground (%)	10
Rock (%)	10
Vegetation (%)	76
Cryptogram (%)	0

Q20

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			36	29	3	6	8	8	1	3	7	3
PCT 1691 – Moderate condition (Q20)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	Cover	Abundance	71.2	63.7	50	0.6	9.9	2.8	0.1	0.3	7.5	7.1
Eucalyptus crebra	30	30	TG		30							
Notelaea microcarpa var. microcarpa	15	10	TG		15							
Lycium ferocissimum	5	15	HT									5
Galenia pubescens var. pubescens	2	30	HT									2
Einadia hastata	2	30	FG					2				
Senecio madagascariensis	0.1	2	HT									0.1
Calotis lappulacea	0.2	20	FG					0.2				
Opuntia aurantiaca	0.1	2	EX								0.1	
Glycine tabacina	0.1	20	OG							0.1		
Einadia nutans	0.1	10	FG					0.1				
Lysimachia arvensis	0.1	2	EX								0.1	
Soliva sessilis	0.1	1	EX								0.1	
Lomandra multiflora subsp. multiflora	0.4	20	GG				0.4					
Microlaena stipoides var. stipoides	5	50	GG				5					
Lagenifera stipitata	0.1	1	FG					0.1				
Lomandra filiformis subsp. filiformis	0.1	2	GG				0.1					
Eremophila debilis	0.1	1	SG			0.1						
Cyperus gracilis	0.1	10	GG				0.1					
Cheilanthes sieberi subsp. sieberi	0.1	2	EG						0.1			
Eragrostis brownii	0.1	10	GG				0.1					
Oxalis perennans	0.1	2	FG					0.1				
Opuntia stricta	0.1	1	EX								0.1	
Acacia sp.	0.1	3	SG			0.1						
Stackhousia viminea	0.1	1	FG					0.1				
Aristida ramosa	4	70	GG				4					
Digitaria diffusa	0.1	5	GG				0.1					
Desmodium varians	0.1	1	OG							0.1		
Geijera salicifolia	5	3	TG		5							
Alternanthera denticulata	0.1	1	FG					0.1				
Opercularia diphylla	0.1	1	FG					0.1				
Persoonia sp.	0.1	1	SG			0.1						
Hibbertia obtusifolia	0.1	2	SG			0.1						
Exocarpos cupressiformis	0.1	2	SG			0.1						
Indigofera australis	0.1	1	SG			0.1						
Tylophora barbata	0.1	2	OG							0.1		
Eragrostis leptostachya	0.1	1	GG				0.1					

Easting	305438
Northing	6427018
Orientation	320
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	
20–29	Yes
10–19	Yes
5–9	Yes
<5	
Hollows	0
Length logs (m)	22

BAM Attributes 1x1 plot (%)	
Litter (%)	45
Bare Ground (%)	32
Rock (%)	0
Vegetation (%)	21
Cryptogram (%)	2

Q21

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version 20180807			50	26	3	1	10	11	0	1	24	3
PCT 485 - Low (Remnant) condition (Q21)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	143	123	38	0.1	73.6	11	0	0.1	20.2	15.1
Casuarina cunninghamiana subsp. cunninghamiana	25	3	TG		25							
Angophora floribunda	8	5	TG		8							
Microlaena stipoides var. stipoides	30	500	GG				30					
Juncus acutus	5	20	HT									5
Sida rhombifolia	1	40	EX								1	
Aristida ramosa	5	50	GG				5					
Austrostipa verticillata	8	60	GG				8					
Rumex brownii	0.3	80	FG					0.3				
Sporobolus creber	4	20	GG				4					
Galenia pubescens var. pubescens	10	60	HT									10
Cynodon dactylon	20	50	GG				20					
Plantago lanceolata	0.1	10	EX								0.1	
Cirsium vulgare	0.1	5	EX								0.1	
Einadia nutans	0.1	10	FG					0.1				
Typha domingensis	2	15	GG				2					
Einadia trigonos	6	100	FG					6				
Echium plantagineum	0.4	30	EX								0.4	
Medicago arabica	1	100	EX								1	
Sida hackettiana	0.1	20	FG					0.1				
Bolboschoenus caldwellii	2	40	GG				2					
Ranunculus lappaceus	2	30	FG					2				
Sida spinosa	0.1	10	EX								0.1	
Cyanthillium cinereum	0.1	1	EX								0.1	
Persicaria sp.	0.1	1	FG					0.1				
Sonchus oleraceus	0.1	3	EX								0.1	
Lysimachia arvensis	0.1	5	EX								0.1	
Phragmites australis	2	10	GG				2					
Paronychia brasiliana	0.1	1	EX								0.1	
Daucus glochidiatus	0.1	20	FG					0.1				
Petrorhagia nanteuilii	0.1	10	EX								0.1	
Sida corrugata	0.1	10	FG					0.1				
Calotis lappulacea	0.1	1	FG					0.1				
Chrysocephalum apiculatum	0.1	1	FG					0.1				
Heliotropium amplexicaule	0.1	2	HT									0.1
Bothriochloa macra	0.5	10	GG				0.5					
Cardamine hirsuta	0.1	1	EX								0.1	
Urtica incisa	2	50	FG					2				
Notobasis microcarpa var. microcarpa	5	1	TG		5							
Datura stramonium	0.1	1	EX								0.1	
Modiola caroliniana	0.4	20	EX								0.4	
Conyza bonariensis	0.3	10	EX								0.3	
Silybum marianum	0.2	20	EX								0.2	
Solanum nigrum	0.1	5	EX								0.1	
Tylophora barbata	0.1	1	OG							0.1		
Verbena bonariensis	0.1	1	EX								0.1	
Capsella bursa-pastoris	0.1	3	EX								0.1	
Cyperus gracilis	0.1	10	GG				0.1					
Stellaria media	0.4	50	EX								0.4	
Gomphrena celosioides	0.1	5	EX								0.1	
Solanum cinereum	0.1	1	SG			0.1						

Easting	305626
Northing	6426746
Orientation	280
Plot size	10x40 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	1
30-49	Yes
20-29	Yes
10-19	Yes
5-9	
<5	Yes
Hollows	2
Length logs (m)	56

BAM Attributes 1x1 plot (%)	
Litter (%)	10
Bare Ground (%)	1
Rock (%)	0
Vegetation (%)	89
Cryptogram (%)	0

Q22

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160907			24	14	0	1	11	2	0	0	10	5
PCT 1691 – Low (DNG) (Q22)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	66.1	53.8	0	0.1	53.3	0.4	0	0	12.3	8.4
Aristida ramosa	20	500	GG				20					
Eragrostis leptostachya	8	100	GG				8					
Romulea rosea	4	1000	HT									4
Senecio madagascariensis	0.2	20	HT									0.2
Hypochaeris radicata	0.2	30	EX								0.2	
Chrysocephalum apiculatum	0.3	50	FG					0.3				
Chloris truncata	1	40	GG				1					
Setaria parviflora	3	50	EX								3	
Paspalum dilatatum	2	40	HT									2
Bothriochloa macra	6	80	GG				6					
Sporobolus creber	10	200	GG				10					
Panicum effusum	5	100	GG				5					
Digitaria brownii	0.1	10	GG				0.1					
Chloris gayana	2	40	HT									2
Lomandra filiformis subsp. filiformis	0.1	10	GG				0.1					
Verbena rigida	0.1	3	EX								0.1	
Phyllanthus virgatus	0.1	1	FG					0.1				
Cyperus gracilis	0.1	10	GG				0.1					
Cynodon dactylon (exotic)	0.5	10	EX								0.5	
Solanum cinereum	0.1	1	SG			0.1						
Digitaria divaricatissima	2	30	GG				2					
Paspalidium criniforme	1	30	GG				1					
Lepidium africanum	0.1	1	EX								0.1	
Galenia pubescens var. pubescens	0.2	1	HT									0.2

Easting	305735
Northing	6427806
Orientation	150
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	
30-49	
20-29	None
10-19	
5-9	
<5	
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	0
Bare Ground (%)	9
Rock (%)	0
Vegetation (%)	90
Cryptogram (%)	1

Q23

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160907			37	24	0	1	11	8	3	1	13	4
PCT 1691 – Low (DNG) (Q23)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	Cover	Abundance	76.6	64.8	0	0.1	53.6	9.5	1.5	0.1	11.8	5.6
Calotis lappulacea	4		FG					4				
Aristida ramosa	20		GG				20					
Carthamus lanatus	2		HT									2
Digitaria divaricatissima	8		GG				8					
Sida hackettiana	3		FG					3				
Galenia pubescens var. pubescens	3		HT									3
Cheilanthes sieberi subsp. sieberi	0.5		EG						0.5			
Romulea rosea	0.1		HT									0.1
Chrysocephalum apiculatum	2		FG					2				
Solica sessilis	5		EX								5	
Sida spinosa	0.1		EX								0.1	
Lysimachia arvensis	0.1		EX								0.1	
Chloris truncata	3		GG				3					
Eriochloa pseudoacrotricha	0.5		GG				0.5					
Cheilanthes distans	0.5		EG						0.5			
Austrostipa scabra	0.1		GG				0.1					
Einadia nutans	0.1		FG					0.1				
Senecio madagascariensis	0.5		HT									0.5
Solanum cinereum	0.1		SG			0.1						
Lepidium africanum	0.1		EX								0.1	
Rumex brownii	0.1		FG					0.1				
Cheilanthes sieberi subsp. sieberi	0.5		EG						0.5			
Lomandra filiformis subsp. filiformis	6		GG				6					
Opuntia aurantiaca	0.1		EX								0.1	
Erodium crinitum	0.1		FG					0.1				
Sida rhombifolia	0.4		EX								0.4	
Eragrostis leptostachya	5		GG				5					
Sida corrugata	0.1		FG					0.1				
Bothriochloa macra	3		GG				3					
Hypochaeris radicata	0.2		EX								0.2	
Crassula colorata	0.1		FG					0.1				
Glycine tabacina	0.1		OG							0.1		
Sporobolus creber	5		GG				5					
Chloris ventricosa	2		GG				2					
Stachys arvensis	0.1		EX								0.1	
Gomphrena celosioides	0.1		EX								0.1	
Panicum effusum	1		GG				1					

Easting	305461
Northing	6427754
Orientation	215
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	
20–29	None
10–19	
5–9	
<5	
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	0
Bare Ground (%)	5
Rock (%)	0
Vegetation (%)	95
Cryptogram (%)	0

Q24

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			41	25	2	3	10	8	1	1	16	5
PCT 1604 – Low (remnant) (Q24)			Sum cove	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	Cover	Abundanc	72.9	45.2	27	5.1	6.8	6	0.2	0.1	27.7	26.5
Corymbia maculata	20	35	TG		20							
Eucalyptus moluccana	7	6	TG		7							
Lycium ferocissimum	1	1	HT									1
Austrostipa verticillata	1	1	GG				1					
Galenia pubescens var. pubescens	25	50	HT									25
Enchylaena tomentosa	4	40	SG			4						
Sida hackettiana	5	100	FG					5				
Eremophila debilis	1	10	SG			1						
Cyperus gracilis	0.2	40	GG				0.2					
Bothriochloa macra	0.8	20	GG				0.8					
Sida rhombifolia	0.2	30	EX								0.2	
Cheilanthes sieberi subsp. sieberi	0.2	20	EG						0.2			
Megathyrsus maximus	0.1	1	HT									0.1
Eriochloa pseudoacrotricha	1	30	GG				1					
Aristida ramosa	1	30	GG				1					
Lomandra multiflora subsp. multiflora	0.3	15	GG				0.3					
Wahlenbergia communis	0.1	2	FG					0.1				
Sida spinosa	0.1	2	EX								0.1	
Pavonia hastata	0.1	1	EX								0.1	
Romulea rosea	0.1	10	HT									0.1
Boerhavia dominii	0.2	10	FG					0.2				
Sida corrugata	0.1	2	FG					0.1				
Medicago polymorpha	0.1	3	EX								0.1	
Lysimachia arvensis	0.1	10	EX								0.1	
Chloris truncata	0.1	1	GG				0.1					
Erodium crinitum	0.1	2	FG					0.1				
Silybum marianum	0.1	1	EX								0.1	
Lagenifera stipitata	0.1	5	FG					0.1				
Digitaria divaricatissima	0.2	3	GG				0.2					
Cymbopogon refractus	2	30	GG				2					
Daucus glochidiatus	0.1	3	FG					0.1				
Verbena bonariensis	0.1	1	EX								0.1	
Chloris gayana	0.3	10	HT									0.3
Opuntia aurantiaca	0.1	2	EX								0.1	
Einadia nutans	0.3	10	FG					0.3				
Glycine tabacina	0.1	2	OG							0.1		
Opuntia stricta	0.1	1	EX								0.1	
Cynodon dactylon (exotic)	0.1	4	EX								0.1	
Carex inversa	0.2	20	GG				0.2					
Abutilon oxycarpum	0.1	1	SG			0.1						
Nothoscordum gracile	0.1	1	EX								0.1	

Easting	303397
Northing	642981
Orientation	150
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	1
30–49	Yes
20–29	Yes
10–19	Yes
5–9	Yes
<5	Yes
Hollows	1
Length logs (m	48
BAM Attributes 1x1 plot (%)	
Litter (%)	64
Bare Ground	11
Rock (%)	0
Vegetation (%	23
Cryptogram (%	2

Q25

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			25	11	0	0	6	4	1	0	14	2
PCT 1691 – Low (DNG) (Q25)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	92.5	60.1	0	0	59.4	0.6	0.1	0	32.4	1.1
Digitaria divaricatissima	55	500	GG				55					
Eragrostis leptostachya	2	30	GG				2					
Cynodon dactylon (exotic)	30	300	EX								30	
Galenia pubescens var. pubescens	1	10	HT									1
Sonchus oleraceus	0.2	30	EX								0.2	
Medicago polymorpha	0.1	10	EX								0.1	
Cirsium vulgare	0.2	20	EX								0.2	
Hypochaeris radicata	0.1	10	EX								0.1	
Cheilanthes sieberi subsp. sieberi	0.1	20	EG						0.1			
Romulea rosea	0.1	20	HT									0.1
Bidens pilosa	0.1	1	EX								0.1	
Nothoscordum borbonicum	0.1	10	EX								0.1	
Soliva sessilis	0.1	1	EX								0.1	
Aristida ramosa	2	20	GG				2					
Erodium crinitum	0.1	1	FG					0.1				
Rumex brownii	0.1	2	FG					0.1				
Sida hackettiana	0.3	20	FG					0.3				
Opuntia aurantiaca	0.1	1	EX								0.1	
Rytidosperma sp.	0.1	1	GG				0.1					
Digitaria brownii	0.2	10	GG				0.2					
Conyza bonariensis	0.1	5	EX								0.1	
Lepidium africanum	0.1	1	EX								0.1	
Cyperus gracilis	0.1	10	GG				0.1					
Modiola caroliniana	0.1	1	EX								0.1	
Sida corrugata	0.1	2	FG					0.1				

Easting	302829
Northing	6430902
Orientation	280
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	None
20–29	
10–19	
5–9	
<5	
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	0
Bare Ground (%)	0
Rock (%)	0
Vegetation (%)	100
Cryptogram (%)	0

Q26

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			35	28	2	1	14	8	2	1	7	2
PCT 1693 – Low (remnant) (Q26)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	106.4	90.5	45	1	26.3	17	0.8	0.4	15.9	10.5
Eucalyptus blakelyi	40	20	TG		40							
Dianella revoluta var. revoluta	15	30	FG					15				
Eragrostis curvula	10	100	HT									10
Aristida ramosa	5	100	GG				5					
Stackhousia viminea	0.2	50	FG					0.2				
Lomandra filiformis subsp. filiformis	2	80	GG				2					
Cynodon dactylon (exotic)	5	50	EX								5	
Zornia dyctiocarpa var. dyctiocarpa	0.3	5	FG					0.3				
Digitaria divaricatissima	3	50	GG				3					
Chrysocephalum apiculatum	1	80	FG					1				
Cheilanthes sieberi subsp. sieberi	0.5	100	EG						0.5			
Sporobolus creber	1	20	GG				1					
Cyperus gracilis	0.2	30	GG				0.2					
Leiocarpa panaetioides	0.1	3	FG					0.1				
Panicum effusum	4	100	GG				4					
Cymbopogon refractus	0.2	10	GG				0.2					
Eragrostis elongata	2	40	GG				2					
Bothriochloa macra	1	10	GG				1					
Lomandra multiflora subsp. multiflora	0.5	10	GG				0.5					
Phyllanthus virgatus	0.1	10	FG					0.1				
Desmodium varians	0.4	100	OG							0.4		
Wahlenbergia communis	0.1	1	FG					0.1				
Plantago lanceolata	0.1	1	EX								0.1	
Sida rhombifolia	0.1	10	EX								0.1	
Einadia nutans	0.2	20	FG					0.2				
Megathyrsus maximus	0.5	10	HT									0.5
Digitaria brownii	2	40	GG				2					
Cheilanthes distans	0.3	30	EG						0.3			
Eulalia aurea	5	60	GG				5					
Hypochaeris radicata	0.1	1	EX								0.1	
Chloris truncata	0.1	10	GG				0.1					
Digitaria diffusa	0.3	20	GG				0.3					
Opuntia stricta	0.1	1	EX								0.1	
Eucalyptus melliodora	5	3	TG		5							
Acacia baileyana	1	1	SG			1						

Easting	305281
Northing	6425708
Orientation	140
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	Yes
20–29	Yes
10–19	Yes
5–9	Yes
<5	Yes
Hollows	0
Length logs (m)	1
BAM Attributes 1x1 plot (%)	
Litter (%)	72
Bare Ground (%)	0
Rock (%)	0
Vegetation (%)	28
Cryptogram (%)	0

Q27

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			32	19	0	0	12	4	1	2	13	3
PCT 1693 – Low (DNG) (Q27)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	73	64.9	0	0	63.8	0.5	0.4	0.2	8.1	3.2
Aristida ramosa	25	200	GG				25					
Sporobolus creber	5	80	GG				5					
Bothriochloa macra	1	20	GG				1					
Gamochaeta americana	0.2	50	EX								0.2	
Chrysocephalum apiculatum	0.1	3	FG					0.1				
Chloris truncata	6	100	GG				6					
Hypochaeris radicata	1	50	EX								1	
Sida corrugata	0.2	20	FG					0.2				
Solva sessilis	0.1	10	EX								0.1	
Eragrostis leptostachya	2	40	GG				2					
Modiola caroliniana	0.1	1	EX								0.1	
Digitaria brownii	6	80	GG				6					
Paspalum dilatatum	3	40	HT									3
Cheilanthes sieberi	0.4	50	EG						0.4			
Stachys arvensis	0.1	2	EX								0.1	
Romulea rosea	0.1	50	HT									0.1
Panicum effusum	10	100	GG				10					
Setaria parviflora	2	30	EX								2	
Cirsium vulgare	1	30	EX								1	
Senecio madagascariensis	0.1	10	HT									0.1
Lepidium africanum	0.1	3	EX								0.1	
Geranium solanderi	0.1	3	FG					0.1				
Cyperus gracilis	0.1	1	GG				0.1					
Paspalidium criniforme	8	80	GG				8					
Lomandra filiformis subsp. filiformis	0.1	5	GG				0.1					
Lysimachia arvensis	0.1	3	EX								0.1	
Lomandra confertifolia	0.1	1	GG				0.1					
Polymeria calycina	0.1	1	OG							0.1		
Sida hackettiana	0.1	3	FG					0.1				
Verbena bonariensis	0.2	10	EX								0.2	
Glycine tabacina	0.1	1	OG							0.1		
Austrostipa verticillata	0.5	5	GG				0.5					

Easting	305920
Northing	6427588
Orientation	10
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	
20–29	None
10–19	
5–9	
<5	
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	1
Bare Ground (%)	6
Rock (%)	0
Vegetation (%)	91
Cryptogram (%)	2

Q28

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			40	23	5	2	10	5	0	1	17	5
PCT 485 – Moderate condition (Q28)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	88.7	78.6	37	1.1	39.7	0.7	0	0.1	10.1	3.1
Casuarina cunninghamiana subsp. cunninghamiana	15	2	TG		15							
Angophora floribunda	10	5	TG		10							
Eucalyptus tereticornis	8	1	TG		8							
Plantago lanceolata	5	100	EX								5	
Aristida ramosa	5	80	GG				5					
Bothriochloa macra	5	80	GG				5					
Lysimachia arvensis	0.2	100	EX								0.2	
Galenia pubescens var. pubescens	0.3	10	HT									0.3
Romulea rosea	0.2	50	HT									0.2
Solanum cinereum	0.1	2	SG			0.1						
Sida rhombifolia	0.2	15	EX								0.2	
Chloris truncata	1	20	GG				1					
Medicago arabica	0.2	30	EX								0.2	
Paspalum dilatatum	2	30	HT									2
Einadia trigonos	0.1	1	FG					0.1				
Cynodon dactylon	10	100	GG				10					
Modiola caroliniana	0.3	30	EX								0.3	
Cirsium vulgare	0.1	2	EX								0.1	
Alternanthera denticulata	0.1	1	FG					0.1				
Sonchus oleraceus	0.2	25	EX								0.2	
Glycine tabacina	0.1	10	OG							0.1		
Brachychiton populneus subsp. populneus	2	1	TG		2							
Soliva sessilis	0.3	40	EX								0.3	
Paronychia brasiliana	0.1	1	EX								0.1	
Einadia nutans	0.3	30	FG					0.3				
Bursaria spinosa subsp. spinosa	1	5	SG			1						
Microlaena stipoides var. stipoides	10	200	GG				10					
Gomphocarpus fruticosus	0.1	2	EX								0.1	
Senecio madagascariensis	0.1	5	HT									0.1
Sida corrugata	0.1	1	FG					0.1				
Sporobolus creber	3	40	GG				3					
Rumex brownii	0.1	2	FG					0.1				
Hypochaeris radicata	0.2	20	EX								0.2	
Austrostipa verticillata	4	50	GG				4					
Notelaea microcarpa var. microcarpa	2	15	TG		2							
Chloris ventricosa	1	20	GG				1					
Rytidosperma setaceum	0.5	10	GG				0.5					
Lycium ferocissimum	0.5	1	HT									0.5
Malva parviflora	0.1	3	EX								0.1	
Cyperus gracilis	0.2	20	GG				0.2					

Easting	305877
Northing	6427300
Orientation	335
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	1
50-79	1
30-49	Yes
20-29	Yes
10-19	Yes
5-9	
<5	
Hollows	1
Length logs (m)	33

BAM Attributes 1x1 plot (%)	
Litter (%)	21
Bare Ground (%)	7
Rock (%)	0
Vegetation (%)	72
Cryptogram (%)	0

Q29

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			42	19	3	1	10	5	0	0	23	6
PCT 1693 – Low (remnant) (Q29)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	118.7	82.9	25	0.3	56.4	1.2	0	0	35.8	7.8
Eucalyptus tereticornis	11	1	TG		11							
Eucalyptus melliodora	9	2	TG		9							
Lycium ferocissimum	2	3	HT									2
Notelaea microcarpa var. microcarpa	5	5	TG		5							
Cynodon dactylon (exotic)	20	300	EX								20	
Medicago polymorpha	3	100	EX								3	
Sida rhombifolia	1	50	EX								1	
Einadia nutans	0.8	50	FG					0.8				
Senecio madagascariensis	0.1	1	HT									0.1
Cirsium vulgare	1	30	EX								1	
Chloris truncata	3	60	GG				3					
Digitaria divaricatissima	0.1	3	GG				0.1					
Austrostipa verticillata	1	5	GG				1					
Malva parviflora	0.1	10	EX								0.1	
Bidens subalternans	0.1	1	EX								0.1	
Lysimachia arvensis	0.1	3	EX								0.1	
Solanum cinereum	0.3	15	SG			0.3						
Galenia pubescens var. pubescens	0.5	15	HT									0.5
Einadia trigonos	0.1	1	FG					0.1				
Rumex brownii	0.1	1	FG					0.1				
Plantago lanceolata	0.2	20	EX								0.2	
Sonchus oleraceus	0.1	3	EX								0.1	
Microlaena stipoides var. stipoides	0.2	10	GG				0.2					
Paspalidium criniforme	30	200	GG				30					
Soliva sessilis	0.2	50	EX								0.2	
Urtica incisa	0.1	1	FG					0.1				
Modiola caroliniana	0.1	3	EX								0.1	
Echium plantagineum	0.3	6	EX								0.3	
Cyperus gracilis	0.1	1	GG				0.1					
Sporobolus creber	15	300	GG				15					
Romulea rosea	0.1	10	HT									0.1
Carthamus lanatus	0.1	1	HT									0.1
Aristida ramosa	2	20	GG				2					
Eriochloa pseudoacrotricha	3	40	GG				3					
Paspalum dilatatum	5	100	HT									5
Setaria parviflora	1	20	EX								1	
Hypochaeris radicata	0.3	30	EX								0.3	
Lepidium africanum	0.1	5	EX								0.1	
Sida spinosa	0.2	20	EX								0.2	
Bothriochloa macra	2	30	GG				2					
Geranium solanderi	0.1	1	FG					0.1				
Medicago arabica	0.2	10	EX								0.2	

Easting	305831
Northing	6426788
Orientation	175
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	2
50–79	1
30–49	
20–29	
10–19	Yes
5–9	
<5	
Hollows	3
Length logs (m)	32.4

BAM Attributes 1x1 plot (%)	
Litter (%)	19
Bare Ground (%)	2
Rock (%)	0
Vegetation (%)	79
Cryptogram (%)	0

Q30

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			13	2	0	0	2	0	0	0	11	1
PCT 485 – Low (DNG) (Q30)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	85.1	73	0	0	73	0	0	0	12.1	6
Paspalidium aversum	70	300	GG				70					
Hirschfeldia incana	2	25	EX								2	
Galenia pubescens var. pubescens	6	20	HT									6
Sonchus oleraceus	0.1	5	EX								0.1	
Malva parviflora	0.2	10	EX								0.2	
Lepidium africanum	0.1	5	EX								0.1	
Trifolium repens	0.1	3	EX								0.1	
Silybum marianum	0.3	5	EX								0.3	
Medicago sativa	0.1	1	EX								0.1	
Rapistrum rugosum	0.1	3	EX								0.1	
Modiola caroliniana	0.1	5	EX								0.1	
Cynodon dactylon	3	40	GG				3					
Lolium perenne	3	40	EX								3	

Easting	302636
Northing	6431178
Orientation	225
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	
20–29	None
10–19	
5–9	
<5	
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	1
Bare Ground (%)	10
Rock (%)	0
Vegetation (%)	89
Cryptogram (%)	0

Q31

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			27	9	1	0	5	3	0	0	18	3
PCT 485 – Low (remnant) (Q31)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	91.6	36	9	0	25.8	1.2	0	0	55.6	16.3
Casuarina cunninghamiana subsp. cunninghamiana	9	4	TG		9							
Juncus acutus	12	20	HT									12
Cynodon dactylon	20	200	GG				20					
Rumex brownii	1	30	FG					1				
Malva parviflora	0.4	20	EX								0.4	
Xanthium spinosum	0.3	20	HT									0.3
Sida rhombifolia	0.2	10	EX								0.2	
Silybum marianum	15	100	EX								15	
Digitaria divaricatissima	0.2	10	GG				0.2					
Lolium perenne	15	100	EX								15	
Plantago lanceolata	0.1	1	EX								0.1	
Galenia pubescens var. pubescens	4	30	HT									4
Rapistrum rugosum	2	40	EX								2	
Nothoscordum borbonicum	0.1	3	EX								0.1	
Paspalidium aversum	0.5	15	GG				0.5					
Datura stramonium	0.1	1	EX								0.1	
Hirschfeldia incana	1	20	EX								1	
Gomphocarpus fruticosus	0.1	1	EX								0.1	
Bidens pilosa	1	50	EX								1	
Soliva sessilis	0.1	3	EX								0.1	
Cyclospermum leptophyllum	0.1	2	EX								0.1	
Typha domingensis	0.1	2	GG				0.1					
Polygonum aviculare	0.1	3	EX								0.1	
Aristida ramosa	5	40	GG				5					
Erodium crinitum	0.1	3	FG					0.1				
Dysphania pumilio	0.1	1	FG					0.1				
Conchrus clandestinus	4	20	EX								4	

Easting	302581
Northing	6430992
Orientation	220
Plot size	10x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	
30–49	
20–29	Yes
10–19	
5–9	Yes
<5	
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	0
Bare Ground (%)	11
Rock (%)	0
Vegetation (%)	89
Cryptogram (%)	0

Q32

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180807			8	2	0	0	2	0	0	0	6	1
PCT 42 Low (DNG) (Q32)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	68.5	55	0	0	55	0	0	0	13.5	5
Cynodon dactylon	50	500	GG				50					
Soliva sessilis	5	200	EX								5	
Echium plantagineum	3	100	EX								3	
Galenia pubescens var. pubescens	5	50	HT									5
Verbena bonariensis	0.3	20	EX								0.3	
Lepidium africanum	0.1	10	EX								0.1	
Gamochaeta americana	0.1	10	EX								0.1	
Chloris truncata	5	30	GG				5					

Easting	305376
Northing	6426493
Orientation	230
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	
30-49	
20-29	None
10-19	
5-9	
<5	
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	0
Bare Ground (%)	16
Rock (%)	0
Vegetation (%)	84
Cryptogram (%)	0

Q33

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180807			7	6	3	2	1	0	0	0	1	1
Planted vegetation (Q33)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	16.3	16.2	15	1.1	0.1	0	0	0	0.1	0.1
Eucalyptus crebra	2	2	TG		2							
Eucalyptus moluccana	5	3	TG		5							
Corymbia maculata	8	20	TG		8							
Acacia sp.	1	3	SG			1						
Galenia pubescens var. pubescens	0.1	1	HT									0.1
Rytidosperma sp.	0.1	1	GG				0.1					
Enchylaena tomentosa	0.1	1	SG			0.1						

Easting	303900
Northing	6429342
Orientation	90
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	
30-49	
20-29	
10-19	Yes
5-9	Yes
<5	Yes
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	95
Bare Ground (%)	5
Rock (%)	0
Vegetation (%)	0
Cryptogram (%)	0

Q34

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180807			35	17	1	5	8	3	0	0	18	4
Planted vegetation (Q34)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	78.8	29.2	0.5	19.1	7.4	2.2	0	0	49.6	6.5
Acacia macradenia	10	6	EX								10	
Acacia deanei subsp. deanei	8	7	SG			8						
Acacia decora	4	3	SG			4						
Acacia nesophila	0.5	1	EX								0.5	
Corymbia maculata	0.5	1	TG		0.5							
Cymbopogon refractus	3	30	GG				3					
Echium plantagineum	0.2	10	EX								0.2	
Lysimachia arvensis	0.5	60	EX								0.5	
Modiola caroliniana	0.2	30	EX								0.2	
Sporobolus creber	1	20	GG				1					
Senecio madagascariensis	0.5	20	HT									0.5
Acacia baileyana	2	2	SG			2						
Cynodon dactylon (exotic)	15	200	EX								15	
Galenia pubescens var. pubescens	2	10	HT									2
Sida hackettiana	2	40	FG					2				
Enteropogon acicularis	0.2	5	GG				0.2					
Cyperus gracilis	0.1	1	GG				0.1					
Sida rhombifolia	0.2	10	EX								0.2	
Chloris gayana	2	20	HT									2
Setaria parviflora	10	100	EX								10	
Oxalis sp.	0.1	10	FG					0.1				
Stachys arvensis	0.1	1	EX								0.1	
Centaurea melitensis	0.1	3	EX								0.1	
Vulpia muralis	0.1	5	EX								0.1	
Panicum effusum	1	20	GG				1					
Acacia falcata	5	5	SG			5						
Chloris truncata	1	20	GG				1					
Gomphocarpus fruticosus	0.1	1	EX								0.1	
Solanum cinereum	0.1	1	SG			0.1						
Melinis repens	6	80	EX								6	
Nothoscordum gracile	0.1	3	EX								0.1	
Erodium crinitum	0.1	1	FG					0.1				
Digitaria divaricatissima	0.1	1	GG				0.1					
Aristida ramosa	1	10	GG				1					
Hyparrhenia hirta	2	20	HT									2

Easting	303915
Northing	6429231
Orientation	340
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	
30-49	
20-29	
10-19	
5-9	
<5	Yes
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	42
Bare Ground (%)	30
Rock (%)	0
Vegetation (%)	28
Cryptogram (%)	0

Q35

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			60	44	4	5	13	15	2	5	16	6
PCT 1693 Good Condition (Q35)			Sum cove	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	Cover	Abundanc	94.5	91	50	5.6	32.5	2	0.2	0.7	3.5	2
Eucalyptus melliodora	25	3	TG		25							
Eucalyptus blakelyi	10	4	TG		10							
Notelaea microcarpa var. microcarpa	10	20	TG		10							
Bursaria spinosa subsp. spinosa	5	20	SG			5						
Chrysocephalum apiculatum	0.2	30	FG					0.2				
Plantago lanceolata	0.3	40	EX								0.3	
Lomandra multiflora subsp. multiflora	0.1	2	GG				0.1					
Chloris ventricosa	5	50	GG				5					
Desmodium varians	0.1	2	OG							0.1		
Cheilanthes distans	0.1	20	EG						0.1			
Senecio madagascariensis	0.3	40	HT									0.3
Rubus fruticosus agg.	0.1	1	HT									0.1
Cheilanthes austrotenuifolia	0.1	20	EG						0.1			
Senecio quadridentatus	0.1	1	FG					0.1				
Ehrharta erecta	0.1	10	HT									0.1
Brachychiton populneus subsp. populneu	5	3	TG		5							
Dichondra repens	0.1	30	FG					0.1				
Lomandra filiformis subsp. filiformis	0.1	1	GG				0.1					
Panicum effusum	0.1	20	GG				0.1					
Ehrharta erecta	1	20	HT									1
Acacia sp.	0.1	2	SG			0.1						
Einadia nutans	0.1	2	FG					0.1				
Oxalis perennans	0.1	20	FG					0.1				
Chloris truncata	5	40	GG				5					
Psydrax odorata subsp. australiana	0.2	2	SG			0.2						
Einadia polygonoides	0.2	20	FG					0.2				
Lysimachia arvensis	0.1	10	EX								0.1	
Opuntia aurantiaca	0.1	2	EX								0.1	
Sonchus oleraceus	0.1	10	EX								0.1	
Brunoniella australis	0.1	20	FG					0.1				
Conyza bonariensis	0.1	1	EX								0.1	
Bothriochloa macra	1	20	GG				1					
Medicago minima	0.1	2	EX								0.1	
Cyperus gracilis	0.2	20	GG				0.2					
Sida hackettiana	0.2	10	FG					0.2				
Dianella caerulea var. cinerascens	0.1	1	FG					0.1				
Eremophila debilis	0.2	4	SG			0.2						
Swainsona galegifolia	0.1	3	FG					0.1				
Breynia oblongifolia	0.1	1	SG			0.1						
Stackhousia viminea	0.1	1	FG					0.1				
Cymbopogon refractus	3	30	GG				3					
Aristida ramosa	2	30	GG				2					
Opuntia stricta	0.1	1	EX								0.1	
Eragrostis leptostachya	2	20	GG				2					
Marrubium vulgare	0.1	1	EX								0.1	
Lobelia purpurascens	0.1	1	FG					0.1				
Asperula conferta	0.2	10	FG					0.2				

Easting	305432
Northing	6426863
Orientation	250
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50–79	1
30–49	Yes
20–29	Yes
10–19	Yes
5–9	Yes
<5	Yes
Hollows	3
Length logs (m	18.5

BAM Attributes 1x1 plot (%)	
Litter (%)	58
Bare Ground	20
Rock (%)	0
Vegetation (%	22
Cryptogram (%	0

Tylophora barbata	0.1	1	OG							0.1					
Euphorbia peplus	0.1	2	EX								0.1				
Lycium ferocissimum	0.2	1	HT									0.2			
Austrostipa verticillata	2	20	GG				2								
Eustrephus latifolius	0.3	30	OG							0.3					
Microlaena stipoides var. stipoides	8	100	GG				8								
Glycine tabacina	0.1	20	OG							0.1					
Wahlenbergia sp.	0.2	40	FG					0.2							
Sida rhombifolia	0.4	30	EX								0.4				
Galenia pubescens var. pubescens	0.3	20	HT									0.3			
Rytidosperma sp.	4	50	GG				4								
Vittadinia sp.	0.1	2	FG					0.1							
Hardenbergia violacea	0.1	3	OG							0.1					

Q36

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	ligh Threat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version 20180807			48	18	1	1	8	7	0	1	30	6
PCT 1693 Low (DNG) (Q36)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	147.2	61.8	0.2	0.6	53.3	5.7	0	2	85.4	11.6
Aristida ramosa	1	20	GG				1					
Vulpia bromoides	1	50	EX								1	
Bromus molliformis	3	30	EX								3	
Senecio madagascariensis	8	200	HT									8
Gamochaeta americana	8	200	EX								8	
Sonchus oleraceus	0.6	40	EX								0.6	
Cyclospermum leptophyllum	0.3	50	EX								0.3	
Facelis retusa	2	100	EX								2	
Trifolium campestre	2	100	EX								2	
Panicum effusum	4	50	GG				4					
Lolium perenne	3	40	EX								3	
Trifolium glomeratum	3	100	EX								3	
Plantago lanceolata	2	100	EX								2	
Hypochaeris radicata	2	100	EX								2	
Parentucellia latifolia	0.6	50	EX								0.6	
Lysimachia arvensis	1	50	EX								1	
Chloris truncata	5	100	GG				5					
Glycine tabacina	2	100	OG							2		
Bothriochloa macra	5	50	GG				5					
Heliotropium amplexicaule	0.1	1	HT									0.1
Cotula australis	0.5	200	FG					0.5				
Paspalum dilatatum	1	0.1	HT									1
Cynodon dactylon (exotic)	20	100	EX								20	
Wahlenbergia communis	0.5	40	FG					0.5				
Galenia pubescens var. pubescens	1	10	HT									1
Silene gallica var. gallica	20	30	EX								20	
Verbena bonariensis	0.5	30	EX								0.5	
Paronychia brasiliana	0.2	30	EX								0.2	
Calotis lappulacea	2	40	FG					2				
Sida rhombifolia	0.5	40	EX								0.5	
Petrorhagia nanteuilii	0.4	40	EX								0.4	
Romulea rosea	0.5	100	HT									0.5
Trifolium arvense	2	200	EX								2	
Chrysocephalum apiculatum	2	60	FG					2				
Cirsium vulgare	0.6	10	EX								0.6	
Sporobolus creber	32	200	GG				32					
Lomandra filiformis subsp. filiformis	0.3	20	GG				0.3					
Sida hackettiana	0.1	2	FG					0.1				
Sida corrugata	0.3	10	FG					0.3				
Solanum cinereum	0.6	30	SG			0.6						
Erica minor	0.6	30	EX								0.6	
Verbena rigida	0.4	20	EX								0.4	
Eragrostis leptostachya	4	50	GG				4					
Conyza bonariensis	0.1	1	EX								0.1	
Austrostipa verticillata	2	2	GG				2					
Erodium crinitum	0.3	10	FG					0.3				
Eucalyptus melliodora	0.2	3	TG		0.2							
Carthamus lanatus	1	30	HT									1

Easting	305763
Northing	6427008
Orientation	155
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	0
50-79	0
30-49	No
20-29	No
10-19	No
5-9	No
<5	Yes
Hollows	0
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	15
Bare Ground (%)	2
Rock (%)	0
Vegetation (%)	83
Cryptogram (%)	0

Q37

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20100907			50	21	2	2	8	8	0	1	29	4
PCT 1693 Low (Remnant) (Q37)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	170.5	53.2	37	0.7	6.3	8.6	0	0.6	117	52
Eucalyptus melliodora	9	2	TG		9							
Eucalyptus blakelyi	28	13	TG		28							
Galenia pubescens var. pubescens	36	100	HT									36
Chloris truncata	1	30	GG				1					
Cynodon dactylon (exotic)	35	100	EX								35	
Solanum cinereum	0.5	15	SG			0.5						
Echium plantagineum	0.4	20	EX								0.4	
Sida rhombifolia	1	100	EX								1	
Einadia trigonos	5	100	FG					5				
Calotis lappulacea	1	40	FG					1				
Solanum nigrum	0.9	30	EX								0.9	
Sisymbrium irio	12	200	EX								12	
Trifolium campestre	3	100	EX								3	
Glycine tabacina	0.6	50	OG							0.6		
Lycium ferocissimum	5	2	HT									5
Medicago minima	0.2	10	EX								0.2	
Cyperus gracilis	1	30	GG				1					
Rapistrum rugosum	2	20	EX								2	
Carex inversa	1	30	GG				1					
Modiola caroliniana	2	30	EX								2	
Bromus catharticus	1	20	EX								1	
Senecio madagascariensis	1	50	HT									1
Einadia nutans subsp. nutans	0.2	10	FG					0.2				
Lysimachia arvensis	1	100	EX								1	
Ehrharta erecta	10	100	HT									10
Cirsium vulgare	0.2	5	EX								0.2	
Cotula australis	2	200	FG					2				
Plantago lanceolata	0.4	30	EX								0.4	
Sonchus oleraceus	0.3	10	EX								0.3	
Bothriochloa macra	0.6	10	GG				0.6					
Polypogon monspeliensis	0.2	30	EX								0.2	
Sida corrugata	0.1	5	FG					0.1				
Erodium crinitum	0.1	5	FG					0.1				
Trifolium glomeratum	1	50	EX								1	
Chloris ventricosa	1	20	GG				1					
Polycarpon tetraphyllum	0.3	80	EX								0.3	
Verbena bonariensis	0.3	20	EX								0.3	
Hordeum vulgare	0.9	30	EX								0.9	
Lolium perenne	2	40	EX								2	
Chenopodium murale	0.4	20	EX								0.4	
Eremophila debilis	0.2	2	SG			0.2						
Arctotheca calendula	0.3	10	EX								0.3	
Sida hackettiana	0.1	3	FG					0.1				
Eragrostis leptostachya	0.6	10	GG				0.6					
Crassula sieberiana	0.1	40	FG					0.1				
Facelis retusa	0.1	2	EX								0.1	
Dichanthium sericeum	0.1	10	GG				0.1					
Microlaena stipoides var. stipoides	1	20	GG				1					
Lepidium africanum	0.1	3	EX								0.1	
Marrubium vulgare	0.3	4	EX								0.3	

Easting	305775
Northing	6427117
Orientation	145
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	0
50-79	0
30-49	Yes
20-29	Yes
10-19	Yes
5-9	Yes
<5	No
Hollows	1
Length logs (m)	52

BAM Attributes 1x1 plot (%)	
Litter (%)	48
Bare Ground (%)	2
Rock (%)	0
Vegetation (%)	50
Cryptogram (%)	0

Q38

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	ighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			42	16	0	0	5	11	0	0	26	2
PCT 1693 Low (DNG) (Q43)			Sum cove	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundanc**	106.7	72.8	0	0	66.1	6.7	0	0	33.9	0.8
Aristida ramosa	56	500	GG				56					
Modiola caroliniana	2	100	EX								2	
Senecio madagascariensis	0.3	8	HT									0.3
Austrostipa verticillata	6	20	GG				6					
Cotula australis	4	100	FG					4				
Lolium perenne	4	50	EX								4	
Bromus molliformis	4	40	EX								4	
Silybum marianum	1	5	EX								1	
Gamochaeta calviceps	8	200	EX								8	
Sida corrugata	0.1	3	FG					0.1				
Verbena bonariensis	0.5	20	EX								0.5	
Carthamus lanatus	0.5	20	HT									0.5
Oxalis radicosa	0.3	30	FG					0.3				
Lepidium africanum	0.3	40	EX								0.3	
Chloris truncata	0.1	5	GG				0.1					
Paronychia brasiliana	0.2	20	EX								0.2	
Geranium solanderi	0.5	50	FG					0.5				
Conyza bonariensis	0.4	30	EX								0.4	
Sonchus oleraceus	0.4	20	EX								0.4	
Cynodon dactylon (exotic)	5	100	EX								5	
Solanum nigrum	0.5	20	EX								0.5	
Bromus catharticus	2	20	EX								2	
Stellaria media	0.3	40	EX								0.3	
Erodium cirnitum	0.6	40	FG					0.6				
Malva parviflora	0.1	1	EX								0.1	
Rumex brownii	0.5	10	FG					0.5				
Avena fatua	2	20	EX								2	
Nuttallanthus canadensis	0.3	50	EX								0.3	
Lactuca serriola	0.2	5	EX								0.2	
Urtica incisa	0.1	10	FG					0.1				
Trifolium repens	0.4	50	EX								0.4	
Crassula sieberiana	0.3	100	FG					0.3				
Facelis retusa	0.2	10	EX								0.2	
Einadia trigonos	0.1	3	FG					0.1				
Hypochaeris radicata	0.6	40	EX								0.6	
Enteropogon acicularis	2	20	GG				2					
Silene gallica var. gallica	0.3	20	EX								0.3	
Eriochloa pseudoacrotricha	2	30	GG				2					
Cirsium vulgare	0.1	1	EX								0.1	
Wahlenbergia gracilis	0.1	1	FG					0.1				
Cerastium glomeratum	0.3	3	EX								0.3	
Pseudognaphalium luteoalbum	0.1	1	FG					0.1				

Easting	305846
Northing	6426548
Orientation	95
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	0
50–79	0
30–49	No
20–29	No
10–19	No
5–9	No
<5	No
Hollows	0
ength logs (m	0
BAM Attributes 1x1 plot (%)	
Litter (%)	10
Bare Ground	0
Rock (%)	0
Vegetation (%	90
Cryptogram (%	0

Q39

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20190807			31	10	6	0	0	4	0	0	21	3
Native plantings (Q47)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	96.1	76.5	76	0	0	0.5	0	0	19.6	3.8
Eucalyptus melliodora	15	7	TG		15							
Eucalyptus dawsonii	18	5	TG		18							
Eucalyptus blakelyi	12	5	TG		12							
Eucalyptus camaldulensis	1	1	TG		1							
Casuarina cunninghamiana subsp. cunninghamiana	5	5	TG		5							
Casuarina glauca	25	50	TG		25							
Lolium perenne	8	200	EX								8	
Galenia pubescens var. pubescens	2	40	HT									2
Silene gallica var. gallica	0.9	40	EX								0.9	
Senecio madagascariensis	0.8	30	HT									0.8
Plantago lanceolata	0.5	40	EX								0.5	
Trifolium campestre	0.1	10	EX								0.1	
Cirsium vulgare	0.3	30	EX								0.3	
Cynodon dactylon (exotic)	3	50	EX								3	
Cyclospermum leptophyllum	0.1	2	EX								0.1	
Lysimachia arvensis	0.4	20	EX								0.4	
Sonchus oleraceus	0.4	20	EX								0.4	
Echium plantagineum	0.6	15	EX								0.6	
Paronychia brasiliana	0.1	1	EX								0.1	
Crassula sieberiana	0.1	5	FG					0.1				
Briza minor	0.2	10	EX								0.2	
Solanum nigrum	0.4	10	EX								0.4	
Cotula australis	0.2	20	FG					0.2				
Wahlenbergia gracilis	0.1	5	FG					0.1				
Petrorhagia nanteuilii	0.2	10	EX								0.2	
Hypochaeris radicata	0.3	20	EX								0.3	
Trifolium arvense	0.1	1	EX								0.1	
Conyza bonariensis	0.1	2	EX								0.1	
Lepidium bonariense	0.1	1	EX								0.1	
Ehrharta erecta	1	20	HT									1
Phyllanthus virgatus	0.1	1	FG					0.1				

Easting	305115
Northing	6426105
Orientation	35
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	
50-79	1
30-49	Yes
20-29	Yes
10-19	Yes
5-9	Yes
<5	Yes
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	95
Bare Ground (%)	1
Rock (%)	0
Vegetation (%)	4
Cryptogram (%)	0

Q40

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			35	24	2	4	6	10	1	1	11	4
PCT 1691 Low (Remnant) (Q49)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	78.6	59.9	43	5.3	9.4	1.9	0.2	0.1	18.7	17
Eucalyptus crebra	42	18	TG		42							
Geijera parviflora	4	4	SG			4						
Galenia pubescens var. pubescens	16	200	HT									16
Calotis lappulacea	0.5	40	FG					0.5				
Chloris truncata	4	60	GG				4					
Solanum nigrum	0.3	30	EX								0.3	
Einadia nutans subsp. linifolia	0.2	20	FG					0.2				
Lepidium bonariense	0.3	40	EX								0.3	
Abutilon oxycarpum	0.2	20	SG			0.2						
Sida rhombifolia	0.5	40	EX								0.5	
Ehrharta erecta	0.5	10	HT									0.5
Sonchus oleraceus	0.1	1	EX								0.1	
Cyperus gracilis	4	100	GG				4					
Dianella longifolia	0.2	5	FG					0.2				
Paronychia brasiliana	0.1	3	EX								0.1	
Cheilanthes sieberi subsp. sieberi	0.2	20	EG						0.2			
Aristida ramosa	0.1	1	GG				0.1					
Wahlenbergia gracilis	0.1	3	FG					0.1				
Dichopogon fimbriatus	0.1	1	FG					0.1				
Solanum cinereum	0.1	2	SG			0.1						
Lomandra filiformis subsp. filiformis	0.1	2	GG				0.1					
Einadia trigonos	0.1	2	FG					0.1				
Senecio madagascariensis	0.4	30	HT									0.4
Carthamus lanatus	0.1	2	HT									0.1
Stackhousia viminea	0.1	10	FG					0.1				
Sida corrugata	0.2	10	FG					0.2				
Chrysocephalum apiculatum	0.3	30	FG					0.3				
Oxalis radicosa	0.1	1	FG					0.1				
Trifolium glomeratum	0.1	2	EX								0.1	
Lepidium africanum	0.3	10	EX								0.3	
Panicum effusum	1	20	GG				1					
Glycine tabacina	0.1	1	OG							0.1		
Eremophila debilis	1	5	SG			1						
Notelaea microcarpa var. microcarpa	1	4	TG		1							
Austrostipa scabra	0.2	3	GG				0.2					

Easting	305531
Northing	6428168
Orientation	200
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	0
50–79	0
30–49	Yes
20–29	Yes
10–19	Yes
5–9	No
<5	Yes
Hollows	0
Length logs (m)	2

BAM Attributes 1x1 plot (%)	
Litter (%)	52
Bare Ground (%)	37
Rock (%)	0
Vegetation (%)	11
Cryptogram (%)	0

Q41

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180807			36	11	1	2	2	6	0	0	25	3
PCT 42 Low (Remnant) (Q41)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	143.1	102.1	16	0.6	80.1	5.4	0	0	41	12.2
Eucalyptus tereticornis	16	1	TG		16							
Echium plantagineum	4	16	EX								4	
Solanum nigrum	0.6	10	EX								0.6	
Cynodon dactylon	80	500	GG				80					
Lolium perenne	6	100	EX								6	
Urtica incisa	4	18	FG					4				
Galenia pubescens var. pubescens	12	20	HT									12
Silybum marianum	2	5	EX								2	
Sisymbrium irio	0.5	10	EX								0.5	
Einadia trigonos	0.6	10	FG					0.6				
Stachys arvensis	0.1	5	EX								0.1	
Malva parviflora	0.6	20	EX								0.6	
Verbena bonariensis	0.6	15	EX								0.6	
Trifolium glomeratum	0.5	50	EX								0.5	
Gamochaeta calviceps	1	100	EX								1	
Erodium crinitum	0.1	1	FG					0.1				
Medicago polymorpha	0.3	20	EX								0.3	
Trifolium campestre	0.5	30	EX								0.5	
Lepidium africanum	0.6	30	EX								0.6	
Bromus catharticus	2	30	EX								2	
Hordeum vulgare	1	20	EX								1	
Carduus tenuiflorus	5	20	EX								5	
Atriplex semibaccata	0.5	10	SG			0.5						
Sonchus oleraceus	2	40	EX								2	
Rapistrum rugosum	1	5	EX								1	
Cotula australis	0.5	100	FG					0.5				
Lactuca serriola	0.1	2	EX								0.1	
Capsella bursa-pastoris	0.1	2	EX								0.1	
Sporobolus creber	0.1	1	GG				0.1					
Senecio madagascariensis	0.1	3	HT									0.1
Einadia nutans subsp. nutans	0.1	3	FG					0.1				
Bromus molliformis	0.2	10	EX								0.2	
Solanum cinereum	0.1	1	SG			0.1						
Galium aparine	0.1	1	EX								0.1	
Rumex brownii	0.1	2	FG					0.1				
Xanthium spinosum	0.1	1	HT									0.1

Easting	305463
Northing	6426681
Orientation	305
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	3
50-79	0
30-49	No
20-29	No
10-19	No
5-9	No
<5	No
Hollows	3
Length logs (m)	29

BAM Attributes 1x1 plot (%)	
Litter (%)	7
Bare Ground (%)	0
Rock (%)	0
Vegetation (%)	93
Cryptogram (%)	0

Q42

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180607			67	47	4	2	14	20	2	5	20	4
PCT 1693 Moderate (Q42)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	Cover	Abundance	125.9	110.3	44	1.1	51.4	12	0.9	0.9	15.6	3.9
Eucalyptus melliodora	5	1	TG		5							
Brachychiton populneus subsp. populneu	3	1	TG		3							
Dianella revoluta var. revoluta	4	50	FG					4				
Notelaea microcarpa var. microcarpa	14	10	TG		14							
Eucalyptus blakelyi	22	13	TG		22							
Aristida ramosa	15	100	GG				15					
Aristida vagans	12	80	GG				12					
Cheilanthes distans	0.4	100	EG						0.4			
Sida rhombifolia	0.6	50	EX								0.6	
Stackhousia viminea	0.1	20	FG					0.1				
Chrysocephalum apiculatum	3	50	FG					3				
Lomandra filiformis subsp. filiformis	3	100	GG				3					
Commelina cyanea	0.2	20	FG					0.2				
Desmodium varians	0.1	10	OG							0.1		
Cheilanthes sieberi subsp. sieberi	0.5	40	EG						0.5			
Digitaria divaricatissima	2	20	GG				2					
Glycine tabacina	0.5	80	OG							0.5		
Opuntia aurantiaca	0.1	1	EX								0.1	
Wahlenbergia luteola	0.6	50	FG					0.6				
Phyllanthus virgatus	0.1	2	FG					0.1				
Verbena bonariensis	0.1	2	EX								0.1	
Dichopogon fimbriatus	0.5	40	FG					0.5				
Senecio madagascariensis	0.3	20	HT									0.3
Panicum effusum	0.6	10	GG				0.6					
Cyperus gracilis	1	50	GG				1					
Eremophila debilis	1	20	SG			1						
Lomandra sp.	0.1	3	GG				0.1					
Solanum nigrum	0.4	10	EX								0.4	
Enchylaena tomentosa	0.1	1	SG			0.1						
Sonchus oleraceus	0.2	20	EX								0.2	
Elymus scaber	1	10	GG				1					
Galenia pubescens var. pubescens	3	15	HT									3
Chloris truncata	3	40	GG				3					
Cynodon dactylon (exotic)	4	50	EX								4	
Dichondra repens	0.4	20	FG					0.4				
Carex inversa	0.6	20	GG				0.6					
Bidens pilosa	0.3	10	EX								0.3	
Vittadinia cuneata var. cuneata	0.1	10	FG					0.1				
Lysimachia arvensis	2	50	EX								2	
Dianella longifolia	0.5	10	FG					0.5				
Enteropogon acicularis	1	10	GG				1					
Plantago lanceolata	2	50	EX								2	
Lolium perenne	1	20	EX								1	
Vittadinia muelleri	0.1	1	FG					0.1				
Cymbopogon refractus	8	80	GG				8					
Bothriochloa macra	4	50	GG				4					

Easting	305447
Northing	6424751
Orientation	170
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	1
50-79	2
30-49	Yes
20-29	No
10-19	Yes
5-9	No
<5	Yes
Hollows	2
Length logs (m)	13

BAM Attributes 1x1 plot (%)	
Litter (%)	88
Bare Ground (%)	0
Rock (%)	0
Vegetation (%)	12
Cryptogram (%)	0

Bromus diandrus	0.5	10	HT									0.5			
Opuntia stricta	0.2	2	EX								0.2				
Petrorhagia nanteuilii	0.3	40	EX								0.3				
Cyanthillium cinereum	0.1	3	EX								0.1				
Swainsona monticola	0.4	15	FG					0.4							
Wahlenbergia communis	0.1	10	FG					0.1							
Anthropodium minus	0.1	1	FG					0.1							
Glycine clandestina	0.1	1	OG							0.1					
Medicago polymorpha	0.2	20	EX								0.2				
Austrostipa scabra	0.1	1	GG				0.1								
Boerhavia dominii	0.1	1	FG					0.1							
Einadia nutans subsp. nutans	0.4	20	FG					0.4							
Crassula sieberiana	0.1	5	FG					0.1							
Glossocardia bidens	0.1	10	OG							0.1					
Wahlenbergia gracilis	0.3	20	FG					0.3							
Calotis lappulacea	0.8	40	FG					0.8							
Convolvulus graminetinus	0.1	1	OG							0.1					
Paspalum dilatatum	0.1	1	HT									0.1			
Silene gallica var. gallica	0.1	1	EX								0.1				
Trifolium arvense	0.1	2	EX								0.1				
Vittadinia sulcata	0.1	1	FG					0.1							

Q43

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180807			16	8	1	1	3	2	1	0	8	2
PCT 1607 Low (DNG) (Q43)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	55.3	47.9	0.2	0.1	47	0.2	0.4	0	7.4	1.2
Aristida ramosa	42	500	GG				42					
Senecio madagascariensis	1	40	HT									1
Melinis repens	5	60	EX								5	
Hypochaeris radicata	0.5	50	EX								0.5	
Cheilanthes sieberi subsp. sieberi	0.4	40	EG						0.4			
Misopates orontium	0.3	20	EX								0.3	
Eucalyptus blakelyi	0.2	15	TG		0.2							
Wahlenbergia gracilis	0.1	10	FG					0.1				
Silene gallica var. gallica	0.1	2	EX								0.1	
Opuntia stricta	0.1	1	EX								0.1	
Hyparrhenia hirta	0.2	1	HT									0.2
Chrysocephalum apiculatum	0.1	1	FG					0.1				
Cassinia sp.	0.1	1	SG			0.1						
Cynodon dactylon (exotic)	0.2	10	EX								0.2	
Cymbopogon refractus	3	20	GG				3					
Aristida vagans	2	20	GG				2					

Easting	303598
Northing	6429295
Orientation	335
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	0
50-79	0
30-49	No
20-29	No
10-19	No
5-9	No
<5	No
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	7
Bare Ground (%)	47
Rock (%)	4
Vegetation (%)	42
Cryptogram (%)	0

Q44

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180807			26	4	0	0	2	2	0	0	22	1
PCT 485 Low (DNG) (Q44)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	106.8	46.3	0	0	46	0.3	0	0	60.5	12
Paspalidium aversum	38	300	GG				38					
Bromus catharticus	4	50	EX								4	
Papaver somniferum	0.1	1	EX								0.1	
Medicago polymorpha	18	100	EX								18	
Sonchus oleraceus	0.5	30	EX								0.5	
Lolium perenne	18	100	EX								18	
Lactuca serriola	0.4	30	EX								0.4	
Galenia pubescens var. pubescens	12	20	HT									12
Cynodon dactylon	8	100	GG				8					
Avena fatua	0.2	5	EX								0.2	
Hordeum vulgare	0.2	10	EX								0.2	
Lepidium africanum	0.4	30	EX								0.4	
Conyza bonariensis	0.3	20	EX								0.3	
Lepidium didymum	0.1	1	EX								0.1	
Verbena rigida	0.2	10	EX								0.2	
Hirschfeldia incana	1	10	EX								1	
Eragrostis cilianensis	2	30	EX								2	
Cotula australis	0.2	20	FG					0.2				
Malva parviflora	0.3	3	EX								0.3	
Capsella bursa-pastoris	0.2	10	EX								0.2	
Bromus molliformis	2	20	EX								2	
Einadia nutans subsp. linifolia	0.1	1	FG					0.1				
Gamochaeta calviceps	0.1	1	EX								0.1	
Oxalis corniculata	0.2	10	EX								0.2	
Cyclospermum leptophyllum	0.1	1	EX								0.1	
Cirsium vulgare	0.2	2	EX								0.2	

Easting	302539
Northing	6431032
Orientation	10
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	0
50-79	0
30-49	No
20-29	No
10-19	No
5-9	No
<5	No
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	2
Bare Ground (%)	6
Rock (%)	0
Vegetation (%)	92
Cryptogram (%)	0

Q45

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			80	62	4	7	20	26	2	3	18	3
PCT 1605 Moderate (Q45)			Sum cove	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundanc**	117.4	109.1	42	2.4	55.4	7.8	0.9	0.6	8.3	3
Eucalyptus crebra	24	15	TG		24							
Notelaea microcarpa var. microcarpa	16	20	TG		16							
Austrostipa scabra	13	200	GG				13					
Cyperus gracilis	5	100	GG				5					
Senecio madagascariensis	1	30	HT									1
Aristida vagans	8	100	GG				8					
Centaurea melitensis	0.3	20	EX								0.3	
Echium plantagineum	0.1	1	EX								0.1	
Glycine tabacina	0.3	30	OG							0.3		
Dichondra sp. A	0.2	20	FG					0.2				
Silene gallica var. gallica	0.3	40	EX								0.3	
Lomandra filiformis subsp. coriacea	0.1	3	GG				0.1					
Lysimachia arvensis	0.4	50	EX								0.4	
Lomandra filiformis subsp. filiformis	6	100	GG				6					
Wahlenbergia communis	0.3	30	FG					0.3				
Solanum cinereum	0.5	20	SG			0.5						
Einadia trigonos	0.4	20	FG					0.4				
Arthropodium milleflorum	0.5	40	FG					0.5				
Desmodium varians	0.2	30	OG							0.2		
Oxalis radicosa	0.2	20	FG					0.2				
Vittadinia cuneata var. cuneata	0.1	2	FG					0.1				
Calandrinia eremaea	0.2	20	FG					0.2				
Sonchus oleraceus	0.1	2	EX								0.1	
Oxytes brachypoda	0.5	20	FG					0.5				
Einadia nutans subsp. nutans	0.3	20	FG					0.3				
Paspalidium criniforme	0.1	1	GG				0.1					
Daucus glochidiatus	0.1	3	FG					0.1				
Stackhousia viminea	0.3	40	FG					0.3				
Brunoniella australis	0.2	20	FG					0.2				
Calotis lappulacea	0.6	50	FG					0.6				
Acacia paradoxa	0.1	1	SG			0.1						
Solanum nigrum	1	20	EX								1	
Chloris ventricosa	3	40	GG				3					
Allocasuarina torulosa	1	1	TG		1							
Cymbopogon refractus	2	20	GG				2					
Cheilanthes sieberi subsp. sieberi	0.3	50	EG						0.3			
Chloris truncata	0.1	2	GG				0.1					
Enneapogon sp.	0.1	5	GG				0.1					
Brachychiton populneus subsp. populne	1	1	TG		1							
Lomandra multiflora subsp. multiflora	0.5	10	GG				0.5					
Rostellularia adscendens var. adscende	0.3	30	FG					0.3				
Evocarpos cupressiformis	0.1	1	SG			0.1						
Dianella longifolia	0.1	3	FG					0.1				
Cheilanthes distans	0.6	60	EG						0.6			
Crassula sieberiana	0.2	100	FG					0.2				
Themeda triandra	2	30	GG				2					
Eragrostis leptostachya	2	30	GG				2					

Easting	304573
Northing	6428908
Orientation	130
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	0
50-79	1
30-49	No
20-29	Yes
10-19	Yes
5-9	No
<5	Yes
Hollows	3
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	56
Bare Ground (%)	1
Rock (%)	0
Vegetation (%)	36
Cryptogram (%)	7

Opuntia aurantiaca	0.1	2	EX								0.1					
Melinis repens	1	20	EX								1					
Petrorhagia nanteuilii	0.3	20	EX								0.3					
Sida corrugata	0.4	40	FG					0.4								
Glycine microphylla	0.1	3	OG							0.1						
Panicum effusum	3	40	GG				3									
Boerhavia dominii	0.1	10	FG					0.1								
Eremophila debilis	0.2	7	SG			0.2										
Enteropogon acicularis	1	10	GG				1									
Asperula conferta	0.1	2	FG					0.1								
Trifolium campestre	0.4	30	EX								0.4					
Abutilon oxycarpum	0.4	20	SG			0.4										
Lepidium bonariense	0.1	5	EX								0.1					
Austrostipa verticillata	3	20	GG				3									
Dysphania carinata	0.1	1	FG					0.1								
Austrostipa setacea	3	40	GG				3									
Lycium ferocissimum	1	1	HT										1			
Sida rhombifolia	0.4	20	EX								0.4					
Bursaria spinosa subsp. spinosa	1	1	SG			1										
Lepidium africanum	0.2	10	EX								0.2					
Digitaria divaricatissima	2	20	GG				2									
Parentucellia latifolia	0.3	20	EX								0.3					
Wahlenbergia gracilis	0.2	10	FG					0.2								
Sporobolus creber	1	10	GG				1									
Eragrostis brownii	0.5	10	GG				0.5									
Calotis hispidula	0.1	2	FG					0.1								
Sigesbeckia australiensis	2	20	FG					2								
Bryophyllum x houghtonii	0.3	5	EX								0.3					
Veronica plebeia	0.1	2	FG					0.1								
Geranium solanderi	0.1	1	FG					0.1								
Ehrharta erecta	1	20	HT										1			
Einadia hastata	0.1	1	FG					0.1								
Solanum brownii	0.1	2	SG			0.1										

Q46

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	High Threat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20100907			61	51	2	3	17	24	2	3	10	3
PCT 1605 Moderate (Q46)			Sum cov	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundanc**	115	107	45	0.4	55.3	4.9	0.7	0.9	7.6	3.2
Eucalyptus crebra	25	11	TG		25							
Notelaea microcarpa var. microcarpa	20	14	TG		20							
Senecio madagascariensis	1	40	HT									1
Erodium crinitum	0.4	20	FG					0.4				
Lomandra filiformis subsp. filiformis	4	100	GG				4					
Cymbopogon refractus	3	40	GG				3					
Galenia pubescens var. pubescens	0.2	10	HT									0.2
Calotis lappulacea	0.5	40	FG					0.5				
Cyperus gracilis	3	100	GG				3					
Eragrostis leptostachya	4	40	GG				4					
Lysimachia arvensis	0.3	30	EX								0.3	
Calotis hispidula	0.1	1	FG					0.1				
Themeda triandra	2	30	GG				2					
Rostellularia adscendens var. adscend	0.2	20	FG					0.2				
Lepidium bonariense	0.1	1	EX								0.1	
Aristida ramosa	6	100	GG				6					
Melinis repens	2	20	EX								2	
Panicum effusum	4	50	GG				4					
Chloris truncata	0.2	10	GG				0.2					
Austrostipa scabra	14	100	GG				14					
Crassula sieberiana	0.1	100	FG					0.1				
Lomandra glauca	0.1	1	GG				0.1					
Digitaria diffusa	6	200	GG				6					
Cheilanthes sieberi subsp. sieberi	0.4	50	EG						0.4			
Calandrinia eremaea	0.1	1	FG					0.1				
Zornia dyctiocarpa var. dyctiocarpa	0.1	30	FG					0.1				
Dysphania carinata	0.2	5	FG					0.2				
Paspalidium gracile	0.2	10	GG				0.2					
Einadia nutans subsp. linifolia	0.2	20	FG					0.2				
Stackhousia viminea	0.1	1	FG					0.1				
Wahlenbergia gracilis	0.4	40	FG					0.4				
Austrostipa verticillata	3	15	GG				3					
Paronychia brasiliana	0.1	10	EX								0.1	
Glycine microphylla	0.1	5	OG							0.1		
Acacia paradoxa	0.2	6	SG			0.2						
Silene gallica var. gallica	0.9	50	EX								0.9	
Chrysocephalum apiculatum	1	30	FG					1				
Stypandra glauca	0.3	7	FG					0.3				
Cheilanthes distans	0.3	20	EG						0.3			
Phyllanthus virgatus	0.1	1	FG					0.1				
Evolvulus alsinoides var. decumbens	0.1	3	FG					0.1				
Commelina cyanea	0.1	1	FG					0.1				
Euphorbia drummondii	0.1	2	FG					0.1				
Glycine tabacina	0.3	30	OG							0.3		
Sporobolus caroli	0.8	10	GG				0.8					
Aristida vagans	4	40	GG				4					
Melinis repens	0.3	20	EX								0.3	
Lomandra multiflora subsp. multiflora	0.4	10	GG				0.4					
Einadia hastata	0.1	1	FG					0.1				
Sida hackettiana	0.1	2	FG					0.1				
Solanum cinereum	0.1	1	SG			0.1						
Dichopogon fimbriatus	0.1	1	FG					0.1				
Brunoniella australis	0.1	2	FG					0.1				
Lycium ferocissimum	2	1	HT									2
Dichondra sp. A	0.2	10	FG					0.2				
Plantago debilis	0.1	1	FG					0.1				
Glycine clandestina	0.5	10	OG							0.5		
Abutilon oxycarpum	0.1	1	SG			0.1						
Sonchus oleraceus	0.1	1	EX								0.1	
Bothriochloa macra	0.6	20	GG				0.6					
Einadia polygonoides	0.1	1	FG					0.1				

Easting	304471
Northing	6428380
Orientation	245
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	0
50-79	1
30-49	No
20-29	Yes
10-19	Yes
5-9	No
<5	Yes
Hollows	1
Length logs (m)	0

BAM Attributes 1x1 plot (%)	
Litter (%)	70
Bare Ground (%)	3
Rock (%)	8
Vegetation (%)	19
Cryptogram (%)	0

Q47

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180807			26	13	5	2	2	3	1	0	13	6
PCT 1607 Low (Remnant) (Q47)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	92.9	57.6	54.1	0.3	2.5	0.5	0.2	0	35.3	1.6
Eucalyptus blakelyi	50	20	TG		50							
Eucalyptus crebra	2	6	TG		2							
Melinis repens	32	500	EX								32	
Senecio madagascariensis	0.6	40	HT									0.6
Opuntia stricta	1	15	EX								1	
Silene gallica var. gallica	0.2	20	EX								0.2	
Hypochaeris radicata	0.1	3	EX								0.1	
Cyperus eragrostis	0.3	10	HT									0.3
Crassula sieberiana	0.1	30	FG					0.1				
Aristida ramosa	0.5	20	GG				0.5					
Enchylaena tomentosa	0.2	2	SG			0.2						
Einadia polygonoides	0.3	10	FG					0.3				
Chloris gayana	0.1	1	HT									0.1
Solanum nigrum	0.2	20	EX								0.2	
Brachychiton populneus subsp. populneus	0.1	1	TG		0.1							
Cassinia sp.	0.1	1	SG			0.1						
Phytolacca octandra	0.1	2	EX								0.1	
Megathyrsus maximus	0.3	2	HT									0.3
Carthamus lanatus	0.1	1	HT									0.1
Cheilanthes sieberi subsp. sieberi	0.2	10	EG						0.2			
Notelaea microcarpa var. microcarpa	1	1	TG		1							
Opuntia aurantiaca	0.1	1	EX								0.1	
Einadia hastata	0.1	1	FG					0.1				
Lycium ferocissimum	0.2	1	HT									0.2
Allocasuarina luehmannii	1	1	TG		1							
Aristida vagans	2	20	GG				2					

Easting	303569
Northing	6429310
Orientation	300
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	0
50-79	0
30-49	No
20-29	Yes
10-19	Yes
5-9	Yes
<5	Yes
Hollows	0
Length logs (m)	16
BAM Attributes 1x1 plot (%)	
Litter (%)	40
Bare Ground (%)	18
Rock (%)	0
Vegetation (%)	42
Cryptogram (%)	0

Q48

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20150907			47	18	1	2	6	8	0	1	29	4
PCT 1691 Low (Remnant) (Q48)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	160.9	61.7	12	1.1	16.6	31	0	1	99.2	12.5
Eucalyptus moluccana	12	1	TG		12							
Cynodon dactylon (exotic)	55	300	EX								55	
Modiola caroliniana	3	50	EX								3	
Galenia pubescens var. pubescens	10	30	HT									10
Medicago polymorpha	5	100	EX								5	
Sisymbrium irio	16	100	EX								16	
Lepidium africanum	0.6	40	EX								0.6	
Solanum cinereum	1	20	SG			1						
Chenopodium murale	0.3	10	EX								0.3	
Plantago lanceolata	0.3	20	EX								0.3	
Lolium perenne	0.9	30	EX								0.9	
Hordeum vulgare	1	30	EX								1	
Austrostipa verticillata	5	30	GG				5					
Medicago orbicularis	0.3	10	EX								0.3	
Sonchus oleraceus	0.3	20	EX								0.3	
Marrubium vulgare	0.2	1	EX								0.2	
Carthamus lanatus	1	40	HT									1
Sida rhombifolia	0.6	30	EX								0.6	
Einadia trigonos	0.3	10	FG					0.3				
Senecio madagascariensis	0.5	30	HT									0.5
Bromus molliformis	0.6	10	EX								0.6	
Einadia polygonoides	10	100	FG					10				
Erodium crinitum	20	100	FG					20				
Rapistrum rugosum	0.5	10	EX								0.5	
Carex inversa	3	40	GG				3					
Marrubium vulgare	0.3	1	EX								0.3	
Capsella bursa-pastoris	0.1	1	EX								0.1	
Trifolium campestre	0.1	1	EX								0.1	
Cotula australis	0.2	50	FG					0.2				
Atriplex semibaccata	0.1	2	SG			0.1						
Chloris truncata	3	50	GG				3					
Calotis hispidula	0.1	1	FG					0.1				
Cyclospermum leptophyllum	0.1	2	EX								0.1	
Stachys arvensis	0.5	40	EX								0.5	
Lepidium bonariense	0.4	20	EX								0.4	
Arctotheca calendula	0.1	1	EX								0.1	
Aristida ramosa	4	40	GG				4					
Glycine tabacina	1	100	OG							1		
Romulea rosea	1	100	HT									1
Maireana enchylaenoides	0.1	1	FG					0.1				
Eriochloa pseudoacrotricha	1	20	GG				1					
Sida corrugata	0.2	20	FG					0.2				
Crassula sieberiana	0.1	50	FG					0.1				
Centaurea melitensis	0.3	10	EX								0.3	
Echium plantagineum	0.1	6	EX								0.1	
Gamochaeta purpurea	0.1	1	EX								0.1	
Bothriochloa macra	0.6	10	GG				0.6					

Easting	305532
Northing	6428888
Orientation	40
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	0
50-79	2
30-49	No
20-29	No
10-19	No
5-9	No
<5	No
Hollows	1
Length logs (m)	9

BAM Attributes 1x1 plot (%)	
Litter (%)	11
Bare Ground (%)	1
Rock (%)	0
Vegetation (%)	88
Cryptogram (%)	0

Q49

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			63	25	3	3	9	9	0	1	38	6
PCT 1691 Low (Remnant) (Q49)			Sum cove	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	Cover	Abundanc	145	58.7	48	2.2	6	2.4	0	0.1	86.3	54.9
Eucalyptus crebra	16	11	TG		16							
Angophora floribunda	16	12	TG		16							
Megathyrsus maximus	5	40	HT									5
Carthamus lanatus	0.9	40	HT									0.9
Cynodon dactylon (exotic)	5	50	EX								5	
Austrostipa verticillata	2	20	GG				2					
Galenia pubescens var. pubescens	4	30	HT									4
Silene gallica var. gallica	2	100	EX								2	
Plantago lanceolata	3	200	EX								3	
Notelaea microcarpa var. microcarp	16	18	TG		16							
Arctotheca calendula	0.2	5	EX								0.2	
Echium plantagineum	2	20	EX								2	
Senecio madagascariensis	2	60	HT									2
Lolium perenne	6	100	EX								6	
Aristida ramosa	3	40	GG				3					
Lysimachia arvensis	1	100	EX								1	
Einadia trigonos	0.2	10	FG					0.2				
Melilotus indica	0.6	40	EX								0.6	
Sonchus oleraceus	0.4	40	EX								0.4	
Rapistrum rugosum	1	20	EX								1	
Foeniculum vulgare	2	20	EX								2	
Hypochaeris radicata	1	100	EX								1	
Chloris gayana	38	200	HT									38
Ehrharta erecta	5	80	HT									5
Medicago polymorpha	2	60	EX								2	
Bromus molliformis	0.1	1	EX								0.1	
Lepidium africanum	0.1	3	EX								0.1	
Trifolium campestre	0.5	50	EX								0.5	
Cirsium vulgare	0.3	20	EX								0.3	
Avena fatua	0.8	10	EX								0.8	
Facelis retusa	0.1	2	EX								0.1	
Rumex brownii	0.1	3	FG					0.1				
Solanum cinereum	0.1	2	SG			0.1						
Glycine tabacina	0.1	10	OG							0.1		
Eragrostis megalosperma	0.2	3	GG				0.2					
Dianella longifolia	1	20	FG					1				
Acacia implexa	2	3	SG			2						
Einadia polygonoides	0.2	30	FG					0.2				
Dichondra sp. A	0.5	20	FG					0.5				
Crassula sieberiana	0.1	50	FG					0.1				
Calotis hispidula	0.1	1	FG					0.1				
Cyclospermum leptophyllum	0.2	20	EX								0.2	
Veronica plebeia	0.1	2	FG					0.1				
Silybum marianum	0.1	1	EX								0.1	
Verbena rigida	0.2	10	EX								0.2	
Paronychia brasiliana	0.2	50	EX								0.2	
Cyperus gracilis	0.2	20	GG				0.2					

Easting	304683
Northing	6429262
Orientation	225
Plot size	20x20 in 20x50

BAM Attributes 20x50m plot	
Stem classes	
80+	0
50-79	0
30-49	Yes
20-29	No
10-19	Yes
5-9	Yes
<5	Yes
Hollows	0
Length logs (m	0

BAM Attributes 1x1 plot (%)	
Litter (%)	22
Bare Ground	4
Rock (%)	1
Vegetation (%	73
Cryptogram (%	0

Chrysocephalum apiculatum	0.1	1	FG					0.1							
Bothriochloa macra	0.1	3	GG				0.1								
Petrorhagia nanteuilii	0.1	3	EX								0.1				
Eleusine tristachya	0.1	1	EX								0.1				
Trifolium glomeratum	0.3	20	EX								0.3				
Sporobolus creber	0.1	5	GG				0.1								
Setaria parviflora	0.5	20	EX								0.5				
Panicum effusum	0.1	1	GG				0.1								
Enchylaena tomentosa	0.1	1	SG			0.1									
Modiola caroliniana	0.1	3	EX								0.1				
Chloris ventricosa	0.2	5	GG				0.2								
Sida rhombifolia	0.3	20	EX								0.3				
Lomandra filiformis subsp. filiformis	0.1	2	GG				0.1								
Hedypnois rhagadioloides	1	60	EX								1				
Gamochaeta calviceps	0.1	1	EX								0.1				
Briza minor	0.1	3	EX								0.1				

Q50

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160607			40	12	2	1	5	4	0	0	28	6
PCT 1693 Low (Remnant) (Q50)			Sum cove	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundanc**	181.3	42	17	0.1	22	2.9	0	0	139.3	31.4
Eucalyptus melliodora	16	1	TG		16							
Notelaea microcarpa var. microcarp	1	1	TG		1							
Plantago lanceolata	35	300	EX								35	
Cenchrus clandestinus	6	50	HT									6
Galenia pubescens var. pubescens	18	50	HT									18
Medicago truncatula	18	300	EX								18	
Lolium perenne	32	300	EX								32	
Senecio madagascariensis	0.3	20	HT									0.3
Cynodon dactylon (exotic)	3	20	EX								3	
Erodium crinitum	2	30	FG					2				
Dichondra repens	0.5	10	FG					0.5				
Sida rhombifolia	0.5	20	EX								0.5	
Cirsium vulgare	0.2	10	EX								0.2	
Lepidium africanum	0.1	1	EX								0.1	
Einadia nutans subsp. nutans	0.3	20	FG					0.3				
Chenopodium murale	0.2	2	EX								0.2	
Cyclospermum leptophyllum	0.1	2	EX								0.1	
Chloris truncata	4	60	GG				4					
Medicago orbicularis	0.1	2	EX								0.1	
Enchylaena tomentosa	0.1	1	SG			0.1						
Modiola caroliniana	0.5	40	EX								0.5	
Paspalidium distans	8	60	GG				8					
Opuntia aurantiaca	0.1	1	EX								0.1	
Paspalum dilatatum	6	50	HT									6
Trifolium glomeratum	8	100	EX								8	
Sonchus oleraceus	0.5	10	EX								0.5	
Verbena rigida	0.2	15	EX								0.2	
Lysimachia arvensis	0.3	30	EX								0.3	
Bothriochloa macra	1	10	GG				1					
Gamochaeta calviceps	0.6	50	EX								0.6	
Petrorhagia nanteuilii	0.1	1	EX								0.1	
Trifolium campestre	0.2	20	EX								0.2	
Bromus catharticus	6	40	EX								6	
Enteropogon acicularis	4	50	GG				4					
Avena fatua	2	20	EX								2	
Solanum nigrum	0.2	5	EX								0.2	
Eriochloa pseudoacrotricha	5	50	GG				5					
Rumex brownii	0.1	1	FG					0.1				
Carthamus lanatus	0.1	1	HT									0.1
Eragrostis curvula	1	10	HT									1

Easting	306345
Northing	6427159
Orientation	350
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	2
50-79	1
30-49	No
20-29	No
10-19	No
5-9	No
<5	Yes
Hollows	2
Length logs (m	0
BAM Attributes 1x1 plot (%)	
Litter (%)	32
Bare Ground	3
Rock (%)	0
Vegetation (%	65
Cryptogram (%	0

Q51

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	ighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20160907			39	18	2	0	8	7	0	1	21	6
PCT 1693 Low (Remnant) (Q51)			Sum cove	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	Cover	Abundanc	95.2	27.5	14	0	10.3	3	0	0.2	67.7	37.4
Eucalyptus tereticornis	12	6	TG		12							
Eucalyptus melliodora	2	1	TG		2							
Paspalum dilatatum	28	300	HT									28
Lolium perenne	15	200	EX								15	
Senecio madagascariensis	0.4	30	HT									0.4
Plantago lanceolata	0.2	20	EX								0.2	
Chloris ventricosa	1	20	GG				1					
Aristida ramosa	1	10	GG				1					
Bromus diandrus	2	30	HT									2
Medicago polymorpha	2	50	EX								2	
Trifolium glomeratum	10	300	EX								10	
Chloris truncata	5	80	GG				5					
Enteropogon acicularis	1	20	GG				1					
Wahlenbergia communis	0.2	15	FG					0.2				
Sonchus oleraceus	0.3	20	EX								0.3	
Einadia nutans subsp. nutans	0.1	3	FG					0.1				
Carex inversa	1	50	GG				1					
Silene gallica var. gallica	0.3	40	EX								0.3	
Glycine tabacina	0.2	10	OG							0.2		
Solanum nigrum	0.2	2	EX								0.2	
Rumex brownii	0.1	1	FG					0.1				
Commelina cyanea	0.1	1	FG					0.1				
Lysimachia arvensis	0.4	30	EX								0.4	
Hypochaeris radicata	0.1	1	EX								0.1	
Romulea rosea	1	100	HT									1
Chrysocephalum apiculatum	2	50	FG					2				
Gamochaeta calviceps	0.1	2	EX								0.1	
Eragrostis curvula	1	10	HT									1
Lomandra filiformis subsp. filiformis	0.1	1	GG				0.1					
Sisyrinchium rosulatum	0.5	40	EX								0.5	
Cyclospermum leptophyllum	0.3	20	EX								0.3	
Sida rhombifolia	0.4	20	EX								0.4	
Verbena rigida	0.4	20	EX								0.4	
Marrubium vulgare	0.1	2	EX								0.1	
Erodium crinitum	0.3	10	FG					0.3				
Geranium solanderi	0.2	20	FG					0.2				
Chloris gayana	5	30	HT									5
Austrostipa setacea	1	20	GG				1					
Eragrostis megalosperma	0.2	1	GG				0.2					

Easting	306369
Northing	6427390
Orientation	170
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	2
50-79	No
30-49	No
20-29	No
10-19	Yes
5-9	Yes
<5	Yes
Hollows	2
Length logs (m	3
BAM Attributes 1x1 plot (%)	
Litter (%)	46
Bare Ground	0
Rock (%)	0
Vegetation (%	54
Cryptogram (%	0

Q52

			Covers	Native	Trees	Shrubs	Grass	Forb	Fern	Other	Exotic	HighThreat
			# spp	Count	Count	Count	Count	Count	Count	Count	Count	Count
Sheet version: 20180807			24	6	0	1	2	3	0	0	18	3
PCT 42 (DNG) (Q52)			Sum cover	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum
Species	**Cover**	**Abundance**	103.7	86.1	0	0.1	85.5	0.5	0	0	17.6	6.2
Cynodon dactylon	85	500	GG				85					
Senecio madagascariensis	0.1	3	HT									0.1
Stachys arvensis	0.1	2	EX								0.1	
Cirsium vulgare	0.1	1	EX								0.1	
Cotula australis	0.3	30	FG					0.3				
Lepidium africanum	0.1	3	EX								0.1	
Galenia pubescens var. pubescens	6	30	HT									6
Xanthium spinosum	0.1	1	HT									0.1
Erodium crinitum	0.1	2	FG					0.1				
Sporobolus creber	0.5	10	GG				0.5					
Lolium perenne	5	50	EX								5	
Parentucellia latifolia	0.1	10	EX								0.1	
Paronychia brasiliana	0.1	10	EX								0.1	
Sonchus oleraceus	0.1	2	EX								0.1	
Bromus catharticus	0.1	2	EX								0.1	
Malva parviflora	0.5	10	EX								0.5	
Medicago polymorpha	0.2	20	EX								0.2	
Solanum cinereum	0.1	1	SG			0.1						
Trifolium campestre	0.3	20	EX								0.3	
Trifolium glomeratum	0.5	40	EX								0.5	
Rumex brownii	0.1	1	FG					0.1				
Gamochaeta purpurea	0.1	5	EX								0.1	
Echium plantagineum	4	20	EX								4	
Verbena bonariensis	0.1	1	EX								0.1	

Easting	305485
Northing	6426641
Orientation	225
Plot size	20x20 in 20x50
BAM Attributes 20x50m plot	
Stem classes	
80+	0
50-79	0
30-49	No
20-29	No
10-19	No
5-9	No
<5	No
Hollows	0
Length logs (m)	0
BAM Attributes 1x1 plot (%)	
Litter (%)	0
Bare Ground (%)	0
Rock (%)	0
Vegetation (%)	100
Cryptogram (%)	0

B3 – Recorded fauna

Scientific name	Common name	Native (N) or Introduced (I)	BC Act status[1]	EPBC Act status[2]
Amphibians				
Crinia signifera	Common Eastern Froglet	N		
Limnodynastes tasmaniensis	Spotted Grass Frog	N		
Litoria caerulea	Green Tree Frog	N		
Litoria latopalmata	Broad-palmed Frog	N		
Litoria peronii	Peron's Tree Frog	N		
Pseudophryne bibronii	Bibron's Toadlet	N		
Uperoleia laevigata	Smooth Toadlet	N		
Birds				
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	N		
Acanthiza nana	Yellow Thornbill	N		
Acanthiza pusilla	Brown Thornbill	N		
Acanthiza reguloides	Buff-rumped Thornbill	N		
Acanthorhynchus tenuirostris	Eastern Spinebill	N		
Accipiter cirrocephalus	Collared Sparrowhawk	N		
Accipiter novaehollandiae	Grey Goshawk	N		
Acridotheres tristis	Common Myna*	I		
Acrocephalus australis	Australian Reed-Warbler	N		
Aegotheles cristatus	Australian Owlet-Nightjar	N		
Alisterus scapularis	Australian King-Parrot	N		
Anas gracilis	Grey Teal	N		
Anas superciliosa	Pacific Black Duck	N		
Anthochaera carunculata	Red Wattlebird	N		
Anthochaera chrysoptera	Little Wattlebird	N		
Anthus novaeseelandiae	Australian Pipit	N		
Aquila audax	Wedge-tailed Eagle	N		
Ardea pacifica	White-necked Heron	N		
Artamus cyanopterus	Dusky Woodswallow	N	V	

Scientific name	Common name	Native (N) or Introduced (I)	BC Act status[1]	EPBC Act status[2]
Aviceda subcristata	Pacific Baza	N		
Cacatua galerita	Sulphur-crested Cockatoo	N		
Cacatua sanguinea	Little Corella	N		
Cacatua tenuirostris	Long-billed Corella	N		
Cacomantis flabelliformis	Fan-tailed Cuckoo	N		
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo	N		
Chenonetta jubata	Australian Wood Duck	N		
Cheramoeca leucosterna	White-backed Swallow	N		
Chrysococcyx lucidus	Shining Bronze-Cuckoo	N		
Colluricincla harmonica	Grey Shrike-thrush	N		
Columba livia	Rock Dove*	I		
Coracina novaehollandiae	Black-faced Cuckoo-shrike	N		
Coracina tenuirostris	Cicadabird	N		
Corcorax melanorhamphos	White-winged Chough	N		
Cormobates leucophaea	White-throated Treecreeper	N		
Corvus coronoides	Australian Raven	N		
Corvus mellori	Little Raven	N		
Corvus orru	Torresian Crow	N		
Coturnix ypsilophora	Brown Quail	N		
Cracticus nigrogularis	Pied Butcherbird	N		
Cracticus tibicen	Australian Magpie	N		
Cracticus torquatus	Grey Butcherbird	N		
Dacelo novaeguineae	Laughing Kookaburra	N		
Daphoenositta chrysoptera	Varied Sittella	N	V	
Dicaeum hirundinaceum	Mistletoebird	N		
Egretta novaehollandiae	White-faced Heron	N		
Entomyzon cyanotis	Blue-faced Honeyeater	N		
Eolophus roseicapilla	Galah	N		
Eopsaltria australis	Eastern Yellow Robin	N		
Falco berigora	Brown Falcon	N		
Falco cenchroides	Nankeen Kestrel	N		

Scientific name	Common name	Native (N) or Introduced (I)	BC Act status[1]	EPBC Act status[2]
Falco longipennis	Australian Hobby	N		
Gallinula tenebrosa	Dusky Moorhen	N		
Geopelia striata	Peaceful Dove	N		
Gerygone olivacea	White-throated Gerygone	N		
Glossopsita concinna	Musk Lorikeet	N		
Glossopsitta pusilla	Little Lorikeet	N	V	
Grallina cyanoleuca	Magpie-lark	N		
Haliaeetus leucogaster	White-bellied Sea-Eagle	N	V	Ma
Haliastur sphenurus	Whistling Kite	N		
Hieraaetus morphnoides	Little Eagle	N	V	
Hirundapus caudacutus	White-throated Needletail	N		V, M, Ma
Hirundo neoxena	Welcome Swallow	N		
Lalage sueurii	White-winged Triller	N		
Lichenostomus chrysops	Yellow-faced Honeyeater	N		
Lichenostomus leucotis	White-eared Honeyeater	N		
Lichenostomus virescens	Singing Honeyeater	N		
Lichmera indistincta	Brown Honeyeater	N		
Malurus cyaneus	Superb Fairy-wren	N		
Malurus lamberti	Variegated Fairy-wren	N		
Manorina melanocephala	Noisy Miner	N		
Meliphaga lewinii	Lewin's Honeyeater	N		
Melithreptus brevirostris	Brown-headed Honeyeater	N		
Merops ornatus	Rainbow Bee-eater	N		Ma
Monarcha melanopsis	Black-faced Monarch	N		M, Ma
Myiagra rubecula	Leaden Flycatcher	N		
Myzomela sanguinolenta	Scarlet Honeyeater	N		
Neochmia temporalis	Red-browed Finch	N		
Ocyphaps lophotes	Crested Pigeon	N		
Oriolus sagittatus	Olive-backed Oriole	N		
Pachycephala pectoralis	Golden Whistler	N		

Scientific name	Common name	Native (N) or Introduced (I)	BC Act status[1]	EPBC Act status[2]
Pachycephala rufiventris	Rufous Whistler	N		
Pardalotus punctatus	Spotted Pardalote	N		
Pardalotus striatus	Striated Pardalote	N		
Pelecanus conspicillatus	Australian Pelican	N		
Petrochelidon nigricans	Fairy Martin	N		
Petrochelidon nigricans	Tree Martin	N		Ma
Phalacrocorax varius	Pied Cormorant	N		
Phaps chalcoptera	Common Bronzewing	N		
Philemon corniculatus	Noisy Friarbird	N		
Phylidonyris niger	White-cheeked Honeyeater	N		
Platycercus elegans	Crimson Rosella	N		
Platycercus eximius	Eastern Rosella	N		
Podargus strigoides	Tawny Frogmouth	N		
Porphyrio porphyrio	Purple Swamphen	N		
Psephotus haematonotus	Red-rumped Parrot	N		
Psophodes olivaceus	Eastern Whipbird	N		
Pyrrholaemus sagittatus	Speckled Warbler	N	V	
Rhipidura albiscapa	Grey Fantail	N		
Rhipidura leucophrys	Willie Wagtail	N		
Rhipidura rufifrons	Rufous Fantail	N		M, Ma
Scythrops novaehollandiae	Channel-billed Cuckoo	N		
Sericornis frontalis	White-browed Scrubwren	N		
Smicrornis brevirostris	Weebill	N		
Strepera graculina	Pied Currawong	N		
Streptopelia chinensis	Spotted Dove*	N		
Sturnus vulgaris	Common Starling*	I		
Tachybaptus novaehollandiae	Australasian Grebe	N		
Taeniopygia bichenovii	Double-barred Finch	N		
Threskiornis spinicollis	Straw-necked Ibis	N		
Todiramphus sanctus	Sacred Kingfisher	N		

Scientific name	Common name	Native (N) or Introduced (I)	BC Act status[1]	EPBC Act status[2]
Trichoglossus haematodus	Rainbow Lorikeet	N		
Vanellus miles	Masked Lapwing	N		
Zosterops lateralis	Silvereye	N		
Fish				
Gambusia affinis	Mosquito fish*	I		
Mammals				
Antechinus flavipes	Yellow-footed Antechinus	N		
Antechinus stuartii	Brown Antechinus	N		
Austronomus australis	White-striped Free-tail Bat	N		
Bos taurus	Cow*	I		
Chalinolobus gouldii	Gould's Wattled Bat	N		
Chalinolobus morio	Chocolate Wattled Bat	N		
Equus caballus	Horse*	I		
Macropus giganteus	Eastern Grey Kangaroo	N		
Macropus robustus	Common Wallaroo	N		
Macropus rufogriseus	Red-necked Wallaby	N		
Myotis macropus	Southern Myotis	N	V	
Nyctophilus geoffroyi	Lesser Long-eared Bat	N		
Oryctolagus cuniculus	Rabbit*	I		
Ozimops ridei	Ride's Free-tailed Bat	N		
Petaurus norfolcensis	Squirrel Glider	N	V	
Phascolarctos cinereus	Koala	N	V	V
Planigale tenuirostris	Narrow-nosed Planigale	N		
Pseudocheirus peregrinus	Ring-tail Possum	N		
Pteropus poliocephalus	Grey-headed Flying-fox	N	V	V
Trichosurus vulpecula	Common Brush-tailed Possum	N		
Vespadelus vulturnus	Little Forest Bat	N		
Vulpes vulpes	Fox*	I		
Wallabia bicolor	Swamp Wallaby	N		

Scientific name	Common name	Native (N) or Introduced (I)	BC Act status[1]	EPBC Act status[2]
Reptiles				
Underwoodisaurus milii	Barking Gecko	N		
Cryptoblepharus pulcher	Elegant Snake-eyed Skink	N		
Ctenotus robustus	Robust Ctenotus	N		
Delma impar	Striped Legless Lizard	N	V	V
Eulamprus quoyii	Eastern Water Skink	N		
Liopholis modesta	Eastern Ranges Rock-skink	N		
Morethia boulengeri	Boulenger's Snake-eyed Skink	N		
Pogona barbata	Bearded Dragon	N		
Varanus varius	Lace Monitor	N		

1. Listed under the NSW *Biodiversity Conservation Act 2016* – CE = Critically Endangered, E1 = Endangered Species, E2 = Endangered Population, V = Vulnerable.
2. Listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* – X = Extinct, CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory, Ma = Marine.

Appendix C – Fauna habitat surveys results

C1 – Hollow bearing trees assessment within the 20% design

Tree ID	Tree species	DBH (cm)	Height (m)	Hollow stem class				General comments
				<5cm	6-15cm	16-25cm	>25cm	
1	*E. moluccana*	90	13		5	2		Galahs nesting
2	*E. moluccana*	80	13		3			
3	*E. moluccana*	100	12		6	2	1	
4	*E. crebra*	100	10				1	
5	*A. leuhmanii*	35	8	3				Corvid nest
6	*E. blakelyi*	110	20		1		1	Eastern Rosella
7	*E. crebra*	60	9	1				
8	*E. crebra*	70	10		2	1		
9	*E. crebra*	90	12			1	1	
10	Stag	60	6		5			Two stems
11	*E. blakelyi*	50	12	1	1	1		
12	Stag	80	10	4	7	1	1	Stag
13	*E. crebra*	50	13	1	1	1		
14	*E. crebra*	60	13		1			
15	*E. crebra*	70	13		1			
16	*E. crebra*	60	11	1	4			
17	Stag	40	9	2	4			
18	*E. crebra*	50	11	3	1			
19	*E. crebra*	70	10	1				Bark decorticating
20	*E. crebra*	40	11				1	
21	*E. crebra*	70	15	1	1			
22	*E. crebra*	40	17		1			
23	Stag	40,30,20	5	3	13	4	1	Fissures present for bats
24	*E. moluccana*	100	9		4	2		
25	Stag	30	6	1	1		1	
26	*E. moluccana*	70	13	2	8	1		

Tree ID	Tree species	DBH (cm)	Height (m)	Hollow stem class				General comments
				<5cm	6-15cm	16-25cm	>25cm	
27	*E. moluccana*	90	12		1	1		
28	*E. moluccana*	110	9	2	4	2		
29	*E. moluccana*	50	4		2			Fissures present for bats
30	*E. crebra*	60	17		2			
31	*E. moluccana*	70	15	4	4	2	2	Beehive present
32	*E. moluccana*	60	10	2	7	1		
33	*E. moluccana*	50	13	3	11	1		
34	*E. moluccana*	40,40	10	1	6	2	1	Two stems
35	*E. crebra*	100	11		2	2		
36	*E. crebra*	80	11		1			
37	*E. crebra*	100	11		1			
38	Stag	120	10	1	5	1	2	
39	*Schinus molle* var. *areira*	35	3	6				
40	*Schinus molle* var. *areira*	20	3	2	2			
41	*Schinus molle* var. *areira*	15	2.5		2			
42	*Schinus molle* var. *areira*	20,20	3	2	2			
43	*Schinus molle* var. *areira*	40	3.5	5				
44	*Schinus molle* var. *areira*	50	3.5	4				
45	*E. blakelyi*	120	25	3	2	2	1	
46	*E. blakelyi*	85	18	2	2			Galah nest
47	*E. blakelyi*	75	18	2				Rosella and Lorikeets
48	*E. blakelyi*	75	18	5				Rosellas
49	*E. tereticornis*	110	25		2		2	
50	Stag	100	30			1	2	Potential for forest owl, no whitewash

Tree ID	Tree species	DBH (cm)	Height (m)	Hollow stem class				General comments
				<5cm	6-15cm	16-25cm	>25cm	
51	*A. floribunda*	70	20	1	1			
52	*E. blakelyi*	90	20	2	2	1		
53	*E. blakelyi*	150	25	2	2	1		
54	*E. melliodora*	110	18			1		
55	Stag	85	25		2	2		Potential for forest owl, no whitewash
56	*A. leuhmanii*	90	30		2			Parrot size
57	*E. tereticornis*	100	25	1	3			
58	*E. tereticornis*	65	30		2			Parrot size
59	*E. tereticornis*	120	20	1	1			Striated Pardalote
60	Stag	90	25	2	2			Rosella present
61	Stag	90	25	2	1	1		Potential for foret owl, no whitewash
62	*E. melliodora*	90	25		1	2		Parrot size
63	*E. melliodora*	50	15	1				
64	*E. melliodora*	73	17	1				
65	*E. grandis x red gum* (ID RBG)	138	23	1	2			
Total				**82**	**149**	**39**	**18**	

C2 – Nest assessment – Spring 2019

NEST ID[1]	Comments
1	Large mature *Eucalyptus blakelyi* tree with Corvid nest present, likely to be used by Australian Raven based on size, location and structure. This species was abundant at the location however no evidence of current usage.
2	Large mature *Eucalyptus crebra* tree with Corvid nest present, likely to be used by Australian Raven based on size, location and structure. This species was abundant at the location however no evidence of current usage.
3	Large stag with large stick nest in forked branch towards the top. Stag is surrounded by remnant vegetation in good condition. Appears to be most likely a Wedge-tailed Eagle nest based on size and presence of two mature Wedge-tailed Eagles flying overhead. No evidence of current usage.
4	Large mature *Casuarina cunninghamiana* subsp. *cunninghamiana* with small mud nest being actively used by Magpie-lark. Bird on nest appears to be sitting on eggs.
5	Small nest built from grass, bark and other light material hanging from a branch. White-throated Gerygone observed actively using the nest.
6	Rainbow Bee-eaters nesting in sandy creek banks. Population of approx. 10 birds observed foraging and entering nests.
7	Mud nest, about 20cm in diameter. Possibly being used by Magpie-lark however no evidence of current use.
8	Stick nest, approx. 40cm diameter. No evidence of current use. Likely to be used by Australian Raven or Australian Magpie based on size, location and structure.

C3 – Habitat assessments within and outside of the study area

Habitat assessment ID (20x50m)	Northing	Easting	PCT	Description	No. HBTs	Hollow sizes	Length of fallen timber	Stem classes (DBH)	Photo
HBA 1 (Outside study area)	6430324.58	303078.73	PCT 1691	Remnant Ironbark (Blossom resources) over storey and exotic understorey. Grazing impacts present. Little regeneration present.	2 x *Eucalyptus crebra*	2x10cm 2x15cm 1x20cm	21m	<5cm: 5 5-9cm: 0 10-19cm: 0 20-29cm: 1 (29cm) 30-49: 1 (32cm) 50-79cm: 0 80>cm: 2 (102,89cm)	
HBA 2 (Inside study area)	6429955.00	303392.86	PCT 1604	Remnant Greybox with Spotted Gum, and scattered Ironbark (Blossom resources) Regeneration present. Leaf litter.	1x *Eucalyptus molucanna*	2x5cm 2x10cm 2x15 1x>20cm	53m	<5cm: 8 5-9cm: 11 10-19cm: 8 20-29cm: 1 30-49cm: 1 50-79cm: 0 80>cm: 1 (99cm)	
HBA 3 (Inside study area)	6429082.27	304552.40	PCT1691	Ironbark dominant community (Blossom resources), very disturbed understorey grazed by cattle. Regrowth present. No bushrock.	1 x *Eucalyptus crebra*	1x5cm	4m	<5cm: 2 5-9cm: 2 10-19cm: 1 20-29cm: 0 30-49cm: 1 (30) 50-79cm: 2 (60,58cm) 80>cm: 0	

Habitat assessment ID (20x50m)	Northing	Easting	PCT	Description	No. HBTs	Hollow sizes	Length of fallen timber	Stem classes (DBH)	Photo
HBA 4 (Outside study area)	6428979.51	304589.04	PCT1691	Ironbark dominant with *Notelea micorcarpra* and *Lycium ferocissimum** in the understorey. Regrowth present. No bushrock.	1 x *Eucalyptus crebra*	1x 10cm	27m	<5cm: 2 5-9cm: 0 10-19cm: 10 20-29cm: 3 30-49cm: 0 50-79cm: 1 (65cm) 80>cm: 1 (86cm)	
HBA 5 (Inside study area)	6428414.36	305571.35	PCT1691	Remnant Ironbark dominated community with a grazed understorey No bushrock.	1 x *Eucalyptus crebra*	1x5cm 2x10cm	5m	<5cm: 0 5-9cm: 0 10-19cm: 1 20-29cm: 2 30-49cm: 2 50-79cm: 2 (70,78cm) 80>cm: 0	
HBA 6 (Outside study area)	6427168.65	305360.30	PCT 1691	Ironbark dominated community (with some redgum) Only one large remnant ironbark in the plot, with dense canopy regrowth.	1 x *Eucalyptus crebra*	1x10cm	6m	<5cm: 18 5-9cm: 25 10-19cm: 0 20-29cm: 0 30-49cm: 0 50-79cm: 1 (78cm) 80>cm: 0	

Habitat assessment ID (20x50m)	Northing	Easting	PCT	Description	No. HBTs	Hollow sizes	Length of fallen timber	Stem classes (DBH)	Photo
HBA 7 (Outside study area)	6427263.46	305162.95	PCT 1691	Ironbark dominated with some scattered Grey Box. Good mid storey and shrub layer but sparse groundcover on the slope.	1 x *Eucalyptus crebra*	2x5cm 1x10cm	13m	<5cm: 1 5-9cm: 5 10-19cm: 0 20-29cm: 1 30-49cm: 2 50-79cm: 1 (71cm) 80>cm;1 (80cm)	
HBA 8 (Inside study area)	6426784.62	305617.13	PCT 485	*Casuarina cunninghamiana* and *Eucalyptus blakelyi* along creekline. Aquatic habitat present. Fish sighted. Potential frog habitat.	1 x dead stag	1x 10cm 3x 15cm 1x20cm	9m	<5cm: 0 5-9cm: 2 10-19cm: 4 20-29cm: 8 30-49cm: 2 50-79cm: 1 80>cm: 0	
HBA 9 (Outside study area)	6426612.51	305970.09	PCT 485	*Casuarina cunninghamiana* and *Eucalyptus blakelyi* along creekline. Aquatic vegetation present (Juncus etc.) in creek.	1 x *Eucalyptus blakelyi*	1x5cm 1x10cm 1x15cm	19m	<5;2 5-9;5 10-19;4 20-29;7 30-49;1 50-79;0 80>;1 (105cm)	

Habitat assessment ID (20x50m)	Northing	Easting	PCT	Description	No. HBTs	Hollow sizes	Length of fallen timber	Stem classes (DBH)	Photo
HBA 10 (Inside study area)	6427096.66	305776.73	PCT 1693	Dominated by *Eucalyptus blakelyi* sparse shrubby regrowth in the understorey present.	1 x dead stag	4x5cm 2x10cm	21m	<5cm: 5 5-9cm: 8 10-19cm: 22 20-29cm: 2 30-49cm: 1 50-79cm: 1 (77) 80>cm: 0	
HBA 11 (Outside study area)	6428073.75	306104.78	PCT1693	Yellow Box and Blakely's Red Gum remnant paddock trees, within cleared paddock which has been significantly disturbed by grazing. No understorey and sparse groundcover.	1 x *Eucalyptus blakelyi* 1 x *Eucalyptus melliodora*	5x5cm 2x10cm	37m	<5cm: 0 5-9cm: 0 10-19cm: 0 20-29cm: 0 30-49cm: 0 50-79cm:0 80>cm: 2 (112, 86cm)	

Appendix D – Tests of significance

The proposal would be assessed under Part 5 Division 5.1 of the EP&A Act. Under this assessment, Section 7.3 of the BC Act requires that a test of significance is undertaken to assess the likelihood of significant impact upon threatened species, populations or ecological communities listed under the BC Act.

Assessment of habitat to be impacted upon by the proposal found that there is potential within the study area for threatened biodiversity to occur. The following species have been assessed for impacts associated with this proposal:

- Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions (includes areas of the EPBC Act listed Central Hunter Valley eucalypt forest and woodland)
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions (includes areas of the EPBC Act listed Central Hunter Valley eucalypt forest and woodland)
- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions (includes areas of EPBC ACT listed White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland)
- Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions
- *Eucalyptus camaldulensis* (River Red Gum) population in the Hunter catchment
- Threatened forest owls
  - Powerful Owl
  - Masked Owl
  - Barking owl
- Threatened woodland birds
  - Gang-Gang Cockatoo
  - Varied Sittella
  - Scarlet Robin
  - Flame Robin
  - Dusky Woodswallow
  - Brown Treecreeper (eastern subspecies)
  - Hooded Robin
  - Turquoise Parrot
  - Speckled Warbler
  - Grey-crowned Babbler
  - Diamond Firetail
- Threatened birds of prey
  - Square-tailed Kite
  - Little Eagle
  - Spotted Harrier
  - Black Falcon
  - White-bellied Sea-eagle
- Threatened blossom nomads
  - Grey-headed Flying-fox
  - Little Lorikeet
  - Swift Parrot
  - Regent Honeyeater
  - Painted Honeyeater
  - Black-chinned Honeyeater

- Threatened waterfowl
  - Australian Painted Snipe
  - Black-necked Stork
  - Freckled Duck
  - Magpie Goose
- Threatened ground-dwelling mammals
  - Spotted-tailed Quoll
- Threatened arboreal mammals
  - Squirrel Glider
  - Koala
- Hollow-dwelling yangochiropteran bats
  - Corben's Long-eared Bat
  - Eastern False Pipistrelle
  - Eastern Coastal Freetail-bat
  - Yellow-bellied Sheath-tail Bat
  - Greater Broad-nosed Bat
- Cave-dwelling yangochiropteran bats
  - Little Bent-winged Bat
  - Large Bent-winged Bat
  - Large-eared Pied Bat
  - Eastern Cave Bat
  - Southern Myotis
- White-throated Needletail
- Striped Legless Lizard.

For threatened biodiversity under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) significance assessments have been completed in accordance with the *Matters of National Environmental Significance, Significant Impact Guidelines 1.1* (Department of Environment, 2013). Species listed under both the BC Act and the EPBC Act has been assessed using both assessment guidelines separately. The following assessments were undertaken to consider impacts of works associated with the Proposal upon threatened species, populations or communities with a moderate or greater likelihood of occurring within the study area which were considered likely to be impacted by the proposal.

Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions

Status

Central Hunter Grey Box – Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions (Central Hunter Grey Box – Ironbark Woodland) is listed as an Endangered Ecological Community under the BC Act and a Critically Endangered Ecological Community under the EPBC Act.

Specific impacts

All patches of PCT 1691 and PCT 1605 recorded within the study area are considered consistent with the Central Hunter Grey Box – Ironbark Woodland threatened ecological community as they conform with the locality, floristics, landscape and geological characteristics of Central Hunter Grey Box – Ironbark Woodland as detailed in the NSW Scientific Committee Final Determination (NSW Scientific Committee, 2019a).

The proposal would require the removal of up to 52.20 ha of Central Hunter Grey Box – Ironbark Woodland from within the construction footprint. Of this, 13.81 ha occurs as low to moderate condition woodland whilst the remaining 38.39 ha occurs as derived native grasslands.

Only patches of moderate and good condition PCT 1691 and PCT 1605 meet the Critically Endangered EPBC Act listing for Central Hunter Valley eucalypt forest and woodland. Up to 8.88ha of Central Hunter Valley eucalypt forest and woodland consistent with the Critically Endangered EPBC Act listing requires removal by the proposal.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**
- **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**

Within the locality of the construction footprint (10km), 10,174ha of remnant Central Hunter Grey Box – Ironbark Woodland has been mapped by the State Vegetation Type (SVT) Mapping for the Upper Hunter (Department of Planning Industry and Environment, 2019). The proposed action would require the removal of 13.81ha of low to moderate condition remnant Central Hunter Grey Box – Ironbark Woodland which represents about 0.1% of that mapped within locality. A comparison of the 38.39ha of DNG to be cleared is unable to be made as the STV mapping only categorised DNG as broad PCT type and does not align it to any specific PCT or TEC.

Central Hunter Grey Box—Ironbark Woodland was the dominant vegetation type within the study area. All impacts to core or higher quality areas of this TEC within the study area have been avoided or minimised through detailed design. The remaining areas within the construction footprint which would be impacted upon by the proposal occur as fragmented patches of disturbed open woodland. Whilst the canopy is largely structurally intact, the midstorey and groundcover stratum of this TEC within the construction footprint is already heavily modified or absent because of past and current land uses (primarily agriculture). As such, these patches largely contained low to moderate native species and diversity.

Due to the overall disturbed nature and small proportion of Central Hunter Grey Box – Ironbark Woodland to be impacted within the locality, it is considered unlikely that the proposed action would have an adverse effect on the extent of Central Hunter Grey Box – Ironbark Woodland or substantially and adversely modify the composition of Central Hunter Grey Box – Ironbark Woodland such that its local occurrence is likely to be placed at risk of extinction.

In relation to the habitat of a threatened species, population or ecological community:

- **the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and**

Within the locality of the construction footprint (10km), 10,174ha of remnant Central Hunter Grey Box—Ironbark Woodland has been mapped by the State Vegetation Type (SVT) Mapping for the Upper Hunter (Department of Planning Industry and Environment, 2019). The proposed action would require the removal of 13.81ha of low to moderate condition remnant Central Hunter Grey Box – Ironbark Woodland which represents about 0.1% of that mapped within locality. A comparison of the 38.39ha of DNG to be cleared is unable to be made as the STV mapping only categorised DNG as broad PCT type and does not align it to any specific PCT or TEC.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

The proposed action would result in the construction of a new two lane highway. Despite the current fragmented nature of the landscape through which it would intersect, the proposed action would result in a new barrier that would likely lead to additional and incremental increases to existing fragmentation impacts on habitats within the landscape. Furthermore, the proposed action would also result in an increase in isolation of habitats as the current habitat patches would be made smaller thereby increasing the physical distance between some habitat fragments.

It is predicted that the fragmentation and isolation impacts caused by the proposed action would unlikely be enough to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches. Functional connectivity for many species would remain in the study area. However, local division of some wildlife populations, isolation of key habitat resources, loss of genetic interchange, and loss of population viability for some species may result.

The isolation that may be caused by the proposal is not likely to have an appreciable impact on nomadic or migratory species such as birds. The proposal is likely to be detrimental to the dispersal of arboreal mammals and other species including frogs and reptiles, but the effects would only be marginally greater than that which is already experienced.

The new highway would divide remaining habitats in the study area creating a new barrier which serves some restriction to fauna movements between habitat patches. However, functional habitat connectivity for more mobile species (e.g. birds, flying-foxes, insectivorous bats, insects, plants) would still remain. The roadway would not totally prevent fauna movement between habitat fragments (fauna can and likely do cross the road) as no impassable barriers such as no solid concrete median strips would be constructed which would otherwise create a considerable hazard.

Due to the current fragmented nature of the habitat within the construction footprint, no impassable barriers such as solid concrete median strips would be constructed, high quality remnants within the study area being avoided and the relatively small proportion of remnant Central Hunter Grey Box – Ironbark Woodland within the locality to be impacted, it is considered unlikely that areas of habitat would become significantly fragmented or isolated from other areas of habitat because of the proposed activity.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The extent of habitat that may be impacted represents a small proportion of remnant Central Hunter Grey Box – Ironbark Woodland within the surrounding landscape (0.1%). All impacts to core or higher quality areas of this TEC and the habitat it provides within the study area have been avoided or minimised through detailed design. The remaining areas within the construction footprint which would be impacted upon by the proposal occur as fragmented patches of disturbed open woodland. Whilst the canopy is largely structurally intact, the midstorey and groundcover stratum of this TEC within the construction footprint is already heavily modified or absent because of past and current land uses (primarily agriculture). As such, these patches largely contained low to moderate native species and diversity.

Owing to the current modified state of habitat and the relatively small extent of remnant habitat to be removed from the locality, the importance of the habitat to be removed, modified, fragmented or isolated is considered unlikely to significantly affect the long-term survival of this ecological community in the locality.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to Central Hunter Grey Box—Ironbark Woodland, the proposal has potential to directly contribute to the following key threatening process listed under the BC Act:

- Clearing of native vegetation
- Loss of hollow-bearing trees
- Removal of dead wood and trees
- Removal of bushrock.

The proposed action also has potential to indirectly contribute to the following key threatening process:

- Infection of native plants by *phytophthora cinnamomic*
- Introduction and establishment of exotic rust fungi of the order pucciniales pathogenic on plants of the family Myrtaceae
- Invasion of native plant communities by exotic perennial grasses
- Invasion, establishment and spread of lantana (*Lantana camara*).

Mitigation measures outlined in section 5.2 (Mitigation measures) of the main report have been recommended to decrease the impact of the key threatening process the proposed action may indirectly contribute to. As such, the overall contribution of the proposed action to key threatening processes listed above is not considered to be significant.

Conclusion

The proposal would require the removal of up to 52.20ha of Central Hunter Grey Box – Ironbark Woodland from within the construction footprint. Of this, 13.81ha occurs as low to moderate condition woodland whilst the remaining 38.39ha occurs as derived native grasslands. The extent of remnant habitat to be removed represents a very small proportion of similar potential habitat available within the surrounding landscape (0.1%).

This potential loss of Central Hunter Grey Box – Ironbark Woodland is considered unlikely to be significant to the maintenance of this ecological community locally, and therefore the proposed works are considered unlikely to have a significant impact which might lead to its extinction locally.

EPBC Significance Assessment – Central Hunter Valley eucalypt forest and woodland

Up to 8.88ha of Central Hunter Valley eucalypt forest and woodland consistent with the Critically Endangered EPBC Act listing requires removal by the proposal.

An action is likely to have a significant impact on a Critically Endangered or Endangered ecological community if there is a real chance or possibility that it will:

- **Reduce the extent of an ecological community.**

The proposed activity would require the removal of up to 8.88ha of native vegetation consistent with the Central Hunter Valley eucalypt forest and woodland TEC protected under the EPBC Act.

Within the locality of the construction footprint (10km), 12,718ha of remnant PCTs which have potential to align to the Central Hunter Valley eucalypt forest and woodland TEC has been mapped by the State Vegetation Type (SVT) Mapping for the Upper Hunter (Department of Planning Industry and Environment, 2019). The removal of 8.88ha represents about 0.1% of that mapped within locality.

Due to the overall disturbed nature and small proportion of Central Hunter Valley Eucalypt forest and woodland to be impacted within the locality, it is considered unlikely that the proposed action would have an adverse effect on the extent of the TEC or substantially and adversely modify the composition of the TEC such that its local occurrence is likely to be placed at risk of extinction.

- **Fragment or increase fragmentation of an ecological community, for example by clearing native vegetation for roads or transmission lines.**

The proposed action would result in the construction of a new two lane highway. Despite the current fragmented nature of the landscape through which it would intersect, the proposed action would result in a new barrier that would likely lead to additional and incremental increases to existing fragmentation impacts on habitats within the landscape.

It is predicted that the fragmentation impacts caused by the proposed action would unlikely be enough to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches. Functional connectivity for many species would remain in the study area. However, local dispersion of some wildlife populations, isolation of key habitat resources, loss of genetic interchange, and loss of population viability for some species.

The new highway would divide remaining habitats in the study area creating a new barrier which serves some restriction to fauna movements between habitat patches. However, functional habitat connectivity for more mobile species (e.g. birds, flying-foxes, insectivorous bats, insects, plants) would still remain. The roadway would not totally prevent fauna movement between habitat fragments (fauna can and likely do cross the road) as no impassable barriers such as no solid concrete median strips would be constructed which would otherwise create a considerable hazard.

Due to the current fragmented nature of the habitat within the construction footprint, no impassable barriers such as solid concrete median strips would be constructed, high quality remnants within the study area being avoided and the relatively small proportion of remnant Central Hunter Valley eucalypt forest and woodland within the locality to be impacted, it is considered unlikely that the proposed action would have a significant impact on ecological processes to affect the viability of the local occurrence of the community.

- **Adversely affect habitat critical to the survival of an ecological community.**

As per Section 1.5.4.7 of the Conservation Advice for Central Hunter Valley eucalypt forest and woodland all areas that meet the minimum (Moderate quality condition class) condition thresholds, or are within the buffer zone, are considered critical to the survival of the TEC. All moderate and good condition patches of PCT 1691 and PCT 1605 to be impacted by the proposed activity is therefore classified as habitat critical to the survival of the TEC.

Within the locality of the construction footprint (10km), 12,718ha of remnant PCTs which have potential to align to critical habitat of Central Hunter Valley eucalypt forest and woodland TEC has been mapped by the State Vegetation Type (SVT) Mapping for the Upper Hunter (Department of Planning Industry and Environment, 2019). The removal of 8.88ha represents about 0.1% of that mapped within locality.

The proposed activity would remove 8.88ha of Central Hunter Valley Eucalypt forest and woodland which constitutes habitat critical to the survival of the TEC. Whilst the proposal would remove an area of this habitat it is a relatively small proportion of that which occurs in the locality and broader region (0.1%). Given the existing modified nature of the community within the construction footprint and the relatively small proportion to be removed from the locality it is considered unlikely that the proposed action would have an adverse effect on the extent of critical habitat or substantially and adversely modify the composition of habitat critical to the TEC such that its local occurrence is likely to be placed at risk of extinction.

- **Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.**

Though the proposed activity would modify the soil profile in the areas that require clearing of vegetation, this impact is unlikely to significantly modify abiotic factors such as the soil profile, groundwater levels of surface water drainage patterns necessary to the survival of remaining Central Hunter Valley eucalypt forest and woodland surrounding the study area.

- **Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.**

Central Hunter Valley eucalypt forest and woodland within the study area is located proximate to urban development, mining land use and agricultural lands. As such, the Central Hunter Valley eucalypt forest and woodland recorded is subject to associated edge effects and a disturbed state. Whilst the referred action may introduce edge effects to the remaining Central Hunter Valley eucalypt forest and woodland within the study area, these would be reduced and managed through recommended mitigation measures.

The referred action does not involve actions that would significantly change the existing disturbance regime such as the intensity or frequency of fires, the intensity or frequency of floods, or flora/fauna harvesting.

The proposed activity is considered unlikely to cause a substantial change in the species composition or occurrence of Central Hunter Valley eucalypt forest and woodland.

Will the action cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

- **Assisting invasive species, that are harmful to the listed ecological community, to become established.**
- **Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.**

The proposed activity has potential to result in minor increases in the establishment, density or diversity of weed species. The Central Hunter Valley eucalypt forest and woodland which occurs in the construction footprint also occurs within the broader locality and region which is surrounded and influenced by urban development, mining, agriculture and roads and as such subject to edge effects resulting in invasive species.

As such, the proposed activity is unlikely to exacerbate invasive species such that it would substantially reduce the quality or integrity of the community's occurrence. The proposal does not involve other processes that are likely to reduce the quality or integrity of Central Hunter Valley eucalypt forest and woodland other than those described above.

Interfere with the recovery of the ecological community

There is no recovery plan under the EPBC Act for Central Hunter Valley eucalypt forest and woodland. There are however several recovery and threat abatement actions detailed in the TEC's approved conservational advice. These actions have been taken into consideration during the preliminary investigations and design phases to ensure the proposal does not significantly impact the TEC. Key actions adhered to by the proposed activity include:

- Avoidance and minimisation of clearing the TEC and surrounding vegetation, priority was given to areas that contained older growth forest, were of higher quality, contained hollow-bearing trees and provided key connectivity values for the locality
- Implementation of effective control and management techniques for invasive species
- Control of run-off to prevent infiltration of litter, dispersal of weeds and eutrophication
- Retaining and relocating habitat resources such as fallen logs to adjacent areas.

It is considered unlikely that proposed activity would significantly interfere with any of the recovery actions detailed in the conservation advice.

Conclusion

The proposed activity would impact on 8.88ha of Central Hunter Valley eucalypt forest and woodland. The removal of 8.88ha represents about 0.1% of that mapped within locality.

The ecological community is unlikely to be significantly impacted by the proposed action.

Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions

Status

Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions (Central Hunter Ironbark – Spotted Gum – Grey Box Forest) is listed as an Endangered Ecological Community under the BC Act and listed as a Critically Endangered Ecological Community under the EPBC Act.

Specific impacts

All patches of PCT 1604 recorded within the study area are considered consistent with the Central Hunter Ironbark—Spotted Gum—Grey Box Forest threatened ecological community as they conform with the locality, floristics, landscape and geological characteristics of Central Hunter Ironbark—Spotted Gum—Grey Box Forest as detailed in the NSW Scientific Committee Final Determination (NSW Scientific Committee, 2019b).

The proposal would require the removal of up to 0.67 ha of Central Hunter Ironbark—Spotted Gum—Grey Box Forest from within the construction footprint. Within the study area this TEC occurred in a modified condition due to past and current land uses.

No patches of PCT 1604 within the study area met the Critically Endangered EPBC Act listing for Central Hunter eucalypt forest and woodland.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**
- **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**

Within the locality of the construction footprint (10km), 2,528ha of remnant Central Hunter Ironbark—Spotted Gum—Grey Box Forest has been mapped by the State Vegetation Type (SVT) Mapping for the Upper Hunter (Department of Planning Industry and Environment, 2019). The proposed action would require the removal of 0.67ha of moderate condition remnant Central Hunter Ironbark—Spotted Gum—Grey Box Forest which represents about 0.03% of that mapped within locality.

Central Hunter Ironbark—Spotted Gum—Grey Box Forest occurred in small patches along the New England Highway at the south of the study area and towards the north of Muswellbrook Coal mine lease. All impacts to core or higher quality areas of this TEC within the study area have been avoided or minimised through detailed design. The remaining areas within the construction footprint which would be impacted upon by the proposal occur as fragmented patches of disturbed open woodland. Whilst the canopy is largely structurally intact, the midstorey and groundcover stratum of this TEC within the construction footprint is already heavily modified or absent because of past and current land uses (primarily agriculture). As such, these patches largely contained low to moderate native species and diversity.

Due to the overall disturbed nature and small proportion of Central Hunter Ironbark—Spotted Gum—Grey Box Forest to be impacted within the locality, it is considered unlikely that the proposed action would have an adverse effect on the extent of Central Hunter Ironbark—Spotted Gum—Grey Box Forest or substantially and adversely modify the composition of Central Hunter Ironbark—Spotted Gum—Grey Box Forest such that its local occurrence is likely to be placed at risk of extinction.

In relation to the habitat of a threatened species, population or ecological community:

- **the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and**

Within the locality of the construction footprint (10km), 2,528ha of remnant Central Hunter Ironbark—Spotted Gum—Grey Box Forest has been mapped by the State Vegetation Type (SVT) Mapping for the Upper Hunter (Department of Planning Industry and Environment, 2019). The proposed action would require the removal of 0.67ha of moderate condition remnant Central Hunter Ironbark—Spotted Gum—Grey Box Forest which represents about 0.03% of that mapped within locality.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

The proposed action would result in the construction of a new two lane highway. Despite the current fragmented nature of the landscape through which it would intersect, the proposed action would result in a new barrier that would likely lead to additional and incremental increases to existing fragmentation impacts on habitats within the landscape. Furthermore, the proposed action would also result in an increase in isolation of habitats as the current habitat patches would be made smaller thereby increasing the physical distance between some habitat fragments.

It is predicted that the fragmentation and isolation impacts caused by the proposed action would unlikely be enough to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches of the TEC. Functional connectivity for many species would remain in the study area. However, local division of some wildlife populations, isolation of key habitat resources, loss of genetic interchange, and loss of population viability for some species may result.

The isolation that may be caused by the proposal is not likely to have an appreciable impact on nomadic or migratory species such as birds. The proposal is likely to be detrimental to the dispersal of arboreal mammals and other species including frogs and reptiles, but the effects would only be marginally greater than that which is already experienced.

The new highway would divide remaining habitats in the study area creating a new barrier which serves some restriction to fauna movements between habitat patches. However, functional habitat connectivity for more mobile species (e.g. birds, flying-foxes, insectivorous bats, insects, plants) would still remain. The roadway would not totally prevent fauna movement between habitat fragments (fauna can and likely do cross the road) as no impassable barriers such as no solid concrete median strips would be constructed which would otherwise create a considerable hazard.

Due to the current fragmented nature of the TEC habitat within the construction footprint, no impassable barriers such as solid concrete median strips would be constructed, high quality remnants within the study area being avoided and the relatively small proportion of remnant Central Hunter Grey Box – Ironbark Woodland within the locality to be impacted, it is considered unlikely that areas of habitat would become significantly fragmented or isolated from other areas of habitat because of the proposed activity.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The extent of habitat that may be impacted represents a small proportion of Central Hunter Ironbark—Spotted Gum—Grey Box Forest within the surrounding landscape (0.03%). The areas within the construction footprint which would be impacted upon by the proposal occur as fragmented patches of disturbed open woodland. Whilst the canopy is largely structurally intact, the midstorey and groundcover stratum of this TEC within the construction footprint is already heavily modified or absent because of past and current land uses (primarily agriculture). As such, these patches largely contained low to moderate native species and diversity.

Owing to the current modified state of habitat and the relatively small extent of remnant habitat to be removed from the locality, the importance of the habitat to be removed, modified, fragmented or isolated is considered unlikely to significantly affect the long-term survival of this ecological community in the locality.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to Central Hunter Ironbark—Spotted Gum—Grey Box Forest, the proposal has potential to directly contribute to the following key threatening process listed under the BC Act:

- Clearing of native vegetation
- Loss of hollow-bearing trees
- Removal of dead wood and trees
- Removal of bushrock.

The proposed action also has potential to indirectly contribute to the following key threatening process:

- Infection of native plants by *phytophthora cinnamomic*
- Introduction and establishment of exotic rust fungi of the order pucciniales pathogenic on plants of the family Myrtaceae
- Invasion of native plant communities by exotic perennial grasses
- Invasion, establishment and spread of lantana (*Lantana camara*).

Mitigation measures outlined in section 5.2 (Mitigation measures) of the main report have been recommended to decrease the impact of the key threatening process the proposed action may indirectly contribute to. As such, the overall contribution of the proposed action to key threatening processes listed above is not considered to be significant.

Conclusion

The proposal would require the removal of up to 0.67ha of Central Hunter Ironbark—Spotted Gum—Grey Box Forest from within the construction footprint. The extent of remnant habitat to be removed represents a very small proportion of similar potential habitat available within the surrounding landscape (0.03%).

This potential loss of Central Hunter Ironbark—Spotted Gum—Grey Box Forest is considered unlikely to be significant to the maintenance of this ecological community locally, and therefore the proposed works are considered unlikely to have a significant impact which might lead to its extinction locally.

White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Status

White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland is listed as Critically Endangered under the BC Act and EPBC Act.

Specific impacts

All patches of PCT 1607 and PCT 1693 recorded within the study area are considered consistent with the White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland threatened ecological community as they conform with the locality, floristics, landscape and geological characteristics of White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland as detailed in the NSW Scientific Committee Final Determination (NSW Threatened Species Scientific Committee, 2020).

The proposal would require the removal of up to 37.95ha of White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland from within the construction footprint. Of this, 5.74ha occurs as low (remnant) to good condition woodland whilst the remaining 32.21ha occurs as derived native grasslands.

Only patches of moderate and good condition PCT 1607 and PCT 1693 meet the Critically Endangered EPBC Act listing for White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland. Up to 0.58ha of White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland consistent with the Critically Endangered EPBC Act listing requires removal by the proposal.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**
- **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**

Within the locality of the construction footprint (10km), 2,544ha of remnant White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland has been mapped by the State Vegetation Type (SVT) Mapping for the Upper Hunter (Department of Planning Industry and Environment, 2019). The proposed action would require the removal of 5.74ha of low (remnant) to moderate condition remnant White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland which represents about 0.2% of that mapped within locality. A comparison of the 32.21ha of DNG to be cleared is unable to be made as the STV mapping only categorised DNG as broad PCT type and does not align it to any specific PCT or TEC.

White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland occurred predominantly within the southern half of the study area within and around the floodplain of Muscle Creek. All impacts to core or higher quality areas of this TEC within the study area have been avoided or minimised through detailed design. The remaining areas within the construction footprint which would be impacted upon by the proposal occur as fragmented patches of disturbed open woodland. Whilst the canopy is largely structurally intact, the midstorey and groundcover stratum of this TEC within the construction footprint is already heavily modified or absent because of past and current land uses (primarily agriculture). As such, these patches largely contained low to moderate native species and diversity.

Due to the overall disturbed nature and small proportion of White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland to be impacted within the locality, it is considered unlikely that the proposed action would have an adverse effect on the extent of White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland or substantially and adversely modify the composition of Central Hunter Grey Box – Ironbark Woodland such that its local occurrence is likely to be placed at risk of extinction.

In relation to the habitat of a threatened species, population or ecological community:

- **the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and**

Within the locality of the construction footprint (10km), 2,544ha of remnant White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland has been mapped by the State Vegetation Type (SVT) Mapping for the Upper Hunter (Department of Planning Industry and Environment, 2019). The proposed action would require the removal of 5.74ha of low (remnant) to moderate condition remnant White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland which represents about 0.2% of that mapped within locality. A comparison of the 32.21ha of DNG to be cleared is unable to be made as the STV mapping only categorised DNG as broad PCT type and does not align it to any specific PCT or TEC.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

The proposed action would result in the construction of a new two lane highway. Despite the current fragmented nature of the landscape through which it would intersect, the proposed action would result in a new barrier that would likely lead to additional and incremental increases to existing fragmentation impacts on this TEC's habitats within the landscape. Furthermore, the proposed action would also result in an increase in isolation of habitats as the current habitat patches would be made smaller thereby increasing the physical distance between some habitat fragments.

It is predicted that the fragmentation and isolation impacts caused by the proposed action would unlikely be enough to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches. Functional connectivity for many species would remain in the study area. However, local division of some wildlife populations, isolation of key habitat resources, loss of genetic interchange, and loss of population viability for some species may result.

The isolation that may be caused by the proposal is not likely to have an appreciable impact on nomadic or migratory species such as birds. The proposal is likely to be detrimental to the dispersal of arboreal mammals and other species including frogs and reptiles, but the effects would only be marginally greater than that which is already experienced.

The new highway would divide remaining habitats in the study area creating a new barrier which serves some restriction to fauna movements between habitat patches. However, functional habitat connectivity for more mobile species (e.g. birds, flying-foxes, insectivorous bats, insects, plants) would still remain. The roadway would not totally prevent fauna movement between habitat fragments (fauna can and likely do cross the road) as no impassable barriers such as no solid concrete median strips would be constructed which would otherwise create a considerable hazard.

Due to the current fragmented nature of the habitat within the construction footprint, no impassable barriers such as solid concrete median strips would be constructed, high quality remnants within the study area being avoided and the relatively small proportion of remnant White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grassland within the locality to be impacted, it is considered unlikely that areas of habitat would become significantly fragmented or isolated from other areas of habitat because of the proposed activity.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The extent of habitat that may be impacted represents a small proportion of remnant White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grasslands within the surrounding landscape (about 0.2%).

All impacts to core or higher quality areas of this TEC and the habitat it provides within the study area have been avoided or minimised through detailed design. The remaining areas within the construction footprint which would be impacted upon by the proposal occur as fragmented patches of disturbed open woodland and areas of DNG. Whilst the canopy is largely structurally intact in areas of remnant vegetation, the midstorey and groundcover stratum within the construction footprint is already heavily modified or absent because of past and current land uses (primarily agriculture). As such, both remnant and DNG patches largely contained low to moderate native species and diversity.

Owing to the current modified state of habitat and the relatively small extent of remnant habitat to be removed from the locality, the importance of the habitat to be removed, modified, fragmented or isolated is considered unlikely to significantly affect the long-term survival of this ecological community in the locality.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grasslands, the proposal has potential to directly contribute to the following key threatening process listed under the BC Act:

- Clearing of native vegetation
- Loss of hollow-bearing trees
- Removal of dead wood and trees
- Removal of bushrock.

The proposed action also has potential to indirectly contribute to the following key threatening process:

- Infection of native plants by *phytophthora cinnamomic*
- Introduction and establishment of exotic rust fungi of the order pucciniales pathogenic on plants of the family Myrtaceae
- Invasion of native plant communities by exotic perennial grasses
- Invasion, establishment and spread of lantana (*Lantana camara*).

Mitigation measures outlined in section 5.2 (Mitigation measures) of the main report have been recommended to decrease the impact of the key threatening process the proposed action may indirectly contribute to. As such, the overall contribution of the proposed action to key threatening processes listed above is not considered to be significant.

Conclusion

The proposal would require the removal of up to 37.95ha of White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grasslands from within the construction footprint. Of this, 5.74ha occurs as low (remnant) to moderate condition woodland whilst the remaining 32.21ha occurs as derived native grasslands. The extent of remnant habitat to be removed represents a very small proportion of similar remnant potential habitat available within the surrounding landscape (about 0.2%).

This potential loss of White Box – Yellow Box – Blakely's Red Gum Woodland and Derived Native Grasslands is considered unlikely to be significant to the maintenance of this ecological community locally, and therefore the proposed works are considered unlikely to have a significant impact which might lead to its extinction locally.

EPBC Significance Assessment – White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Up to 0.58ha of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands consistent with the Critically Endangered EPBC Act listing requires removal by the proposal.

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

- **Reduce the extent of an ecological community**
- **Fragment or increase fragmentation of an ecological community, for example by clearing native vegetation for roads or transmission lines.**

The proposed action would result in the construction of a new two lane highway. Despite the current fragmented nature of the landscape through which it would intersect, the proposed action would result in a new barrier that would likely lead to additional and incremental increases to existing fragmentation impacts on habitats within the landscape.

It is predicted that the fragmentation impacts caused by the proposed action would unlikely be enough to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches. Functional connectivity for many species would remain in the study area. However, local dispersion of some wildlife populations, isolation of key habitat resources, loss of genetic interchange, and loss of population viability for some species.

The new highway would divide remaining habitats in the study area creating a new barrier which serves some restriction to fauna movements between habitat patches. However, functional habitat connectivity for more mobile species (e.g. birds, flying-foxes, insectivorous bats, insects, plants) would still remain. The roadway would not totally prevent fauna movement between habitat fragments (fauna can and likely do cross the road) as no impassable barriers such as no solid concrete median strips would be constructed which would otherwise create a considerable hazard.

Due to the current fragmented nature of the habitat within the construction footprint, no impassable barriers such as solid concrete median strips would be constructed, high quality remnants within the study area being avoided and the relatively small proportion of remnant White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands within the locality to be impacted, it is considered unlikely that the proposed action would have a significant impact on ecological processes to affect the viability of the local occurrence of the community.

- **Adversely affect habitat critical to the survival of an ecological community.**

As per Section 4.2 of the White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands National Recovery Plan all areas that meet the minimum condition thresholds for the EPBC Act listing TEC should be considered critical to the survival of the ecological community. All moderate and good condition patches of PCT 1693 and PCT 1607 to be impacted by the proposed activity is therefore classified as habitat critical to the survival of the TEC.

Within the locality of the construction footprint (10km), 2,544ha of remnant PCTs which have potential to align to critical habitat of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands TEC has been mapped by the State Vegetation Type (SVT) Mapping for the Upper Hunter (Department of Planning Industry and Environment, 2019). The removal of 0.58ha represents about 0.02% of that mapped within locality.

The proposed activity would remove 0.58ha of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands which constitutes habitat critical to the survival of the TEC. Whilst the proposal would remove an area of this habitat it is a relatively small proportion of that which occurs in the locality and broader region (about 0.02%). Given the existing modified nature of the community within the construction footprint and the relatively small proportion to be removed from the locality it is considered unlikely that the proposed action would have an adverse effect on the extent of critical habitat or substantially

and adversely modify the composition of habitat critical to the TEC such that its local occurrence is likely to be placed at risk of extinction.

- **Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.**

Though the proposed activity would modify the soil profile in the areas that require clearing of vegetation, this impact is unlikely to significantly modify abiotic factors such as the soil profile, groundwater levels of surface water drainage patterns necessary to the survival of remaining White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands surrounding the study area.

- **Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.**

White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands within the study area is located proximate to urban development, mining land use and agricultural lands. As such, the White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands recorded is subject to associated edge effects and a disturbed state. Whilst the referred action may introduce edge effects to the remaining White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands within the study area, these would be reduced and managed through recommended mitigation measures.

The referred action does not involve actions that would significantly change the existing disturbance regime such as the intensity or frequency of fires, the intensity or frequency of floods, or flora/fauna harvesting.

The proposed activity is considered unlikely to cause a substantial change in the species composition or occurrence of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands.

Will the action cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

- **Assisting invasive species, that are harmful to the listed ecological community, to become established**
- **Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.**

The proposed activity has potential to result in minor increases in the establishment, density or diversity of weed species. The White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands which occurs in the construction footprint also occurs within the broader locality and region which is surrounded and influenced by urban development, mining, agriculture and roads and as such subject to edge effects resulting in invasive species.

As such, the proposed activity is unlikely to exacerbate invasive species such that it would substantially reduce the quality or integrity of the community's occurrence. The proposal does not involve other processes that are likely to reduce the quality or integrity of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands other than those described above.

Interfere with the recovery of the ecological community

There is recovery under the EPBC Act for White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland. The proposed action is likely to interfere with one recovery action for the TEC being '*achieving no net loss in extent and condition of the ecological community throughout its geographical range'*. The proposal would result in the reduction of 0.58ha of the TEC.

Conclusion

The proposed activity would impact on 0.58ha of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grasslands. The removal of 0.58ha represents about 0.02% of that mapped within locality.

The ecological community is unlikely to be significantly impacted by the proposed action.

Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions

Status

Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions (Hunter Floodplain Red Gum Woodland) is listed as an Endangered Ecological Community under the BC Act. This ecological community is not a listed threatened entity under the EPBC Act.

Specific impacts

All patches of PCT 42 recorded within the study area are considered consistent with the Hunter Floodplain Red Gum Woodland threatened ecological community as they conform with the locality, floristics, landscape and geological characteristics of Hunter Floodplain Red Gum Woodland as detailed in the NSW Scientific Committee Final Determination (NSW Scientific Commitee, 2019).

The proposal would require the removal of up to 3.46ha of Hunter Floodplain Red Gum Woodland from within the construction footprint. Of this, 0.08ha occurs as remnant woodland whilst the remaining 3.38ha occurs as derived native grasslands. Within the study area this TEC occurred in a highly modified condition due to past and current land uses.

Hunter Floodplain Red Gum Woodland is not consistent with any EPBC Act listed threatened ecological community.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Not applicable

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**
- **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**

Within the locality of the construction footprint (10km), 378.7ha of remnant Hunter Floodplain Red Gum Woodland has been mapped by the State Vegetation Type (SVT) Mapping for the Upper Hunter (Department of Planning Industry and Environment, 2019). The proposed action would require the removal of 0.08ha of low (remnant) condition Hunter Floodplain Red Gum Woodland which represents about 0.02% of that mapped within locality. A comparison of the 3.38ha of DNG to be cleared is unable to be made as the STV mapping only categorised DNG as broad PCT type and does not align it to any specific PCT or TEC.

Hunter Floodplain Red Gum Woodland occurred in small patches along the floodplain of Muscle Creek towards the south of the study area. Impacts to higher quality areas of this TEC within the study area have been avoided or minimised through detailed design. The remaining areas within the construction footprint which would be impacted upon by the proposal occur as fragmented patches of disturbed open woodland. Whilst the canopy is largely structurally intact, the midstorey and groundcover stratum of this TEC within the construction footprint is already heavily modified or absent because of past and current land uses (primarily agriculture). As such, these patches largely contained low diversity of native species.

Due to the overall disturbed nature and small proportion of Hunter Floodplain Red Gum Woodland to be impacted within the locality, it is considered unlikely that the proposed action would have an adverse effect on the extent of Hunter Floodplain Red Gum Woodland or substantially and adversely modify the composition of Hunter Floodplain Red Gum Woodland such that its local occurrence is likely to be placed at risk of extinction.

In relation to the habitat of a threatened species, population or ecological community:

- **the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and**

Within the locality of the construction footprint (10km), 378.7ha of remnant Hunter Floodplain Red Gum Woodland has been mapped by the State Vegetation Type (SVT) Mapping for the Upper Hunter (Department of Planning Industry and Environment, 2019). The proposed action would require the removal of 0.08ha of low (remnant) condition Hunter Floodplain Red Gum Woodland which represents about 0.02% of that mapped within locality. A comparison of the 3.38ha of DNG to be cleared is unable to be made as the STV mapping only categorised DNG as broad PCT type and does not align it to any specific PCT or TEC.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

The proposed action would result in the construction of a new two lane highway. Despite the current fragmented nature of the landscape through which it would intersect, the proposed action would result in a new barrier that would likely lead to additional and incremental increases to existing fragmentation impacts on habitats within the landscape. Furthermore, the proposed action would also result in an increase in isolation of habitats as the current habitat patches would be made smaller thereby increasing the physical distance between some habitat fragments.

It is predicted that the fragmentation and isolation impacts caused by the proposed action would unlikely be enough to prevent the breeding and dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches of the TEC. Functional connectivity for many species would remain in the study area. However, local division of some wildlife populations, isolation of key habitat resources, loss of genetic interchange, and loss of population viability for some species may result.

The isolation that may be caused by the proposal is not likely to have an appreciable impact on nomadic or migratory species such as birds. The proposal is likely to be detrimental to the dispersal of arboreal mammals and other species including frogs and reptiles, but the effects would only be marginally greater than that which is already experienced due to the highly modified nature of the TEC.

The new highway would divide remaining habitats in the study area creating a new barrier which serves some restriction to fauna movements between habitat patches. However, functional habitat connectivity for more mobile species (e.g. birds, flying-foxes, insectivorous bats, insects, plants) would still remain. The roadway would not totally prevent fauna movement between habitat fragments (fauna can and likely do cross the road) as no impassable barriers such as no solid concrete median strips would be constructed which would otherwise create a considerable hazard.

Due to the current fragmented nature of the TEC habitat within the construction footprint, no impassable barriers such as solid concrete median strips would be constructed, higher quality remnants within the study area being avoided and the relatively small proportion of remnant Hunter Floodplain Red Gum Woodland within the locality to be impacted, it is considered unlikely that areas of habitat would become significantly fragmented or isolated from other areas of habitat because of the proposed activity.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The extent of habitat that may be impacted represents a small proportion of Hunter Floodplain Red Gum Woodland within the surrounding landscape (0.02%). The areas within the construction footprint which would be impacted upon by the proposal occur as fragmented patches of disturbed open woodland. Whilst the canopy is largely structurally intact, the midstorey and groundcover stratum of this TEC within the construction footprint is already heavily modified or absent because of past and current land uses (primarily agriculture). As such, these patches largely contained low to moderate native species and diversity.

Owing to the current modified state of habitat and the relatively small extent of remnant habitat to be removed from the locality, the importance of the habitat to be removed, modified, fragmented or isolated is considered unlikely to significantly affect the long-term survival of this ecological community in the locality.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to Hunter Floodplain Red Gum Woodland, the proposal has potential to directly contribute to the following key threatening process listed under the BC Act:

- Clearing of native vegetation
- Loss of hollow-bearing trees
- Removal of dead wood and trees
- Removal of bushrock.

The proposed action also has potential to indirectly contribute to the following key threatening process:

- Infection of native plants by *phytophthora cinnamomic*
- Introduction and establishment of exotic rust fungi of the order pucciniales pathogenic on plants of the family Myrtaceae
- Invasion of native plant communities by exotic perennial grasses
- Invasion, establishment and spread of lantana (*Lantana camara*).

Mitigation measures outlined in section 5.2 (Mitigation measures) of the main report have been recommended to decrease the impact of the key threatening process the proposed action may indirectly contribute to. As such, the overall contribution of the proposed action to key threatening processes listed above is not considered to be significant.

Conclusion

The proposal would require the removal of up to 3.46ha of Hunter Floodplain Red Gum Woodland from within the construction footprint. Of this, 0.08ha occurs as remnant woodland whilst the remaining 3.38ha occurs as derived native grasslands. The extent of remnant habitat to be removed represents a very small proportion of similar potential habitat available within the surrounding landscape (0.02%).

This potential loss of Hunter Floodplain Red Gum Woodland is considered unlikely to be significant to the maintenance of this ecological community locally, and therefore the proposed works are considered unlikely to have a significant impact which might lead to its extinction locally.

Eucalyptus camaldulensis (River Red Gum)

Status

Eucalyptus camaldulensis (River Red Gum) is listed as an Endangered Population under the BC Act within the Hunter catchment. This species is not a listed threatened entity under the EPBC Act.

Specific impacts

The proposed action would not require the direct removal of any *Eucalyptus camaldulensis* individuals. Impacts to the species would be limited to potential indirect impacts associated with the construction of the proposal given the population's proximity to temporary construction ancillary structures.

The population occurred in low (remnant) condition PCT 42 which is subject to existing edge effects, genetic barriers and fragmentation impacts associated with past and current land uses including agriculture, urban development, rail and road carriageways and mining.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity 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.

Eucalyptus camaldulensis is a tree species which can grow to 30 metres tall. The species can flower most years from late spring to mid-summer. Whilst flowering intensity per year is unpredictable and about 45% of flowers fail to reach maturity the species has potential to produce a high volume of flowers and seeds. The flowers are largely pollinated by birds but are also to a lesser extent pollinated by birds and small mammals. Once pollinated the seeds can take up to six months to reach maturity before they are released from the capsule (CSIRO, 2004).

The impacts of the proposed action would be limited to potential indirect impacts associated with the construction of the proposal. The habitat in which the species is growing habitat is exposed to existing factors such as edge effects, genetic barriers and fragmentation impacts associated past and current land uses.

The potential impacts which could result from the proposed action is not likely to be enough to prevent the dispersal of plant pollinators or the dispersal of plant propagules (i.e. seed or other vegetative reproductive material) between habitat patches. The proposed action is considered unlikely to lead to a significant effect on processes such as pollination, seed dispersal and recruitment of the species which could affect the breeding of any population of these species in the study area such that it would place the species at risk of extinction.

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**
- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

- **the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and**

The proposed action would not require the direct removal of any *Eucalyptus camaldulensis* individuals. Impacts to the species would be limited to potential indirect impacts associated with the construction of the proposal given the populations proximity to temporary construction ancillary structures.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

No direct impacts on the population are proposed and as such the population itself would not be fragmented or isolated. The proposed action would however incrementally increase existing fragmentation impacts on suitable habitat for the population within the vicinity of the population via the construction of a new bridge over Muscle Creek.

The extent of suitable habitat within the study area and surrounding landscape is already subjected to fragmentation impacts associated with past and current land practices (primarily agriculture and road and rail infrastructure). Furthermore, there is an existing bridge over Muscle Creek at this location. The proposed action would involve the removal of the existing bridge and the construction of a new concrete bridge which would be greater in width. This incremental increase is in width and separation of remnant habitat patches would remain via connectivity of water along Muscle Creek under the bridge.

Given the above, the proposed action is considered unlikely to result in areas of habitat becoming fragmented or isolated such that it would have a significant impact on the population.

- **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.**

Impacts to the population would be limited to potential indirect impacts associated with the construction of the proposal given the population's location to ancillary construction facilities structures.

Given the context of the habitat to be potentially modified is subject to existing edge effects, fragmentation and barriers which occur within the surrounding landscape and the extent of higher quality habitat in conservation reserves adjoining the study area, the importance of the habitat to be potentially modified is considered unlikely to significantly affect the long-term survival of this ecological community in the locality.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to the *Eucalyptus camaldulensis*, the proposed action is considered likely to directly contribute to one key threatening processes listed under the BC Act; being '*clearing of native vegetation'*. The proposed action also has potential to indirectly contribute to key threatening processes associated with introduction, invasion and spread of weeds and pests. Mitigation measures outlined in section 5.2 (Mitigation measures) of the main report have been recommended to minimise these indirect impacts.

As such, the overall contribution of the proposed action to key threatening processes listed above is likely to be minimal.

Conclusion

The proposal would not directly impact any *Eucalyptus camaldulensis* individuals. Potential impacts to the species would be limited to indirect impacts associated with the construction of the proposal.

Furthermore, habitat adjoining the construction footprint is already subject to existing edge effects, genetic barriers and fragmentation impacts associated with past and current land uses including agriculture, urban development, rail and road carriageways and mining.

Due to the above, the proposed action is not considered likely to have a significant impact upon this Endangered Population, which might lead to its extinction locally.

Threatened forest owls

Status

Powerful Owl (*Ninox strenua*) listed as Vulnerable under the BC Act

Masked Owl (*Tyto novaehollandiae novaehollandiae*) listed as Vulnerable under the BC Act

Barking Owl (*Ninox connivens*) listed as Vulnerable under the BC Act.

Specific impact

Fauna habitat assessments conducted assessed the likelihood of Powerful Owl, Masked Owl and Barking Owl occurring in the study area as moderate. The proposal would result in the removal of 42 hollow-bearing trees, of which 25 contain large hollows (>25cm DBH) and up to 97.92ha of potential habitat for these species which is likely utilised on an intermittent basis as part of a far larger home range of local individuals. Of the 97.92ha of habitat to be impacted, 75.66ha occurs as DNG and 22.26ha occurs as remnant vegetation.

Although hollow-bearing trees that are of sufficient size and density to provide suitable breeding habitat for the large forest owls were recorded, no suitable nesting trees were identified as being actively used by these species during the targeted surveys. As such, the proposal is considered likely to be limited to impacts on foraging habitat for this species, and breeding habitat is not considered further.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity 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.

About 97.92ha of potential foraging habitat would be affected by the proposed action. Although, the construction footprint has habitat attributes which may support a moderate density of prey species, the ability of the construction footprint to support these species is not considered likely to be reduced to the extent that a significant adverse effect might be brought to bear upon local populations of either the Powerful Owl, Masked Owl or Barking Owl.

It is likely that these three threatened owl species intermittently utilise the construction footprint whilst foraging within the greater locality, as such, they would not be reliant on the habitat within the construction footprint for local populations to persist.

Although the proposed action would cause a small incremental loss of foraging habitat for these species, it is unlikely that the proposed action would significantly reduce the viability of local populations as breeding habitat was not recorded.

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**

Not applicable.

- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community: the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposal would remove up to 97.92ha of potential large forest owl foraging habitat, which is considered unlikely to be of significant importance in relation to the large home ranges these species would maintain.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

The proposal would remove up to 97.92ha of potential large forest owl foraging habitat, which is considered unlikely to be of significant importance in relation to the large home ranges these species would maintain.

Given the high mobility of these species (some using home ranges up to 1,500ha) and that there is an abundance of similar and higher quality habitat occurring widely in the locality, it is considered unlikely that habitat would become further isolated or fragmented significantly beyond that currently existing in the construction footprint and wider locality.

Habitats associated with the construction footprint is exposed to existing factors such as edge effects, genetic barriers and fragmentation impacts associated past and current land uses. The fragmentation of habitats associated with the construction footprint is considered unlikely to significantly diminish access for forest owls, although it is likely to reduce accessibility for their prey species.

It is considered unlikely that the proposed action would significantly further exacerbate existing fragmentation to the point that local populations of either prey species or threatened owls would be significantly affected.

- **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.**

No actively used breeding habitat would be impacted by the proposed action. The proposed action would however remove 25 trees containing large hollows (>25cm) which have potential to be used by large forest owls for breeding.

The extent of potential foraging habitat to be removed represents a relatively small proportion of foraging habitat available within the surrounding landscape. Owing to the relatively small extent of potential habitat removal and the high mobility of these species, the proposed action is unlikely to significantly affect their long-term survival.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to the Powerful Owl, Masked Owl and Barking, the proposal is consistent with three key threatening processes:

- Clearing of native vegetation (97.92ha)
- Removal of hollow-bearing trees (42 hollow bearing trees of which 25 contain large hollows (i.e. >25cm DBH)
- Removal of dead wood and dead trees.

Although hollow-bearing trees that are of sufficient size and density to provide suitable breeding habitat for the large forest owls were recorded, no suitable nesting trees were identified as being actively used by these species during the targeted surveys. As such, the proposal is considered likely to be limited to impacts on foraging habitat for this species.

The extent of native vegetation clearing and foraging habitat removal associated with the proposed action is considered relatively small in terms of the available habitat for large forest owl species within the surrounding landscape.

Conclusion

The home ranges of local Powerful Owl, Masked Owl and Barking Owl individuals is considered likely to encompass the construction footprint. Habitat within the construction footprint is currently limited to foraging habitat, as no suitable nesting trees were identified as being actively used by these species during the targeted surveys. All species may intermittently utilise the construction footprint and its habitats whilst foraging within the greater locality. The impacts to potential habitat for large forest owls would not be significantly impacted by the proposed action and therefore is unlikely to have a significant impact upon these species.

Threatened woodland birds

Status

Gang-gang Cockatoo (*Callocephalon fimbriatum*) listed as Vulnerable under the BC Act

Varied Sittella (*Daphoenositta chrysoptera*) listed as Vulnerable under the BC Act

Scarlet Robin (*Petroica boodang*) listed as Vulnerable under the BC Act

Flame Robin (*Petroica phoenicea*) listed as Vulnerable under the BC Act

Dusky Woodswallow (*Artamus cyanopterus cyanopterus*) listed as Vulnerable under the BC Act

Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*) listed as Vulnerable under the BC Act

Hooded Robin (*Melanodryas cucullata*) listed as Vulnerable under the BC Act

Turquoise Parrot (*Neophema pulchella*) listed as Vulnerable under the BC Act

Speckled Warbler (*Pyrrholaemus sagittatus*) listed as Vulnerable under the BC Act

Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis*) listed as Vulnerable under the BC Act

Diamond Firetail (*Stagonopleura guttata*) listed as Vulnerable under the BC Act.

Specific impacts

Fauna habitat assessments conducted, assessed the likelihood of the above species occurring in the study area as moderate or higher. Of these, three were recorded within the study area during targeted surveys completed including Speckled Warbler, Dusky Woodswallow and Varied Sittella. The proposal would result in the removal of 22.26ha of potential habitat for these species, that is likely to be utilised on an intermittent basis as part of a far larger home range of local individuals.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity 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.

Up to 22.26ha of potential habitat would be affected by the proposed action. Although, habitat within the construction footprint represents potential foraging and breeding habitat attributes for these species, the ability of the construction footprint to support such species is not considered likely to be diminished to the extent that a significant adverse effect might be brought to bear upon local populations.

Although the proposed action would cause a small incremental loss of foraging habitat for threatened woodland birds it is unlikely that the proposed action would significantly reduce the viability of populations occurring locally.

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**

Not applicable.

- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community: the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposed action would remove up to 22.26ha of potential habitat, including habitat suitable for foraging and breeding, although this area of vegetation is considered unlikely to be of significant importance for such species in relation to the abundance of similar and higher quality habits for these species in the greater locality.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

Given the high mobility these species as well as the fact that similar and higher quality habitat is easily accessible to them in the locality, it is not considered likely that habitat would become significantly more isolated or fragmented beyond that currently existing in the construction footprint and wider locality.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The extent of potential habitat to be removed represents a relatively small proportion of foraging habitat available within the surrounding landscape. Owing to the relatively small proportion of potential habitat removal and the mobility of these species, the proposed action l is unlikely to significantly affect their long-term survival.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to the threatened woodland birds, the proposal is consistent with three key threatening process:

- Clearing of native vegetation
- Removal of hollow-bearing trees
- Removal of dead wood and dead trees.

The extent of native vegetation clearing and habitat removal associated with the construction footprint is considered relatively small in terms of the available habitat for these species within the surrounding landscape. It is unlikely that the proposed action would significantly increase these key threatening processes to the point that local populations are significantly impacted.

Conclusion

Threatened woodland birds are considered to likely utilise habitats within the construction footprint. Whilst potential habitat exists in the construction footprint, there is an abundance of similar and higher quality habitat in the wider locality. The impacts are not of a magnitude that would significantly diminish the integrity of habitat opportunities in the study area's vicinity. Therefore, the proposed action would represent an incremental loss of available local habitat, which is unlikely to have a significant impact upon these species.

Threatened birds of prey

Status

Square-tailed Kite (*Lophoictinia isura*) listed as Vulnerable under the BC Act

Little Eagle (*Hieraaetus morphnoides*) listed as Vulnerable under the BC Act

Spotted Harrier (*Circus assimilis*) listed as Vulnerable under the BC Act

Black Falcon (*Falco subniger*) listed as Vulnerable under the BC Act

White-bellied Sea-eagle (*Haliaeetus leucogaster*) listed as Vulnerable under the BC Act.

Specific impacts

Two of the raptors mentioned above was recorded within the study area; being the Little Eagle and White-bellied Sea-eagle. The remaining species are considered to have a moderate likelihood of utilising habitat available within the construction footprint.

Up to 97.92ha of potential habitat was identified in the construction footprint and would be affected by the proposed action. Of the 97.92ha of habitat to be impacted, 75.66ha occurs as DNG and 22.26ha occurs as remnant vegetation. It is likely that the habitat within the construction footprint would only be intermittently utilised by these species whist foraging within the greater locality.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity 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.

Up to 97.92ha of potential habitat is likely to be affected by the proposal. Due to the mobility and large home range of these species, and the linear footprint of this proposal, the proposed action is unlikely to affect their life cycle or ability to forage and breed. Local populations of threatened raptors are unlikely to be restricted to habitat within the construction footprint, as similar and higher quality habitat occurs widely in the locality. The impact of 97.92ha of potential habitat would represent <1% of habitat in the greater locality and the study area would only represent a small part of the home ranges of locally occurring individuals.

Although the proposed action would result in the loss of potential foraging habitat, such habitat would only be a small component of locally occurring resources accessible to these species, and it is unlikely to constitute important habitat that would place threatened birds of prey at a greater risk of extinction.

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**

Not applicable.

- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community: the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposal is likely to affect up to 97.92ha of potential foraging and breeding habitat for these species. No actively used nesting trees where identified during targeted surveys for any of these species.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

Habitat connectivity is unlikely to be affected by the proposed action due to the mobility of birds of prey. Vegetation removal would largely be limited to a linear corridor. As the habitat within construction footprint is already impacted by edge effects, the proposed action would not adversely fragment or isolate any previously undisturbed patches of habitat. Furthermore, given these species' high mobility and that habitat of similar and higher quality occurs widely in the locality, it is considered unlikely that habitat would become further isolated or significantly fragmented beyond that currently existing in the construction footprint.

- **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.**

Up to 97.92ha of potential habitat for threatened raptor species would be affected by the proposed action. An abundance of similar and higher quality foraging opportunities would be retained both within the study area and wider locality. Owing to the relatively small proportion of potential foraging habitat impacted and the vast abundance of habitat in the locality, the proposed action is unlikely to significantly affect the long-term survival of threatened bird of prey species, although the loss of native vegetation habitat must considered to be an incremental loss of local habitat.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to the threatened raptors, the proposal is consistent with one key threatening process being clearing of native vegetation. The extent of native vegetation clearing and habitat removal associated with the construction footprint is considered relatively small in terms of the available habitat for these species within the surrounding landscape.

Conclusion

Up to 97.92ha of potential habitat would be impacted by the proposed action. Owing to the abundance of land in the locality and the existing disturbances of this habitat (fragmentation) the loss of this foraging habitat is unlikely to adversely affect these species. Although the loss of habitat would represent an incremental loss of potentially suitable habitat, the proposed action is unlikely to have a significant impact upon these species and their local populations.

Threatened blossom nomads

Status

Grey-headed Flying-fox (*Pteropus poliocephalus*) listed as Vulnerable under both the BC Act and EPBC Act

Little Lorikeet (*Glossopsitta pusilla*) listed as Vulnerable under the BC Act

Swift Parrot (*Lathamus discolor*) listed as Critically Endangered under the BC Act and EPBC Act

Regent Honeyeater (*Anthochaera phrygia*) listed as Critically Endangered under the BC Act and EPBC Act

Painted Honeyeater (*Grantiella picta*) listed as Vulnerable under the BC Act and EPBC Act

Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*) listed as Vulnerable under the BC Act.

Specific impacts

During field surveys the Little Lorikeet and Grey-headed Flying-fox were recorded within the study area. The proposed action would affect up to 22.26ha of potential foraging habitat for these opportunistic blossom nomads including native vegetation. A total of 42 hollow-bearing trees would be impacted by the proposed action, this may provide breeding habitat for the Little Lorikeet. Breeding habitat (camps) were not recorded within the construction footprint for the Grey-headed Flying-fox. The Swift Parrot breeds in Tasmania and as such the proposed action would not impact breeding habitat for the species. Marginal quality habitat breeding habitat opportunities exists for the Regent Honeyeater, Painted Honeyeater and Black-chinned Honeyeater within the study area.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity 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.

Up to 22.26ha of potential habitat is likely to be impacted by the proposed action. The potential habitat to be impacted includes foraging habitat, the study area would only be a small component of locally occurring resources that would be accessible to these species. Thus, the proposed action is not considered likely to impact blossom nomads such that a viable local or intermittent seasonal population would be placed at a significant risk of extinction.

The Little Lorikeet could possibly utilise the construction footprint for breeding, a total of 42 hollow-bearing trees would be impacted by the proposed action. The Grey-headed Flying-fox usually setup roosting camps in association with blossom availability, which are usually situated in dense vegetation and associated with water. No roost camps are located within the construction footprint or study area. Swift Parrot breeding habitat would not be impacted by the proposed action as it is restricted to Tasmania. Marginal quality breeding habitat opportunities occur within the study area however areas of higher quality habitat have been retained.

The proposed action would remove vegetation along a linear corridor. Considering the mobile nature of these species, this action is unlikely to isolate the species habitat significantly. Given this, it is considered unlikely that the proposed action would have an adverse effect on the life cycle of this species, such that a viable local populations is to be placed at risk of extinction.

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**

Not applicable.

- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community: the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposal would remove up to 22.26ha of vegetation that provides potential foraging habitat for these species. Hollows potentially suitable for Little Lorikeet breeding purposes were also recorded within the construction footprint amongst the 42 hollow-bearing trees recorded in the 20% design construction footprint. No breeding camps for the Grey-headed Flying-fox were recorded. The 22.26ha of habitat to be impacted also provides potential breeding habitat for the Regent Honeyeater, Painted Honeyeater and Black-chinned Honeyeater. None of these species were recorded breeding within this habitat during the targeted surveys however may use the habitat on an intermittent basis during nomadic movements in response to blossom productivity which fluctuates annually.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

Habitat connectivity is unlikely to be significantly affected by the proposed action for these species due to their high mobility. Habitat impacts by the proposed action consist of vegetation removal, largely limited to a linear disturbance corridor. As the habitat within construction footprint is already impacted by edge effects, the proposed action would not adversely fragment or isolate any previously undisturbed patches of habitat. Furthermore, given these species' high mobility and that habitat of similar and higher quality occurs widely in the locality, it is considered unlikely that habitat would become further isolated or significantly fragmented beyond that currently existing in the construction footprint.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The extent of potential habitat to be removed represents a small proportion of habitat available within the surrounding landscape. Owing to the relatively small proportion of habitat removal within the surrounding landscape and the mobility of the species, the proposed action is unlikely to affect the long-term survival of either of these species.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to the blossom nomads, the proposed action is largely only consistent with one key threatening process under the BC Act, being clearing of native vegetation.

In regard to Little Lorikeet the proposed action is also consistent with an additional key threatening process being, removal of hollow bearing trees. Due to the small extent of impact and the intermittently utilisation of habitat resources within the construction footprint, it is unlikely that the removal of hollow-bearing trees would exacerbate this key threatening process to an extent in which the local population would be at risk or be significantly impacted.

The extent of native vegetation clearing and habitat removal associated with the proposed action is considered very small in terms of the available habitat for blossom nomad species within the surrounding landscape.

Conclusion

The extent of native vegetation clearing (up to 22.26ha), and habitat removal (42 hollow-bearing trees) associated with the proposed action is proportionally small in terms of the available habitat for this species within the surrounding landscape. The potential loss of foraging habitat for the blossom nomads is not considered to be important in regard to the maintenance of this species locally, and therefore the proposed action are not likely to have a significant impact upon these species, which might lead to their extinction locally.

EPBC Act significance assessment – Grey-headed Flying-fox

The Grey-headed Flying-fox is listed as Vulnerable under the EPBC Act. The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of the Environment, 2013a). Under the Act, important populations are:

- Likely to be key source populations either for breeding or dispersal
- Likely to be necessary for maintaining genetic diversity, and/or
- At or near the limit of the species range.

Is this part of an important population?

Grey-headed Flying-foxes occur across a range of wooded habitats where their favoured food, eucalypt blossom occurs. They set up roosting camps in association with blossom availability, which are usually situated in dense vegetation and associated with water. Grey-headed Flying-foxes can migrate up to 75km north during the winter and during this time young flying-foxes establish camps.

The construction footprint and study area does not contain suitable habitat for roosting camps and no significant roosting camps occur within its close vicinity. Therefore, a population of Grey-headed Flying-foxes in the construction footprint is not considered to be important, as no roost sites would be affected by the proposed action.

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

Not applicable. Grey-headed Flying-foxes occurring in the in the construction footprint would not form part of an important population.

Reduce the area of occupancy of an important population

Not applicable. Grey-headed Flying-foxes occurring in the in the construction footprint would not form part of an important population.

Fragment an existing important population into two or more populations

Not applicable. Grey-headed Flying-foxes occurring in the in the construction footprint would not form part of an important population.

Adversely affect habitat critical to the survival of a species

No critical habitat is listed for this species under the EPBC Act. Habitat critical to the survival of a species may also include areas that are not listed on the Register of Critical Habitat if they are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development, or
- For the reintroduction of populations or recovery of the species or ecological community (Department of the Environment Water Heritage and the Arts, 2009).

The proposed action would remove 22.26ha of potential habitat, which represents potential foraging habitat for this species. As this species is highly mobile, with individuals foraging up to 50km from roost sites, it is likely that suitable foraging resources could be accessed widely throughout the locality and beyond. Therefore, this would not meet the above criteria.

Disrupt the breeding cycle of an important population

Not applicable. Grey-headed Flying-foxes occurring in the in the construction footprint would not form part 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 action would remove up to 22.26ha of potential habitat for this species. It is not expected that the proposed action would significantly modify, destroy, remove, isolate or decrease the availability or quality of habitat for the Grey-headed Flying-fox to cause the species to decline. Although vegetation clearing would represent a loss within the area, it is not considered likely that the action would result in disturbance to the extent that the species would decline.

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

It is not likely that invasive species (such as introduced predators) that are harmful to the Grey-headed Flying-fox would become further established as a result of the proposed action.

Introduce disease that may cause the species to decline

No. There are no known diseases that are likely to increase in the area as a result of the proposed action.

Interfere substantially with the recovery of the species

Due to the small proportion of foraging habitat likely to be affect by the proposed action and as no roost camps are located in the vicinity of the construction footprint, the proposed action is not likely to interfere with the recovery of this species.

Conclusion

The extent of native vegetation clearing (22.26ha) and habitat removal associated with the proposed action proportionally small in terms of the available habitat for these species within the surrounding landscape. Although the loss of foraging habitat for Grey-headed Flying-fox is considered to be an incremental loss of suitable habitat locally, the proposed action is not likely to have a significant impact upon available resources for flying-foxes in the vicinity of the construction footprint or its wider locality and the habitat to be impacted is not considered important to the long-term survival of the Grey-headed Flying-fox.

EPBC Act significance assessment – Swift Parrot

The Swift Parrot is listed as Critically Endangered under the EPBC Act.

The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of the Environment, 2013a).

An action if likely to have a significant impact on a Critically Endangered or Endangered species if there is a real chance or possibility that it will result in one or more of the following:

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

The Swift Parrot distribution extends generally from Brisbane in the north to Tasmania in the south and across to Adelaide in the west (Higgins, 1999). The entire population resides in Tasmania from September to April during the breeding period, and no Swift Parrots breed on the mainland. On the mainland during the winter months they are widely nomadic in response to the varying distribution of blossom (Higgins, 1999). Swift Parrot movements locally vary from year to year in response to resources in their range.

Up to 22.26ha of potential foraging habitat for the Swift Parrot would be affected by the proposed action. While the limited habitat in the construction footprint has the potential to be used by these species, it is not likely to be of high importance due to its relatively small area and the availability of greater quality habitat within the locality and wider region.

Any identified population of Swift Parrot in the proposal locality would not be restricted to habitat within the construction footprint and due to the species' large home range and nomadic nature, similar foraging habitat can be accessed in the locality. Therefore, the proposed action is not considered likely to significantly contribute to a long-term decline in the size of a population of the species.

Reduce the area of occupancy of the species

While the proposed action would remove up to 22.26ha it is considered that the proposed action would not reduce the area of occupancy of this species given the better-quality habitat in the locality and greater region.

Nevertheless, the removal of up to 22.26ha of potential habitat is considered to be a relatively small incremental loss of suitable habitat locally and as such has the potential to incrementally reduce the area of occupancy for the Swift Parrot during seasons when individuals of this species may be reliant on local resources.

Fragment an existing population into two or more populations

Habitat connectivity is not likely to be significantly impacted by the proposed action for the species, given that this species is highly mobile and nomadic, the development footprint would not present a significant barrier to these species. It is not considered likely that habitat would become further isolated or fragmented significantly beyond that currently existing in the study area.

Adversely affect habitat critical to the survival of a species

The national recovery plan for the Swift Parrot identifies habitat critical to the survival of the Swift Parrot as 'areas of priority habitat for which the Swift Parrot has a level of site fidelity or possess phenological characteristics likely to be of importance to the Swift Parrot, or otherwise identified by the recovery team'.

No critical habitat has been listed for the Swift Parrot to date. Furthermore, the study area does not contain any areas of important habitat mapped for the Swift Parrot by DPIE.

Disrupt the breeding cycle of a population

Swift Parrots breed in Tasmania during spring and summer, migrating to south-eastern Australia during autumn and winter (Department of Environment and Conservation, 2006). While Swift Parrots are dependent on flowering resources across a wide range of habitats (woodlands and forests) within their NSW wintering grounds, the removal of about 22.26ha of potential foraging habitat is unlikely to disrupt their movements to Tasmanian breeding grounds. As such the proposed action is unlikely to affect their breeding cycle.

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 action would disturb up to 22.26ha of native vegetation considered to be foraging habitat for this nomadic blossom forager. The removal of up to 22.26ha of potential habitat is considered to be an incremental loss, decreasing the amount of suitable foraging habitat available locally. However, this species is likely to forage in the higher quality habitat within greater locality. Considering the mobile nature of this species, this action is unlikely to isolate the species habitat significantly. Given the marginal condition of habitat observed it is unlikely that the proposal would modify, destroy, remove or isolate habitat for this species to the extent that is likely to cause the species to decline.

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

It is not likely that invasive species (such as introduced predators) that are harmful to the Swift Parrot would become further established as a result of the proposed action.

Introduce disease that may cause the species to decline

No. There are no known diseases that are likely to increase in the area as a result of the proposed action.

Interfere substantially with the recovery of the species

The Action Plan for Australian Birds (Garnett and Crowley, 2000) notes pressure on Swift Parrot breeding areas from forestry and firewood collection in Tasmania. On the mainland though pressures relate to the loss of foraging habitats due to clearing for agriculture and residential development (Garnett and Crowley, 2000).

A National Recovery Plan for the Swift Parrot Lathamus discolor was prepared in 2011 (Saunders, 2011). Recovery actions outlined in this plan include:

- Identify the extent and quality of habitat
- Manage and protect swift parrot habitat at the landscape scale
- Monitor and manage the impact of collisions, competition and disease
- Monitor population and habitat.

The proposed action would be in conflict with the second recovery action above, to manage and protect swift parrot habitat at the landscape scale.

Conclusion

The removal of up to 22.26ha of vegetation, which contains potential foraging resources, could be utilised by this species intermittently during periods of seasonal blossom variation. However, considering the abundance of high-quality foraging resources in surrounding landscape the foraging habitat to be removed is considered marginal and small in terms of what is available locally to this species. Considering the mobility of this species, the proposed action would not fragment or isolate any locally occurring population. In addition, the species does not breed in NSW and therefore no breeding habitat would be impacted due to the proposed action.

The proposed action therefore, is considered to represent an incremental loss of available local habitat, although it is not considered likely to have a significant impact as it is unlikely to affect the long-term viability of the species.

EPBC Act significance assessment – Regent Honeyeater

The Regent Honeyeater is listed as Critically Endangered under the EPBC Act.

The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of the Environment, 2013a).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will result in one or more of the following:
Lead to a long-term decrease in the size of a species

Up to 22.26ha of potential foraging habitat for the Regent Honeyeater would be affected by the proposed action. While habitat in the construction footprint has the potential to be used by these species, it is not likely to be of high importance due to its relatively small area and the availability of greater quality habitat within the locality and wider region.

While the Regent Honeyeater has not been recorded in association with the proposal, the proposal is situated about 35km to the east of one of the main breeding areas for the species in NSW; being the Capertee Valley. However, there is a general paucity of records for the species in the locality, with only one record from 1905 (Environment Energy and Science Group, 2020).

Any identified population of Regent Honeyeater in the proposal locality would not be restricted to habitat within the construction footprint and due to the species' large home range and nomadic nature, similar foraging habitat can be accessed in the locality. Therefore, the proposed action is not considered likely to significantly contribute to a long-term decline in the size of a population of these species.

Reduce the area of occupancy of a population

In a worst case scenario, the proposed action is likely to affect up to 22.26ha of potential foraging habitat for this species. Although the proposed action would result in the loss of potential foraging habitat, the incremental loss of a small area of potential habitat, only represents a small component of similar locally occurring resources accessible to this species.

While the proposed action would remove up to 22.26ha it is considered that the proposed action would not reduce the area of occupancy of this species given the better quality habitat in the locality and greater region.

Nevertheless, the removal of up to 22.26ha of potential habitat is considered to be a small incremental loss of suitable habitat locally and as such has the potential to incrementally reduce the area of occupancy for the Regent Honeyeater during seasons when individuals of this species may be reliant on local resources.

Fragment an existing population into two or more populations

Habitat connectivity is not likely to be significantly affected by the proposed work, given that this species is highly mobile and nomadic, the proposed action would not present a significant barrier to these species. It is not considered likely that habitat would become further isolated or fragmented significantly beyond that currently existing in the construction footprint.

Adversely affect habitat critical to the survival of a species

No critical habitat has been listed for the Regent Honeyeater to date. As outlined in the National Recovery Plan Habitat critical to the survival of the Regent Honeyeater includes:

- Any breeding or foraging areas where the species is likely to occur
- Any newly discovered breeding or foraging locations.

While the Regent Honeyeater has not been recorded in association with the proposal. Although it appears that Regent Honeyeaters are usually associated with habitats to the west and south east of the proposal, it is likely that the species may use habitat resources in proximity to the proposal on at least a transient basis. As the species is not restricted to or reliant on habitat therein for foraging, it is unlikely that this proposed action would adversely affect habitat critical to the survival of this species.

Disrupt the breeding cycle of a population

Within the Regent Honeyeaters current distribution there are four known key breeding areas where the species is regularly recorded. These are the Bundarra-Barraba, Capertee Valley and Hunter Valley districts in New South Wales, and the Chiltern area in north-east Victoria. The construction footprint does not occur within these known breeding areas. Furthermore, this species is highly mobile and is known to disperse widely (Higgins et al., 2001). The 22.26ha potential marginal quality habitat likely to be affected is representative of larger patches of locally occurring resources that would be accessible to this species. Therefore, the removal of up to 22.26ha of potential habitat is unlikely to disrupt the breeding cycle of a population of Regent Honeyeater.

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 action would disturb up to 22.26ha of native vegetation considered to be foraging habitat for this species. The removal of up to 22.26ha of potential habitat is considered to be an incremental loss, decreasing the amount of suitable foraging habitat available locally. However, this species is likely to forage in the higher quality habitat within greater locality. Considering the mobile nature of this species, this action is unlikely to isolate the species habitat significantly. Given the marginal condition of habitat observed it is unlikely that the proposed action would modify, destroy, remove or isolate habitat for this species to the extent that is likely to cause the species to decline.

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

It is not likely that invasive species (such as introduced predators) that are harmful to the Regent Honeyeater would become further established as a result of the proposed action.

Introduce disease that may cause the species to decline

No. There are no known diseases that are likely to increase in the area as a result of the proposed action.

Interfere substantially with the recovery of the species

For the Regent Honeyeater, the *Action Plan for Australian Birds* (Garnett and Crowley, 2000) addresses the need for further ecological research on the species and the conservation and protection of roosting habitat and identification of specific breeding requirements.

Recovery strategies outlined in Regent Honeyeater Recovery Plan (Department of the Environment, 2016b) include:

- Improve the extent and quality of regent honeyeater habitat
- Bolster the wild population with captive-bred birds until the wild population becomes self-sustaining
- Increase understanding of the size, structure, trajectory and viability of the wild population
- Maintain and increase community awareness, understanding and involvement in the recovery program.

The proposed action would be in conflict with the first objective above to a small extent, by not improving the extent of habitat for the Regent Honeyeater. It is unlikely that the impact of relatively small areas of marginal habitat would significantly exacerbate the recovery of the species and significantly impact this species.

Conclusion

The extent of native vegetation clearing and foraging habitat removal associated with the proposed action is considered to be small in terms of available habitat for the species within region and there is a general paucity of records for the species in the locality of the proposal (i.e. only on historic record from 1905). The irregular distribution of blossom resources, which is a key driver of nomadism of this species, may cause this species to occasionally forage within the construction footprint. Although it is considered unlikely that the loss of potential foraging habitat would cause the local extinction of the Regent Honeyeater, the removal of up to 22.26ha of vegetation could be utilised by this species intermittently during periods of seasonal blossom variation. The proposed action is not considered to fragment any locally occurring populations, affect habitat critical to their survival, disrupt their breeding cycles, or interfere with the recovery of these species. The proposed action therefore, is considered to represent an incremental loss of available local habitat, although it is not considered likely to have a significant impact as it is unlikely to affect the long-term viability of the species.

EPBC Act significance assessment – Painted Honeyeater

The Painted Honeyeater is listed as Vulnerable under the EPBC Act. The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of the Environment, 2013a). Under the Act, important populations are:

- Likely to be key source populations either for breeding or dispersal
- Likely to be necessary for maintaining genetic diversity, and/or
- At or near the limit of the species range.

Is this part of an important population?

The Painted Honeyeater is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory. The greatest concentrations and almost all records of breeding come from south of 26ºS, on inland slopes of the Great Dividing Range between the Grampians, Victoria and Roma, Queensland. Fruiting mistletoe primarily influences the Painted Honeyeater's seasonal north-south movements, with its breeding season closely matched. After breeding, many birds move in to semi-arid regions such as north-eastern South Australia, central and western Queensland, and central Northern Territory. Breeding occurs from October to March when mistletoe fruits are most available (TSSC, 2015).

The species is a mistletoe specialist, and inhabits mistletoes in eucalypt forests/woodlands, riparian woodlands of Black Box and River Red Gum, Box-ironbark-yellow Gum woodlands, Acacia-dominated woodlands, Paperbarks, Casuarinas, Callitris, and trees on farmland or gardens. The species prefers woodlands which contain a higher number of mature trees, as these host more mistletoes, and is more common in wider blocks of remnant woodland than in narrower strips (TSSC, 2015).

If any population is present, they are unlikely to be key source populations for dispersal or for maintaining genetic diversity. Also, this location is not at the limit of this species known range. As such any individual or population recorded within the construction footprint would not be considered part of an important population.

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

Not applicable. Painted Honeyeaters occurring in the in the construction footprint would not form part of an important population.

Reduce the area of occupancy of an important population

Not applicable. Painted Honeyeater occurring in the in the construction footprint would not form part of an important population.

Fragment an existing important population into two or more populations

Not applicable. Painted Honeyeater occurring in the in the construction footprint would not form part of an important population.

Adversely affect habitat critical to the survival of a species

No critical habitat is listed for this species under the EPBC Act. Habitat critical to the survival of a species may also include areas that are not listed on the Register of Critical Habitat if they are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development, or
- For the reintroduction of populations or recovery of the species or ecological community (Department of the Environment Water Heritage and the Arts, 2009).

The area of potential habitat likely to be affected by proposed action (22.26 ha) represents a relatively small component of locally occurring resources that would be accessible to this species. Therefore, the removal of about this potential habitat would not be considered critical to the survival of this species.

Disrupt the breeding cycle of an important population

Not applicable. Painted Honeyeater occurring in the construction footprint is not part 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 action would remove up to 22.26ha of potential habitat for this species. It is not expected that the proposed action would significantly modify, destroy, remove, isolate or decrease the availability or quality of habitat for the Painted Honeyeater to cause the species to decline. Although vegetation clearing would represent a loss within the area, it is not considered likely that the action would result in disturbance to the extent that the species would decline.

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

It is not likely that invasive species (such as introduced predators) that are harmful to the Painted Honeyeater would become further established as a result of the proposed action.

Introduce disease that may cause the species to decline

No. There are no known diseases that are likely to increase in the area as a result of the proposed action.

Interfere substantially with the recovery of the species

The proposed action is contrary to the recovery objectives and actions outlined in the Saving Our Species program and the National Recovery Program for the Painted Honeyeater. Contributing to the degradation and removal of habitat (i.e. mature trees containing mistletoe). It is considered unlikely that the amount of potential clearing would interfere substantially with the recovery of the species.

Due to the abundance of similar, and likely better-quality habitat in the locality and greater region, the proposed action is not likely to interfere with the recovery of this species.

Conclusion

Although the Painted Honeyeater was not recorded during field surveys, there is potential foraging resources for this species within the construction footprint. While the proposed action would remove up to 22.26ha it is considered that the proposal would not reduce the area of occupancy of this species given the better-quality habitat in the locality and greater region. As core populations, breeding areas, and the species stronghold do not occur within the locality, it is considered unlikely that the proposal would have a significant impact on the Painted Honeyeater.

Threatened waterfowl

Status

Australian Painted Snipe (*Rostratula australis*) listed as Endnagered under both the BC Act and EPBC Act

Black-necked Stork (*Ephippiorhynchus asiaticus*) listed as Vulnerable under the BC Act

Magpie Goose (*Anseranas semipalmata*) listed as Vulnerable under the BC Act.

Specific impacts

None of these species were recorded within the study area during targeted field surveys. The study area does however provide marginal quality habitat for these three species in the form of artificially created dams and riparian vegetation along Muscle Creek. The intermittent use of these habitats by these species is unable to be discounted as part of wider movements within the landscape. The proposed action would require the removal of up to 2.413ha of this marginal quality habitat.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity 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.

Up to 2.41ha of potential marginal quality habitat is likely to be impacted by the proposed action. The potential habitat to be impacted includes marginal habitat that the species may use on an intermittent basis as part of their wider movements within the landscape, the study area would only be a small component of locally occurring resources that would be accessible to these species. Thus, the proposed action is not considered likely to impact these waterfowl such that a viable local or intermittent seasonal population would be placed at a significant risk of extinction.

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**

Not applicable.

- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community: the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposed action would remove up to 2.41ha of vegetation that provides potential marginal quality habitat that may be used on an intermittent basis by Magpie Goose, Australian Painted Snipe and Black-necked Stork. No residential or breeding of these species were observed during the field survey and as such this habitat is likely to only represent foraging habitat for the species.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

Habitat connectivity is unlikely to be affected by the proposed action due to the mobility of the threatened waterfowl. Vegetation removal would largely be limited to a linear corridor. As the habitat within construction footprint is already impacted by edge effects, the proposed action would not adversely fragment or isolate any previously undisturbed patches of habitat. Furthermore, given these species' high mobility and that habitat of similar and higher quality occurs widely in the locality, it is considered unlikely that habitat would become further isolated or significantly fragmented beyond that currently existing in the construction footprint.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The extent of potential habitat to be removed represents a small proportion of marginal quality foraging habitat available within the surrounding landscape. Owing to the relatively small proportion of habitat removal and the mobility of the species, the proposed action is unlikely to affect the long-term survival of either of these species.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to the threatened waterfowl, the proposed action is consistent with three key threatening process under the BC Act, being clearing of native vegetation, removal of dead wood and dead trees and alteration of natural flow regimes of rivers and streams and their floodplains and wetlands.

The extent of native vegetation clearing and habitat removal associated with the proposed action is considered very small in terms of the available habitat for these species within the surrounding landscape. Furthermore, impacts that may alter natural flow regimes would be considered and minimised through proposal design and are not considered likely to significantly exacerbate any of the above key threatening process which may affect these species.

Conclusion

The extent of native vegetation clearing (up to 2.41ha) associated with the proposed action is proportionally small in terms of the available habitat for this species within the surrounding landscape. The potential loss of marginal foraging habitat which may potentially be used by the Magpie Goose, Australian Painted Snipe and Black-necked Stork on an intermittent basis is not considered to be important in regard to the maintenance of this species locally, and therefore the proposed action are not likely to have a significant impact upon these species, which might lead to their extinction locally.

EPBC Act significance assessment – Australian Painted Snipe

The Australian Painted Snipe is listed as Vulnerable under the EPBC Act. The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of the Environment, 2013a). Under the Act, important populations are:

- Likely to be key source populations either for breeding or dispersal
- Likely to be necessary for maintaining genetic diversity, and/or
- At or near the limit of the species range.

Is this part of an important population?

The Australian Painted Snipe is a migratory species which has a scattered distribution across many parts of Australia. Some individuals tend to be residential but others are nomadic and temporarily occupy areas where and when suitable habitat exists.

Given no Australian Painted Snipes were recorded during targeted surveys and the marginal quality habitat recorded (artificially constructed dams, riparian vegetation along Muscle Creek and the artificially modified wetland immediately outside the construction footprint north of the New England Highway) it is considered unlikely that residential individuals occupy areas of the construction footprint. It is likely however that nomadic individuals may utilise the marginal habitat present on an intermittent basis when suitable habitat and conditions arise as part of their wider movements across NSW.

The construction footprint and study area does is unlikely to be a key source for breeding or dispersal, nor necessary for maintaining genetic diversity and the study area is not at the limit of the species distribution. Therefore, a population of Australian Painted Snipe in the construction footprint is not considered to be important population.

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

Not applicable. Australian Painted Snipe occurring in the in the construction footprint would not form part of an important population.

Reduce the area of occupancy of an important population

Not applicable. Australian Painted Snipe occurring in the in the construction footprint would not form part of an important population.

Fragment an existing important population into two or more populations

Not applicable. Australian Painted Snipe occurring in the in the construction footprint would not form part of an important population.

Adversely affect habitat critical to the survival of a species

The Australian Painted Snipe draft national recovery plan identifies habitat critical to the species as areas mapped in the indicative distribution map (particularly is suitable breeding habitat occurs) and any location outside this area that may be periodically occupied by the species when conditions are favourable.

The proposed action would remove up to 2.41ha of potential habitat, which represents marginal foraging habitat for this species (i.e. artificially constructed dams and riparian vegetation along Muscle Creek). As this species is highly mobile and given the poor quality habitat to be impacted it is considered unlikely that impacts associated with the proposed actions would significantly impact on habitat critical to the survival of the species.

Disrupt the breeding cycle of an important population

Not applicable. Australian Painted Snipe occurring in the in the construction footprint would not form part 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

Not applicable. Australian Painted Snipe occurring in the in the construction footprint would not form part of an important population.

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

It is not likely that invasive species (such as introduced predators) that are harmful to the Australian Painted Snipe would become further established as a result of the proposed action.

Introduce disease that may cause the species to decline

No. There are no known diseases that are likely to increase in the area as a result of the proposed action.

Interfere substantially with the recovery of the species

Due to the small proportion of marginal quality foraging habitat likely to be affected by the proposed action, the proposed action is not likely to interfere with the recovery of this species.

Conclusion

Although the Australian Painted Snipe was not recorded within the study area during field surveys, there is potential marginal quality foraging resources that the species may use on an intermittent basis as part of its movements through the landscape. While the proposed action would remove up to 2.41ha of marginal quality foraging habitat it is considered that the proposal would not reduce the area of occupancy of this species given the better-quality habitat in the locality and greater region. As core populations, breeding areas, and the species stronghold do not occur within the locality, it is considered unlikely that the proposal would have a significant impact on the Australian Painted Snipe.

Threatened ground-dwelling mammals

Status

Spotted-Tailed Quoll (*Dasyurus maculatus maculatus*) listed as Vulnerable under BC Act and Endangered under the EPBC Act.

Specific impacts

The Spotted-Tailed Quoll was not recorded during field surveys. Up to 22.26ha of potential habitat for this species would be impacted by the proposed action.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Spotted-Tailed Quoll was not recorded during field investigations, however individuals have been recorded as occurring within similar habitats to those where the species has been recorded in the wider region. The Spotted-Tailed Quoll is carnivorous and is forages on small to medium sized animals, including invertebrates, reptiles, birds, mammals and carrion.

The proposed action would affect up to 22.26ha of potential habitat. This habitat occurs as disturbed woodland within a fragmented landscape. The habitat is disturbed due to past and current land uses including mining, agriculture, road, rail and power infrastructure and urban development thereby it is subject to existing edge effects and fragmentation.

An abundance of similar or higher quality foraging opportunities occur in the wider locality of the construction footprint. Impacts to up to 22.26ha is a small proportion of available habitat within locality as such the proposed action is unlikely to significantly diminish the functional integrity of Spotted-Tailed Quoll habitat within locality.

The loss of potential habitat for the Spotted-Tailed Quoll is considered unlikely to have a significant adverse effect on its life cycle such that a viable local population would be placed at a greater risk of extinction.

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**

Not applicable.

- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community: the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposed action would impact up to 22.26ha of potential habitat for Spotted-Tailed Quolls.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

The potential habitat for the Spotted-Tailed Quoll recorded occurs as disturbed woodland within a fragmented landscape. The habitat is disturbed due to past and current land uses including mining, agriculture, road, rail and power infrastructure and urban development thereby it is subject to existing edge effects and fragmentation. The removal of this habitat may incrementally increase existing fragmentation however is considered unlikely to significantly exacerbate existing levels of fragmentation.

Despite the impact of 22.26ha, associated remnant vegetation would be retained in the study area that would continue to provide linkages to surrounding habitat. Fauna crossings would also be constructed to assist in wildlife movements within habitats in the locality. Although the proposed action would create a new barrier it is considered unlikely to significantly exacerbate existing levels of fragmentation.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The proposed action would impact of up to 22.26ha of potential habitat for Spotted-Tailed Quoll. Although the proposed action would add incrementally to habitat loss locally it is considered it is considered unlikely that onsite impacts would significantly impact populations of Spotted-Tailed Quoll that would significantly reduce the long-term viability of local populations.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposed action is consistent with two key threatening processes under the BC Act:

- Clearing of native vegetation
- Removal of dead wood and dead trees.

The extent of native vegetation clearing and habitat removal associated with the proposed action is considered relatively small in terms of the available habitat for these species within the surrounding landscape, although it is an incremental loss of suitable habitat locally.

Conclusion

The proposed action would affect up to 22.26ha of potential habitat for Spotted-Tailed Quoll. An abundance of similar or higher quality habitat occurs in the wider locality. Therefore, the loss of this potential habitat is considered unlikely to have a significant adverse effect on the life cycle of this species such that a viable local population would be placed at a greater risk of extinction.

EPBC Act significance assessment – Spotted-tailed Quoll

The Spotted-tailed Quoll is listed as Vulnerable under the EPBC Act. The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of the Environment, 2013a). Under the Act, important populations are:

- Likely to be key source populations either for breeding or dispersal
- Likely to be necessary for maintaining genetic diversity, and/or
- At or near the limit of the species range.

Is this part of an important population?

The Spotted-tailed Quoll was not recorded during field surveys, the species has however been recorded in the locality and potential habitat was recorded in the construction footprint.

Locally, the construction footprint does not contain habitat that is likely to be inhabited by quolls on a permanent basis. This is partly due to its highly disturbed nature. Although this area may intermittently be utilised by the species whilst they forage in the greater locality, it is unlikely that the construction footprint would sustain populations in the absence of larger areas of higher quality and unfragmented habitat, such as the extensive forests associated with the remnant vegetation to the west and east of the construction footprint.

While not likely to be necessary for maintaining source populations, the habitat does represent movement corridors, which may play a part in the maintaining of genetic diversity from source populations.

The location of the construction footprint is not at or near the limit of the species' range. Therefore, the construction footprint cannot be considered to support quolls that are an important population.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will result in one or more of the following:

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

Not applicable. Spotted-Tailed Quolls in the construction footprint would not form part of an important population.

Reduce the area of occupancy of an important population

Not applicable. Spotted-Tailed Quolls in the construction footprint would not form part of an important population.

Fragment an existing important population into two or more populations

Not applicable. Spotted-Tailed Quolls in the construction footprint would not form part of an important population.

Adversely affect habitat critical to the survival of a species

No critical habitat is listed for this species under the EPBC Act. Habitat critical to the survival of a species may also include areas that are not listed on the Register of Critical Habitat if they are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development, or
- For the reintroduction of populations or recovery of the species or ecological community (Department of the Environment Water Heritage and the Arts, 2009).

The proposal would the remove of up to 22.26ha of suitable habitat for these species. Whilst the construction footprint provides potential habitat, there is large areas of suitable resources that are accessible in the adjacent remnant vegetation and are higher in quality (i.e. not adjacent to busy roads). Therefore, this would not meet the above criteria.

Disrupt the breeding cycle of an important population

Not applicable. Spotted-Tailed Quolls in the construction footprint would not form part 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

No, not likely to result in species decline.

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

It is not likely that invasive species (such as introduced predators) that are harmful to the Spotted-Tailed Quoll would become further established as a result of the proposed action.

Introduce disease that may cause the species to decline

The proposed action is unlikely to introduce a disease that may cause the Spotted-tailed Quoll to decline.

Interfere substantially with the recovery of the species

A recovery plan for the species has been developed under the EPBC Act. The proposed action is likely to interfere with one of these recovery actions being '*maintain and restore habitat corridors and unprotected freehold land*'. The proposal would result in the reduction of up to 22.26ha of potential habitat and would impact on habitat corridors within the study area.

Conclusion

Although the Spotted-Tailed Quoll was not recorded in the study area during field investigations, the construction footprint provides potential habitat for these species. The proposed action would affect up to 22.26ha of potential habitat. The construction footprint is situated within a disturbed environment and onsite habitat is already subject to existing edge effects and fragmentation. It is likely that the proposed action would not act as important habitat for the species due to its location, conditions and limited extent. Therefore, it is unlikely that the proposed action would have a significant impact upon these species.

Threatened arboreal mammals

Status

Squirrel Glider (*Petaurus norfolcensis*) listed as Vulnerable under BC Act

Koala (*Phascolarctos cinereus*) listed as Vulnerable under the both BC Act and EPBC Act.

Specific impacts

The Squirrel Glider and Koala were both recorded within the study area during targeted field surveys. Up to 22.26ha of potential habitat for these species would be impacted by the proposed action.

In regards to the Squirrel Glider, about 42 hollow bearing trees would be impacted by the proposed action, which represents potential breeding opportunities for the species.

In regards to the Koala, scats were recorded from a single location within the study area and scattered records of the species do occur in the locality. No other signs such as scratches, observations or vocalisations were recorded. This supports the theory that the local population is sparsely occurring and habitat within the construction footprint may be used on an intermittent basis during local movements, but it not likely to represent a core habitat for the species within the locality.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The construction footprint contains 22.26ha of potential habitat for the Koala and Squirrel Glider. This habitat to be potentially impacted would be linear in nature and occurs as modified woodland subject to existing impacts associated with agriculture, mining, road, rail and power infrastructure and urban development. Existing effects (such as noise, dust, light pollution) and habitat fragmentation are existing disturbances reducing the functionality of the habitat.

An abundance of similar and higher quality habitat occurs in the adjacent vegetation within and outside the study area that is suitable for Squirrel Glider and Koala habitation. The impact of up to 22.26ha of potential habitat would represent a small proportion of habitat available to these species.

In addition, the removal of about 42 hollow-bearing trees for Squirrel Glider is likely to be negligible in comparison to the accessible habitat resources within the locality particularly given the large separation between many of the trees to be impacted upon. Consequently, the proposed action is unlikely to have an adverse effect on the life cycle of the Squirrel Glider or Koala such that a viable local population of these species are likely to be placed at risk of extinction.

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**

Not applicable.

- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community: the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposal would impact up to 22.26ha of potential habitat for the Squirrel Glider and Koala, including 42 hollow-bearing trees.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

The proposed action would result in the construction of a new two lane highway. Despite the current fragmented nature of the landscape through which it would intersect, the proposed action would result in a new barrier that would likely lead to additional and incremental increases to existing fragmentation impacts on habitats within the landscape. Furthermore, the proposed action would also result in an increase in isolation of habitats as the current habitat patches would be made smaller thereby increasing the physical distance between some habitat fragments.

The roadway would not totally prevent fauna movement between habitat fragments (fauna can and likely do cross the road) as no impassable barriers such as no solid concrete median strips would be constructed which would otherwise create a considerable hazard. Despite this, the proposal is likely to be detrimental to the dispersal of arboreal mammals it is unlikely however to significantly increasing fragmentation given the current fragmentation impacts which occur.

Due to, it is considered unlikely that areas of habitat would become significantly fragmented or isolated from other areas of habitat because of the proposed activity.

Although the proposed action would increase the separation between fragmented patches of vegetation, fauna crossing structures such as aerial and underpasses would be constructed to maintain wildlife connectivity in areas where connectivity is highest within the study area. Furthermore, the habitat is already subject to fragmentation impacts, no impassable barriers such as solid concrete median strips would be constructed, high quality remnants within the study area being avoided and the area to be removed is relatively small in proportion with similar or higher quality habitat within the locality. Therefore, it is considered unlikely that potential Squirrel Glider and Koala habitat would become significantly isolated or fragmented from other areas of habitat as a result of the proposed action.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The amount of foraging habitat proposed for removal occurs as a narrow corridor of vegetation which is subject to existing pressures associated with agriculture, wild dogs and fragmentation. Existing edge effects (such as noise, dust, light pollution) and habitat fragmentation are existing disturbances relevant to the habitat.

The habitat proposed for removal is small in proportion to the amount of continuous high quality habitat to the east of the study area. In light of the status and condition of the habitat to be removed, it is unlikely that the proposed action would significantly impact important habitat that is important to the long-term survival of local populations of threatened arboreal mammals.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to arboreal mammals, the proposed action is consistent with three key threatening processes under the BC Act:

- Clearing of native vegetation
- Removal of hollow-bearing trees (42)
- Removal of dead wood and dead trees.

The extent of native vegetation clearing and habitat removal associated with the proposed action is considered relatively small in terms of the available habitat for these species within the surrounding landscape, although it is an incremental loss of suitable habitat locally.

Removal of hollow-bearing trees would be minor only, with 42 hollow-bearing tree likely to be removed. This impact would represent a small proportion of hollow-bearing trees in higher quality habitat within the locality (contained in national park estates and conservation areas). Where possible hollow-bearing trees would be retained.

Conclusion

The proposal would impact up to 22.26ha of potential habitat for the Squirrel Glider and Koala, including 42 hollow-bearing trees. The habitat to be impacted occurs as a narrow corridor of marginal vegetation which is already subjected to fragmentation impacts associated with current and past land uses. The habitat that would be impacted would constitute a relatively small extent of available potential habitat within the locality and would likely be utilised intermittently within each species home range. It is therefore unlikely that the proposed action would lead to a significant impact on these species.

EPBC Act significance assessment – Koala

The Koala listed as Vulnerable under the EPBC Act. The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of the Environment, 2013a). Under the Act, important populations are:

- Likely to be key source populations either for breeding or dispersal
- Likely to be necessary for maintaining genetic diversity, and/or
- At or near the limit of the species range.

Is this part of an important population?

Scats were recorded from a single location within the study area and scattered records of the species do occur in the locality. No other signs such as scratches, observations or vocalisations were recorded. This supports the theory that the local population is sparsely occurring and habitat within the construction footprint may be used on an intermittent basis during local movements, but it not likely to represent an important population.

Vegetation in the construction footprint contained a number of tree species as listed below.

Tree species listed under Schedule 2 of the Koala Habitat Protection SEPP:

- *Eucalyptus tereticornis* (Forest Red Gum)
- *Eucalyptus camaldulensis* (River Red Gum)

An additional seven Koala feed trees listed as canopy tree species known to be used by Koalas within the Central Coast koala management area (KMA) including:

- *Allocasuarina torulosa* (Forest Oak)
- *Casuarina glauca* (Swamp Oak) – planted
- *Angophora floribunda* (Rough-barked Apple)
- *Corymbia maculata* (Spotted Gum)
- *Eucalyptus crebra (Narrow*-leaved Ironbark)
- *Eucalyptus moluccana* (Grey Box)
- *Eucalyptus melliodora* (Yellow Box).

Furthermore, *Eucalyptus blakelyi* (Blakely's Red Gum) was also recorded and is also a canopy tree species known to be used by Koalas in the adjoining KMAs.

Although the site does provides feed tree species, similar and more preferable habitat occurs more widely within the locality. Furthermore, habitat within the construction footprint may be used on an intermittent basis during local movements, but it is not likely to represent important habitat.

This species would not be at the limit of its known range; nor would the population there be likely to be a key source population or necessary for maintaining genetic diversity. Therefore, it is considered that a population of these species, if present, is unlikely to be an 'important population'.

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

Not applicable. Koalas occurring in the in the construction footprint would not form part of an important population.

Reduce the area of occupancy of an important population

Not applicable. Koalas occurring in the in the construction footprint would not form part of an important population.

Fragment an existing important population into two or more populations

Not applicable. Koalas occurring in the in the construction footprint would not form part of an important population.

Adversely affect habitat critical to the survival of a species

No critical habitat is listed for this species under the EPBC Act. Habitat critical to the survival of a species may also include areas that are not listed on the Register of Critical Habitat if they are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development, or
- For the reintroduction of populations or recovery of the species or ecological community (Department of the Environment Water Heritage and the Arts, 2009).

The EPBC Act Referral Guidelines for Koalas (Department of the Environment, 2014) states that impact areas that score >5 contain habitat critical to the survival of the Koala. Based on study area vegetation, past occurrences, connectivity and threats, it was assessed that the study area does not contain critical habitat for Koala. Under the EPBC Act Referral Guidelines for Koalas a score of 9 was obtained and as such the vegetation and habitat within the study area would be considered as habitat critical to the survival of the Koala.

Although the site does provides habitat in the form of feed tree and use species, similar and more preferable habitat occurs more widely within the locality. Given the paucity of and scattering of records the habitat within the construction footprint is likely used on an intermittent basis during local movements, but it is not likely to represent important habitat for this species within the broader locality. The proposed action is therefore unlikely to affect habitat of critical importance to these species.

Disrupt the breeding cycle of an important population

Not applicable. Koalas occurring in the in the construction footprint would not form part 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 action would impact up to 22.26ha of habitat in a linear corridor comprised of fragmented woodland. Koala scats were recorded one a single location west of the construction footprint within higher quality vegetation. This higher quality woodland which contains higher connectivity values have been avoided through the design of the proposal.

Although the site does provide feed and use tree species, similar and more preferable habitat occurs more widely within the locality. The construction footprint may be used on an intermittent basis during local movements, but it is not likely to represent important habitat for this species. Considering these species large home ranges and mobility, the proposed action is therefore unlikely to fragment or modify the habitat in a way that would cause these species to decline.

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

It is not likely that invasive species (such as introduced predators) that are harmful to the Koala would become further established as a result of the proposed action.

Introduce disease that may cause the species to decline

The proposed action is unlikely to introduce a disease that may cause the Koala to decline.

Interfere substantially with the recovery of the species

The Modification would not interfere with the Saving Our Species (OEH, 2017) recovery strategy or Approved Recovery Plan (DECC, 2008). The construction footprint does not occur within any priority management or koala management areas for the species (OEH, 2017; DECC, 2008).

Conclusion

The proposal would impact 22.26ha of Koala habitat. The habitat to be impacted occurs as a narrow corridor of marginal condition vegetation which is subject to existing pressures associated with agriculture, wild dogs and fragmentation. The habitat that would be impacted would constitute <1% of available potential habitat within the locality (10km) and would likely be utilised intermittently within the species home range. It is unlikely that the impact for Koala in the construction footprint would have a significant impact on the local Koala population.

Hollow-dwelling yangochiropteran bats

Status

Corben's Long-eared Bat (*Nyctophilus corbeni*) listed as Vulnerable under the BC Act and EPBC Act

Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) is listed Vulnerable under the BC Act

Eastern Coastal Freetail-Bat (*Micronomus norfolkensis*) is listed as Vulnerable under the BC Act

Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*) is listed as Vulnerable under the BC Act

Greater Broad-nosed Bat (*Scoteanax rueppellii*) is listed as Vulnerable under the BC Act.

Specific Impacts

The proposed action would remove about 97.92ha of potential habitat, in the form of all native vegetation communities with foliage foraging opportunities. Of the 97.92ha of habitat to be impacted, 75.66ha occurs as DNG and 22.26ha occurs as remnant vegetation. The 22.26ha of remnant vegetation also provides potential breeding and roosting opportunities for the species. In addition to vegetation to be cleared, about 42 hollow-bearing trees are expected to be impacted by the proposed action. Habitat to be impacted provides foraging, roosting and breeding resources for these species.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity 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.

Up to 97.92ha of vegetation to be impacted provides foraging and roosting for yangochiropteran bats, 42 hollow-bearing trees would be removed as part of the proposed action and avoidance has been made where possible.

The habitat to be impacted include native vegetation communities that is in a modified state due to past and current land uses such as mining, agriculture, road and rail infrastructure and urban development. As such, this habitat is subject to edges effects (including noise, dust and light spill) and fragmentation.

An abundance of high quality roosting opportunities occur in the wider locality. The removal of up to 97.92ha would represent <1% of available habitat for these species. The removal of 42 hollow-bearing trees is likely to constitute only a small amount of breeding habitat for these species.

While vegetation to be removed represents foraging and breeding opportunities for hollow-dwelling yangochiropteran bats, it is considered unlikely that the removal of this vegetation would significantly affect locally occurring yangochiropteran bat populations, due to quality of the habitat to be impacted, the retention of similar and higher quality vegetation within the study area and presence of higher quality habitat adjacent to the study area and in the wider locality.

The action proposed is unlikely to have an adverse effect on the life cycle of hollow-dwelling yangochiropteran bats to the point where these species are likely to be placed at risk of extinction.

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**

Not applicable.

- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

About 42 hollow-bearing trees and up to 97.92ha of vegetation representing potential habitat for these species is likely to be affected by the proposed action.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

Habitat connectivity is unlikely to be affected by the proposed action due to the mobility of bat species. Vegetation removal would largely be limited to a linear corridor. As the habitat within construction footprint is already impacted by edge effects, the proposed action would not adversely fragment or isolate any previously undisturbed patches of habitat. Furthermore, given these species' high mobility and that habitat of similar and higher quality occurs widely in the locality, it is considered unlikely that habitat would become further isolated or significantly fragmented beyond that currently existing in the construction footprint.

- **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.**

Although the proposed action would add incrementally to habitat loss within the locality it is unlikely to exacerbate fragmentation at local or regional scales that would prevent these species from foraging or roosting within the locality. Given the proportion of available habitat to be impacted, the mobile nature of these species, and the availability of suitable habitat in the wider locality, the loss of a very small amount of potential foraging and roosting habitat is unlikely to affect the long-term survival of these species.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The construction footprint does not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to the threatened hollow-dwelling microbats, the proposal is consistent with three key threatening process:

- Clearing of native vegetation
- Removal of hollow-bearing trees (42)
- Removal of dead wood and dead trees.

The extent of native vegetation clearing, and habitat removal, associated with the proposed action is considered relatively small in terms of the available habitat for these species within the surrounding landscape. It is unlikely that the proposed action would significantly increase these key threatening processes to the point that local populations are significantly impacted.

Conclusion

Up to 97.92ha of potential habitat in the form of modified remnant woodland and DNG containing hollow-bearing trees (42) would be impacted by the proposed action. This habitat may be used by these species for foraging and roosting purposes. Habitat to be impacted already occurs in a disturbed state due to past and current land uses such as mining, agriculture, road and rail infrastructure and urban development and is therefore subject to existing edge effects and fragmentation. As the proposal would result in disturbance to linear corridors and given the high mobility of assessed species, the proposed action is unlikely to represent significant increases to habitat isolation and or fragmentation for these species. The habitat is not considered critical habitat to long term survival of these species within the locality. Given this, the proposed action is considered unlikely to lead to a significant impact on these species their habitat.

EPBC significance assessment – Corben's Long-eared Bat

Corben's Long-eared Bat is listed as Vulnerable under the EPBC Act. The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of the Environment, 2013b). Under the Act, important populations are:

- Likely to be key source populations either for breeding or dispersal
- Likely to be necessary for maintaining genetic diversity, and/or
- At or near the limit of the species range.

Is this part of an important population?

Corben's Long-eared Bat occur across a range of wooded habitats but more distinctly common within box/ironbark/cypress-pine vegetation which contain hollow-bearing trees which the species prefers to use as breeding habitat.

The construction footprint contains suitable roosting and breeding habitat for the species in the form of hollow-bearing trees (42 recorded within the 20% design construction footprint).

There are no areas in the vicinity of the construction footprint which are known locations for aggregations of this species, so local individuals are unlikely to be necessary for maintaining genetic diversity.

Individual Corben's Long-eared Bats if occurring within the construction footprint are not likely to be at or near the limit of the species' range.

Therefore, a population of Corben's Long-eared Bat in the construction footprint is not considered to be important part of an important population.

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

Not applicable. Corben's Long-eared Bat occurring in the in the construction footprint would not form part of an important population.

Reduce the area of occupancy of an important population

Not applicable. Corben's Long-eared Bat occurring in the in the construction footprint would not form part of an important population.

Fragment an existing important population into two or more populations

Not applicable. Corben's Long-eared Bat occurring in the in the construction footprint would not form part of an important population.

Adversely affect habitat critical to the survival of a species

No critical habitat is listed for this species under the EPBC Act. Habitat critical to the survival of a species may also include areas that are not listed on the Register of Critical Habitat if they are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development, or
- For the reintroduction of populations or recovery of the species or ecological community (Department of the Environment Water Heritage and the Arts, 2009).

The proposed action would remove up to 97.92ha of potential habitat, which represents foraging (all 97.92ha) and breeding habitat (limited to 22.26ha of remnant vegetation) for this species. This species is highly mobile, it is likely that suitable foraging resources could be accessed widely throughout the locality and beyond. Therefore, foraging habitat impacted by the proposed action would not meet the above criteria as critical habitat.

Disrupt the breeding cycle of an important population

Not applicable. Corben's Long-eared Bat occurring in the in the construction footprint would not form part 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 foraging habitat for the Corben's Long-eared Bat impacted by the proposed action occurs largely as DNG and as highly modified remnant forest. Within locality of the construction footprint large tracts of vegetation which represent higher quality foraging and breeding habitat would remain and have been avoided by the proposal through detailed design. As such, the habitat to be impacted represents a small proportion of available habitat locally. As such, the available or quality of habitat is unlikely to be impacted 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

It is not likely that invasive species (such as introduced predators) that are harmful to the Corben's Long-eared bat would become further established as a result of the proposal.

Introduce disease that may cause the species to decline

No. There are no known diseases that are likely to increase in the area as a result of the proposed action.

Interfere substantially with the recovery of the species

Due to highly disturbed nature and limited areas foraging habitat likely to be affect by the proposed action compared to that which occurs in the locality and surrounding landscape (97.92ha), the proposed action is not likely to interfere with the recovery of this species.

Conclusion

The extent of native vegetation clearing and habitat removal associated with the proposed action (97.92ha) represents a small proportion of available higher quality habitat in the locality and surrounding landscape. Although the loss of foraging and breeding habitat for Corben's Long-eared Bat is considered to be an incremental loss of suitable habitat locally, the proposed action is not likely to have a significant impact upon available resources for the species in general in the vicinity of the construction footprint or its wider locality and the habitat to be impacted is not considered important to the long-term survival of the Corben's Long-eared Bat.

Cave-dwelling yangochiropteran bats

Status

Little Bent-wing-bat (*Miniopterus australis*) is listed as Vulnerable under the BC Act

Large Bent-wing-bat (*Miniopterus orianae oceanensis*) is listed as Vulnerable under the BC Act

Large-eared Pied Bat (*Chalinolobus dwyeri*) is listed as Vulnerable under both the BC Act and EPBC Act

Eastern Cave Bat (*Vespadelus troughtoni*) is listed as Vulnerable under the BC Act

Southern Myotis (*Myotis macropus*) listed as Vulnerable under the BC Act

Specific impacts

The proposal would impact up to 97.92ha of potential foraging habitat in the form of remnant forest (22.26ha) and DNG (75.66ha). No significant breeding or roosting habitat (i.e. caves or artificial structures) would be impacted by the proposed action.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

No roosting opportunities for cave-dwelling yangochiropteran bat species were identified during field investigations. Significant roost sites used by cave-dwelling yangochiropteran bats are often large with deep connecting tunnels or crevices; have restricted airflow to maintain humidity and have the presence of standing water (Department of Environment and Conservation, 2004a). No significant roost sites were identified in the construction footprint.

There are foraging opportunities for these species associated with remnant vegetation and DNG, throughout the construction footprint and in the wider locality. Up to 97.92ha of foraging habitat would be affected by the proposed action. These species often prefer to forage along the ecotonal edges between open and wooded habitats and these types of foraging opportunities would continue to exist throughout the construction footprint and further abroad. An abundance of available occurs within the locality, the impact of up to 97.92ha would represent a loss of <1% of potential habitat for these species.

Therefore, the proposed action is unlikely to cause significantly adverse effects upon cave-dwelling yangochiropteran bat species, due to the relatively small proportion of available habitat removed and absence of any significant cave-dwelling roosts (breeding habitat).

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**

Not applicable.

- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community: the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

Potential foraging habitat for cave-dwelling yangochiropteran bat species was recorded within the construction footprint during field surveys. Up to 97.92ha of foraging habitat is likely to be affected by the proposed action. No significant roosting habitat would be impacted.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

Habitat connectivity is unlikely to be affected by the proposed action due to the mobility of bat species. Vegetation removal would largely be limited to a linear corridor. As the habitat within construction footprint is already impacted by edge effects, the proposed action would not adversely fragment or isolate any previously undisturbed patches of habitat. Furthermore, given these species' high mobility and that habitat of similar and higher quality occurs widely in the locality, it is considered unlikely that habitat would become further isolated or significantly fragmented beyond that currently existing in the construction footprint.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

The construction footprint provides a relatively small amount of potential foraging habitat for these species compared to what is available in the locality and surrounding landscape. The removal of up to 97.92ha of potential foraging habitat would present <1% of available habitat for these species. Foraging opportunities occurring within the construction footprint, such as ecotonal zones, would continue to exist and an abundance of similar and potential higher quality foraging opportunities would remain available the wider locality. The proposed action would not impact habitat considered critical to the long-term survival of populations in the locality.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to cave-dwelling yangochiropteran bats, the proposed action is consistent with one key threatening process under the BC Act, being clearing of native vegetation.

The removal of potential foraging habitat associated with the proposed action (97.92 ha) is considered to represent a small proportion of available higher quality habitat in the locality and adjoining the construction footprint. Although the proposed action would represent a small loss of potential foraging habitat, such habitat only represents a very small component of locally occurring resources accessible to these species.

Conclusion

The proposed action would impact up to 97.92ha, representing a very small amount of potential foraging habitat for these species. Whilst potential habitat exists within the construction footprint, the extent of habitat removal associated with the proposed action is considered relatively small in terms of available local habitat for these species. Although the loss of habitat would represent a small incremental loss of cave-dwelling yangochiropteran bat habitat, the proposed action is unlikely to have a significant impact upon these species.

EPBC significance assessment – Large-eared Pied Bat

The Large-eared Pied Bat is listed as Vulnerable under the EPBC Act. The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of the Environment, 2013b). Under the Act, important populations are:

- Likely to be key source populations either for breeding or dispersal
- Likely to be necessary for maintaining genetic diversity, and/or
- At or near the limit of the species range.

Is this part of an important population?

Large-eared Pied Bats occur across a range of wooded habitats in association with sandstone escarpments which contain their preferred cave roosting habitat sources.

The construction footprint does not contain suitable habitat for roosting locations for Large-eared Pied bats with no significant escarpment habitats within its close vicinity.

There are no areas in the vicinity of the construction footprint which are known locations for aggregations of this species, so local individuals are unlikely to be necessary for maintaining genetic diversity.

Individual Large-eared Pied Bats occurring within the construction footprint are not at or near the limit of the species' range.

Therefore, a population of Large-eared Pied Bat in the construction footprint is not considered to be important part of an important population.

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

Not applicable. Large-eared Pied Bats occurring in the in the construction footprint would not form part of an important population.

Reduce the area of occupancy of an important population

Not applicable. Large-eared Pied Bats occurring in the in the construction footprint would not form part of an important population.

Fragment an existing important population into two or more populations

Not applicable. Large-eared Pied Bats occurring in the in the construction footprint would not form part of an important population.

Adversely affect habitat critical to the survival of a species

No critical habitat is listed for this species under the EPBC Act. Habitat critical to the survival of a species may also include areas that are not listed on the Register of Critical Habitat if they are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development, or
- For the reintroduction of populations or recovery of the species or ecological community (Department of the Environment Water Heritage and the Arts, 2009).

The proposed action would remove up to 97.92ha of potential habitat, which represents foraging habitat for this species. This species is highly mobile, it is likely that suitable foraging resources could be accessed widely throughout the locality and beyond. Therefore, foraging habitat impacted by the proposed action would not meet the above criteria as critical habitat.

Disrupt the breeding cycle of an important population

Not applicable. Large-eared Pied Bats occurring in the in the construction footprint would not form part of an important population, therefore impacts associated with the construction footprint would not affect 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 foraging habitat for the Large-eared Pied Bat impacted by the proposed action occurs largely as DNG and as highly modified remnant forest. Within locality of the construction footprint large tracts of vegetation which represent higher quality foraging habitat would remain and have been avoided by the proposal through detailed design. As such, the habitat to be impacted represents a small proportion of available habitat locally. As such, the available or quality of habitat is unlikely to be impacted 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

It is not likely that invasive species (such as introduced predators) that are harmful to the Large-eared Pied Bat would become further established as a result of the proposal.

Introduce disease that may cause the species to decline

No. There are no known diseases that are likely to increase in the area as a result of the proposed action.

Interfere substantially with the recovery of the species

Due to highly disturbed nature and limited areas foraging habitat likely to be affect by the proposed action compared to that which occurs in the locality and surrounding landscape (97.92ha) and absence of breeding habitat within or adjacent to the construction footprint, the proposed action is not likely to interfere with the recovery of this species.

Conclusion

The extent of native vegetation clearing and habitat removal associated with the proposed action (97.92ha) represents a small proportion of available higher quality habitat in the locality and surrounding landscape. Although the loss of foraging habitat for Large-eared Pied Bat is considered to be an incremental loss of suitable habitat locally, the proposed action is not likely to have a significant impact upon available resources for cave-dwelling bats in general in the vicinity of the construction footprint or its wider locality and the habitat to be impacted is not considered important to the long-term survival of the Large-eared Pied Bat.

White-throated Needletail

Status

The White-throated Needletail is listed as Vulnerable under the EPBC Act.

Specific impacts

The species was recorded foraging in aerial habitats over the study area during the targeted surveys. The construction footprint only provides aerial foraging habitats for this species. The proposal would impact up to 97.92ha of potential foraging habitat for the species that is likely to be used for foraging as part of a far larger home range.

EPBC significance assessment – White-throated Needletail

The White-throated Needletail is listed as Vulnerable under the EPBC Act. The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of the Environment, 2013b). Under the Act, important populations are:

- Likely to be key source populations either for breeding or dispersal
- Likely to be necessary for maintaining genetic diversity, and/or
- At or near the limit of the species range.

Is this part of an important population?

The White-throated Needletail a migratory species and occurs in Australia only between late spring and early autumn but mostly in summer. This species are non-breeding migrants with breeding taking place in Northern Asia (Birdlife Australia, 2020). The White-throated Needletail feeds on flying insects, such as termites, ants, beetles and flies. They catch the insects in flight in their wide gaping beaks. They have been recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows. Probably recorded most often above wooded areas, including open forest and rainforest (Birdlife Australia, 2020). This species is not or near the limit of its range as it occurs over eastern and northern Australia and in Northern Asia (Birdlife Australia, 2020).

White-throated Needletail is almost exclusively aerial and 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

As the construction footprint does not contain key resources for breeding or dispersal, does not occur at the limit of the species distribution range and is unlikely to be necessary for maintaining genetic diversity populations which may occur are not considered to form part of an ‘important population’.

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

Not applicable. White-throated Needle-tail occurring in the in the construction footprint would not form part of an important population.

Reduce the area of occupancy of an important population

Not applicable. White-throated Needletail occurring in the in the construction footprint would not form part of an important population.

Fragment an existing important population into two or more populations

Not applicable. White-throated Needletail occurring in the in the construction footprint would not form part of an important population.

Adversely affect habitat critical to the survival of a species

No critical habitat is listed for this species under the EPBC Act. Habitat critical to the survival of a species may also include areas that are not listed on the Register of Critical Habitat if they are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development, or
- For the reintroduction of populations or recovery of the species or ecological community (Department of the Environment Water Heritage and the Arts, 2009).

The proposed action would remove up to 97.92ha of potential aerial foraging habitat for the species. The White-throated Needletail is a migratory species and breeds in northern Asia. The species forages on the wing and the vegetation within the construction footprint is likely to provide aerial foraging habitat for this species. This species occurs widely along the coast of NSW and QLD whilst in Australia suitable foraging resources could be accessed widely throughout the locality and beyond. Therefore, this would not meet the above criteria and the construction footprint is not critical to the survival of the White-throated Needletail.

Disrupt the breeding cycle of an important population

Not applicable. White-throated Needletail occurring in the in the construction footprint would not form part 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

No, not likely to result in species decline.

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

It is not likely that invasive species (such as introduced predators) that are harmful to the White-throated Needletail would become further established as a result of the proposal.

Introduce disease that may cause the species to decline

No. There are no known diseases that are likely to increase in the area as a result of the proposed action.

Interfere substantially with the recovery of the species

As this species does not breed in Australia and forages on the wing and has the potential to occur intermittently within the locality, the proposal is not likely to interfere with the recovery of this species.

Conclusion

The construction footprint only provides aerial foraging habitat with no breeding occurring within Australia. The White-throated Needletail is likely to use the construction footprint for aerial foraging on an intermittent basis and the proposal is not likely to have a significant impact upon available resources for this species in the vicinity of the construction footprint or its wider locality. Therefore, the habitat to be impacted is not considered important to the long-term survival of the White-throated Needletail.

Striped Legless Lizard

Status

The Striped Legless Lizard is listed as Vulnerable under the BC Act and EPBC Act.

Specific impacts

A population of Striped Legless Lizard was recorded within the study area. All core habitat for the species within the study area has been avoided through the design phase of the proposal.

The proposal does however have potential to have indirect impacts on core habitat primarily via edge effects and weed incursions which may modify the species habitat making it unfavourable for the species to inhabit. To minimise these impacts specific mitigation measures would be implemented.

Section 7.3 test of significance

In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The Striped Legless Lizard habitat contains native vegetation communities that occur as disturbed areas of derived native grassland and woodland habitats due to agricultural and mining practices. Majority of the area is already highly disturbed and fragmented due to previous land use practices. Impacts to this habitat would be limited to potential indirect impacts only and with the implantation of mitigation measures this impacts are likely to be avoided or minimised so that known foraging and shelter habitat for Striped Legless Lizards would not be impacted upon. The removal of any rocky areas would be avoided where practical.

Therefore, the proposal is unlikely to cause significantly adverse effects upon the life cycle of Striped Legless Lizard species to the point that this species is likely to be placed at risk of extinction, due to the small area of impact.

In the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

- **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**

Not applicable.

- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction**

Not applicable.

In relation to the habitat of a threatened species, population or ecological community: the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposed action would not require the direct removal of any Striped Legless Lizard core habitat. Potential impacts on the species associated with the proposed action would be limited to potential indirect impacts such as edge effects and weed incursions which may modify the species habitat making it unfavourable for the species to inhabit. To minimise these impacts specific mitigation measures would be implemented.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and**

The known habitat occurs on fragmented land that has been previously been impacted by agricultural and mining practices. Areas which may be indirectly impacted upon are likely to be small and vegetation removal would be largely limited to previously disturbed areas. As the proposal footprint occurs wholly outside of the known area of habitat fragmentation of the population into two or more populations is unlikely to occur.

Given the above, the proposal is considered unlikely to represent significant increases to habitat isolation and or fragmentation.

- **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.**

Although the proposed action could incrementally add to habitat loss within the locality, it is unlikely to exacerbate fragmentation at local or regional scales that would prevent these species from throughout the locality. Given the small area which could be indirectly impacted upon, and the availability of suitable habitat in the wider locality, the loss of a very small amount of potential habitat is unlikely to affect the long-term survival of these species.

Whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly)

The study area did not represent a declared area of outstanding biodiversity value and is not in the immediate vicinity of such areas.

Whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

With respect to the Striped Legless Lizard, the proposal is consistent with one key threatening process, being *clearing of native vegetation*. The proposed action also has potential to indirectly contribute to key threatening processes associated with introduction, invasion and spread of weeds and pests. Mitigation measures outlined in section 5.2 (Mitigation measures) of the main report have been recommended to minimise these indirect impacts.

As such, the overall contribution of the proposed action to key threatening processes listed above is likely to be minimal.

Conclusion

Impacts associated with the proposed action would be limited to potential indirect impacts. All core habitat for the species has been avoided by the proposal through design. The implementation of mitigation measures would ensure indirect impacts are avoided and/or minimised. These potential indirect impacts may represent a small incremental increase in edge effects however are considered unlikely to lead to a significant impact on the Striped Legless Lizard.

EPBC significance assessment – Striped Legless Lizard

The Striped Legless Lizard is listed as Vulnerable under the EPBC Act. The following assessment has been undertaken following the Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (Department of the Environment, 2013b). Under the Act, important populations are:

- Likely to be key source populations either for breeding or dispersal
- Likely to be necessary for maintaining genetic diversity, and/or
- At or near the limit of the species range.

Is this part of an important population?

The Striped Legless has a patchy distribution throughout south-eastern NSW, ACT, north-eastern, central and south-western Victoria and south-eastern South Australia. Known populations occur within the Muswellbrook LGA. A priority management site occurs about 1.5km to the west of the construction footprint. It is likely that individuals that may occur within the study area would form part of this local population. It is likely that any individuals that occur within the construction footprint contribute to the conservation of the species locally; particularly if they are connected to the population associated with priority management site.

The construction footprint occurs near the limit of the species range. Although not currently considered to be an important population, the population may be considered as important in the future. Individuals that occur within the construction footprint may facilitate to enhance genetic diversity across the region or to maintain genetic diversity should other existing populations suffer significant impacts. A conservative approach has been taken for this assessment, and the impacted habitat has been considered to be supporting important population.

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

No known habitat for the species would be impacted by the proposal. Impacts associated with the proposal would be limited to potential indirect impacts only. Given the small area of potential indirect impacts, and with the implementation of mitigation measures to reduce indirect impacts, it is considered unlikely that a long-term decrease in the size of the populations of the species would occur within the broader region.

Additionally, residual indirect impacts from the proposal are unlikely to lead to a long-term decrease in the size of the populations within the locality.

Reduce the area of occupancy of an important population

The proposal would not remove any known habitat for the species. The area of habitat for this species which has potential to be indirectly impacted by the proposal is small and is occurs within disturbed and fragmented agricultural/mining land. This includes disturbances such as weed invasion and potential predation by cats and foxes. Given the small amount of marginal habitat being impacted and the presence of better-quality known habitat (within priority management area) outside of the construction footprint, this reduction in potential area of occupancy for the known population is not considered to be significant.

Additionally, residual indirect impacts from the proposal are unlikely to reduce the area of occupancy of an important population.

Fragment an existing important population into two or more populations

The proposal occurs on fragmented land that has been previously been impacted by agricultural and mining practices. Areas which may be indirectly impacted upon are likely to be small and vegetation removal would be largely limited to previously disturbed areas. As the proposal footprint occurs wholly outside of the known area of habitat fragmentation of the population into two or more populations is unlikely to occur.

Additionally, residual indirect impacts from the proposal are unlikely to result in fragmentation of important populations within the broader site.

Adversely affect habitat critical to the survival of a species

No critical habitat is listed for this species under the EPBC Act. Habitat critical to the survival of a species may also include areas that are not listed on the Register of Critical Habitat if they are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development, or
- For the reintroduction of populations or recovery of the species or ecological community (Department of the Environment Water Heritage and the Arts, 2009).

To date, no critical habitat has been declared for this species on the Register of Critical habitat. The area of potential habitat for this species within proximity to the construction footprint would not be considered to be critical habitat to the survival of the species as it is small and is suffering previous disturbance from the site's former use. This includes disturbances such as weed invasion, habitat disturbance from livestock and potential predation by cats and foxes.

Disrupt the breeding cycle of an important population

The area of known habitat for this species within the study area occurs on fragmented land that has been previously been impacted by agricultural and mining practices. Disturbance would be largely limited to previously disturbed areas. The potential indirect impacts which may arise due to the construction of the proposal is unlikely to disrupt the breeding cycle of the populations occurring within the study area.

Additionally, residual indirect impacts from the proposal are unlikely to result in the disruption of the breeding cycle of populations within the broader site.

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

Direct and indirect impacts are unlikely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Mitigation measure would be implemented so that significant indirect impacts to habitat in association with the proposal would be prevented.

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

It is not likely that invasive species (such as introduced predators) that are harmful to the Striped Legless Lizard would become further established as a result of the proposal.

Introduce disease that may cause the species to decline

No. There are no known diseases that are likely to increase in the area as a result of the proposed action.

Interfere substantially with the recovery of the species

The loss and degradation of native grassland, is primarily responsible for the decline of the Striped Legless Lizard (Smith and Robertson, 1999). The National Recovery Plan for the species lists 10 specific conservation objectives aimed at focusing resources on achieving the primary objective of ensuring the long-term survival of the species throughout its distribution. The primary recovery criterion for this main objective is viable populations or clusters of populations of the species are represented and maintained in reserves or appropriately managed sites across the known distribution of the species. The 10 specific conservation objectives are as follows:

- Establish and maintain national forums for the discussion and organisation of *D. impar* across its natural distribution
- Determine the distribution of potential *D. impar* habitat
- Determine the current distribution and abundance of *D. impar* in Victoria, New South Wales, the Australian Capital Territory and South Australia
- Establish a series of reserves and other managed areas such that viable populations are maintained across the known distribution of the species
- Determine the habitat use and ecological requirements of *D. impar*
- Identify the nature and extent of the threatening processes affecting *D. impar*
- Undertake a program of monitoring to provide a basis for adaptive management of *D. impar*
- Increase community awareness and involve the community in aspects of the recovery program
- Assess the need for salvage and translocation, determine their feasibilities, develop protocols and undertake a trial translocation if appropriate
- Ensure that captive population(s) are used to support education and research elements of the Recovery Plan.

The proposal is unlikely to interfere with any of the recovery actions outlined.

Conclusion

The proposal has potential to have indirect impacts on the known habitat for the species such as weed incursions and edge effects which may modify the species habitat making it unfavourable for the species to inhabit. To minimise these impacts specific mitigation measures would be implemented. Habitat to be potentially impacted upon occurs on fragmented land that has been previously been impacted by agricultural and mining practices. The habitat is not considered critical habitat to long term survival of the species within the locality. Given this, the proposal is considered unlikely to lead to a significant impact on this species habitat.

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