



SMEC INTERNAL REF: 30018041

Biodiversity Assessment

Muswellbrook Pumped Hydro Energy Storage Lower Reservoir Geotechnical Investigation

Client Reference No. 30018041

Prepared for: Muswellbrook Pumped Hydro Company Pty Ltd

14 April 2023

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1. Introduction

1.1 Background

Geotechnical investigation works are to be performed as part of the feasibility studies for the Muswellbrook Pumped Hydro Energy Storage (PHES) Project. The geotechnical investigation works are comprised of works at the 'Lower Reservoir' site on land owned by Muswellbrook Coal, and the 'Upper Reservoir' site encompassing lands on the top and western slope of Bells Mountain. SMEC is preparing and lodging a local Development Application (DA) for each site on behalf of Muswellbrook Pumped Hydro Company Pty Ltd under Part 4 (DA) of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

This Biodiversity Assessment Report was prepared for the Lower Reservoir geotechnical investigation works (henceforth the 'Proposal').

1.2 Purpose of this report

The purpose of this Biodiversity Assessment Report is to support the Statement of Environmental Effects (SEE), which has been prepared for the Proposal. This report assesses the potential construction and operational impacts to biodiversity values associated with carrying out the geotechnical investigations for the lower reservoir for the pumped hydro proposal, including all works related to accessing the geotechnical investigation locations. Desktop and ecological survey assessment methods, results and the likely and potential ecological impacts of the Proposal. The report also provides recommendations for mitigation measures to minimise impacts of the Proposal.

1.3 Proposed works

The geotechnical investigations are required to collect information on the underlying structural geology, including that of a prominent geological fault line known to exist under the site, so as to inform the feasibility and concept design of the proposed PHES project.

The geotechnical investigations are likely to take up to three months to complete, subject to weather and drilling progress. There are two types of investigation proposed – boreholes and test pits. Both require clearing of a relatively level pad. For boreholes the maximum pad size has been assessed as 25 metre x 25 metre square area to accommodate the drilling rig, laydown area for equipment including a water tank. Test pits require less area in which an excavation can be performed and are assumed to be a maximum of 10 metres x 10 metres.

Excess drilling water and cuttings would be stored in a lined waste skip bin, located in the delineated and fenced off laydown area. Waste would be removed by the nominated waste disposal contractor. Rock core recovered during drilling would be initially stored in core trays and on pallets within the delineated laydown area. Upon completion of the drilling investigation, the core trays and pallets would be removed offsite and relocated to an agreed storage location. Boreholes would be decommissioned within 28 days of completing all drilling, testing, and imaging.

Access tracks are required for trucking in the drilling or excavating plant and equipment, supplying drilling water by truck to tanks on the drilling pads and daily access to the pads by light four-wheel drive vehicles. Where possible, existing access tracks including mine roads and electrical transmission line easements will be utilised. Some new tracks would need to be constructed to reach investigation sites on the mid to upper slopes of Bells Mountain. The access tracks which are created or improved for the geotechnical investigations will require routine maintenance to facilitate future site access, subject to suitable erosion controls. Routine maintenance will involve semi-regular clearing to manage encroachment or manage weeds within the delineated clearing boundary within this report (Figure 1-3).

The construction methodology would minimise clearing impact on road sections on slopes requiring widening by using an end-haul (full bench) construction (Figure 1-1). The method would involve cutting out the embankment and removing the material to a dump site rather than creating a down slope batter. On flatter sections and existing track, a nominal width of four metres would be expected for access tracks. Where cross slope cutting is required, an average clearing width of six metres would be expected. The access tracks would generally be surfaced with the natural material, expected to be suitable on most of the upper section. Track improvement with a gravel surface would be used where the natural material is not suitable for the gradient. This is expected to be more prevalent on the slopes where softer soils and clays are more common.

Upon completion of the drilling and geotechnical investigations, including removal of the temporary laydown area, rehabilitation works are likely to involve reinstating areas where a cut/fill bench was created and re-seeding areas that are not required for future site access to regenerate to their previous vegetation type.

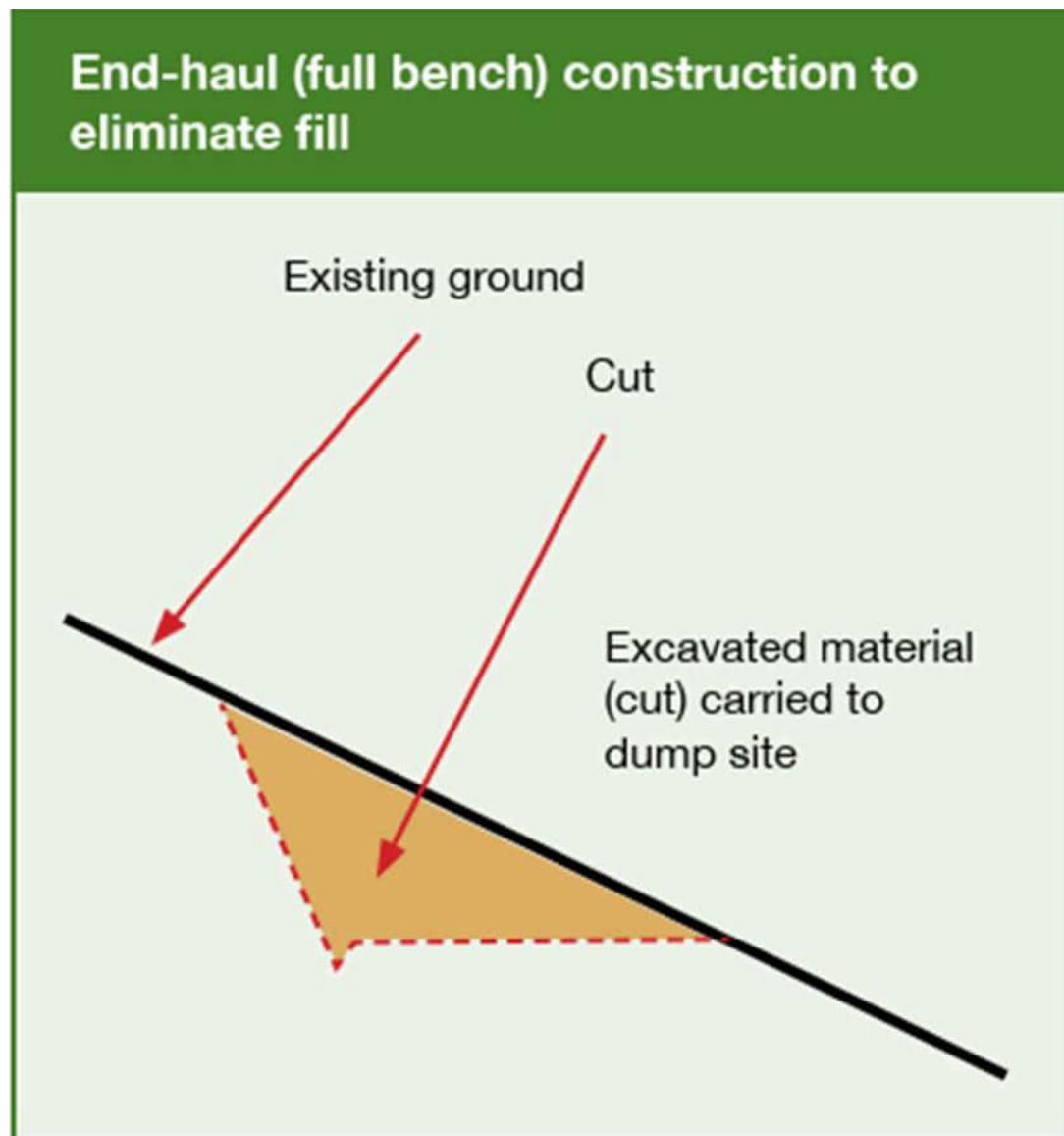
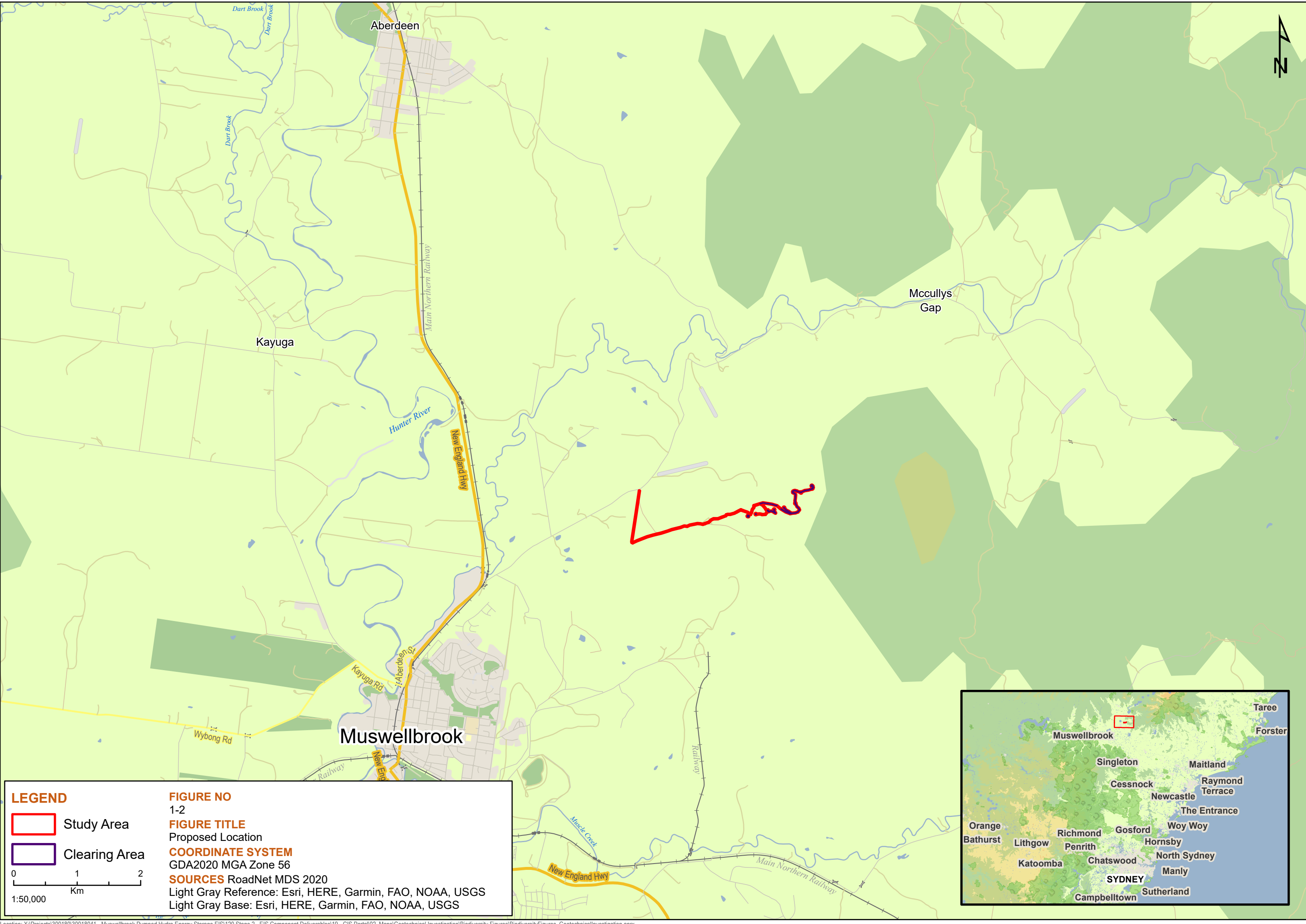


Figure 1-1: Typical new access track cross section showing a full bench construction

1.4 Study area

The study area is located approximately 4.4 kilometres north east of the Muswellbrook township in the upper Hunter Valley region of New South Wales in the Muswellbrook Local Government Area (LGA). The investigation areas are located on the side of Bells Mountain spanning up to the mid to upper slopes. The Proposal is primarily located on Muswellbrook Coal land on the southern slopes of Bells Mountain (Figure 1-2). The 'study area' (Figure 1-3) for this assessment comprises:

- The length of the proposed access tracks with a buffer of 10 metres from each side of the centre of the alignment
- The survey sites (geotechnical investigation pads and an additional three sites along the access tracks), with a 20 metre buffer from the centre of the pads (Figure 2-1).



LEGEND

Study Area

Clearing Area

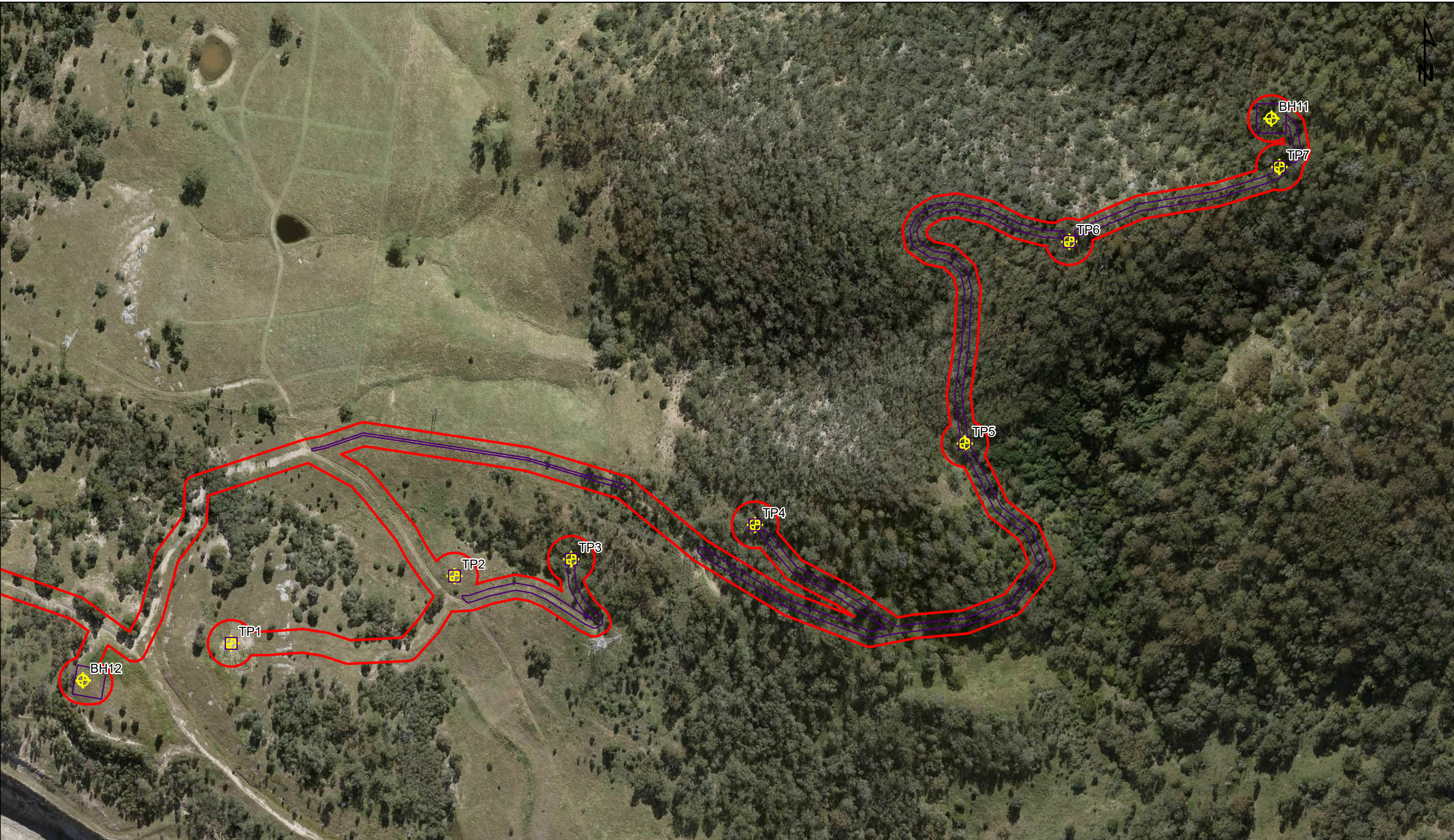
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FIGURE NO
1-2

FIGURE TITLE
Proposed Location

COORDINATE SYSTEM
GDA2020 MGA Zone 56

SOURCES RoadNet MDS 2020
Light Gray Reference: Esri, HERE, Garmin, FAO, NOAA, USGS
Light Gray Base: Esri, HERE, Garmin, FAO, NOAA, USGS



LEGEND

Study Area

Clearing Area

Test Location

FIGURE NO
1-3

FIGURE TITLE
Study Area

COORDINATE SYSTEM
GDA2020 MGA Zone 56

SOURCES Roads © RoadNet MDS 2020
MetroMap WMS Services: Aerial 22/04/2021

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1.5 Legislative context

With reference to terrestrial biodiversity, the following legislation is relevant to the Proposal:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Biodiversity Conservation Act 2016* (BC Act).

1.5.1 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth EPBC Act is the Australian Government's key piece of environmental legislation. Under the EPBC Act, approval is required for any proposed action that will have, or is likely to have a significant impact on a matter of national environmental significance (MNES) protected by the EPBC Act. Potentially significant impacts on any MNES trigger a referral process under the EPBC Act.

MNES considered in this biodiversity report include listed threatened species, populations and ecological communities as well as migratory species protected under international agreements. Particular consideration has been given to threatened biota that occur or could occur in the study area. Potential impacts are discussed in Section 4 of this report.

The assessment has found that the Proposal will not have a significant impact on the environment, thus a referral under the EPBC Act is not required.

1.5.2 Biodiversity Conservation Act 2016

The BC Act is NSW's main legislation that identifies threatened species, populations and ecological communities at the State scale. The BC Act seeks to:

- Conserve biological diversity at bioregional and State scales,
- Maintain the diversity and quality of ecosystems and enhance their capacity to adapt to change and provide for the needs of future generations,
- Assess the extinction risk of species and ecological communities and identify key threatening processes through an independent and rigorous scientific process, and
- Establish a framework to avoid, minimise and offset the impacts of proposed development and land use change on biodiversity.

Section 7.2 of the BC Act provides that DAs that are likely to significantly affect threatened species must be accompanied by a biodiversity development assessment report (BDAR). Under Section 7.2 of the BC Act, development or an activity is likely to significantly affect threatened species if:

- a) It is likely to significantly affect threatened species or ecological communities, or their habitats, according to the test in section 7.3, or
- b) The development exceeds the biodiversity offsets scheme threshold if the biodiversity offsets scheme applies to the impacts of the development on biodiversity values, or
- c) It is carried out in a declared area of outstanding biodiversity value.

Impacts to threatened species and ecological communities as a result of the Proposal are assessed in Section 4 of this report.

1.5.3 Biosecurity Act 2015

The *Biosecurity Act 2015* (Biosecurity Act) replaced the *Noxious Weeds Act 1993* on 1 July 2017. The Biosecurity Act is a wide-ranging legislation that outlines the requirements of government, councils, private landholders and public authorities in the management of biosecurity matters. Priority weeds are regulated under the Biosecurity Act with a general biosecurity duty to prevent, eliminate or minimize any biosecurity risk they may pose. Some priority weeds have additional management obligations which may apply generally, or under specific circumstances. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised as is reasonably practicable.

Section 4.2.2 outlines weeds with Biosecurity duties in the Muswellbrook LGA that occur within the study area.

2. Methodology

2.1 Desktop review

Database searches and literature reviews were undertaken to identify threatened species, populations and Threatened Ecological Communities (TECs) that have been recorded or are predicted to occur within the locality.

Searches were undertaken within a five-kilometre radius, centred on the study area. Data sources used were:

- BioNet Atlas Species Sightings (DPE 2022a)
- EPBC Protected Matters Search Tool (DCCEEW 2022)
- BioNet Atlas Threatened Biodiversity Profiles (DPE 2022b)
- BioNet Vegetation Classification (DPE 2022d)
- Atlas of Living Australia online database (ALA 2022)
- The Native Vegetation of the Sydney Metropolitan Area - Version 3.1 (OEH, 2016) VIS_ID 4489 (DPE 2016)
- The NSW State Vegetation Type Map (SVTM) – Edition C1.1.M1 (DPE 2022e)
- State Vegetation Type Map: Upper Hunter v1.0. VIS_ID 4894 (DPE 2022f).

A likelihood of occurrence table (Appendix B) was compiled to assess the likelihood of each of the threatened species identified during desktop research being present within the study area. The assessment was based on habitat requirements in the Threatened Biodiversity Profiles Database, PlantNet, species profiles and scientific literature where available. It includes consideration of location of nearby records and observation dates, presence of key habitat features and information about species populations in the area. The likelihood table was updated following the site inspection. Exclusively marine or aquatic species were removed due to the absence of suitable habitat.

2.2 Field survey

Field surveys were carried out by two ecologists over two days from 22-23 August 2022, and over three days and two nights from 26-28 October 2022.

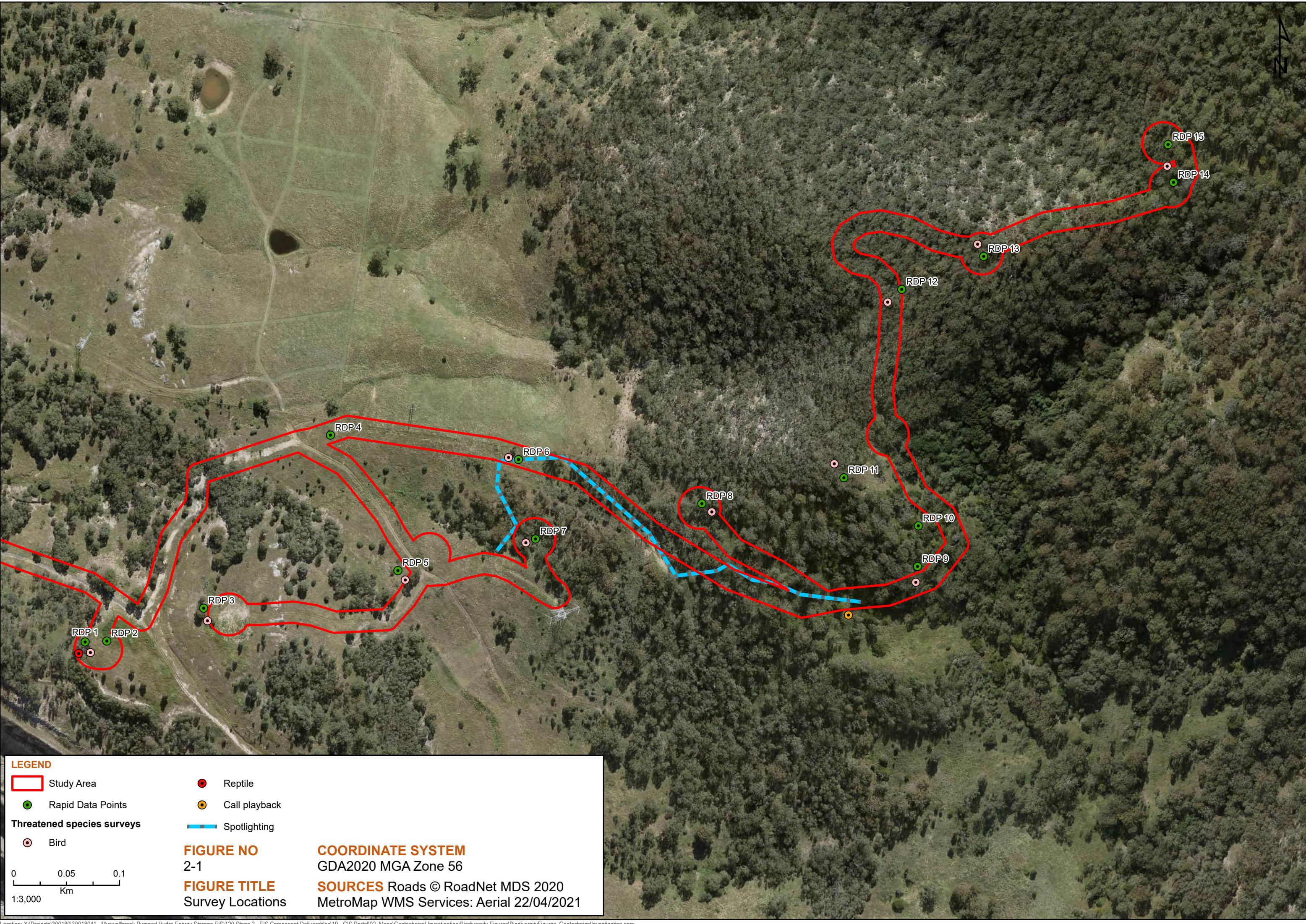
The conservation significance of flora and fauna species and vegetation communities was determined according to:

- BC Act for significance within NSW
- EPBC Act for significance within Australia.

2.2.1 Vegetation

Rapid data points (RDPs) were conducted on 22-23 August and 26-28 October 2022 to check for presence of native vegetation communities (Figure 2-1). The information collected included the dominant species for major structural layers – the canopy, shrub layer and ground layer. Additional species were also collected if they were relevant to providing diagnostic evidence to a potentially present TEC in the location. The methodology has been adapted from the Native Vegetation Interim Type Standard (Sivertsen 2009).

Habitat assessments were conducted at each of survey sites (Figure 2-1). The presence of microhabitat features such as large trees hollow-bearing trees, fallen logs, grass tussocks and logs were noted for each survey site. Occurrence of hollow-bearing trees clearly within the path of access tracks or geotechnical test sites were mapped.



LEGEND

Study Area

Rapid Data Points

Threatened species surveys

Bird

Reptile

Call playback

Spotlighting

FIGURE NO
2-1

FIGURE TITLE
Survey Locations

COORDINATE SYSTEM
GDA2020 MGA Zone 56

SOURCES Roads © RoadNet MDS 2020
MetroMap WMS Services: Aerial 22/04/2021

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Km
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2.2.2 Flora

Targeted threatened flora surveys were conducted for species listed as threatened under the EPBC and/or BC Acts and assessed with a moderate or higher likelihood of occurring in the study area. Threatened flora surveys were conducted over the study area using the *NSW survey guide for the Biodiversity Assessment Method – Surveying threatened plants and their habitats* (DPIE 2020) as a guide. Surveys incorporated the use of transects to search for target species in areas of potential habitat. Specifically, transects were spaced approximately 10 metres apart by performing a sweep forward and back along the access alignments and around the survey pad locations. More in-detailed surveys were performed around the RDP sites.

Table 2-1: Targeted threatened flora species

Species	Common Name	Source	Known Habit in the Hunter IBRA Subregion
<i>Acacia pendula</i>	Endangered population	Tender - Table 2 (SMEC 2021)	PCT 1605, 1691
<i>Cymbidium caniculatum</i>	Endangered population	Tender - Table 2 (SMEC 2021) Appendix B	PCT 1543, 1691
<i>Cynanchum elegans</i>	White-flowered Wax Plant	Tender - Table 2 (SMEC 2021) Appendix B	PCT 1543, 1691
<i>Dichanthium setosum</i>	Bluegrass	Appendix B	PCT 796, 1608, 1691
<i>Diuris tricolor</i>	Pine Donkey Orchid	Tender - Table 2 (SMEC 2021) Appendix B	PCT 1691
<i>Eucalyptus glaucina</i>	Slaty Redgum	Tender - Table 2 (SMEC 2021)	PCT 1691
<i>Pomaderris brunnea</i>	Brown Pomaderris	Tender - Table 2 (SMEC 2021)	Not know in this subregion or Study area PCTS
<i>Prasophyllum petilum</i>	Tarengo Leek Orchid	Tender - Table 2 (SMEC 2021)	PCT 1691
<i>Thesium australe</i>	Austral Toadflax	Tender - Table 2 (SMEC 2021) Appendix B	Not PCT associations in study area.
<i>Tylophora linearis</i>	<i>Tylophora linearis</i>	Tender - Table 2 (SMEC 2021)	Not known in this subregion or study area PCTS

2.2.3 Fauna

Species with a moderate or higher likelihood of occurrence in the study area (Appendix B) based on recent records and the availability of suitable habitat within the study area were targeted during the fauna survey period. Some species were excluded from survey where their presence can be assumed (eg. microbats) or the habitat assessment provides a more accurate prediction of their presence based on the impact area in comparison to the species' home ranges and limited survey period available (eg. some diurnal birds and Spotted-tailed Quoll).

The total survey effort for threatened fauna species is provided in Table 2-2. Details of each survey method utilised are provided below.

Table 2-2: Summary of fauna survey effort

Survey	Target species	Total effort
Diurnal bird surveys	White-throated Needletail Fork-tailed Swift Yellow Wagtail Swift Parrot Regent Honeyeater	22-23 August 2022 26-28 October 2022 15 surveys across 11 locations
Active reptile searching	Striped Legless Lizard	26 October 2022 One survey at one location
Spotlighting	Giant Burrowing Frog Brush-tailed Phascogale Squirrel Glider Greater Glider Yellow-bellied Glider Parma Wallaby Koala	26-27 October 2022 Two surveys of one transect
Call playback	Masked Owl Sooty Owl	26-27 October 2022 Two surveys at two locations

2.2.3.1 Targeted fauna surveys

Diurnal bird surveys

Dawn and dusk surveys for diurnal birds were carried out by two observers within three hours of sunrise or sunset for a period of 30 minutes. Surveys were carried out at each geotechnical investigation site (one survey was conducted for both TP7 and BH11 due to their proximity) and three sites along the access track. Locations are shown in Figure 2-1. Surveys for Swift Parrots were carried out on 22 and 23 August 2022, with the remaining diurnal bird surveys undertaken over 26 – 28 October 2022. Birds were identified visually or by vocalisations. Incidental listening for threatened bird calls were performed at all times while traversing the study area.

Reptile surveys

Active reptile searching for the Striped Legless Lizard was undertaken on 26 October 2022 in suitable grassland or grassy woodland habitat with tussock grasses, rocks and logs for shelter. Only one site, BH12, was considered to have suitable habitat for the Striped Legless Lizard including grass tussocks and surface stones. Searching included turning rocks and logs for sheltering lizards, with these features returned to their original positions.

Spotlighting

Spotlighting was conducted along a 500 metre transect for one hour per survey over two nights on 26 and 27 October 2022 using handheld torches. Attention was directed to the tree and shrub layer to detect arboreal mammals and to the ground to detect the Giant Burrowing Frog.

Call playback

Call playback for the Masked Owl and Sooty Owl was conducted at one site over two nights on 26 and 27 October 2022. An initial 10-minute listening period was followed by playing the call of each target species intermittently for five minutes. This was followed by a five-minute listening period and spotlighting in the vicinity to detect any owls that had flown in without calling.

Opportunistic sightings

Opportunistic sightings of fauna were recorded during other field activities and while moving between surveys sites.

2.3 Limitations

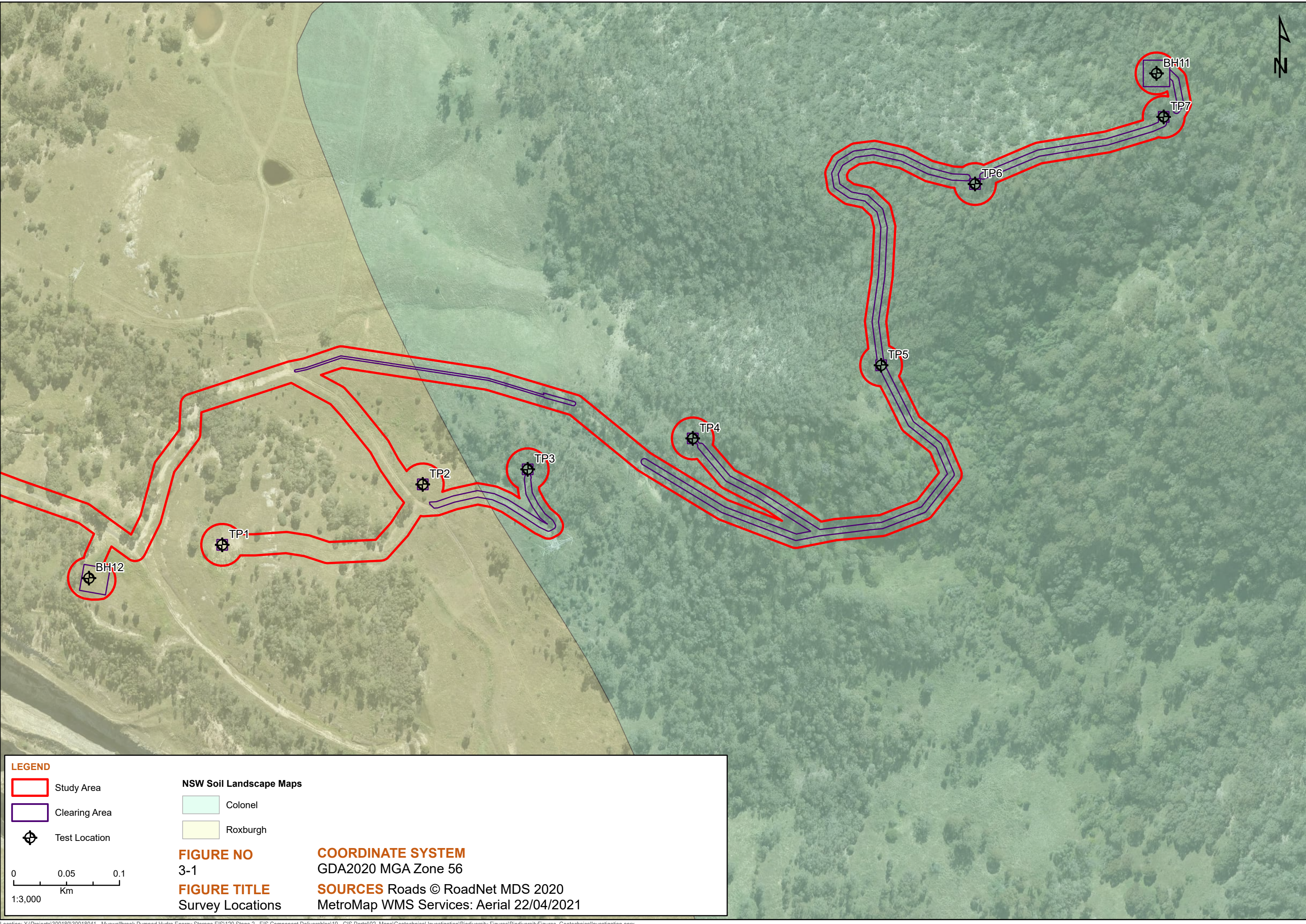
- The proposed construction methodology as referenced in this report are considered to be indicative of a typical geotechnical investigation scope and may be subject to minor changes. However, the overall footprint of the proposed geotechnical investigations would remain within the clearing boundary delineated within this report.
- Weather conditions and time constraints prevented Swift Parrot surveys from being undertaken for the full duration at all geotechnical test sites during the species' survey window.
- Diurnal bird surveys at the top of the Lower Reservoir site were carried out outside of the optimal survey times at due to difficulty accessing the site during dawn and safety concerns leaving the site after dusk.
- Threatened fauna surveys were limited to those targeting diurnal birds, reptiles and nocturnal species.
- No fauna trapping or ultrasonic detection was undertaken. Threatened microbat species considered likely to occur in the Proposal area were assumed present.
- Species not detected during surveys or not present at the time of survey does not necessarily mean they do not occur. Such species have been assessed considering the availability and condition of suitable habitat and recent reliable records of occurrence within or nearby the study area.
- A detailed habitat tree assessment was not included in the scope of works and therefore not all habitat trees within the study area were mapped.
- The handheld GPS used to record the survey tracks was lost in the field. Ecologist walked in parallel along the alignment and the ground coverage was high with the study area being within 5m of all transects.

3. Results

3.1 Existing environment

According to broadscale soil landscape mapping, the lower slopes are underlain by the Roxburgh soil landscape (Kovac 1991) (Figure 3-1). The Roxburgh soil landscape covers undulating low hills and undulating hills and is dominated by yellow podzolic soils (Kovac and Lawrie 1991). Generally, soils are derived from sandstone, shale, mudstone, conglomerate and coal associated with the Singleton Coal Measures. This soil landscape type has been extensively cleared for grazing land. Much of the lower slope in the study area have been cleared historically and are now supporting the regrowth of young forest and woodland interspersed with areas of derived native grassland.

From the mid to upper slopes the study area is within the Colonel (Figure 3-1). This soil landscape covers rolling hills and rolling mountains often with scree slope. It commonly has rocky outcrops and steeper slopes between 18 and 50 degrees. The landscape type has generally been subjected to relatively little clearing across its range. The site appears to exhibit signs of significant disturbance in times of European history. Logging is likely to have occurred across the study area as evidence by cut stumps and relatively few very large old trees. Seasonal grazing over much of the mountain is evidenced by stock fencing, the general distribution of weed species, and discussion with local land-owners. Prickly pear (I species) was historically prevalent on the mountain prior to the introduction of biological control and 'Prickly Pear Leases' were available on the summit of Bells Mountain (Michael Keegan, pers comm 2022).



LEGEND

Study Area

Clearing Area

Test Location

NSW Soil Landscape Maps

Colonel

Roxburgh

FIGURE NO
3-1

FIGURE TITLE
Survey Locations

COORDINATE SYSTEM
GDA2020 MGA Zone 56

SOURCES Roads © RoadNet MDS 2020
MetroMap WMS Services: Aerial 22/04/2021

0 0.05 0.1
Km
1:3,000

3.2 Vegetation communities

The site inspection revealed that the vegetation observed across the study area was broadly consistent with the Plant Community Types (PCTs) as identified and delineated by the broadscale regional mapping - the *State Vegetation Type Map: Upper Hunter v.1.0. VIS_ID 4894* (DPE 2022f). Reference was also made to the newer State-wide vegetation mapping (SVTM 2022e) which uses the New Eastern PCTs.

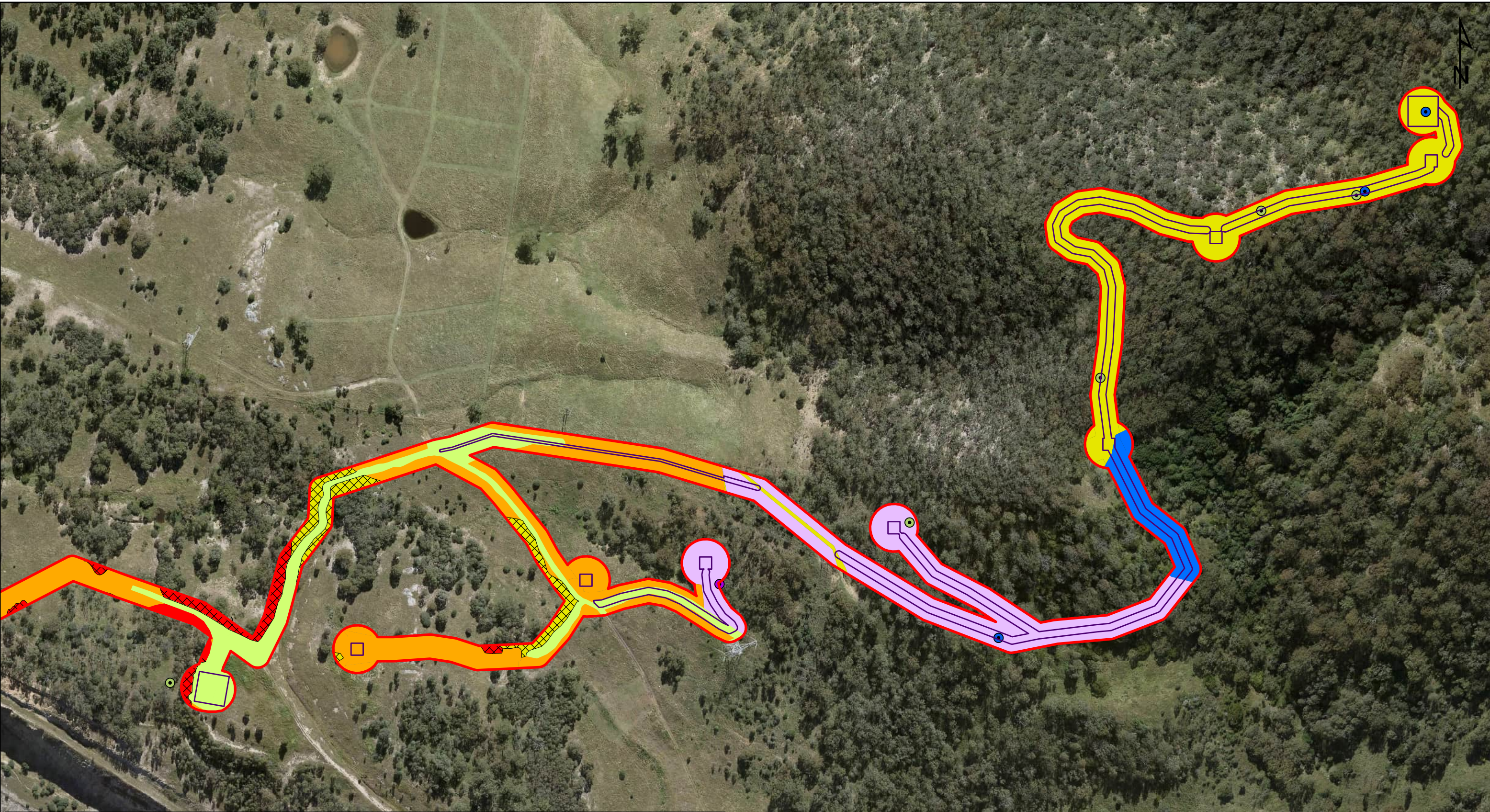
Five native vegetation communities and one non-native community were therefore identified as potentially being impacted by the proposed works (Figure 3-2):

- PCT 1605: Narrow-leaved – Native Olive Shrubby Open Forest of the Central and Upper Hunter
- PCT 1608: Grey Box - Grey Gum - Rough-barked Apple - Blakely's Red Gum grassy open forest of the central Hunter
- PCT 1691: Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter
- PCT 1543 Rusty Fig - Native Quince - Native Olive dry rainforest of the Central Hunter Valley
- PCT 796: Derived Grassland of the NSW South Western Slopes
- Non-native areas, highly disturbed without native dominant vegetation cover.

According to a review of the BioNet Vegetation Classification Database (DPE2022D), each of these PCTs may align with the following threatened ecological communities (TECs):

- PCT 1605 may align with:
 - Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions, Listed as an Endangered Ecological Community (EEC) under the BC Act
 - Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions listed as an EEC under the BC Act.
- PCT 1608: Grey Box - Grey Gum - Rough-barked Apple - Blakely's Red Gum grassy open forest of the central Hunter.
 - White Box Yellow Box Blakely's Red Gum Woodland¹, listed as a CEEC under the BC Act
 - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as a Critically Endangered Ecological Community (CEEC) under the EPBC Act.
- PCT 1691 may align with:
 - White Box Yellow Box Blakely's Red Gum Woodland¹, listed as an CEEC under the BC Act,
 - Central Hunter Grey Box - Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions, listed as an EEC under the BC Act
 - Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions, listed as an EEC under the BC Act.
- PCT 796 may align with:
 - White Box Yellow Box Blakely's Red Gum Woodland, listed as a CEEC under the BC Act
 - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as a Critically Endangered Ecological Community (CEEC) under the EPBC Act.
- PCT 1543: Rusty Fig - Native Quince - Native Olive dry rainforest of the Central Hunter Valley
 - Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions
 - Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions.

The investigation areas and access routes do not contain any Areas of Outstanding Biodiversity Values (AOBVs) as declared under the BC Act nor do they contain mapped biodiversity values as per the Biodiversity Values Map and Threshold Tool (DPE 2022c).



LEGEND

Study Area

Clearing Area

Threatened Ecological Communities

Habitat trees

Habitat tree

Hollow-bearing tree

Recorded threatened species

Speckled Warbler

Vegetation

Non-native

PCT 796: Derived grassland of the NSW South Western Slopes

PCT 1543: Rusty Fig - Native Quince - Native Olive dry rainforest of the Central Hunter Valley

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

PCT 1608: Grey Box - Grey Gum - Rough-barked Apple - Blakely's Red Gum grassy open forest of the central Hunter

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

FIGURE NO
3-2

FIGURE TITLE
Survey Locations

COORDINATE SYSTEM
GDA2020 MGA Zone 56

SOURCES Roads © RoadNet MDS 2020
MetroMap WMS Services: Aerial 22/04/2021

0 0.05 0.1
Km
1:3,000

3.2.1 PCT 1605: Narrow-leaved – Native Olive Shrubby Open Forest of the Central and Upper Hunter

This was the most common vegetation type mapped across the study area, particularly on the mid and upper slopes of Bells Mountain (Figure 3-2). The canopy was usually dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*) with occasional Rough-barked Apple (*Angophora floribunda*), Forest Red Gum (*Eucalyptus tereticornis*) and Yellow box (*Eucalyptus melliodora*). In some areas *E. tereticornis* were relatively prevalent. The mid-storey was dominated by Native Olive (*Notelaea microcarpa* var. *microcarpa*) and Sticky Daisy Bush (*Olleria eliptica*). Native ground layer species recorded in this area included Barbed Wire Grass (*Cymbopogon refractus*), Slender Panic (*Paspalidium gracile*), Blue Trumpet (*Ajuga australis*), Rock Fern (*Cheilanthes sieberi*). Exotic/weed species recorded in this community included Fireweed (*Senecio madagascariensis*), Pimpernel (*Anagalis arvensis*), Carpet Weed (*Galenia pubescens*) and South African Pigeon Grass (*Setaria spaciolata*).

The species recorded that are diagnostic of PCT 1605 include Narrow-leaved Ironbark (*E. crebra*) and Native Olive (*N. microcarpa* var. *microcarpa*). As per the BioNet Vegetation Classification 2.0 (DPIE, 2020), PCT 1605 is an open forest with a canopy dominated by Narrow-leaved Ironbark (*E. crebra*) with an open shrub mid-storey layer and a ground layer that is predominantly grassy.

Most of this vegetation community in the study area does not align with Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC (BC Act) and Central Hunter Valley eucalypt forest and woodland CEEC (EPBC Act). Areas on the steeper rocky slopes do not conform to the landscape and geological positions specified in their final determinations. The TEC is found on Permian sediments on the lower slopes and rolling hills. Bells Mountain is rocky and primarily composed of Carboniferous period conglomerates (Rasmus, Rose D and Rose G 1969).

Vegetation on the mid and upper slopes of Bells Mountain exhibits a dense shrub layer (not a result of tree regrowth but genuine shrub species), which is in contrast to the TECs description of a sparse and open shrub layer in the final determinations (Commonwealth of Australia (2016); NSW Scientific Committee 2010). It should be noted that that under the revised Eastern PCTs currently in transition, this PCT has a strongly direct lineage to the new PCT 3525: Upper Hunter Box-Blakely's Red Gum Grassy Forest, a PCT without a listed association with any TEC.

Some areas of PCT 1605 regrowth on the lower foot slopes of Bells Mountain do meet the description of the TEC – and this is covered in the Section 3.3.



Figure 3-3: PCT 1605 on the mid slopes of Bells Mountain

3.2.2 PCT 1608: Grey Box - Grey Gum - Rough-barked Apple - Blakely's Red Gum grassy open forest of the central Hunter.

This community is described as open forests to woodlands characterised by Grey Box (*Eucalyptus moluccana*) in association with a range of other eucalypts. The mid-storey consists of a relatively diverse shrub layer and sparse climbers. The ground layer is predominately grassy with various forbs and graminoids and is found on the hills of the central and upper Hunter Valley at mid to low elevations. In the study area this community is found in more sheltered and generally south facing positions on the slopes (Figure 3-2). Grey Box (*E. moluccana*), possibly with some hybridisation with *E. albens* is co-dominant with Grey Gum (*E. punctata*). Less common is Yellow Box (*E. melliodora*) and (*A. floribunda*). The shrub layer was found to be usually dense with *Notolea macrocarpa*, *Olleria elliptica*, *Pittosporum undulatum* and *Solanum brownii*. The ground layer usually included grasses; Weeping Grass (*Microlaena stipoides*), *Austrostipa verticillate* and *Poa labellardei*. Common forbs were *Gallium leptogonium*, *Dichondra repens* and *Desmodium brachypodum*. Despite the association this PCT can have with the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland (both BC and EPBC listed community), the vegetation in areas of this PCT do not conform to the TEC, again based on landscape position on steep rocky Carboniferous era geology, and the presence of dense shrubby understory. It should be noted that in that under the revised Eastern PCT currently in transition this PCT shows a strong lineage to the new PCT 3439 - Hunter Escarpment Grey Gum Sheltered Forest, a PCT not considered to have associations with any TEC.



Figure 3-4: PCT 1608 on the mid-slopes of Bells Mountain

3.2.3 PCT 1691: Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter

Confined to the lower slopes of the mountain (Figure 3-2), this vegetation community is dominated by Narrow-leaved Ironbark (*E. crebra*) with some grey box/white box hybrid (*Eucalyptus moluccana* x *albens*). The shrub layer was relatively sparse but the grassy understorey was dense and dominated by Barbed Wire Grass (*C. refractus*), Yellow Burr-daisy (*Calotis lappulacea*), Common Everlasting (*Chrysocephalum apiculatum*), variable Glycine (*Glycine tabacina*). Exotic/weed species were mainly fireweed and carpet weed (*Galenia pubescens*).

The species recorded that are diagnostic of PCT 1691 include Narrow-leaved Ironbark (*E. crebra*), Grey Box/White Box hybrid (*E. moluccana* x *albens*) and Yellow Burr-daisy (*C. lappulacea*).

This vegetation community in the study area is considered likely to align with Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC (BC Act) and Central Hunter Valley eucalypt forest and woodland CEEC (EPBC Act).

Most of this community in the study area appears to have been subject to clearing on the lower, flatter areas and most trees are relatively young re-growth. A representative photograph of this community is shown in Figure 3-9 in Section 3.3.

3.2.4 PCT 796: Derived grassland of the NSW South Western Slopes

Open grassy areas on the foot slopes and flats near around the base of the mountain are comprised of a similar assemblage of native grasses, herbs and forbs found in the surrounding woodland (Figure 3-2). Clearing is likely to have occurred for grazing and regrowth of juvenile eucalypts are seen recolonising the periphery of these patches. The grasslands are in relatively good condition being comprised of more than 50% native ground-cover and containing a reasonable diversity of forb species. Disturbances within the derived native grasslands could be noted along existing

access tracks, the cuttings of the drainage channel and the area adjacent to BH12 where clearing occurred during coal pit wall re-stabilisation works in 2008. These highly disturbed grassland areas where exotic species tend to dominate have been mapped as non-native areas.

Canopy species were generally absent in this community although regeneration of juvenile narrow-leaved ironbark (*E. crebra*) were present. Mid-storey shrub species were limited to a few occurrences of native olive (*N. microcarpa* var. *microcarpa*), Prickly Wattle (*Acacia paradoxa*) and western Boobialla (*Myoporum montanum*). Dominant native grass species include Barbed Wire Grass (*C. refractus*), Slender Panic (*P. gracile*), Windmill Grass (*Chloris truncata*), Tall Chloris (*Chloris ventricosa*), and *Austrostipa* spp. Common native herbs and forbs include Corrugated Sida (*Sida corrugata*), Common Everlasting (*C. apiculatum*), Yellow Burr-daisy (*C. lappulacea*), Common Sedge (*Carex breviculmis*), Spiked Sida (*Sida hackettiana*), Narrawa Burr (*Solanum cinereum*) and variable Glycine (*G. tabacina*). Exotic/weed species were prevalent including South African Pigeon Grass (*S. spaelata*), Red Natal Grass (*Melinis repens*), Paddy's Lucerne (*Sida rhombifolia*), Purpletop (*Verbena bonariensis*), Stinking Roger (*Tagetes minuta*), Carpet Weed (*G. pubescens*), Fireweed (*Senecio madascariensis*) and Narrow-Leaved Cotton Bush (*Gomphocarpus fruticosus*).

The species recorded that are diagnostic of PCT 796 include Windmill Grass (*C. truncata*), Wheatgrass (*Elymus scabra*), Common Everlasting (*C. apiculatum*), Weeping Grass (*M. stipoides*) and Bluebell (*Wahlenbergia* spp.).

This vegetation community was considered for its potential to align with White Box Yellow Box Blakely's Red Gum Woodland EEC (BC Act) and White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC (EPBC Act). These derived grasslands are surround both up and down slope by woodland communities where narrow-leaved ironbark (*E. crebra*) is by far the dominant species with occasion Grey Box/White Box hybrids (*E. moluccana* x *albens*). Regrowth on the perimeter of the derived native grassland is also almost exclusively *E. crebra*. There is strong evidence that none of the definitive species of the TEC (Whitebox, Yellow Box or Blakely's Red Gum) are or, were historically a major component of the canopy. Hybrids are recognised in species determination, however even though White Box (*E. albens*) is considered present, again its presence is in the minority.



Figure 3-5: PCT 794 are a derived grassland from historic clearing of the canopy trees.

3.2.5 PCT 1543: Rusty Fig - Native Quince - Native Olive dry rainforest of the Central Hunter Valley

An area of south east facing hill slope was relatively open, most likely as a result of past clearing but now in a state of regrowth (Figure 3-2, Figure 3-6). This community generally lacked eucalypts except for *Angophora floribunda* and contained scattered rainforest trees including White Cedar (*Melia azerderach*), Hard Alectryon (*Alectryon subdentatus*), Whalebone Tree (*Streblus brunonianus*), *P. undulatum* and Grey Myrtle (*Backhousia myrtifolia*) in more sheltered positions. The ground layer was primarily grassy with *M. stipoides* and *Astrostipa verticillata* and in shady positions under trees, Maiden Hair Ferns (*Adiantum aethopicus*), Sickie Fern (*Pellaea falcta*) and Native Stinging Nettle (*Urtica incisa*) were common. In the community's current regrowth form, it does not exhibit a closed canopy which is part of the structural definition of rainforest or vine thicket formations of the potential TECs associated with this community. Therefore, the vegetation in the study area does not meet the final determinations for Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions or Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions. It was noted that approximately 50 metres away in the gully to the east a closed rainforest canopy was present, however the composition of this area was not investigated further and is currently outside the area of potential impact.



Figure 3-6: Regenerating PCT 1543: Rusty Fig - Native Quince - Native Olive dry rainforest of the Central Hunter Valley

3.2.6 Non-native

Existing mine-site access tracks or power easement tracks with high levels of surface disturbance and areas where cleared grassland is highly disturbed with exotic cover generally greater than 50% are mapped as non-native (Figure 3-2). Common weed species are the same as those noted in areas of derived grassland.



Figure 3-7: Non-native vegetation in the form of highly disturbed grassland adjacent to TP2 – main non-native grasses visible are African Pigeon Grass (*Setaria spaelata*) and Coolatai (*Hyparrhenia hirta*)



Figure 3-8: Existing mine access track off Limestone avenue.

3.3 Threatened ecological communities

The TECs that have been identified as potentially being impacted by the proposed works are listed in Table 3-1.

Table 3-1: TECs identified as potentially being impacted by the proposed works

PCT	BC Act	EPBC Act
PCT 1605: Narrow-leaved – Native Olive Shrubby Open Forest of the Central and Upper Hunter	Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC	Central Hunter Valley eucalypt forest and woodland CEEC
PCT 1691: Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter		

3.3.1 Central Hunter Grey Box-Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC (BC Act)

Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions is the name given to the ecological community that generally occurs on Permian sediments in the Hunter Valley and is characterised by the assemblage of species provided by paragraph 2 of the Final Determination (NSW Scientific Committee, 2010). The community typically forms a woodland to open forest on slopes and undulating hills (NSW Scientific Committee, 2010).

This EEC has been considered to occur in the study area, confined to the flatter slopes which correspond to the Roxburgh soil landscape (Figure 3-2). Characteristic species observed in the study area that are diagnostic of this EEC include Narrow-leaved Ironbark (*E. crebra*), rough-barked apple (*A. floribunda*), Barbed Wire Grass (*C. refractus*), Common Everlasting (*C. apiculatum*), Yellow Burr-daisy (*C. lappulacea*), Blue Trumpet (*Brunoniella australis*), Rock

Fern (*C. sieberi*) and variable Glycine (*G. tabacina*). In the study area the EEC typically occurred as an open forest on Permian sediments.

As part of the proposed works some tree clearing and track works are expected to occur in this EEC. Consequently, a five-part test of significance was conducted (Appendix C). The five-part test of significance concluded that there would be no significant impact to the EEC as a result of the proposed works.



Figure 3-9: Central Hunter Grey Box-Ironbark Woodland TEC on the lower slopes. One Grey box is visible in the foreground. Narrow-leaved ironbark (*Eucalyptus crebra*) is the dominant tree.

3.3.2 Central Hunter Valley eucalypt forest and woodland CEEC (EPBC Act)

Central Hunter Valley eucalypt forest and woodland CEEC includes eucalypt woodlands and open forests typically with a shrub layer of variable density and/or a grassy ground layer (DoE 2015). The canopy of the CEEC is dominated by one or more of a complex of four eucalypt tree species – Narrow-leaved Ironbark (*E. crebra*), Spotted Gum (*Corymbia maculata*), Slaty Gum (*Eucalyptus dawsonii*) and Grey Box (*E. moluccana*). The CEEC also may include sub-dominant or locally dominant species (such as *A. floribunda*) and hybrid species (such as *E. moluccana* x *E. albens*) (DoE, 2015). Contra-indicative species include Forest Oak (*Allocasuarina torulosa*), White Mahogany (*Eucalyptus acmenoides*) and Red Ironbark (*Eucalyptus fibrosa*). Areas of the ecological community must meet the key diagnostic characteristics and the minimum condition thresholds for moderate quality as per Sections 1.5.1 and 1.5.3 of the Conservation Advice in order to be considered the CEEC (DoE 2015).

This CEEC has been identified where PCT 1605 and 1691 were considered to occur in the study area (Figure 3-2). The CEEC is considered to be in moderate quality condition. This is based on the vegetation in the study area meeting the following key diagnostic characteristics and minimum condition thresholds (DoE 2015):

Key diagnostic characteristics

- It occurs in 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
- It does not occur on alluvial flats, river terraces, aeolian sands, Triassic sediments or escarpments
- It is a woodland or forest with a projected canopy cover of trees of 10% or more
- The canopy is dominated by narrow-leaved ironbark (*Eucalyptus crebra*)
- The contra-indicative species are largely absent
- A ground layer is present as a sparse to thick layer of native grasses and other native herbs and/or native shrubs.

Minimum condition thresholds

- The patch is ≥ 0.5 hectares and $\geq 50\%$ of perennial understorey vegetative cover is native and the patch contains at least 12 native understorey species.

As part of the proposed works, some tree removal and geotechnical works were expected to occur in this EEC. Consequently, an assessment of significance was conducted (refer to Appendix E). The assessment of significance concluded that there would be no significant impact to the EEC as a result of the proposed works. Geotechnical pads located within this EEC have since been moved to avoid clearing any of this EEC.

3.4 Groundwater dependent ecosystems

Vegetation communities in the study area have been identified as 'low potential GDEs' (Bureau of Meteorology 2023) and have therefore not been considered further.

3.5 Flora

The desktop assessment identified five threatened flora with a moderate likelihood of occurring in the study area (Appendix B). None of the threatened flora species were recorded in the study area during the field surveys (Appendix A).

3.6 Fauna

Incidental and targeted fauna surveys identified 36 native species; 26 birds, five mammals, three reptiles and two frogs (Appendix A). An additional two unidentified microbat species were observed during the nocturnal surveys. One introduced species, the European Rabbit (*Oryctolagus cuniculus*), was incidentally observed on Limestone Road whilst accessing the Proposal area.

One of the recorded species, the Speckled Warbler (*Chthonicola sagittata*), is listed as vulnerable under the BC Act.

3.6.1 Threatened fauna

Fifty-four species listed as threatened or migratory under the BC Act and/or EPBC Act were predicted to occur through database searches (Appendix B). Of these species, 32 were identified as having a moderate or higher likelihood of occurrence in the study area based on the availability of suitable habitat and recent nearby sightings.

Of these, eight species were assessed as having a high likelihood of occurring (Appendix A) and one species listed as vulnerable under the BC Act was recorded during the survey period; the Speckled Warbler (Figure 3-2). Assessments of significance were carried out for these species (Appendix C).

Table 3-2: Threatened fauna species recorded or assessed as having a high likelihood of occurrence in the study area

Scientific name	Common name	NSW status	EPBC status
<i>Chthonicola sagittata</i>	Speckled Warbler	V	-
<i>Dasyurus maculatus maculatus</i> (SE mainland population)	Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	V	E
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	V	-

Scientific name	Common name	NSW status	EPBC status
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat	V	V
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	-
<i>Phascolarctos cinereus</i>	Koala	E	E
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V	-
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	-
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V	-

3.6.2 Fauna habitat

The study area and surrounding landscape contains habitat features suitable for supporting a range of native species. Hollow-bearing trees containing large hollows were recorded in the study area. Fallen logs also occur in areas with more mature vegetation. An overview of the microhabitat features present at each of the survey sites is outlined in the table below.

Table 3-3: Vegetation type and microhabitat features at survey sites in the study area

Survey site	Vegetation	Habitat tree	Hollows	Logs	Rocks	Tussocks
BH11	PCT 1605	X		X	X	
BH12	/ non-native				X	X
TP1	PCT 796			X		
TP2	PCT 796					
TP3	PCT 1608	X	X	X	X	
TP4	PCT 1608			X	X	
TP5	PCT 1605 / 1608	X	X	X	X	
TP6	PCT 1605	X	X	X	X	
TP7	PCT 1605			X	X	
RDP6	PCT 796			X		
RDP9	PCT 1608			X	X	
RDP12	PCT 1605	X				

Fauna habitat types within the study area generally correspond to the vegetation communities described in Section 3.2. Fauna habitat within the study area includes dry sclerophyll forest (PCT 1605 and PCT 1608), grassy woodland (PCT 1691), dry rainforest (PCT 1543), native grassland (PCT 796) and disturbed exotic dominant pasture. Direct impacts to threatened fauna habitat of species likely to occur are outlined in Table 4-4 and Table 4-5.

Dry sclerophyll forest

Dry sclerophyll forest represented by PCT 1605 was the most common habitat type within the study area. This habitat consists of a predominantly grassy understorey with a medium to tall canopy of *E. crebra* with occasional *A. floribunda*, *E. tereticornis* and *E. melliodora*. Hollow-bearing trees, fallen trees, leaf litter and rocks were generally available. The mid and upper slopes of Bells Mountain exhibit a moderately dense shrub layer rather than open grasslands. This habitat type provides suitable habitat for many species. PCT 1608 has a predominately grassy understorey with various forbs. The mid-storey consists of a relatively diverse shrub layer and sparse climbers, and the canopy is characterised by *E. moluccana* and other eucalypts. This vegetation type also supports hollow-bearing trees, fallen trees, leaf litter and rocks.

Grassy woodland

Grassy woodland habitat (PCT 1691) has a dense grassy understorey dominated by *C. refractus*, *C. lappulacea*, *C. apiculatum* and *G. tabacina*. It has a relatively sparse shrub layer and the canopy layer was dominated by *E. crebra* with some *E. moluccana* x *albena*.

BH12 was the only survey site within the study area that contained grassy woodland habitat (PCT 1691) and suitable microhabitat features to potentially support Striped Legless Lizards. Microhabitat features found at this site included logs, rocks and a grassy understory with tussocks.

Regrowth dry rainforest

This habitat type within the study area was in a state of regrowth and did not exhibit a closed canopy, however approximately 50 metres outside of the study area the habitat type displayed a closed canopy consistent with rainforest habitat. This regrowth dry rainforest habitat (PCT 1543) was present on an area of south-east facing hill slope, along a proposed access track in the study area. This community had a primarily grassy understorey with *A. aethopicus*, *P. falcta* and *U. incisa* in more shaded areas. This habitat contained young, scattered rainforest trees including *M. azerderach*, *A. subdentatus*, *S. brunonianus*, *P. undulatum* and *B. myrtifolia*, and lacked eucalypts except for *A. floribunda*. Despite the absence of mature trees and other microhabitat features, this vegetation still provides potential foraging habitat for woodland bird and mammal species.

Grassland

The grassland recorded within the study area (PCT 796) is dominated by native grass species including *C. refractus*, *P. gracile*, *C. truncate*, *C. ventricosa*, and *Austrostipa* spp. This habitat had a limited presence of regenerating juvenile canopy species (*E. crebra*) and mid-storey shrub species (*N. microcarpa* var. *macrocarpa*, *A. paradoxa* and *M. montanum*).

This derived grassland community is not associated with the threatened species likely to occur within the study area, however it may provide some foraging habitat for the Speckled Warbler and Yellow-bellied Sheath-tail-bat near other vegetation types. It is suitable for kangaroos and birds of prey were observed hunting over these areas.

Disturbed exotic dominant pasture

Introduced species comprised over 50% of the vegetation cover and included *S. spaciolata*, *M. repens*, *S. rhombifolia*, *V. bonariensis*, *T. minuta*, *G. pubescens*, *S. madascariensis* and *G. fruticosus*. It is suitable for kangaroos and birds of prey were observed hunting over these areas.

4. Impact assessment

4.1 Direct impacts

4.1.1 Clearing vegetation

The proposal will require the clearing of up to 0.908 hectares of native vegetation. Clearing for test pads requires cut and fill earthworks to create a level surface. The clearing for the testing pads is not to be permanent as vegetation regrowth will be facilitated post investigation. Maximum clearing of native vegetation for the two borehole pads (25 x 25 metres each) and the seven test pit pads (10x10 metres each) is 0.1325 hectares. BH12 was initially located partly on neighbouring woodland, however the location of BH12's pad was moved further east on to exotic grassland to avoid the neighbouring woodland altogether. The precise orientation and position of the test pads shown in the figures may be adjusted slightly during construction to suit localised contours and avoid large trees where possible.

The breakdown for the clearing in each vegetation type for the test pads are outline in Table 4-1. The locations of TP1 and TP2 were also adjusted to avoid clearing of neighbouring TECs.

Table 4-1: Clearing required for boreholes (BH) and test pits (TP) pads

Investigation area	Pad dimensions (m)	Vegetation Type	TEC	Area (hectares)
BH11	25 x 25	PCT 1605	no	0.0625
BH12	25 x 25	Non-native	no	0.0625
TP1	10 x 10	PCT 796	no	0.01
TP2	10 x 10	PCT 796	no	0.01
TP3	10 x 10	PCT 1608	no	0.01
TP4	10 x 10	PCT 1608	no	0.01
TP5	10 x 10	PCT 1605	no	0.01
TP6	10 x 10	PCT 1605	no	0.01
TP7	10 x 10	PCT 1605	no	0.01
Total native clearing for pads.				0.1325

The majority of the vegetation clearing will be from the clearing of new access tracks. Existing access tracks are to be used where possible and the those used by the coal mine or power transmission maintenance can be seen in the aerial imagery in Figure 1-3. The exact clearing extent required for new access tracks will be determined by slope and the condition of substrates encountered along the proposed alignment. Nominal clearing estimates based on the topography within the section lengths within various vegetation zones are presented in Table 4-2. Track width is to be minimised at all times and flatter sections along the ridgeline could be contained to four metres in many cases (although six meters is showing in Figure 1-3). Some of the steepest section of cross-slope track may require greater than six metres of clearing width. Overall, most of the tracks have an assumed six metres clearing width and provides an upper estimate for vegetation clearing as a result.

The long-term status of the proposed access track up Bells Mountain, terminating at TP7 is currently unknown, pending possible future use of this track to the upper PHES reservoir located on the mountain top. Side branches off the main route up the mountain which terminate at test sites TP1, TP2, TP3, TP4 TP5 and BH11 are not considered permanent and are to be allowed to regenerate post investigation.

A section of new track in areas of derived native grassland (PCT 796) located on the lower slopes is unlikely to require slashing or surface treatment, however, a precautionary two metre clearing width has been included for this community to account for wheel rut disturbance (Table 4-2).

Table 4-2: Estimated clearing by plant community type including access tracks and test pads.

PCT and	Terrain	Track Clearing width (metres)	Area (hectares)
Non-native (Exotic grassland)	Lower slopes	2-4	0.1514
PCT 796 (Grassland)	Lower slopes	2	0.0535
PCT 1543 (Dry Rainforest)	Moderate gradients on mid slope	6	0.0785
PCT1608 (Dry Sclerophyll Forest)	Mid slope	6	0.3375
PCT 1605 (Dry Sclerophyll Forest)	Mid slope and ridgeline	6	0.4387
Total native vegetation clearing			0.908

4.1.2 Removal of threatened species' habitat

4.1.2.1 Flora

No threatened flora species were recorded in the study area, however it is possible that certain species could have gone undetected during surveys. Potential habitat for five threatened species with known associations with the PCT's present has been considered.

Table 4-3: Direct impacts on potential threatened flora habitat

Habitat type	Threatened flora species	Potential habitat directly impacted within study area (hectares)
PCT 1605 (Dry Sclerophyll Forest)	<i>Cymbidium canaliculatum</i>	0.4387
(PCT 1691 Grassy Woodland)	<i>Diuris tricolor</i> (Pine Donkey Orchid) <i>Dichanthium setosum</i> (Bluegrass) <i>Thesium austral</i> (Austral Toadflax)	0
(PCT 1543) Dry rainforest	<i>Cynanchum elegans</i> (White-flowered Wax Plant)	0.0785
PCT 796 Native grassland	<i>Diuris tricolor</i> (Pine Donkey Orchid) <i>Dichanthium setosum</i> (Bluegrass) <i>Thesium austral</i> (Austral Toadflax)	0.0535
Native Grassland and Exotic pasture	<i>Dichanthium setosum</i> (Bluegrass)	0.2049

4.1.2.2 Fauna

The study area provides suitable nesting and foraging habitat for threatened woodland birds, bats and arboreal mammals in four native vegetation communities (Table 4-4 and Table 4-5), which is likely to form part of a larger home range for these species on Bells Mountain. During diurnal bird surveys, a Speckled Warbler pair were observed perched in a small Native Olive (*Notelaea macrocarpa*) tree within site TP03.

The study area also supports a number of hollow-bearing trees that may provide breeding habitat for a number of arboreal mammals and birds.

The study area is also considered to have potential Striped Legless Lizard habitat. Although there are no records for this species in the study area, it is a species that even following extensive surveys in areas known to have records they are often extremely hard to detect.

Estimated removal of each habitat type and direct impacts to threatened fauna habitat is outlined in Table 4-4 and Table 4-5, respectively.

Table 4-4: Estimated areas of threatened fauna habitat removal

Vegetation Type	Habitat type	Area (hectares)
PCT 1543	Dry rainforest	0.0785
PCT 1605	Dry sclerophyll forest	0.4387
PCT 1608	Dry sclerophyll forest	0.3375
PCT 1691	Grassy woodland	0
Total clearing of threatened fauna habitat		0.855

Table 4-5: Direct impacts to potential threatened fauna habitat

Threatened fauna species	Dry sclerophyll forest	Grassy woodland	Regrowth dry rainforest	Grassland	Exotic pasture	Hollow-bearing trees	Total habitat directly impacted by the project (hectares)
Speckled Warbler	Foraging Breeding	-	Foraging Breeding	-	-	-	0.855
Spotted-tail Quoll	Foraging Breeding	-	Foraging	-	-	Yes	0.855
Large Bent-winged Bat	Foraging	-	Foraging	-	-	-	0.855
Corben's Long-eared Bat	Foraging Breeding	-	Foraging	-	-	Yes	0.855
Squirrel Glider	Foraging Breeding	-	Foraging	-	-	Yes	0.855
Koala	Foraging Breeding	-	Foraging	-	-	-	0.855
Yellow-bellied Sheathtail-bat	Foraging Breeding	-	Foraging	-	-	Yes	0.855
Greater Broad-nosed Bat	Foraging Breeding	-	Foraging	-	-	Yes	0.855
Eastern Cave Bat	Foraging	-	Foraging	-	-	-	0.855

4.1.3 Fauna injury or mortality

Injury or mortality of fauna is possible during the Proposal and routine maintenance of access tracks. Removal of fauna habitat, including hollow-bearing trees, may result in the injury or mortality of species using this habitat, or more indirectly as they compete to establish a new territory in neighbouring habitat after being displaced. The impact is expected to be minor given the temporary nature of the works and small disturbance footprint.

Mitigation measures to reduce fauna injury and mortality have been proposed in Section 5.

4.1.4 Key threatening processes

Key Threatening Processes (KTP) listed under the BC Act considered relevant to the Proposal:

- Bushrock removal
- Clearing of native vegetation
- Loss of hollow-bearing trees
- Removal of dead wood and dead trees.

One KTP listed under the EPBC Act is considered relevant to the Proposal is Land clearance. Likely impacts of these KTPs have been discussed in Sections 4.1.1, 4.1.2 and 4.1.3. The impact of each of these KTPs is expected to be minor due to the small scale of the proposed works.

4.2 Indirect impacts

4.2.1 Edge effects

Edge effects relate to where ecological processes, interactions and conditions are altered along the boundary of two or more different adjoining habitats. Often at these boundaries, ecological conditions like air temperature, soil moisture or light intensity may be different to adjoining habitats. The differentiation of these conditions may decrease the suitability of the altered habitat for native species yet increase its suitability for non-native and invasive species.

The vegetation clearing associated with the Proposal will increase edge effects to the vegetation in the Lower Reservoir Proposal area. The edge effects that will impact the vegetation may facilitate the invasion and spread of exotic species, reduce the resilience of native vegetation, changing foraging and breeding behaviour, and change predator-prey relationships.

4.2.2 Weeds and exotic flora

Three priority weed species listed for the Hunter Local Land Service region (DPI 2017), were identified in the study area. The class and duty associated with all plants and specific duties for the weed species identified in the study area is outlined in Table 4-6.

Table 4-6: Priority weeds listed for the Hunter identified within the study area

Weed	Duty
All plants	<p>General Biosecurity Duty</p> <p>All plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.</p>
Coolatai grass (<i>Hyparrhenia hirta</i>)	<p>Regional Recommended Measure</p> <p>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.</p>

Weed	Duty
Fireweed (<i>Senecio madagascariensis</i>)	Prohibition on certain dealings Must not be imported into the state, sold, bartered, exchanged or offered for sale.
Common prickly pear (<i>Opuntia stricta</i>)	Prohibition on certain dealings Must not be imported into the state, sold, bartered, exchanged or offered for sale.

* Biodiversity Regulation 2017 Division 8, Clause 33.

Mechanical vegetation removal, earthworks and increased human activity during construction and routine maintenance has the potential to facilitate the spread of weeds. In general, the exotic weeds are more prevalent on the lower slopes particularly near Limestone Ave and care should be taken to avoid spread up the mountain. Coolatai grass was not observed above contours corresponding to TP2.

Another weed that appears to be particularly invasive in areas of disturbance such as around the transmission towers is Carpet weed (*Galenia pubescens*). It is a difficult weed to eliminate once established and it's spread should be avoided through the spread of seeds or plant fragments in order to satisfy the General Biosecurity Duty.

4.2.3 Invasion and spread of pests

Vertebrate pests such are likely to be present in the study area due to the proximity to urban areas and farmland. The European Red Fox (*Vulpes vulpes*), Feral Pig (*Sus scrofa*) and domestic and feral cats (*Felis catis*) are likely to roam freely throughout the study area and prey on native birds, reptiles and small mammals. Rabbits (*Oryctolagus cuniculus*) were observed in the Proposal area. The proposal is unlikely to increase the presence of pest species within the study area.

4.2.4 Invasion and spread of pathogens and disease

Human traffic and machine traffic have the potential to act as vectors of plant disease and pathogens, such as plant diseases caused by *Phytophthora cinnamomi* and Myrtle Rust (*Puccinia psidii*), along with frog disease Chytridiomycosis caused by chytrid fungus.

4.2.5 Noise, light and vibration

The Proposal will inevitably result in an increase in noise, light and vibration impacts in the study area and adjacent areas during geotechnical works and routine maintenance of access tracks. Artificial light can adversely affect many species and ecological communities by changing behaviour or physiology, reducing survivorship or reproductive output. It can also change the availability of habitat or feed resource, and attract predators and pest species (Commonwealth of Australia 2019).

4.2.6 Hydrological

Road cuttings and cut and fill works for test pads are unlikely to significantly change surface hydrology significantly but may result in erosion or sediment run-off. Wastewater from borehole drilling disposed of from the test pads will temporarily increase surface water flow.

5. Recommendations and summary

5.1 Recommended mitigation measures

To prevent and mitigate any direct and indirect impacts on adjacent vegetation and threatened species' habitat the following mitigation measures are recommended:

- Disturbance will be kept within the geotechnical investigation areas and access tracks as delineated in Figure 1-3
- Clearing extents will be clearly staked and marked with flagging tape
- Minor adjustments to the position of test pads if feasible can significantly reduce impacts. In all cases pad positioning should be adjusted where feasible to minimising clearing of mature trees and avoiding excavating within their drip zone (canopy extent)
- Recommendations for avoidance measures when refining test pad positions are listed below in Table 5-1
- Disturbance to other key habitat features such as fallen logs or ephemeral soaks should also be avoided
- Ensure machinery is free of weed material before entering and exiting the investigation areas to avoid the introduction or spread of weed species. Implement appropriate hygiene including wash down and/or disinfection measures for vehicles, machinery and equipment where practical, to minimise the introduction or spread of weed propagules or plant/animal diseases
- Should any of the priority weeds – Fireweed (*Senecio madagascariensis*), Coolatai grass (*Hyparrhenia hirta*) or Common pear (*Opuntia stricta*) be found to occur during vegetation clearance – these weeds should be removed and disposed of appropriately
- Ensure that a spill-kit is on hand to address any fuel or oil spillages from plant and equipment undertaking the proposed works
- Backfilling of any holes associated with drilling or excavation associated with the cut and fill bench should utilise soil excavated onsite as this soil is likely to contain native seeds enabling the re-establishment of native species following completion of the proposed works
- All waste material and rubbish associated with the proposed vegetation clearing and excavations, are to be removed from site and properly disposed of upon completion
- Rock and soil excavated for the construction of access track cuttings, when not reused in the agreed impact area must be disposed on the Muswellbrook Coal excavation site
- Erosion and sediment control measures are to be implemented around the works area during the Proposal and routine maintenance of access tracks to prevent sediment or sediment-laden water from moving off-site and affecting adjacent vegetation communities, species' habitat or watercourses.
- Works should be carried out outside of the Speckled Warbler breeding season. If works are to occur during the Speckled Warbler breeding season (August to January), an Ecologist must undertake a pre-works survey to determine the presence of Speckled Warbler nests before vegetation is to be cleared. If Speckled Warbler nests are found, timing of works and mitigation must be reconsidered
- Should any threatened fauna species be observed during the Proposal, works will cease, and an Ecologist will be notified. The Ecologist will advise whether it is appropriate to allow the animal to self-relocate or whether further intervention is required to relocate the animal. If the species cannot be relocated, works must stop, and mitigation must be reconsidered
- If any native fauna is encountered during the proposed works, stop and allow the individual to self-relocate. If injured, contact WIRES (1300 094 737) to rescue the animal and remove it from the site
- Limit work during excessively wet or muddy conditions, where ground disturbance may be exacerbated
- Following finalisation of geotechnical investigation sites and access track locations, and prior to carrying out the works, an Environment Management Plan is to be developed that considers all biodiversity values and plans to avoid and minimise risks to these retained values. This should include measures such as re-positioning logs or

hollows, pre-clearance surveys, timing of clearing works to avoid fauna breeding or dormancy, sediment and erosion control measures and invasive weed control and management.

- Avoid loss of mature eucalypt trees over 50 centimetres in diameter, including all mature trees with hollows where possible by avoiding direct felling or earthworks within their root zone – ie. the main canopy extent or “dripline”.
- Keep vegetation clearing to the minimum extent practicable required for the Proposal, not exceeding the maximum extent assessment in this report
- Areas of TEC to be retained should be clearly marked on maps and provided to the geotechnical investigation supervisor
- Any indirect or indirect impact to TECs outside the designated clearing boundary should be immediately reported to the nominated Proposal Ecologist.

Table 5-1: Adjustments to pad positions

Test Site	Adjustment	Reason
BH12	Remain within cleared grassland and avoid encroachment into the drip line of any mature trees.	Completely avoid impact to any trees and TEC by utilizing non-native grassland.
TP1	Position pad on disturbed grassland. No encroachment into the dripline of mature trees.	Avoid all trees representing a TEC. An existing Geotech pad site is located here visible in Figure 1-3 and Figure 2-1.
TP2	Avoid encroachment under drip line of mature trees	Avoid impact to the mature trees within a TEC area south of access track.
TP4	Shifted approx. 10 metres south to avoid boulder outcrop.	Large boulders are potential fauna habitat and would also make levelling difficult.

5.2 Summary

Five native vegetation communities were identified in the study area, two of which may correspond to threatened ecological communities. Assessments of significance determined that no significant impacts were likely to any threatened vegetation community. The proposal will require the clearing of up to 0.908 hectares of native vegetation.

Habitat assessment and field surveys identified nine fauna species that were recorded during the recent surveys or have a high likelihood of occurring within the study area. Assessments of significance determined that the Proposal is unlikely to have a significant impact on any of these species. Five threatened flora species are considered likely to have a moderate likelihood of occurring in the study area but were not identified during the field surveys.

The impact assessment has determined that a BDAR is not required as:

- There are no likely significant impacts to threatened species or ecological communities, or their habitats
- The development does not exceed the clearing limits for triggering the requirement for a BDAR
- The proposal will not be carried out on a declared area of outstanding biodiversity value.

Any changes to the Proposal methodology or clearing outside the limits identified in this report will need to be re-assessed to ensure that the impacts do not exceed the thresholds to trigger the preparation of a BDAR.

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Appendix A Species List

Flora

Scientific Name	Common Name	NSW Status	Comm. Status	Exotic
<i>Acacia paradoxa</i>	Kangaroo Thorn	-	-	
<i>Adiantum aethiopicum</i>	Common Maidenhair	-	-	
<i>Ajuga australis</i>	Austral Bugle	-	-	
<i>Alectryon subdentatus f. subdentatus</i>		-	-	
<i>Anagallis arvensis</i>	Scarlet Pimpernel	-	-	*
<i>Angophora floribunda</i>	Rough-barked Apple	-	-	
<i>Aristida ramosa</i>	Purple Wiregrass	-	-	
<i>Asperula conferta</i>	Common Woodruff	-	-	
<i>Austrostipa densiflora</i>	Foxtail Speargrass	-	-	
<i>Austrostipa</i> spp.		-	-	
<i>Austrostipa verticillata</i>	Slender Bamboo Grass	-	-	
<i>Brachychiton populneus</i>	Kurrajong	-	-	
<i>Caesia parviflora</i>	Pale Grass-lily	-	-	
<i>Caesia parviflora</i> var. <i>parviflora</i>		-	-	
<i>Calotis lappulacea</i>	Yellow Burr-daisy	-	-	
<i>Carex breviculmis</i>		-	-	
<i>Cheilanthes sieberi</i>	Rock Fern	-	-	
<i>Chloris ventricosa</i>	Tall Chloris	-	-	
<i>Choretrum</i> spp.		-	-	
<i>Chrysocephalum apiculatum</i>	Common Everlasting	-	-	
<i>Clerodendrum tomentosum</i>	Hairy Clerodendrum	-	-	
<i>Cymbopogon refractus</i>	Barbed Wire Grass	-	-	
<i>Desmodium brachypodium</i>	Large Tick-trefoil	-	-	
<i>Desmodium</i> spp.	Tick-trefoil	-	-	
<i>Dianella longifolia</i>	Blueberry Lily	-	-	
<i>Dichelachne crinita</i>	Longhair Plumegrass	-	-	
<i>Dichelachne sieberiana</i>		-	-	
<i>Dichondra repens</i>	Kidney Weed	-	-	
<i>Ehrharta erecta</i>	Panic Veldtgrass	-	-	*
<i>Einadia trigonos</i>	Fishweed	-	-	
<i>Elymus scaber</i>	Wheatgrass, Common Wheatgrass	-	-	
<i>Eragrostis leptostachya</i>	Paddock Lovegrass	-	-	
<i>Eremophila debilis</i>	Amulla	-	-	
<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark	-	-	
<i>Eucalyptus melliodora</i>	Yellow Box	-	-	

Scientific Name	Common Name	NSW Status	Comm. Status	Exotic
<i>Eucalyptus moluccana</i>	Grey Box	-	-	
<i>Eucalyptus punctata</i>	Grey Gum	-	-	
<i>Eucalyptus tereticornis</i>	Forest Red Gum	-	-	
<i>Galenia pubescens</i>	Galenia	-	-	*
<i>Galium leptogonium</i>		-	-	
<i>Geijera parviflora</i>	Wilga	-	-	
<i>Geranium molle</i>	Cranesbill Geranium	-	-	*
<i>Glycine tabacina</i>	Variable Glycine	-	-	
<i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton Bush	-	-	*
<i>Hyparrhenia hirta</i>	Coolatai Grass	-	-	*
<i>Lepidosperma laterale</i>	Variable Sword-sedge	-	-	
<i>Linaria pelisseriana</i>	Pelisser's Toadflax	-	-	*
<i>Lomandra filiformis</i>	Wattle Matt-rush	-	-	
<i>Lomandra multiflora</i>	Many-flowered Mat-rush	-	-	
<i>Lysimachia arvensis</i>	Scarlet Pimpernel	-	-	*
<i>Melia azedarach</i>	White Cedar	-	-	
<i>Microlaena stipoides</i>	Weeping Grass	-	-	
<i>Myoporum montanum</i>	Western Boobialla	-	-	
<i>Notelaea microcarpa</i>	Native Olive	-	-	
<i>Olearia elliptica</i>	Sticky Daisy-bush	-	-	
<i>Passiflora herbertiana</i>		-	-	
<i>Phyllanthus virgatus</i>	Wiry Spurge	-	-	
<i>Pimelea curviflora</i> var. <i>gracilis</i>		-	-	
<i>Pittosporum undulatum</i>	Sweet Pittosporum	-	-	
<i>Poa labillardierei</i>	Tussock	-	-	
<i>Pomax umbellata</i>	Pomax	-	-	
<i>Scutellaria humilis</i>	Dwarf Skullcap	-	-	
<i>Senecio madagascariensis</i>	Fireweed	-	-	*
<i>Senecio quadridentatus</i>	Cotton Fireweed	-	-	
<i>Setaria pumila</i>	Pale Pigeon Grass	-	-	*
<i>Sida rhombifolia</i>	Paddy's Lucerne	-	-	*
<i>Solanum brownii</i>	Violet Nightshade	-	-	
<i>Solanum cinereum</i>	Narrawa Burr	-	-	
<i>Stackhousia muricata</i>	Stackhousia	-	-	
<i>Streblus brunonianus</i>	Whalebone Tree	-	-	
<i>Swainsona galegifolia</i>	Smooth Darling Pea	-	-	
<i>Trifolium repens</i>	White Clover	-	-	*
<i>Vittadinia muelleri</i>		-	-	

Scientific Name	Common Name	NSW Status	Comm. Status	Exotic
<i>Vulpia</i> spp.	Rat's-tail Fescue	-	-	*
<i>Wahlenbergia gracilis</i>	Sprawling Bluebell	-	-	
<i>Wahlenbergia multicaulis</i>	Tadgell's Bluebell	-	-	
<i>Wahlenbergia stricta</i>	Tall Bluebell	-	-	

Fauna

Scientific name	Common name	BC Act Status	EPBC Act Status
Birds (26)			
<i>Anthochaera carunculata</i>	Red Wattlebird	-	-
<i>Aquila audax</i>	Wedge-tailed Eagle	-	-
<i>Ardea pacifica</i>	White-necked Heron	-	-
<i>Chenonetta jubata</i>	Australian Wood Duck	-	-
<i>Chthonicola sagittata</i>	Speckled Warbler	V	-
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	-	-
<i>Climacteris</i> spp.	Unidentified treecreeper	-	-
<i>Corvus coronoides</i>	Australian Raven	-	-
<i>Cracticus torquatus</i>	Grey Butcherbird	-	-
<i>Dacelo novaeguineae</i>	Laughing Kookaburra	-	-
<i>Eolophus roseicapilla</i>	Galah	-	-
<i>Eopsaltria australis</i>	Eastern Yellow Robin	-	-
<i>Eudynamys orientalis</i>	Eastern Koel	-	-
<i>Eurystomus orientalis</i>	Dollarbird	-	-
<i>Falco cenchroides cenchroides</i>	Nankeen Kestrel	-	-
<i>Gymnorhina tibicen</i>	Australian Magpie	-	-
<i>Malurus cyaneus</i>	Superb Fairy-wren	-	-
<i>Manorina melanocephala</i>	Noisy Miner	-	-
<i>Pachycephala pectoralis</i>	Golden Whistler	-	-
<i>Philemon corniculatus</i>	Noisy Friarbird	-	-
<i>Platycercus eximius</i>	Eastern Rosella	-	-
<i>Podargus strigoides</i>	Tawny Frogmouth	-	-
<i>Rhipidura leucophrys</i>	Willie Wagtail	-	-
<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo	-	-
<i>Strepera graculina</i>	Pied Currawong	-	-
<i>Zosterops lateralis</i>	Silvereye	-	-
Frogs (2)			
<i>Crinia signifera</i>	Common Eastern Froglet	-	-
<i>Litoria peronii</i>	Peron's Tree Frog	-	-

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Scientific name	Common name	BC Act Status	EPBC Act Status
Mammals (7)			
<i>Macropus giganteus</i>	Eastern Grey Kangaroo	-	-
<i>Notamacropus rufogriseus</i>	Red-necked Wallaby	-	-
<i>Osphranter robustus</i>	Common Wallaroo	-	-
<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	-	-
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	-	-
Microchiroptera suborder	Unidentified Microbat	-	-
Microchiroptera suborder	Unidentified Microbat	-	-
Reptiles (3)			
<i>Cryptoblepharus virgatus</i>	Cream-striped Shinning-skink	-	-
<i>Diplodactylus vittatus</i>	Wood Gecko	-	-
<i>Varanus varius</i>	Lace Monitor	-	-

V = Vulnerable

Appendix B Likelihood of Occurrence Table

Scientific Name	Common Name	NSW status	Comm. status	Source	Records	Habitat requirements	Likelihood
Communities							
Central Hunter Grey Box—Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	E	-	BioNet	-	Occurs in the Central Hunter Valley between about Singleton and Muswellbrook. Occurs in areas of relatively low rainfall and high temperatures. It is associated mostly with Permian lithology, and is situated on gently undulating hills, slopes and valleys, or occasionally on rocky knolls.	High. Associated vegetation community present.	
Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions	E	-	BioNet	-	Occurs in the central Hunter Valley mainly between Maitland and Muswellbrook. Occupies undulating country including low rises and slopes, occurring on all aspects. It may also occur on alluvial and colluvial soils in valleys. It mostly occurs on clayey soils found on Permian sediments.	Low. Associated vegetation communities not present	
Central Hunter Valley eucalypt forest and woodland	-	CE	BioNet, PMST	-	Occurs in the Hunter Valley region (primarily in the Central Hunter). Generally occurs on soils derived from the Permian sedimentary bedrock found on the valley floors and on lower hillslopes and low ridges.	Recorded. Identified in the study area.	
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E	-	BioNet	-	This community occurs in the intertidal zone along the NSW coast. Occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea.	Nil. Incorrect landscape position	
Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland	-	E	PMST	-	Typically occurs in low-lying coastal alluvial areas with minimal relief, such as swamps, floodplain pockets, depressions, alluvial flats, back-barrier flats, fans, terraces, and behind fore-dunes. Most commonly occurs at elevations below 20 metres above sea-level (ASL) but may occur occasionally up to 220 metres ASL on hill slopes, for example in association with perched swamps and lakes, or a naturally high-water table.	Nil. Incorrect landscape position	

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Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E	-	BioNet	-	Known from along the majority of the NSW coast. However, it is distinct from Sydney Freshwater Wetlands which are associated with sandplains in the Sydney Basin bioregion. Extensively cleared and modified. Poorly reserved, known to occur in Ukerebagh, Tuckean, Tabbimoble Swamp, Hexham Swamp, Pambalong and Pitt Town Nature Reserves and Bungawalbin, Scheyville and Seven Mile Beach National Parks.	Nil. Incorrect landscape position
Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions		E	-	BioNet	-	Generally occurs on floodplains and floodplain rises. The community is known to contain the endangered River Red Gum population in the Hunter Catchment.	Nil. Geographic restrictions.
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions		E	-	BioNet	-	Occurs between Muswellbrook, Beresfield, Mulbring and Cessnock. Occurs on the Permian sediments, and on gentle slopes of depressions and drainage flats of the Hunter Valley floor.	Nil. Incorrect landscape position.
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion		V	-	BioNet	-	Mainly occurs on the southern side of the Hunter Valley from near Bulga to the Bylong/Goulburn River National Park area. It occurs on colluvial soils on exposed footslopes associated with the interface between Triassic Narrabeen sandstones and Permian sediments. Known to occur in Singleton, Muswellbrook and Upper Hunter LGAs. Tends to occur in relatively hot and dry parts of the landscape.	Low. Associated vegetation communities not identified or mapped in the area.
Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions		E	-	BioNet	-	Important site characteristics include low precipitation and high levels of solar radiation. This semi-arid soil environment will have selected the more xerophytic species from the available regional assemblage of rainforest species. Mainly occurs on rocky slopes on Carboniferous sediments and volcanics, occasionally with limestone.	Moderate. May be present near the study area.
Hunter Valley Weeping Myall (<i>Acacia pendula</i>) Woodland		-	CE	BioNet, PMST	-	The known stands of the ecological community occur between the localities of Warkworth and Wybong (Umwelt, 2006a; Bell, 2007a; Umwelt, 2008), including a well-documented patch at Jerrys Plains cemetery. Lies on the floor of the Hunter	Low. <i>Acacia pendula</i> not found in the study area.

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						Valley, at elevations of 60 to 150 metres above sea level (ASL). Occurs in small stands on heavy, brown clay soils.	
Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion		CE	-	BioNet	-	Currently known from parts of the Muswellbrook and Singleton Local Government Areas. Associated with heavy clay soils on depositional landforms in the south-western part of the Hunter River valley floor.	Low. <i>Acacia pendula</i> not found in the study area.
Kurri Sand Swamp Woodland in the Sydney Basin Bioregion		E	-	BioNet	-	Known to occur in the Kurri Kurri–Cessnock area of the Cessnock LGA in the lower Hunter Valley, but it may occur elsewhere. Occurs on soils developed on poorly-drained Tertiary sand deposits that blanket Permian sediments.	Nil. Incorrect landscape position
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E	-	BioNet	-	Occurs only on the coast and is found at locations in the NSW North Coast Bioregion, Sydney Basin Bioregion and South East Corner Bioregion. Littoral Rainforest is very rare and occurs in many small stands. In total, it comprises less than one percent of the total area of rainforest in NSW. Occurs on sand dunes and on soil derived from underlying rocks.	Nil. Incorrect landscape position
Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions		E	-	BioNet	-	Remnants occur within the LGAs of Cessnock, Maitland, Singleton, Lake Macquarie, Newcastle and Port Stephens but may also occur elsewhere within the bioregion. Occurs principally on Permian geology in the central to lower Hunter Valley. The Permian substrates most commonly supporting the community belong to the Dalwood Group, the Maitland Group and the Greta and Tomago Coal Measures, although smaller areas of the community may also occur on the Permian Singleton and Newcastle Coal Measures and the Triassic Narrabeen Group. The community is strongly associated with, though not restricted to, the yellow podsolic and solodic soils of the Lower Hunter soil landscapes of Aberdare, Branxton and Neath.	Nil. Associated PCT not present.

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Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions		V	-	BioNet	-	Likely to occur or have occurred in Muswellbrook. Typically occurs on Carboniferous sediments in gullies and on steep hillslopes with south facing aspects. It is generally found at elevations less than 300 m ASL with a mean annual rainfall less than 900 mm.	Moderate. Pockets may be present near the study area.
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions		E	-	BioNet	-	The Hawkesbury River notionally marks the southern limit of Lowland Rainforest in the NSW North Coast and Sydney Basin bioregions. South of the Sydney metropolitan area, Lowland Rainforest is replaced by Illawarra Subtropical Rainforest of the Sydney Basin Bioregion, which is listed as an endangered ecological community. Milton Ulladulla Subtropical Rainforest is also a related rainforest endangered ecological community that occurs still further south in the South East Corner Bioregion.	Low. Associated vegetation communities not present.
Lowland Rainforest of Subtropical Australia		-	CE	BioNet, PMST	-	Primarily occurs from Maryborough in Queensland to the Clarence River (near Grafton) in New South Wales (NSW). The ecological community also includes isolated areas between the Clarence River and Hunter River such as the Bellinger and Hastings Valleys. Occurs on basalt and alluvial soils, including sand and old/elevated alluvial soils as well as floodplain alluvia. It also occurs occasionally on historically enriched rhyolitic soils and basaltically enriched metasediments. Lowland Rainforest mostly occurs in areas <300 m above sea level.	Low. Associated vegetation communities not present.
Quorrobolong Scribbly Gum Woodland in the Sydney Basin Bioregion		E	-	BioNet	-	Currently known from only a small area between Quorrobolong and Mulbring in the Cessnock local government area, but may also occur elsewhere within the Hunter Valley. Occupies gentle slopes and rises on a residual sand deposit overlying the Permian clay sediments of the Hunter Valley floor.	Nil. Associated PCT not present.
River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria		-	CE	BioNet, PMST	-	Found in the South East Corner and Sydney Basin bioregions. This encompasses the area from around Sale on the south-east coast of Victoria to around Raymond Terrace, just north of Newcastle on the New South Wales east coast. Occurs on alluvial	Nil. Incorrect landscape position

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						landforms related to coastal river floodplains and associated sites where transient water accumulates, including floodplains, river-banks, riparian zones, lake foreshores, creek lines (including the floors of tributary gullies), floodplain pockets, depressions, alluvial flats, fans, terraces, and localised colluvial fans.	
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E	-	BioNet	-	Found on the river flats of the coastal floodplains. Known from parts of the Local Government Areas of Port Stephens, Maitland, Singleton, Cessnock, Lake Macquarie, Wyong, Gosford, Hawkesbury, Baulkham Hills, Blacktown, Parramatta, Penrith, Blue Mountains, Fairfield, Holroyd, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Sutherland, Wollongong, Shellharbour, Kiama, Shoalhaven, Palerang, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions. Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains.	Nil. Incorrect landscape position.
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E	-	BioNet	-	Found on the coastal floodplains of NSW. Associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains. Generally occurs below 20 m (rarely above 10 m) elevation. The structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees.	Nil. Incorrect landscape position.
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E	-	BioNet	-	Known from parts of the LGAs of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes and Port Stephens, Lake Macquarie, Wyong, Gosford, Hornsby, Pittwater, Warringah, Manly, Liverpool, Rockdale, Botany Bay, Randwick, Sutherland, Wollongong, Shellharbour, Kiama and Shoalhaven	Nil. Incorrect landscape position.

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						but may occur elsewhere in these bioregions. Associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains. Generally occurs below 20 m (though sometimes up to 50 m) elevation.	
Sydney Freshwater Wetlands in the Sydney Basin Bioregion		E	-	BioNet	-	Largely restricted to freshwater swamps in coastal areas. Occurs on sand dunes and low-nutrient sandplains along coastal areas in the Sydney Basin bioregion. It is known from the Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Woollahra, Waverley, Botany, Rockdale, Randwick, Sutherland and Wollongong local government areas, but is likely to occur elsewhere within the bioregion. Has been extensively cleared and filled and remnants are often small and disturbed. Largely restricted to freshwater swamps in swales and depressions on sand dunes and low nutrient sandplains such as those of the Warriewood and Tuggerah soil landscapes. Swampy areas on alluvium with a saline influence do not fall within this community.	Nil. Habitat features not present.
Themeda grassland on seaciffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions		E	-	BioNet	-	Found on a range of substrates in the NSW North Coast, Sydney Basin and South East Corner bioregions. Stands on sandstone are infrequent and small. Larger stands are found on old sand dunes above cliffs and on metasedimentary headlands. Overall, the community has a highly restricted geographic distribution comprising small, but widely scattered patches. The community is found on a range of substrates, although stands on sandstone are infrequent and small.	Nil. Incorrect landscape position.
Warkworth Sands Woodland in the Sydney Basin Bioregion		E	-	BioNet	-	Confined to a small area near Warkworth, about 15 km south-west of Singleton in the Hunter Valley. Occurs on aeolian sand deposits south of Singleton in the Hunter Valley.	Nil. Habitat features not present.
White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar,		CE	-	BioNet	-	Found from the Queensland border in the north, to the Victorian border in the south. It occurs in the NSW North Coast, New England Tableland,	Recorded. Identified in the study area.

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Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and						Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions. Characterised by the presence or prior occurrence of White Box, Yellow Box and/or Blakely's Red Gum and a generally grassy understorey.	
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland		-	CE	BioNet, PMST	-	Characterised by current or prior occurrence of White Box, Yellow Box and/or Blakely's Red Gum and a generally grassy understorey. Remnants generally occur on fertile lower parts of the landscape where soil fertility is relatively high compared to the surrounding landscape.	Recorded. Identified in the study area.
Flora							
<i>Acacia pendula</i>	Acacia pendula population in the Hunter catchment	E	-	BioNet	27	Only recorded to date at 6 locations: Jerrys Plains, Edderton, Wybong, Appletree Creek, Warkworth and Appletree Flat. These locations occur within the Muswellbrook and Singleton Local Government Areas, with the population potentially also occurring within the Mid-Western Regional and Upper Hunter LGA's. Within the Hunter catchment the species typically occurs on heavy soils, sometimes on the margins of small floodplains, but also in more undulating locations.	Low. Species not observed.
<i>Androcalva procumbens</i>	null	-	V	PMST	-	In sandy sites mainly confined to the Dubbo;-Mendooran;-and Gilgandra region, also in Pilliga and Nymagee areas; rare. NSW subdivisions: North Western Slopes, Central Western Slopes, North Western Plains, South Western Plains	Low. Sandy soils not present.
<i>Cymbidium canaliculatum</i>	Cymbidium canaliculatum population in the Hunter Catchment	E	-	BioNet	1	Typically grows in the hollows, fissures, trunks and forks of trees in dry sclerophyll forest or woodland, where its host trees typically occur on Permian Sediments of the Hunter Valley floor. Most commonly found in Eucalyptus albens (White Box) dominated woodlands (including those dominated by the intergrade E. albens-moluccana), much of which may constitute the endangered ecological community (EEC) 'White Box Yellow Box Blakely's Red Gum Woodland'. It has been found, less	Moderate. Suitable habitat present. Not observed during survey.

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						commonly, to grow on <i>E. dawsonii</i> (Slaty Box), <i>E. crebra</i> (Narrow-leaved Ironbark), <i>E. moluccana</i> (Grey Box), <i>Angophora floribunda</i> (Rough-barked Apple), <i>Acacia salicina</i> (Cooba) and on some other species, including dead stags. It is also known to use man-made structures, such as fence posts and wooden bridges as its host.	
<i>Cynanchum elegans</i>	White-flowered Wax Plant	E	E	PMST	-	Usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; Coastal Tea-tree <i>Leptospermum laevigatum</i> – Coastal Banksia <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> coastal scrub; Forest Red Gum <i>Eucalyptus tereticornis</i> aligned open forest and woodland; Spotted Gum <i>Corymbia maculata</i> aligned open forest and woodland; and Bracelet Honeymyrtle <i>Melaleuca armillaris</i> scrub to open scrub.	Moderate. Suitable habitat present. Not observed during survey.
<i>Dichanthium setosum</i>	bluegrass	V	V	PMST	-	Bluegrass occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, extending to northern Queensland. It occurs widely on private property, including in the Inverell, Guyra, Armidale and Glen Innes areas. Associated with heavy basaltic black soils and red-brown loams with clay subsoil. Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture. (Often collected from disturbed open grassy woodlands on the northern tablelands, where the habitat has been variously grazed, nutrient-enriched and water-enriched). Associated species include <i>Eucalyptus albens</i> , <i>Eucalyptus melanophloia</i> , <i>Eucalyptus melliodora</i> , <i>Eucalyptus viminalis</i> , <i>Myoporum debile</i> , <i>Aristida ramosa</i> , <i>Themeda triandra</i> , <i>Poa sieberiana</i> , <i>Bothriochloa ambigua</i> , <i>Medicago minima</i> , <i>Leptorhynchos squamatus</i> , <i>Lomandra</i> aff. <i>longifolia</i> , <i>Ajuga australis</i> , <i>Calotis hispidula</i> and <i>Austroanthonia</i> , <i>Dichopogon</i> , <i>Brachyscome</i> , <i>Vittadinia</i> , <i>Wahlenbergia</i> and <i>Psoralea</i> species. Locally common or found as scattered clumps in broader populations. The	Moderate. At lower limits of predicted habitat, associated PCTs present on site, no seedheads at time of survey so surveys would not have detected presence.

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						extensive distribution and wide environmental tolerances make predictions about suitable habitat difficult.	
<i>Diuris tricolor</i>	Pine Donkey Orchid	V	-	BioNet	1	Usually recorded from disturbed habitats. Associated species include <i>Callitris glaucophylla</i> , <i>Eucalyptus populnea</i> , <i>Eucalyptus intertexta</i> , Ironbark and Acacia shrubland. The understorey is often grassy with herbaceous plants such as <i>Bulbine</i> species. Grows in sclerophyll forest among grass, often with native Cypress Pine (<i>Callitris</i> spp.). 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.	Moderate. Associated with PCT 1691 and can be found in disturbed areas of grassland
<i>Diuris tricolor</i>	Pine Donkey Orchid population in the Muswellbrook local government area	E	-	BioNet	1	Found in sclerophyll woodland and derived grassland on flats or small rises, on a range of substrates including sandy or loamy soils. The habitat of <i>Diuris tricolor</i> in the Muswellbrook LGA has been fragmented by past land clearing.	Moderate. Associated with PCT 1691 and can be found in disturbed areas of grassland
<i>Eucalyptus camaldulensis</i>	<i>Eucalyptus camaldulensis</i> population in the Hunter catchment	E	-	BioNet	1	May occur with <i>Eucalyptus tereticornis</i> , <i>Eucalyptus melliodora</i> , <i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i> and <i>Angophora floribunda</i> . Most of the occurrences are on private land and there are no known occurrences in conservation reserves.	Low. No suitable habitat.
<i>Eucalyptus glaucina</i>	Slaty Red Gum	V	V	BioNet, PMST	2	Grows in grassy woodland and dry eucalypt forest. Grows on deep, moderately fertile and well-watered soils.	Low. Only associated with PCT 1691 which has a limited distribution in the study area. Were not recorded during surveys.
<i>Euphrasia arguta</i>	null	CE	CE	PMST	-	Rediscovered in the Nundle area of the NSW north western slopes and tablelands in 2008. Prior to this, it had not been collected for 100 years. Historically, <i>Euphrasia arguta</i> has only been recorded from relatively few places within an area extending from Sydney to Bathurst and north to Walcha. Historic records of the species noted the following habitats: 'in the open forest country around Bathurst in sub humid places', 'on the grassy country near Bathurst', and 'in meadows near rivers'. Plants from the	Low. Species has very limited known distribution and grassy habitat is highly disturbed on the site.

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						Nundle area have been reported from eucalypt forest with a mixed grass and shrub understorey; here, plants were most dense in an open disturbed area and along the roadside, indicating the species had regenerated following disturbance. Near Nundle, local populations had apparently declined at sites that had been disturbed twice within three years, in contrast with sites that were disturbed only once.	
<i>Lepidium aschersonii</i>	Spiny Pepper-cress	V	V	PMST	-	Not widespread, occurring in the marginal central-western slopes and north-western plains regions of NSW (and potentially the south western plains). Found on ridges of gilgai clays dominated by Brigalow (<i>Acacia harpophylla</i>), Belah (<i>Casuarina cristata</i>), Buloke (<i>Allocasuarina luehmanii</i>) and Grey Box (<i>Eucalyptus microcarpa</i>). In the south has been recorded growing in Bull Mallee (<i>Eucalyptus behriana</i>). Often the understorey is dominated by introduced plants. The species grows as a component of the ground flora, in grey loamy clays. Vegetation structure varies from open to dense, with sparse grassy understorey and occasional heavy litter.	Low. Suitable habitat not present
<i>Pomaderris brunnea</i>	Rufous Pomaderris, Brown Pomaderris	E	V	PMST	-	Brown Pomaderris is found in a very limited area around the Colo, Nepean and Hawkesbury Rivers, including the Bargo area and near Camden. Grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines.	Low. Lack of alluvial soils and no Pomaderris species observed during survey.
<i>Prasophyllum</i> sp. <i>Wybong</i> (C.Phelps ORG 5269)	a leek-orchid	-	CE	PMST	-	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. Occurs in open eucalypt woodland and grassland in New South Wales. 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.	Low. The only PCT in the study area this species is associated with in the hunter is the derived grassland PCT 796, which is highly disturbed.

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<i>Pterostylis gibbosa</i>	Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood	E	E	PMST	-	Known from a small number of populations in the Hunter region (Milbrodale), the Illawarra region (Albion Park and Yallah) and the Shoalhaven region (near Nowra). It is apparently extinct in western Sydney which is the area where it was first collected (1803).	Low. Outside of range and not recorded during surveys.
<i>Thesium australe</i>	Austral Toadflax, Toadflax	V	V	PMST	-	Suitable habitat for this species includes grassland and grassy woodland, often in damp sites. This species is often found growing in association with Kangaroo Grass (<i>Themeda australis</i>).	Moderate. No local sightings, suitable habitat present.
<i>Vincetoxicum forsteri</i> (listed as <i>Tylophora linearis</i>)	null	V	E	PMST	-	Grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of <i>Eucalyptus fibrosa</i> , <i>Eucalyptus sideroxylon</i> , <i>Eucalyptus albens</i> , <i>Callitris endlicheri</i> , <i>Callitris glaucophylla</i> and <i>Allocasuarina luehmannii</i> . Also grows in association with <i>Acacia hakeoides</i> , <i>Acacia lineata</i> , <i>Melaleuca uncinata</i> , <i>Myoporum</i> species and <i>Casuarina</i> species.	Low. No local sightings, not known or predicted in the Hunter IBRA region in the Threatened Biodiversity Profile Data Collection.
Birds							
<i>Actitis hypoleucos</i>	Common Sandpiper	-	M	PMST	-	Utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. Has been recorded in estuaries and deltas of streams, as well as on banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. 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.	Low. Preferred habitat not present in study area.
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	CE	PMST	-	Inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. In NSW the distribution is very patchy and mainly confined to the two main breeding areas at Capertee Valley and the Bundarra-Barraba region and surrounding fragmented woodlands. Birds are also found in drier	Moderate. Suitable habitat available in study area and feed trees Yellow Box and White Box are present. The site is not mapped as a key

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						coastal woodlands and forests. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River She-oak. These habitats have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany.	breeding habitat within NSW.
<i>Apus pacificus</i>	Fork-tailed Swift	-	M	PMST	-	Breeds in the northern hemisphere, wintering south to Australia. Almost exclusively aerial, flying from less than 1 m to at least 300 m above ground. Mostly occurs over inland plains but sometimes above foothills or in coastal areas over cliffs, beaches, islands and well out to sea. Also occurs over towns and cities. Mostly occurs over dry and/or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh, grassland, spinifex sandplains, farmland and sand-dunes. Sometimes occurs above forests. Probably roosts aerially but has occasionally been observed to land.	Moderate. Known to occur over most types of habitat.
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E	E	PMST	-	Inhabits temperate freshwater wetlands and occasionally estuarine reedbeds, with a preference for permanent waterbodies with tall dense vegetation. The species prefers wetlands with dense vegetation, including sedges, rushes and reeds. Freshwater is generally preferred, although dense saltmarsh vegetation in estuaries and flooded grasslands are also used by the species.	Low. Preferred wetland habitat not present in study area.
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	-	M	PMST	-	Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation.	Low. Preferred habitat not present in study area.
<i>Calidris ferruginea</i>	Curlew Sandpiper	E	CE, M	PMST	-	Coastal migratory species with a NSW distribution from Hastings Point to Shoalhaven Heads. Found in open, sandy beaches with exposed sand bars and rocky outcrops. Rare use of near-coastal wetlands.	Nil. Coastal habitat not present in study area.

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<i>Calidris melanotos</i>	Pectoral Sandpiper	-	M	PMST	-	Shallow freshwaters with low vegetation, flooded pasture, swamp margins, sewage ponds; occasionally mudflats and saltmarsh	Low. Preferred habitat not present in study area.
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V	E	PMST	-	Occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests in winter. In summer this species prefers open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry coastal forests.	Moderate. Suitable habitat present in study area and nearby.
<i>Calyptorhynchus lathami lathami</i>	South-eastern Glossy Black-Cockatoo	V	V	PMST	-	South-eastern glossy black cockatoos feed almost exclusively on the seeds of sheoaks (<i>Allocasuarina</i> spp. and <i>Casuarina</i> spp.), usually relying on one or two species within a region (Higgins 1999). In south-east Queensland and north-east New South Wales, they show preference for black sheoak (<i>A. littoralis</i>) and forest sheoak (<i>A. torulosa</i>), although there are also records of them feeding on stringybark sheoak (<i>A. inophloia</i> ; G Castley, D Guthrie & Roselli unpublished data), coastal sheoak (<i>C. equisetifolia</i>), and to a lesser extent river sheoak (<i>C. cunninghamiana</i>) and swamp sheoak (<i>C. glauca</i>) during limited times of the year (Glossy Black Conservancy 2010). Forest sheoak is the preferred species along mountain ridges and slopes (Glossy Black Conservancy 2010). South-eastern glossy black cockatoos are known to nest in river red gums (<i>E. camaldulensis</i>) along the Murrumbidgee River and other inland waterways in NSW (M Cameron 2021, pers comm 27 August).	Moderate. Few very old trees with large hollows. <i>Allocasuarina</i> species not observed in the study area, but <i>Allocasuarina torulosa</i> is known to be present on the eastern slopes of Bells Mountain.
<i>Chthonicola sagittata</i>	Speckled Warbler	V	-	BioNet	11	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. 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	Recorded. Identified in the study area.

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						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. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding.	
<i>Circus assimilis</i>	Spotted Harrier	V	-	BioNet	1	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. Found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	Low. Suitable habitat in the study area and one historic record in the locality.
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	-	BioNet	4	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	Moderate. Suitable habitat in the study area and recent records in the locality.
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E	-	BioNet	1	Black-necked Storks are 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). Key habitat are floodplain wetlands (swamps, billabongs, watercourses and dams) of the major coastal rivers.	Low. No preferred habitat in study area.
<i>Erythrotriorchis radiatus</i>	Red Goshawk	CE	V	PMST	-	Distributed sparsely through northern and eastern Australia, from the western Kimberley Division of northern Western Australia to north-eastern Queensland and south to far north-eastern NSW, and with scattered records in central Australia. Very rare in NSW, extending south to about 30°S, with most records north of this. In NSW, preferred	Low. Preferred habitat not present in study area.

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						habitats include mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers.	
<i>Falco hypoleucos</i>	Grey Falcon	E	V	PMST	-	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast.	Moderate. Suitable habitat present in study area and nearby.
<i>Gallinago hardwickii</i>	Latham's Snipe, Japanese Snipe	-	M	PMST	-	Soft wet ground, shallow water with tussocks, inundated parts of paddocks, seepage below dams, saltmarsh and mangrove fringes. Occurs in permanent and ephemeral wetlands up to 2000 m above sea-level. They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). Can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity. Foraging habitats are characterised by areas of mud (either exposed or beneath a very shallow covering of water) and some form of cover (e.g. low, dense vegetation).	Low. Preferred habitat not present in study area.
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	-	BioNet	8	Mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes. Nest in small hollows (entrance approx. 3 cm) of Eucalyptus spp. between 2 - 15 m above the ground.	Moderate. Suitable habitat in the study area and recent records in locality.
<i>Grantiella picta</i>	Painted Honeyeater	V	V	PMST	-	Occurs in Eucalyptus woodland and forests, preferably with an abundance of mistletoe (<i>Amyema</i> spp.). Can also occur along watercourses and in farmland. Nests from spring to autumn in outer canopy of eucalypts, she-oak, paperbark and mistletoe branches.	Moderate. No local records, Suitable habitat in study area and nearby.
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	V	-	BioNet	1	Habitat includes coastlines, estuaries, large rivers and lakes. It has occasionally been recorded over	Low. No preferred habitat in study area.

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						adjacent habitats. Builds a large stick nest in a tall tree and rarely on artificial structures.	
<i>Hieraaetus morphnoides</i>	Little Eagle	V	-	BioNet	3	Occupies habitats rich in prey (birds, reptiles and mammals) within open eucalypt forest, woodland and open woodland. Requires tall living trees for building a large stick nest.	Moderate. Suitable habitat in study area and recent records in locality.
<i>Hirundapus caudacutus</i>	White-throated Needletail	-	V, M	BioNet, PMST	2	Migratory, aerial species usually seen in eastern Australia from October to April.	Moderate. Recent records in locality, may be present flying over site.
<i>Lathamus discolor</i>	Swift Parrot	E	CE	PMST	-	Migrates to the Australian south-east mainland between February and October. 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, Spotted Gum Red Bloodwood, Forest Red Gum, Mugga Ironbark and White Box.	Moderate. No breeding sites on mainland Australia. Suitable winter flowering Eucalypts present for foraging. Not observed during targeted survey in Aug 2022.
<i>Monarcha melanopsis</i>	Black-faced Monarch	-	M	PMST	-	Mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical (mesophyll) rainforest, subtropical (notophyll) rainforest, mesophyll (broadleaf) thicket/shrubland, warm temperate rainforest, dry (monsoon) rainforest and (occasionally) cool temperate rainforest.	Low. Preferred habitat not abundant in study area but may be present in other areas of the mountain.
<i>Motacilla flava</i>	Yellow Wagtail	-	M	PMST	-	Occurs in a variety of damp or wet habitats with low vegetation. Outside of the breeding season it is also found in cultivated areas. Typically forages in damp grassland and on relatively bare open ground at edges of waterbodies, but also feeds in dry grassland and in fields of cereal crops.	Moderate. Grassland habitat present in study area.
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	-	M	PMST	-	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. Specially found in wet sclerophyll forests.	Moderate. Suitable habitat present in study area and nearby but is largely dry sclerophyll forest.

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<i>Numenius madagascariensis</i>	Eastern Curlew, Far Eastern Curlew	-	CE, M	PMST	-	Estuaries, tidal mudflats, sandspits, saltmarsh, mangroves	Nil. Coastal habitat not present in study area.
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	-	BioNet	1	Occurs from Cape York south through Queensland, NSW and Victoria and formerly to the south east of South Australia. Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Woodlands on fertile soils in coastal regions. Feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. Build and maintain several conspicuous, dome-shaped stick nests about the size of a football. A nest is used as a dormitory for roosting each night. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts.	Moderate. Known to be locally common in the Hunter Valley and recorded within 5 km.
<i>Rhipidura rufifrons</i>	Rufous Fantail	-	M	PMST	-	In east and south-east Australia, the Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (<i>Eucalyptus microcorys</i>), Mountain Grey Gum (<i>E. cypellocarpa</i>), Narrow-leaved Peppermint (<i>E. radiata</i>), Mountain Ash (<i>E. regnans</i>), Alpine Ash (<i>E. delegatensis</i>), Blackbutt (<i>E. pilularis</i>) or Red Mahogany (<i>E. resinifera</i>); usually with a dense shrubby understorey often including ferns.	Low. Preferred habitat not present in study area.
<i>Rostratula australis</i>	Australian Painted Snipe	E	E	PMST	-	Inhabits shallow inland wetlands such as freshwater and brackish water bodies. Nests on the ground amongst tall reed-like vegetation near water, and feeds near the water's edge and on mudflats.	Low. Preferred habitat not present in study area.
<i>Tyto novaehollandiae</i>	Masked Owl	V	-	-	-	Occurs throughout NSW, roosting and nesting in heavy forest. Hunts over open woodland and farmland, with a home range of 500 - 1000 ha. The main requirements are tall trees with suitable large hollows for nesting and roosting and adjacent areas for foraging. Feeds on small mammals.	Moderate. Suitable habitat present within study area.

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<i>Tyto tenebricosa</i>	Sooty Owl	V	-	BioNet	1	Inhabits subtropical and warm temperate rainforest, and moist or dry eucalypt forest with a well-developed mid-storey of trees or shrubs. Roost and nest sites for the species occur in gullies. Breeding pairs utilise large hollows for nesting and prey on other hollow dependent species. Roost in hollows or dense vegetation.	Moderate. Suitable habitat present in study area and nearby. One record in locality.
Frogs							
<i>Heleioporus australiacus</i>	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 300 m from breeding sites, burrowing below the soil surface or in the leaf litter. Home ranges are approximately 0.04 ha in size. Breeding habitat of this species is generally soaks or pools within first or second order streams. They are also commonly recorded from 'hanging swamp' seepage lines and where small pools form from the collected water.	Moderate. Some potential non-breeding habitat present in study area.
<i>Litoria aurea</i>	Green and Golden Bell Frog	E	V	PMST	-	Large populations in NSW are located around coastal and near coastal areas of the metropolitan areas of Sydney, Shoalhaven and mid north coast. It inhabits marshes, dams and stream-sides, particularly those containing bullrushes (<i>Typha</i> spp.) or spikerushes (<i>Eleocharis</i> spp.)	Low. Preferred habitat not present in study area.
<i>Litoria booroolongensis</i>	Booroolong Frog	E	E	PMST	-	Restricted to NSW and north-eastern Victoria, predominantly along the western-flowing streams of the Great Dividing Range. It has disappeared from much of the Northern Tablelands, however several populations have recently been recorded in the Namoi catchment. The species is rare throughout most of the remainder of its range. Live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Adults occur on or near cobble banks and other rock structures within stream margins. Shelter under rocks or amongst vegetation near the ground on the stream edge. Sometimes bask in the sun on exposed rocks	Low. Preferred habitat not present in study area.

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						near flowing water during summer. Eggs are laid in submerged rock crevices and tadpoles grow in slow-flowing connected or isolated pools.	
Mammals							
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat, Large Pied Bat	V	V	PMST	-	Roosts in disused mine shafts, caves, overhangs and disused Fairy Martin nests for shelter and to raise young. Potentially roost in tree hollows. Occurs in low to mid-elevation dry open forest and woodlands, preferably with extensive cliffs, caves or gullies. This species is largely restricted to the interface of sandstone escarpment (for roost habitat) and relatively fertile valleys (for foraging habitat).	Moderate. Suitable roosting habitat present nearby on Bells Mountain, may utilise hollows in study area. No local records.
<i>Dasyurus maculatus maculatus</i> (SE mainland population)	Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	V	E	BioNet. PMST	7	Most common in large unfragmented patches of forest. Has also been recorded from dry sclerophyll forest, open woodland and coastal heathland, and despite its occurrence in riparian areas, it also ranges over dry ridges. This habitat ranges from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.	High. Suitable habitat present in study area and old records in the locality.
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V	-	BioNet	1	Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	Low. Suitable habitat in the study area but only one historic record in locality.
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	V	-	BioNet	6	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. They form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. This species tends to hunt in forested areas.	High. Suitable foraging habitat in study area and roosting habitat available on Bells Mountain. Recent records in locality.
<i>Myotis macropus</i>	Southern Myotis	V	-	BioNet	3	This species 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. They forage over	Low. No standing water in study area.

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						streams and pools catching insects and small fish by raking their feet across the water surface.	
<i>Notamacropus parma</i> / <i>Macropus parma</i>	Parma Wallaby	V	V	PMST	-	Range is confined to the coast and ranges of central and northern NSW from the Gosford district to south of the Bruxner Highway between Tenterfield and Casino. Preferred habitat is moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas, rainforest margins and occasionally drier eucalypt forest.	Moderate. Suitable habitat present in study area and nearby. No local sightings
<i>Nyctophilus corbeni</i>	Corben's Long-eared Bat	V	V	BioNet, PMST	2	Overall, the distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. Inhabits a variety of vegetation types, including mallee, bullocke <i>Allocasuarina leuhmanni</i> 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. Slow flying agile bat, utilising the understorey to hunt non-flying prey - especially caterpillars and beetles - and will even hunt on the ground.	High. Suitable habitat and recent records in locality.
<i>Petauroides volans</i>	Greater Glider (southern and central)	-	E	PMST	-	Occupy relatively small home ranges (1-4 ha) in tall, moist eucalypt forests and woodlands with old trees and abundant hollows.	Moderate. Suitable habitat in study area, large tree hollows not abundant.
<i>Petaurus australis australis</i>	Yellow-bellied Glider (south-eastern)	V	V	PMST	-	Found at altitudes ranging from sea level to 1400 m above sea level and has a widespread but patchy distribution. In NSW, it predominantly occurs in forests along the eastern coast, from the NSW-Qld border to the NSW-Vic border. The distribution also extends inland to the western slopes of the Great Dividing Range in parts of NSW and Qld (van der Ree et al. 2004). Occurs in eucalypt-dominated woodlands and forests, including both wet and dry sclerophyll forests (Kavanagh et al. 1995; Rees et al. 2007). Shows a preference for large patches of mature old growth forest that provide suitable trees	Moderate. Suitable habitat present in study area. Large old growth trees not abundant.

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						for foraging and shelter. (Milledge et al. 1991; Eyre & Smith 1997; Incoll et al. 2001; Eyre & Goldingay 2003; Eyre 2002, 2004; van der Ree et al. 2004; Kavanagh et al. 2021).	
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	-	BioNet	6	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.	High. Suitable habitat present in study area, numerous recent records in the locality.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E	V	PMST	-	This species prefers rocky habitats, including loose boulder-piles, rocky outcrops, steep rocky slopes, cliffs, gorges, isolated rock stacks and tree limbs. Preference for north-facing slopes and cliff lines. A range of vegetation types are associated with Brush-tailed Rock-wallaby habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest.	Low. No local records, no associated PCTs present although some rocky habitat is present.
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V	-	-	-	Mainly found east of the Great Dividing Range. Prefers dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest. Agile climber foraging preferentially in rough barked trees of 25 cm DBH or greater.	Moderate. Suitable habitat present within study area. No local records
<i>Phascolarctos cinereus</i>	Koala	E	E	BioNet, PMST	5	Inhabits a range of eucalypt forest and woodland communities. Adequate floristic diversity, availability of feed trees (primarily Eucalyptus tereticornis and E. viminalis) and presence of mature trees very important. Preferred food tree species vary with locality and there are quite distinct regional preferences. They are able to persist in fragmented habitats, and even survive in isolated trees across a predominantly agricultural landscape.	High. High preferred use eucalypts present in study area and recent records in locality.

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Scientific Name	Common Name	NSW status	Comm. status	Source	Records	Habitat requirements	Likelihood
<i>Pseudomys novaehollandiae</i>	New Holland Mouse, Pookila	-	V	PMST	-	Inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. Nest in burrows and have a preference for deeper top soils and softer substrates to aid digging.	Low. Associated PCTs and habitat not present
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	BioNet, PMST	5	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 commonly found in gullies, close to water, in vegetation with a dense canopy. They travel up to 50 km to forage, on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines.	Moderate. Suitable foraging habitat in study area. Known camp located in Muswellbrook.
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat	V	-	BioNet	1	Wide-ranging species found across northern and eastern Australia. Roosts singly or in groups of up to six, in tree hollows, buildings, and 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.	High. Suitable habitat present and one recent record in locality.
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	-	BioNet	3	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. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species.	High. Suitable habitat and recent records in locality.
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V	-	BioNet	7	Found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey. 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.	High. Suitable habitat in study area, numerous records.

Biodiversity Assessment

Muswellbrook Pumped Hydro Energy Storage Lower Reservoir
Geotechnical Investigation
Prepared for Muswellbrook Pumped Hydro Company Pty Ltd

Client Reference No. 30018041
SMEC Internal Ref. 30018041
15 March 2023

Scientific Name	Common Name	NSW status	Comm. status	Source	Records	Habitat requirements	Likelihood
Reptiles							
<i>Aprasia parapulchella</i>	Pink-tailed Worm-lizard, Pink-tailed Legless Lizard	V	V	PMST	-	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. More specifically in the ACT, known habitat include areas around Queanbeyan and regions along the Murrumbidgee and Molonglo River corridors and on adjacent outlying hills (ACT Government - Environment and Planning 2016). In general, lizards occur in open grassland habitats that have a substantial cover of small rocks (Osbourne and Jones 1995). Lizards also show a preference for sunny aspects, avoiding south facing slopes, these sites tend to be well drained. 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 (Osbourne and Jones 1995). 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 (Swan, Shea et al. 2004).	Low. Some grassland habitat at bottom of study area, although this area is south-facing. None found during active reptile searches in potential habitat.
<i>Delma impar</i>	Striped Legless Lizard	V	V	BioNet, PMST	11	Occurs in the Southern Tablelands, the South West Slopes, the Upper Hunter and possibly on the Riverina. Populations are known in the Goulburn, Yass, Queanbeyan, Cooma, Muswellbrook and Tumut areas. 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.	Moderate. Some suitable habitat within the study area and several recent records in the locality.

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Appendix C Assessments of Significance

BC Act Assessments of Significance

The NSW Environmental Planning and Assessment Act 1979 (EP&A Act) requires proponents and consent authorities to consider if a proposed activity will have a significant effect on threatened species, endangered populations or ecological communities listed under the BC Act.

Threatened species, endangered populations or ecological communities (or their habitat) considered to have a reasonable potential to occur ('moderate' or 'high' likelihood of occurrence) or were recorded within the study area and with a reasonable potential to be impacted by the proposed development have been assessed in this section via the application of the 'Five Part Test of Significance'. These assessments have been conducted in accordance with s.7.3 of the BC Act and the Threatened Species Test of Significance Guidelines (OEH 2018).

Threatened species, endangered populations or ecological communities included under this assessment are:

- Central Hunter Grey Box – Ironbark Woodland EEC
- Speckled Warbler (*Chthonicola sagittata*)
- Squirrel Glider (*Petaurus norfolcensis*)
- Hollow-roosting microbats: Greater Broad-nosed Bat (*Scoteanax rueppellii*), Corben's Long-eared Bat (*Nyctophilus corbeni*) and Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*)
- Cave-roosting microbats: Large Bent-winged Bat (*Miniopterus orianae oceanensis*) and Eastern Cave Bat (*Vespadelus troughtoni*)
- Koala (*Phascolarctos cinereus*)
- Spotted-tailed Quoll (*Dasyurus maculatus*).

Central Hunter Grey Box – Ironbark Woodland listed as an Endangered Ecological Community (EEC)

Three test pads (BH12, TP1 and TP2) will be closely located to areas of this CEEC. Following recommendations by ecologists, all test sites were able to be moved to avoid direct clearing of this community.

(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

Not applicable to a TEC.

(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

The proposed cut and fill works for the test pads will not directly remove Central Hunter Grey Box – Ironbark Woodland EEC. Indirect impacts are limited and further discussed below and may have minor impacts on species composition but are unlikely to alter distribution. The lack of direct impact and magnitude of indirect impacts are unlikely to have an adverse effect on the extent of the ecological community such that its local occurrence would be placed at risk of extinction.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

The quality of the EEC near the works areas is disturbed and in a state of regrowth following historic clearing. All the pads sites near this EEC are close the edge of the regenerating areas of tree canopy in either derived grassland or disturbed exotic pasture. Each pad site represents a small focal patch of disturbance relative to the surrounding community in the locality. The proposed works could introduce or spread weed species into adjoining areas of EEC

with the potential to alter the composition of the community. However appropriate mitigation measures such as plant wash down measures have been recommended to minimise this risk. By avoiding opening the canopy or directly disturbing the ground layer within the TEC the risk of weed incursion is low. On this basis, it is therefore unlikely that the proposed works would substantially and adversely modify the composition of the ecological community such that its local occurrence would 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

The small extent of clearing and limited disturbance to key habitat features means that the extent of habitat to be removed is negligible in context of the much larger patch of habitat adjacent the cut and fill extent and in the locality.

(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

The test pads are isolated areas of disturbance near the local occurrence of the community and will not contribute significantly to fragmentation of the EEC or isolation of areas of habitat from each other by removing significant areas of derived grassland

(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

The area of habitat suitable for the local occurrence of this community is represented by the vegetation type on Permian sediments on the lower slopes of Bells Mountain. The importance of the area to be removed is considered to have negligible importance for the long-term survival of any threatened species or the 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)

There are no areas of outstanding biodiversity value mapped in or near the proposal site

(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

The proposed activity will have a minor contribution to the following key threatening processes (KTP):

- Clearing of native vegetation.

In addition, it is possible that the proposed activity may contribute to the following KTPs:

- Invasion of native plant communities by exotic perennial grasses.

The significance of these impacts of these KTP are already covered by the proceeding assessment points.

Conclusion

The scale of the impacts to Central Hunter Grey Box – Ironbark Woodland EEC are considered unlikely to have a significance impact on the quality and integrity of this EEC such that a local occurrence would be placed at risk of extinction.

Speckled Warbler (*Chthonicola sagittata*) - Vulnerable

The Speckled Warbler (*Chthonicola sagittata*) has a patchy distribution that stretches from south-eastern QLD south to VIC, reaching as far west as the Grampians. The Speckled Warbler inhabits open Eucalypt woodlands with rocky ridges, gullies, and sparse native tussocks grasses and shrubbery. The Speckled Warbler feeds on seeds and insects, mostly foraging on the ground under bushes and trees, and around tussocks. They build a domed nest out of dry grass and bark strips in a slight hollow in the ground or at the base of a dense plant, generally among fallen branches or other debris. Speckled Warbler pairs occupy a breeding territory of approximately 10 hectares, with a slightly larger territory when not breeding. Throughout its range the Speckled Warbler's population density has declined, with declines greater than 40% where no vegetation remnants larger than 100 hectares survive. Threats include loss and fragmentation, predation by native and non-native species, exclusion from habitat from over abundant Noisy Miners, Climate Change, and habitat infestation by invasive weeds. The clearing area contains approximately 0.86 hectares of potential woodland, forest and grassy woodland habitat.

(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

A Speckled Warbler pair was recorded perched in a small tree in the subject site. The subject site and study area provides suitable foraging and breeding habitat for the Speckled Warbler. The Speckled Warbler breeds and lays a clutch of 3-4 eggs between August and January. The proposal will result in the removal of approximately 0.86 hectares of vegetation likely to provide foraging and breeding habitat for the Speckled Warbler, including trees, shrubs and tussocks. As the Speckled Warbler's breeding territory covers 10 hectares and there is an abundance of suitable nesting materials available in the study area, it is unlikely that the removal of this habitat will place the Speckled Warbler 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

Not applicable to threatened species.

(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

The proposal will involve clearing 0.84 hectares of suitable breeding and foraging habitat.

(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

The proposal involves the widening of existing access tracks and the creation of some new access tracks and geotechnical investigation sites in the study area. Existing tracks already are already associated with some minor fragmentation and the clearing width would increase slightly (no more than several metres). New tracks would also create small habitat gaps, but these are not likely to cause fragmentation for the Speckled Warbler due to its preference for open habitats and its ability to fly. No area of habitat would be completely disconnected from the large area of intact vegetation on Bells Mountain.

(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,

While the Speckled Warbler was observed in the subject site, and the subject site provides sufficient foraging, nesting and sheltering habitat to support the entire lifecycle of the species, the removal of 0.86 hectares of suitable vegetation in the subject site, and the minor gaps created, are unlikely to lead to its local extinction.

(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)

The proposal will not impact any declared areas of outstanding biodiversity values.

(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.

The following KTPs are considered relevant to Speckled Warbler in the study area:

- Clearing of native vegetation
- Removal of dead wood and dead trees.

The proposal constitutes two KTPs relevant to the Speckled Warbler.

Conclusion

The Speckled Warbler was identified in the subject site during recent surveys and suitable habitat for this species occurs throughout the study area. The proposal would require the removal of 0.86 hectares of vegetation that would provide foraging, nesting and sheltering habitat for this species. Given the small area of habitat to be removed, in proximity to the large amount of suitable intact habitat on Bells Mountain, the proposal is not expected to have a significant impact on the long-term survival of the Speckled Warbler. A Species Impact Statement is not required for the Speckled Warbler.

Squirrel Glider (*Petaurus norfolcensis*) - Vulnerable

The Squirrel Glider (*Petaurus norfolcensis*) has a wide, sparse distribution in eastern Australia, ranging from northern QLD south to western VIC near the SA/VIC border. It occupies a variety of drier Eucalypt forests and woodlands, generally those with a number of trees species, but habitats containing a single species (e.g. mature River Red Gum) may be permanently occupied. Squirrel Gliders feed on Acacia gum, eucalypt sap, nectar, honeydew and manna, invertebrates and pollen. Winter flowering trees are generally an important habitat component. They require habitat with abundant tree hollows for shelter and nesting. Breeding occurs between March and June, more rarely at other times, and females produce one to two offspring per litter, occasionally producing a second litter. Squirrel Gliders live in small groups consisting of an adult male, one or more adult females, and offspring in a tree hollow den.

(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

Although no Squirrel Gliders were observed during recent surveys, there are six records from 2020 within five kilometres of the subject site. The proposal will result in the removal of approximately 0.86 hectares of vegetation likely to provide foraging habitat, including winter flowering trees (Ironbarks, Red Gums). The proposal may result in the removal of hollow-bearing trees which could adversely impact the life cycle of the species, either by removing potential nesting sites or removing tree hollows that are currently being used by Squirrel Gliders. However, due to the abundance of habitat available in the study area, it is unlikely that the removal of vegetation in the subject site will place the Squirrel Glider 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

Not applicable to a threatened species.

(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

The proposal will involve clearing 0.86 hectares of vegetation of potential foraging habitat and may result in the removal of hollow-bearing trees which are required for breeding and shelter.

(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

No area of habitat will be completely disconnected from the large area of intact vegetation on Bells Mountain. At the widest points, access tracks are a maximum 6 metres in width. This would have impacts on the Squirrel Glider's gliding ability. To glide across a 6 metre gap, a Squirrel Glider would lose about 3.3 metres of height. Allowing for a landing 2 metres above the ground and a launch point 2 metres below the apex of a tree, a minimum tree height of 7.3 metres would be required. It is likely that there will still be an abundance of trees minimum 7.3 metres tall along the access tracks to allow for potential Squirrel Glider movement to continue throughout the study area.

(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

Five hollow-bearing trees were mapped within the subject site, with the potential for more to be present, which may be removed as a result of the proposal. Hollow-bearing trees are crucial for the survival of Squirrel Gliders, however the removal of five hollow-bearing trees in the subject site as a result of the proposal is unlikely to lead to the species' local extinction.

(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)

The proposal will not impact any declared areas of outstanding biodiversity values.

(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

The following KTPs are considered relevant to Squirrel Glider in the study area:

- Clearing of native vegetation
- Loss of hollow-bearing trees
- Removal of dead wood and dead trees.

The proposal constitutes two KTPs relevant to the Squirrel Glider.

Conclusion

The actions associated with the proposal would require the removal of 0.86 hectares of foraging habitat and potentially the removal of hollow-bearing trees which are crucial sheltering and breeding habitat for the Squirrel Glider. Given the small area of habitat to be removed, in proximity to the large amount foraging habitat, lack of significant habitat fragmentation and the amount of potential breeding habitat in the study area, it is considered unlikely that the proposal will negatively impact the long-term survival of the Squirrel Glider.

Hollow-roosting microbats: Greater Broad-nosed Bat (*Scoteanax rueppellii*), Corben's Long-eared Bat (*Nyctophilus corbeni*) and Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*) - Vulnerable

The Greater Broad-nosed Bat has a distribution that stretches from the Atherton Tableland in QLD to north-eastern Victoria. It occurs mainly in the gullies and river systems that drain the Great Dividing Range all the way down to the coast. The Greater Broad-nosed Bat utilises a variety of habitats from open woodlands, rainforests and wet and dry sclerophyll forests. It generally forages along habitat edges, frequently along rivers and creeks, at a height of 6-8 m. This species of bat commonly roosts in tree hollows but has been observed roosting in man-made structures. The reproductive biology of this bat is poorly understood. The Greater Broad-nosed Bat requires large hollows for breeding and maternity roosts.

The Corben's Long-eared Bat is distributed around the Murray Darling Basin and adjacent areas, particularly in the Pilliga Scrub Region. Corben's Long-eared Bat occurs in a range of woodland habitats but mostly inhabits box, ironbark and cypress pine woodlands. This bat requires large hollows for breeding and maternity roosts. It forages in the understorey, often gleaning insects from foliage and even from the ground. One or two offspring are born in autumn.

The Yellow-bellied Sheath-tail-bat has a wide-ranging distribution through tropical Australia. In the summer it migrates south to NSW, Victoria and south-east QLD. A fast-moving species that forages above the canopy or in cleared areas. This bat will roost in mixed groups of five to 30 individuals in large tree hollows however solitary individuals have been found under sandstone slabs. Recent surveys observed at least two unidentified species of microbat foraging in the subject site. Although no targeted surveys were undertaken, due to the nature of the site these threatened microbat species are assumed present.

(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

The proposal will result in the loss of 0.86 hectares of potential foraging habitat and the removal of hollow-bearing trees. The loss of hollow-bearing trees could adversely impact the life cycle of microbats, either by removing potential roosting sites or removing tree hollows that are currently being used. However, due to the abundance of habitat available in the study area, it is unlikely that the removal of vegetation in the subject site will place microbats 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

Not applicable to a threatened species.

(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

These bat species use relatively open terrain such as open woodland and waterways to forage for flying insects. The removal of 0.86 hectares vegetation would reduce potential foraging habitat for these species. All three bat species require large to medium sized tree hollows (hollows greater than 10 cm in diameter) for breeding and maternity roosts. Multiple hollows of this size were observed in the study area. The proposal may result in the removal of suitable breeding habitat for these species.

(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

The clearing widths required to provide access to the geotechnical sites would require the creation of small habitat gaps. However, this would not result in habitat fragmentation due to the high mobility of these flying mammals. No area of habitat will be completely disconnected from the large area of intact vegetation on Bells Mountain.

(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

Vegetation within the subject site provides suitable foraging and breeding habitat for the Greater Broad-nosed Bat, Corben's Long-eared Bat and Yellow-bellied Sheathtail-bat. However, due to the small scale of vegetation to be cleared for the proposal and the availability of foraging and roosting habitat within the locality, it is unlikely that the vegetation lost from the study area would lead to a local extinction of any of these species.

(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)

The proposal will not impact any declared areas of outstanding biodiversity values.

(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

The following key threatening processes are relevant to the Greater Broad-nosed Bat, Corben's Long-eared Bat and Yellow-bellied Sheathtail-bat for this proposal:

- Clearing of native vegetation
- Loss of hollow-bearing trees
- Loss of dead wood and dead trees.

Conclusion

The proposed development will result in the clearing of suitable foraging habitat, and may result in the removal of several hollow-bearing trees. Due to the occurrence of suitable foraging and breeding habitat within the study area, the small extent of vegetation actually being removed, it is unlikely that the proposal will result in the local extinction of any microbat species. A Species Impact Statement is not required for the Greater Broad-nosed Bat, Corben's Long-eared Bat and Yellow-bellied Sheathtail-bat.

Cave-roosting microbats: Large Bent-winged Bat (*Miniopterus orianae oceanensis*) and Eastern Cave Bat (*Vespadelus troughtoni*) – Vulnerable

The Large Bent-winged Bat (*Miniopterus orianae oceanensis*) occurs along the east and north-western coasts of Australia. Caves are the primary roosting habitat for the Large Bent-winged Bat, but it also uses derelict mines, storm-water tunnels, buildings and other man-made structures. This bat breeds in caves with very specific temperature regimes and few breeding sites are known to occur in NSW. Outside the breeding seasons they travel long distances to forage and roost.

The Eastern Cave Bat is distributed along a broad band on both sides of the Great Dividing Range, ranging from northern QLD to southern NSW and as far west as the Warrumbungle Range. The Eastern Cave Bat occurs in dry open forest and woodland near cliffs or rocky overhangs. Caves are their primary roosting habitat but they have also been recorded in disused mines. The feeding and breeding requirements of this bat are not well understood.

Recent surveys observed at least two different species of microbat foraging in the subject site. Although no targeted surveys were undertaken, due to the nature of the site these threatened microbat species are assumed present.

(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

No potential roosting sites were identified within the subject site, therefore activities associated with the proposal are unlikely to place local populations of these species at risk of extinction. Breeding habitat does occur in the locality, however it is unlikely that the proposal will cause enough disturbance to significantly impact the species. A small amount of foraging habitat would be removed, but this is not likely to be extensive enough to place viable local populations 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

Not applicable to a threatened species.

(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

The proposal will involve clearing 0.86 hectares of vegetation that may provide foraging habitat for these species. No suitable roosting sites for these species were identified within the subject site.

(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

The clearing widths required to provide access to the geotechnical sites would require the creation of small habitat gaps. However, this would not result in habitat fragmentation due to the high mobility of these flying mammals. No area of habitat will be completely disconnected from the large area of intact vegetation on Bells Mountain.

(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

Both species should be able to cope with any minor removal of foraging habitat. This is because there is an abundance of foraging habitat within the study area. The removal of vegetation in the subject site as a result of the proposal is unlikely to cause a local extinction of the species.

No cave habitat occurs in the subject site, therefore no breeding habitat will be directly impacted by the proposal.

(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)

The proposal will not impact any declared areas of outstanding biodiversity values.

(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

The following KTPs are considered relevant to the Large Bent-winged Bat and Eastern Cave Bat in the study area:

- Clearing of native vegetation.

Conclusion

The proposed development will result in the clearing of potential foraging habitat. No breeding habitat occurs in the subject site and will therefore not be directly impacted by the proposal. Due to the occurrence of potential foraging habitat within the study area and locality, the small extent of vegetation actually being removed, it is unlikely that the proposal will result in the local extinction of any microbat species. A Species Impact Statement is not required for the Large Bent-winged Bat and Eastern Cave Bat.

Koala (*Phascolarctos cinereus*) – Endangered

The Koala is an arboreal marsupial with a fragmented distribution throughout eastern Australia from north-east QLD to the Eyre Peninsula in South Australia. In NSW, it primarily occurs on the central and north coasts with some populations west of the Great Dividing Range. It inhabits eucalypt forests and woodlands where it is known to feed on the foliage of over 70 eucalypt species and 30 non-eucalypt species. Within any particular area a smaller number of locally preferred species will be used. A Koala will spend most of its time in a tree but will descend and traverse open ground to move between trees.

The Koala generally has a solitary existence, yet still has complex social hierarchies based on a dominant male with a territory overlapping several females with sub-ordinate males existing on the periphery. Female koalas start breeding between two and three years of age and generally produce one koala per year, with twins on rare occasions. They breed between September and February and the newborn Koala remains in its mother's pouch for about 7 months. After 12 months the young koala is weaned and the mother can breed again. Weaning coincides with favourable climatic conditions and high food availability to assist young koalas to successfully become independent.

(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

Although no Koalas were observed during recent surveys, a lost individual was recorded in the coal loading area of Muswellbrook Coal Mine in 2018, a koala scat was recorded on Muscle Creek Road in 2020, and a koala was observed between Muscle Creek Road and Muswellbrook Coal Mine in 2004. The study area was found to contain multiple high preferred use trees (*E. albens*, *E. moluccana*, *E. tereticornis*, *E. punctata*, *E. melliodora*) and significant use trees (*E. creba*). These mature eucalypts are present in the study area and subject site and are likely to provide koala habitat.

The proposal would result in the removal of 0.86 hectares of foraging habitat, including high preferred and significant use feed trees, and cause minor habitat loss. Moreover, on the basis of current evidence, a low-density Koala population may be present. Due to this combination of factors, it is unlikely that actions associated with the proposal will place a local population of Koalas 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

Not applicable to a threatened species.

(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

The proposal will involve clearing 0.86 hectares of potential habitat, of which 0.86 hectares provides foraging habitat and 0.78 hectares potential breeding habitat.

(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

The proposal involves clearing of access tracks and geotechnical investigation sites up the mountain, resulting in gaps up to 6 m wide. This is less than the mean on-ground movement of about 50 metres between consecutively occupied trees. Thus, no area of habitat will be completely disconnected from the large area of intact vegetation on Bells Mountain.

(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

Whilst the subject site may provide sufficient foraging and breeding habitat to support the entire lifecycle of the Koala, the removal of 0.86 hectares of vegetation in the subject site is unlikely to lead to its local extinction due to the amount of similar habitat that would remain.

(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)

The proposal will not impact any declared areas of outstanding biodiversity values.

(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

The following KTPs are considered relevant to the Koala in the study area:

- Clearing of native vegetation.

Conclusion

The actions associated with the proposal would require the removal of 0.86 hectares of potential Koala habitat. Given the small area of habitat to be removed, in proximity to the large amount of suitable intact habitat on Bells Mountain, the proposal is not expected to have a significant impact on the long-term survival of the Koala. A Species Impact Statement is not required for the Koala.

Spotted-tailed Quoll (*Dasyurus maculatus*) – Vulnerable

The Spotted-tailed Quoll (*Dasyurus maculatus*) occurs in south-eastern Australia, ranging from south-eastern QLD down to Victoria. In NSW it is mainly confined to within 200 km of the coast. It inhabits a range of habitat types, including woodland, open forest, rainforest, inland riparian forest and coastal heath, from the coastline to the sub-alpine zone. The Spotted-tailed quolls creates den sites out of hollow-bearing trees, logs, burrows made by other animals, caves and rock outcrops. They are generalist predators and prefer to eat medium-sized mammals (500g – 5kg). They have large home ranges, with females occupying 200-500 hectares and males occupying 500 to over 4000 hectares.

(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

Although no Spotted-tailed Quolls were recorded in the study area, there are old records within the locality and Muswellbrook locals have claimed to have seen them in the area recently. The proposal will result in the clearing of 0.86 hectares of vegetation likely to provide suitable habitat and may result in the removal of at least five hollow-bearing trees. However, due to the species' large home ranges and their ability to utilise other habitat features for den sites, it is unlikely that the proposal will place the Spotted-tailed Quoll 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

Not applicable to a threatened species.

(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

The proposal will involve clearing 0.86 hectares of native vegetation likely to provide habitat, 0.76 hectares of which may provide suitable breeding habitat.

(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

The proposal involves clearing of access tracks and geotechnical investigation sites up the mountain. Clearing widths of up to 6 metres for access tracks and 10 x 10 metres for geotechnical investigation sites would not cause habitat fragmentation for the Spotted-tailed Quoll. No area of habitat would be completely disconnected from the large area of intact vegetation on Bells Mountain.

(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

Whilst the subject site may provide sufficient shelter, hunting and breeding habitat to support the entire lifecycle of the Spotted-tailed Quoll, the removal of vegetation in the subject site is unlikely to lead to its local extinction as the Spotted-tailed Quoll has a large home range and an abundance of habitat in the surrounding study area and locality relative to the area impacted by clearing.

(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)

The proposal will not impact any declared areas of outstanding biodiversity values.

(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

The following KTPs are considered relevant to the Spotted-tailed Quoll in the study area:

- Clearing of native vegetation

-
- Loss of hollow-bearing trees
 - Removal of dead wood and dead trees.

Conclusion

The actions associated with the proposal would require the removal of 0.86 hectares of potential Spotted-tailed Quoll foraging habitat and 0.76 hectares breeding habitat. Given the small area of habitat to be removed, in proximity to the large amount of suitable intact habitat on Bells Mountain, the proposal is not expected to have a significant impact on the long-term survival of the Spotted-tailed Quoll. A Species Impact Statement is not required for the Spotted-tailed Quoll.

EPBC Act Assessments of Significance

Under the Commonwealth EPBC Act, the approval of the Commonwealth Minister for the Environment is required for any action that may have a significance impact on Matters of National Environmental Significance (MNES). These matters are:

- Listed threatened species and communities;
- Migratory species protected under international agreements;
- Ramsar wetlands of international importance;
- The Commonwealth marine environment;
- World Heritage properties;
- National Heritage places;
- Great Barrier Reef Marine Park;
- Nuclear actions; and
- A water resource, in relation to coal seam gas development and large coal mining development.

Ecological MNES (or their habitat) considered to have a reasonable potential to occur ('moderate' or 'high' likelihood of occurrence) or were recorded within the study area and with reasonable potential to be impacted by the proposed developments have been assessed in this section via the application of the 'Assessment of Significance'.

Threatened species, endangered populations or ecological communities included under this assessment include:

- Central Hunter Valley eucalypt forest and woodland CEEC
- Corben's Long-eared Bat (*Nyctophilus corbeni*)
- Koala (*Phascolarctos cinereus*)
- Spotted-tailed Quoll (*Dasyurus maculatus*).

Central Hunter Valley eucalypt forest and woodland CEEC

Impact Summary

Three test pads (BH12, TP1 and TP2) will be closely located to areas of this CEEC. Following recommendations by ecologists, all test sites were able to be moved to avoid direct clearing of this community.

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 cut and fill works for the test pads will not directly reduce the extent of Central Hunter Valley eucalypt forest and woodland CEEC.

- **Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines**

The test pads themselves are small isolated and non-linear areas of disturbance within the local occurrence of the community and will not contribute significantly to fragmentation of the CEEC or isolation of areas of habitat from each other.

- **Adversely affect habitat critical to the survival of an ecological community**

According to the Conservation Advice (2015), areas that meet the minimum (moderate quality condition class) condition thresholds, are considered critical to the survival of the ecological community. Additional areas such as adjoining native vegetation and areas that meet the description of the ecological community but not the Condition thresholds are also important to the survival of the ecological community and should be taken into consideration as part of the surrounding environment and landscape context (TSSC, 2006). On this basis, the CEEC if it were impacted is considered to be part of habitat critical to the survival of the ecological community. Given the lack of direct impact to

this habitat and low risk of indirect impacts the proposal is unlikely to constitute a significant impact to a matter of National Matter of Environmental Significance.,

- **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**

The proposed cut and fill works for the test pads could cause temporary alterations or disruptions to abiotic factors such as soil and nutrients in the immediate area of vegetation clearance. Hydrological alteration is unlikely. Reinstatement of topsoil post investigation will return most of the basic abiotic factors required for the community, although with a degree of disturbance or modification which may persist. Based on the small-scale extent of the proposed works it is not expected that the abiotic factors necessary for the ecological community's survival would be substantially modified or destroyed.

- **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**

. The cut and fill works are minor in scale and extent, and by staying outside the community are unlikely to result in a substantial change in the species composition of an occurrence of the ecological community in the locality, including a decline or loss of functionally important species. Alterations to species composition could be altered indirectly through the introduction of a new weed species however appropriate mitigation measures such as plant wash down measures have been recommended to minimise this risk.

- **Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:**
 - **Assisting invasive species, that are harmful to the listed ecological community, to become established, or**
 - **Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or**

Many of the exotic species that occur in the investigation areas, also occur throughout the broader locality. Vehicle hygiene measures have been recommended to minimise the potential for the introduction and spread of weed species. However, given the temporary nature of the proposed works, it is unlikely that additional weed species would be introduced to a degree that it would cause a substantial reduction in the quality or integrity of the occurrence of the CEEC. No fertilisers, herbicides or other chemicals or pollutants are expected to be used as part of the proposed works. A spill kit is expected to be on-hand for where machinery and plant equipment are undertaking the proposed works.

- **Interfere with the recovery of an ecological community.**

All forms of vegetation clearance of the CEEC are considered to interfere with the recovery of the CEEC however given the extent to be cleared is negligible it is unlikely to substantially interfere with the recovery given the extent of potential habitat in the surrounding landscape.

Conclusion

Based on the small-scale extent and temporary nature of the proposed works, the impacts to Central Hunter Valley eucalypt forest and woodland CEEC are considered to be negligible. The proposed works is considered unlikely to have a significance adverse impact on the occurrence of this CEEC in the locality.

Corben's Long-eared Bat (*Nyctophilus corbeni*) – Vulnerable

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

There were two recent records of Corben's Long-eared Bat within 5 km of the study area. No targeted ultrasonic surveys were carried out however due to the nature of the site this species is assumed present. The proposal will result in the removal of 0.86 hectares of potential habitat and some hollow-bearing trees. Due to the availability of suitable habitat in the locality relative to the small area impacted by clearing (0.86 ha), it is unlikely to lead to the decline of the species. Additionally, there is no evidence that the population on Bells Mountain is considered an important population.

- **Reduce the area of occupancy of an important population.**

The proposal will lead to the removal of 0.86 hectares of potential habitat, including some hollow-bearing trees. Any reduction in habitat as a result of the proposal will therefore reduce the area of occupancy for Corben's Long-eared Bat. There is no evidence however, that the population on Bells Mountain is an important population. The current conservation advice does not include information on the Corben's Long-eared Bat's area of occupancy.

- **Fragment an existing important population into two or more populations.**

The proposal involves clearing of access tracks and geotechnical investigation sites up the mountain resulting in gaps up to 6 metres wide. The clearing widths required to provide access to the geotechnical sites would require the creation of small habitat gaps, however, this would not result in habitat fragmentation due to the high mobility of these flying mammals. No area of habitat will be completely disconnected from the large area of intact vegetation on Bells Mountain.

- **Adversely affect habitat critical to the survival of a species.**

Habitat critical to the survival of Corben's Long-eared Bat has not been defined, but is likely to include areas that are necessary for activities such as foraging and breeding. Such habitat is present in the subject site. The proposal would result in the removal of 0.86 hectares of this habitat.

- **Disrupt the breeding cycle of an important population.**

There is limited information on the reproductive biology of Corben's Long-eared Bat. The proposal may disturb and disrupt the breeding cycle of individual Corben's Long-eared Bats in the study area, particularly with the removal and destruction of hollow-bearing trees, dead trees and trees with loose bark. Due to the relatively small area of vegetation to be cleared and the availability of habitat in the study area, it is unlikely that the proposal will disrupt the breeding cycle of the local Corben's Long-eared Bat population. There is also no evidence that the population on Bells Mountain is 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 actions associated with the proposal will result in the removal of 0.86 hectares of potential habitat. Due to the high mobility of these flying mammals, vegetation clearing will not cause any isolating effects. Consequently, the proposal will remove potential habitat but not isolate this habitat from other potential habitat. It is unlikely that this will cause a decline in the local Corben's Long-eared Bat population.

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

The risk of predation on Corben's Long-eared Bat by invasive species is unknown. It is also likely that potential invasive predators such as feral cats (*Felis catus*) and European Red Fox (*Vulpes vulpes*) are already established and present in the study area. Track construction may allow feral predators greater access into native habitat, however, this impact is already in operation as tracks are currently present in the study area.

- **Introduce disease that may cause the species to decline.**

The proposal would not introduce disease harmful to Corben's Long-eared Bat.

- **Interfere substantially with the recovery of the species.**

There is no adopted or made Recovery Plan for this species.

Conclusion

The actions associated with the proposal will remove a small area of foraging and breeding habitat. However, as Corbin's Long-eared Bats are highly mobile and there is an abundance of suitable habitat present in the study area, it is unlikely that the proposal will have a significant impact on the species.

Koala (*Phascolarctos cinereus*) – Endangered

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

There were two recent records of Koalas within 5 km of the study area, one of which was a scat. No Koalas or signs of Koala occurrence were observed during recent surveys. The proposal would affect 0.86 hectares of potential habitat and is, therefore, unlikely to remove enough mature Eucalypt feed trees to lead to a long-term decrease in the size of the local population.

- **Reduce the area of occupancy of the species.**

The area of occupancy (the area within the extent of occurrence (distribution) that is occupied by the species) is estimated at 19,428 km² (DAWE 2022). The actions associated with the proposal will lead to the removal of 0.86 hectares of potential habitat. Some of the trees that make up this potential habitat have been classed as high preferred use trees (*E. albens*, *E. moluccana*, *E. tereticornis*, *E. punctata*, *E. melliodora*) under the State and Environmental Planning Policy (Biodiversity and Conservation) 2021 in the Central Coast Koala Management Area (KMA). Any reduction of habitat as a result of the proposal will reduce the area of occupancy for Koalas. However, this loss is not significant in relation to the area of occupancy.

- **Fragment an existing population into two or more populations.**

The proposal involves clearing of access tracks and geotechnical investigation sites up the mountain resulting in gaps up to 6 m wide. This is less than the mean on-ground movement of about 50 metres between consecutively occupied trees. Thus, no area of habitat will be completely disconnected from the large area of intact vegetation on Bells Mountain, therefore it is unlikely for any existing Koala population to be fragmented into two or more populations as a result.

- **Adversely affect habitat critical to the survival of a species.**

Habitat critical to the survival of the Koala includes habitat used to meet essential life cycle requirements, including foraging and breeding. Such habitat is present in the subject site. The proposal would result in the removal of 0.86 hectares of this habitat.

- **Disrupt the breeding cycle of a population.**

The dominant males are territorial and therefore any removal of trees occupying this territory could potentially cause a change to use of this territory. This could lead to disputes with other males with overlapping or adjacent territories which could flow-on to disrupt breeding patterns and behaviours within the greater Koala population. Food availability and quality is an important factor which can impact breeding and offspring survival. However, given the minor amount of habitat loss, it is unlikely that the proposal will disrupt the breeding cycle of any potential koala population on Bells Mountain.

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

The actions associated with the proposal will result in the removal of 0.86 hectares of potential Koala habitat. Edge effects will likely reduce the native biodiversity of fringing vegetation and lower the availability of quality habitat. Vegetation clearing will not cause any fragmentation effects. Consequently, the proposal will remove potential habitat but not isolate this habitat from other potential habitat. It is unlikely that this will cause the species to decline.

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

The proposal could lead to the promotion of the exotic plant species *Lantana camara*. *Lantana camara* is known to out-compete many native species including the juveniles of potential feed trees. The promotion of *Lantana camara* could therefore indirectly impact upon the potential foraging habitat of the Koala by reducing the number and quality of feed trees.

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- **Introduce disease that may cause the species to decline.**

Most koala populations are impacted by Koala retrovirus and Chlamydia (*Chlamydia pecorum*) and it is likely that these diseases are already present in any potential Koala population in the study area. The prevalence of disease has been found to increase as a result of habitat loss and fragmentation (Lunney *et al.* 2012; Davies *et al.* 2013), however, the proposal is unlikely to introduce any new diseases that directly affect the Koala.

There are diseases that could be introduced that would affect the some of the tree species Koalas forage on. These plant diseases are:

- *Phytophthora cinnamomi*
- Exotic Rust Fungi of the order Pucciniales pathogenic, on plants of the family *Myrtaceae*

It is difficult to assess the indirect impacts that any potential infection to feed trees in the study area would have on the Koala. It is unlikely that it would cause a quantifiable reduction to the local population unless an outbreak of one of these pathogens was to occur causing a dramatic reduction to all feed trees in the Hunter Region.

- **Interfere substantially with the recovery of the species.**

The recovery of the species will depend on research, community support, provision of principles for state-level conservation planning, increasing protected priority Koala habitat, improving habitat quality and restoration, and managing population viability.

Clearing of vegetation will reduce the quality and extent of potential habitat, but this is unlikely to result in the loss of the local population due to the small clearing footprint. Sufficient habitat would remain, containing preferred browse species, to enable future colonisation of the remaining habitat. It is unlikely that the proposal would substantially interfere with the recovery of the Koala.

Conclusion

The actions associated with the proposal will remove potential Koala habitat and could potentially impact breeding behaviour. However, evidence suggests a low-density population may be present and the area of vegetation to be cleared is relatively minimal. Therefore, it is unlikely that the proposal will have a significant impact on the Koala.

Spotted-tailed Quoll (southeastern mainland population) (*Dasyurus maculatus maculatus*) – Endangered

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

There were six old records of Spotted-tailed Quoll within 5 km of the study area, and more recent sightings claimed by Muswellbrook locals. No Spotted-tailed Quoll or signs of Quoll occurrence were observed during recent surveys. However, it is assumed to occur due to the presence of suitable habitat and habitat features (e.g. tree hollows, hollow logs). Due to the Spotted-tailed Quoll's large home range and availability of suitable habitat in the locality relative to the small area impacted by clearing (0.86 ha), it is unlikely to lead to the decline of any possible local populations of Spotted-tailed Quoll.

- **Reduce the area of occupancy of an population.**

The area of occupancy of the Spotted-tailed Quoll is an estimated 2,512 km² (Threatened Species Scientific Committee 2020). The actions associated with the proposal will lead to the removal of 0.86 hectares of potential habitat, of which 0.86 hectares and 0.76 hectares is potential hunting and breeding habitat, respectively. Any reduction of habitat as a result of the proposal will reduce the area of occupancy for Spotted-tailed Quoll. The vegetation that fringes the areas of removed vegetation will also likely experience edge effects that will reduce the native biodiversity of these fringe areas and lower the possibility of Spotted-tailed Quoll occupation.

- **Fragment an existing population into two or more populations.**

The proposal involves clearing of access tracks and geotechnical investigation sites up the mountain. Clearing widths of up to 6 metres would not cause habitat fragmentation for the Spotted-tailed Quoll. No area of habitat would be completely disconnected from the large area of intact vegetation on Bells Mountain, therefore it is unlikely for any existing Spotted-tailed Quoll population to be fragmented into two or more populations as a result.

- **Disrupt the breeding cycle of an population.**

The proposal may disturb and disrupt the breeding cycle of individual Spotted-tailed Quolls in the study area, particularly with the removal and destruction of hollow-bearing trees, logs or animal burrows. Due to the large ranges of Spotted-tailed Quolls, it is unlikely that clearing in the subject site will disrupt the breeding cycle of any Spotted-tailed Quoll population that may be occurring on Bells Mountain.

- **Adversely affect habitat critical to the survival of a species.**

Habitat critical to the survival of the Spotted-tailed Quoll has not been defined, but is likely to include areas that are necessary for activities such as foraging and breeding. Such habitat is present in the subject site. The proposal would result in the removal of 0.86 hectares of this habitat.

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

The actions associated with the proposal will result in the removal of 0.86 hectares of potential habitat, which is only a small percentage of the Spotted-tailed Quoll's home-range area. Vegetation clearing will not cause any isolating effects. Consequently, the proposal will remove potential habitat but not isolate this habitat from other potential habitat. It is unlikely that this will cause a decline in the local Spotted-tailed Quoll population.

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

Predation by feral cats (*Felis catus*) and European Red Fox (*Vulpes vulpes*), or competition with these species, have direct negative impacts the Spotted-tailed Quoll. However, it is likely that these species are already present in the study area. Track construction may allow feral predators greater access into native habitat, however, this impact is already in operation as tracks are currently present in the study area.

- **Introduce disease that may cause the species to decline**

The proposal is unlikely to introduce any diseases that directly affect the Spotted-tailed Quoll, however there are diseases that could be introduced that would affect the some of the tree species their prey forages on. These plant diseases are as follows:

- *Phytophthora cinnamomi*

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- Exotic Rust Fungi of the order Pucciniales pathogenic, on plants of the family *Myrtaceae*

It is difficult to assess the indirect impacts that any potential infection to prey habitat trees in the study area would have on the Spotted-tailed Quoll. It is unlikely that it would cause a quantifiable reduction to the local population unless an outbreak of one of these pathogens was to occur causing a dramatic reduction to all prey habitat in the Hunter Region.

- **Interfere substantially with the recovery of the species**

The recovery of the species will depend maintaining and restoring Spotted-tailed Quoll habitat, and preventing the establishment and promotion of invasive species. The clearing of vegetation would result in a small reduction in the extent of potential habitat, which is unlikely to have a substantial impact on recovery of the Spotted-tailed Quoll at the species scale.

Conclusion

The actions associated with the proposal will remove a small amount of potential Spotted-tailed Quoll breeding and foraging habitat, however as the species occupies large home ranges and there is an abundance of suitable habitat within the study area and locality, it is unlikely that the proposal would have a significant impact on the Spotted-tailed Quoll.



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