



Moss Vale Road Urban Release Area Masterplan and Development Control Plan

Flora and Fauna Assessment

Prepared for
Allen Price & Scarratts Pty Ltd

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Abbreviations

Abbreviation	Description
BC Act	<i>Biodiversity Conservation Act 2016, NSW</i>
CEEC	Critically Endangered Ecological Community
DotEE	Department of the Environment and Energy, Commonwealth
DPI	Department of Primary Industries, NSW
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999, Commonwealth</i>
FM Act	<i>Fisheries Management Act 1994, NSW</i>
GDE	Groundwater Dependent Ecosystem
KTP	Key Threatening Process
LLSA Act	<i>Local Land Services Amendment Act 2017, NSW</i>
MVRN	Moss Vale Road North
OEH	Office of Environment and Heritage, NSW
PCT	Plant Community Type, from the NSW Vegetation Information System
PMST	Protected Matters Search Tool
SEPP	State Environmental Planning Policy, NSW
TAP	Threat Abatement Plan
TEC	Threatened Ecological Community
URA	Urban Release Area
VIS, VIS-C	NSW Vegetation Information System (classification), - state-wide database of vegetation types

Executive summary

Eco Logical Australia Pty Ltd (ELA) was engaged by Allen Price & Scarratts (APS) to undertake a Flora and Fauna Assessment (FFA) for the Moss Vale Road North (MVRN) Urban Release Area (URA).

The MVRN URA is approximately 266.1ha in area (excluding roads zoned within an R1 area) and is located north-west of Bomaderry and east of Cambewarra. The subject land was rezoned for residential development under the Shoalhaven Local Environmental Plan (SLEP) 2014. APS are now in the process of preparing a Development Control Plan (DCP) for the URA.

The objectives of this assessment were to:

- Identify and describe the vegetation communities present in the study area and their conservation significance.
- Identify and describe the fauna habitats present in the study area and their condition and value to the long-term viability of local populations and migratory species.
- Identify flora and fauna species of conservation significance which are present or likely to occur in the study area, and the value of the site habitats for their long-term survival.
- Identify the wildlife corridor potential and condition of riparian zones, and measures for their remediation.
- Make recommendations regarding any environmental management and impact mitigation/amelioration measures which should be implemented to limit the effects of the future residential development on vegetation, fauna, habitats, and other environmental features as necessary.
- Provide preliminary assessment of the relevant statutory instruments which will apply to future Development Applications.

The site falls over land broadly described as undulating, with a broad amphitheatre rising from Abernethy's Creek, which is joined by a smaller tributary and runs west to east across the central part of the URA. Elevation ranges from RL20 m AHD in the south-east rising to RL50 m in the south near Moss Vale Rd, and up to RL70 m in the north-west corner which rises to the Cambewarra Range.

Numerous dams have been established on the site, ranging from a few hundred square metres, to a dam about 1.8 ha which is largely included in an E2 zone and will be the focus of a commercial and recreational district. Abernethy's Creek and a number of other minor watercourses on site are subject to flooding (1:100 ARI); these areas are largely encapsulated in the E2 zones.

There are no SEPP 14 wetlands on-site. No subterranean or aquatic Groundwater Dependent Ecosystems (GDEs) are mapped within the site. However, modelling shows three areas of mostly moderate potential terrestrial GDEs within the study site.

The site vegetation communities in term of distribution, floristics and condition reflect the long-term use of the area for pastoralism. All vegetation remnants contain a simplified assemblage of the original native ecosystems, often dominated by regrowth. The majority of the property is currently improved pasture with limited remnants generally associated with the major riparian zones or hill crests.

Historically the land appears to have been largely dominated by PCT1206 *Spotted Gum - Blackbutt shrubby open forest*, with Spotted Gum being the dominant canopy tree with canopy associates and undergrowth varying with local edaphics. The riparian zones have been highly degraded overall, with the original associations likely to have been a transition of PCT 1245 *Sydney Blue Gum x Bangalay - Lilly*

Pilly moist forest, via a wet sclerophyll forest/rainforest/ecotone, to a swamp forest community, based on remnant species present and occurrence of PCTs in similar situations in the locality.

No threatened flora were detected, and none were considered likely potential occurrences due to lack of or condition of potential habitat, and lack of close proximity records. BioNet (2017) shows a record of *Zieria baeuerlenii* (Bomaderry Zieria) in the cleared southern end of the site from 1989. The identification is certified by the Royal Botanical Gardens, however the description refers to the habitat as a dry rocky slope on Nowra sandstone within undisturbed *Eucalyptus punctata* woodland. This record is clearly geographically inaccurate with the actual record being to the south in the known restricted habitat in Bomaderry.

Potential occurrences of locally recorded threatened flora are evaluated in **Appendix A**. The only species with some potential to occur may have been *Cryptostylis hunteriana* (Leafless Tongue Orchid), however after targeted survey and considering the failure to detect even common species of orchids, this cryptic species is not considered a potential occurrence.

Currently, the only precisely definable Threatened Ecological Community (TEC) on site is *Freshwater Wetlands on Coastal Floodplains*. This TEC appears to be a derived form, occupying the central channel of the watercourses which have undoubtedly altered via erosion and sedimentation since clearing of the original vegetation. Such changes may have seen shallowing of former channels, with removal of forest allowing colonisation due to increased solar access (such plants are absent where the riparian zone is enclosed by forest and streamflow is permanent due to a rocky substrate).

PCT 1245 is not recognised as conforming to any TEC accordingly to the Bionet Vegetation Information System, however much of the remnant vegetation mapped as this PCT on site falls on alluvial soil landscapes. Legal precedents and Final Determinations have clarified that all vegetation on coastal floodplains is a TEC. Presence of Flooded Gum plus Bangalay x Sydney Blue Gum hybrids on site, plus rare occurrences of Forest Red Gum and *Angophora floribunda* localised to the alluvial soil landscape, plus the presence of many understorey, groundcover, shrub and vine species listed in the Final Determination, suggest that an intergrade form of the TECs *Riverflat Eucalypt Forest on Coastal Floodplains* and *Swamp Sclerophyll Forest on Coastal Floodplains* may have occurred, depending on local relief and position in the catchment. Such intergrades are recognised in all the Final Determinations. Applying the Precautionary Principle, therefore, all areas of PCT 1245 on alluvial soil landscapes are mapped as the TEC - *Riverflat Eucalypt Forest on Coastal Floodplains*.

Habitat components also vary in condition and diversity. Hollow-bearing trees are relatively abundant, with the majority captured in the E2 zones. Wombat burrows were locally common in the forest remnants and along Abernethy's Creek. Leaf litter was generally of low value as was groundcover, limiting habitat for small terrestrial mammals and frogs. Fruiting trees, shrubs and vines were present but limited in abundance, but sap species and preferred nectar sources (particularly Spotted Gum) were common. Allocasuarinas were absent, indicating the Glossy Black Cockatoo is unlikely to visit the site; and the limited extent of forest and poor connectivity was a key constraint on the diversity and abundance of arboreal mammals, which limits potential for forest owls to occur. Aquatic habitat presented as a series of pools and channels in the 2nd and 3rd order streams, and numerous dams, but threatened frogs such as the Green and Golden Bell Frog (*Litoria aurea*) were unlikely potential occurrences due to isolation and edge effects.

In terms of connectivity, the site is not part of a regional corridor. Local corridor value is marginal, due to the dominance of pastoralism on site and in surrounding lands, the patchy nature of remnant vegetation,

the barriers posed by Moss Vale Rd and the Princes Highway, and edge effects e.g. predation and the impact of Noisy Miners. Connectivity is only sufficient for very mobile and habitat generalist species.

No threatened fauna species were detected. However, acknowledging the limitations of all ecological surveys and considering the ecology of locally recorded threatened species and the habitat on site as well as nearby to the north-west, 13 species (comprising several Microchiropteran bats, the Grey-headed Flying Fox and a number of birds tolerant of agricultural woodland habitats) were considered potential occurrences. Two of these are listed under Commonwealth legislation, with two migratory bird species also considered potential occurrences.

The network of riparian zones in the study area offers at best a marginal corridor for frogs due to the historical clearing of the landscape, including virtually all of the lower riparian zones, and conversion to improved pasture. Cover is extremely limited in all but the 3rd order streams, where some channels are thickly lined with Cumbungi (*Typha* sp.) and have a series of pools. The central north-east tributary has the best development of this vegetation, linking a large dam with a small distinct wetland upstream. While the Green and Golden Bell Frog has been recorded moving across broadly similar landscapes after major breeding events such as that which occurred from 2010 to 2014 (Daly 2014), the site is > 10 km west of known habitat and separated by both Broughton Creek (estuarine), the Princes Highway, and an even more intensively modified (cropping land) landscape. Given this and lack of likely source habitat on site (the large dams comprise the largest extent of permanent habitat), it is very unlikely that a population of this endangered frog could be present. Fisheries habitat value of the watercourses on site was also considered limited due to the extent of modification as a result of previous long term agricultural landuses, including access by stock to all riparian zones.

IMPACT ASSESSMENT

The identified ecological constraints were considered in the masterplan design. The key recommendations were to minimise vehicular crossings of the major E2 riparian zones (i.e. the central branch of Abernethy's Creek) and ensure that these crossings facilitated wildlife movement, and to align roading to provide a setback from the E2 zones rather than have residential lots abut these areas. Weeds will need to be managed as per a Vegetation Management Plan. Weeds could potentially be introduced via imported road base materials and construction vehicles. Standard hygiene practices will control this risk and also reduce the likelihood of transferring *Phytophthora cinnamomi* throughout the site. Erosion and sedimentation controls should also be implemented during the construction phase.

Assuming that all native vegetation will be cleared except in areas zoned E2, the development would result in the clearing of 10.02 ha of native vegetation, including 1.83 ha of TEC. However, 10.51 ha of native vegetation, including 6.15 ha of TEC, would be protected in the E2 zones. Given that the wildlife corridors/VRZs indicated in the draft masterplan (current as of March 2nd 2018) occupy a larger area than the E2 zone, the area of clearing for the proposal is therefore likely to be less than the figures given here.

Forty-six hollow-bearing trees fall into the R1 area. These should be retained where consistent with safety; arborist assessment may be required to identify any unsound trees that require removal. Where tree removal is required for safety reasons, the trunks and large limbs (>20 cm diameter) are to be re-used as coarse woody debris in the riparian E2 zones, in line with Fairfull (2013). They should be placed in locations where they are unlikely to be washed downstream and result in flooding. Any hollow-bearing trees to be removed may contain fauna at the time of clearing. Such fauna may be placed under stress, injured or killed during tree felling. The risk of fauna mortality can be mitigated by avoiding clearing during likely breeding periods, undertaking a preliminary inspection and delaying works until young have left the

nest / hollow, or employing a suitably qualified person to direct removal of such habitat components and manage fauna welfare.

Provisions of the *Water Management Act 2000* will see most of the riparian zones (virtually all of which are in E2 zones) revegetated in due course. Assessment found the E2 zones, which predominantly include riparian zones from 1st to 3rd order, were largely in low to very low condition, with most converted or having a high component of pasture species which can be challenging to rehabilitate, especially when remnant ecosystems have limited resilience. Some 1st and 2nd order streams mapped as E2 were also considered redundant in restoration value due to isolation within the residential area, and efforts were recommended to focus on floodplain habitats with higher value and resilience.

Assessment under SEPP 44 – Koala Habitat Protection found the site contained a limited area of Potential Koala Habitat, which is a result of artificial plantings. Lack of original habitat and the isolation of this artificial habitat as well as lack of evidence of use and limited local records led to the conclusion that the site did not contain Core Koala Habitat. A Koala Plan of Management is thus not required.

Some future Development Applications (DAs) (e.g. on parts of Lot 4 DP268209 and Lot 1 DP1191186 where native vegetation will be cleared) are likely to trigger the Biodiversity Offset Scheme under the new *Biodiversity Conservation Act 2016* due to exceeding clearing limits of native vegetation. Future DAs that involve clearing Sensitive Biodiversity Value Lands (restricted to Abernethy's Creek), or where a significant impact is considered likely following consideration of a Five Part Test Assessment of Significance, will also trigger the Biodiversity Offset Scheme.

Crossing of fisheries habitat in the riparian zones will trigger the need for permits under ss200 and 201 for the *Fisheries Management Act 1994* for crossings of the watercourses, and appropriate structures will need to be used to allow free fish passage. Section 7.6 of the Shoalhaven Local Environmental Plan will also need to be considered in future DAs. Post-development, any proposal to remove vegetation which is not part of a DA and not triggering the *State Environmental Planning Policy (Vegetation in Non-Rural Area) 2017* (the Vegetation SEPP) will require approval from SCC under the Chapter G4 of the DCP or provisions under the area-specific DCP, as per clause 5.9 of the SLEP. Such approval may include the need for a Five Part Test under the BC Act for threatened species, populations or ecological communities.

Consideration of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) indicated referral was unlikely to be triggered for any future DAs.

1 Introduction

1.1 Background

Eco Logical Australia Pty Ltd (ELA) has been engaged by Allen Price & Scarratts (APS) to undertake a Flora and Fauna Assessment (FFA) for the Moss Vale Road North (MVRN) Urban Release Area (URA).

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The objectives of this assessment were to:

1. Identify and describe the vegetation communities present in the study area and their conservation significance.
2. Identify and describe the fauna habitats present in the study area and their condition and value to the long-term viability of local populations and migratory species.
3. Identify flora and fauna species of conservation significance which are present or likely to occur in the study area, and the value of the site habitats for their long-term survival.
4. Identify the wildlife corridor potential and condition of riparian zones, and measures for their remediation.
5. Make recommendations regarding any environmental management and impact mitigation/amelioration measures, which can be implemented to limit the effects of the future residential development on vegetation, fauna, habitats, and other environmental features as necessary.
6. Provide preliminary assessment of the relevant statutory instruments which will apply to future Development Applications.

1.2 Site, study area and locality

The **site** comprises portions of the following lands as shown in Figure 1 and described in Table 1:

Table 1: Division of urban land in the URA

Property Address	Lot/DP	Approx. area of affected landholding	Approx. area of urban land of various zones
220 Moss Vale Rd, Cambewarra	Lot 4 DP268209	83.3Ha	33.7Ha – R1 2.3Ha – B1 5.5Ha – B7 2.6Ha – RE1
344 Moss Vale Rd, Cambewarra	Lot 54 DP1024592	23.8Ha	5.0Ha – R1
91A Bells Lane, Cambewarra	Lot 3 DP708356	2.8Ha	0.95Ha – R1
91B Bells Lane, Cambewarra	Lot 4 DP708356	17.9Ha	11.05Ha – R1
125 Bells Lane, Cambewarra	Lot 2 DP630811	2.3Ha	2.3Ha – R1
66A Bells Lane, Meroo Meadow	Lot 3 DP847399	1.0Ha	1.0Ha – R1

Property Address	Lot/DP	Approx. area of affected landholding	Approx. area of urban land of various zones
66B Bells Lane, Meroo Meadow	Lot 21 DP854369	1.0Ha	1.0Ha – R1
66C Bells Lane, Meroo Meadow	Lot 22 DP854369	1.0Ha	1.0Ha – R1
66D Bells Lane, Meroo Meadow	Lot 1 DP882059	2.6Ha	2.6Ha – R1
91D Bells Lane, Meroo Meadow	Lot 2 DP1191186	4.1Ha	3.44Ha – R1
191 Bells Lane, Meroo Meadow	Lot 1 DP1191186	63.6Ha	55.92Ha – R1
194 Bells Lane, Meroo Meadow	Lot 2 DP582036	2.3Ha	2.3Ha – R1
202 Bells Lane, Meroo Meadow	Lot 5 DP618693	6.3Ha	2.5Ha – R1
132 Bells Lane, Meroo Meadow	Lot 6 DP618693	2.0Ha	2.0Ha – R1
Bells Lane, Meroo Meadow	Lot 7 DP618693	27.32Ha	18.41Ha – R1
50 Abernethy's Lane, Meroo Meadow	Lot 1 DP1134376	3.6Ha	0.61Ha – R1
112 Bells Lane, Meroo Meadow	Lot 2 DP1134376	21.2Ha	15.23Ha – R1
Total Land Holdings		266.1 Ha	159.0 Ha – R1 2.3 Ha – B1 5.5 Ha – B7 2.6 Ha – RE1

Additional description regarding land zonings in the site is provided in section **3.1.1**.

The **study area** for the purposes of this report is nominated to comprise the site and approximately 100 metres (m) beyond the limits of the site. This area is nominated as it includes areas where stormwater runoff and edge effects are likely to be most pronounced.

The **locality** is defined in this report (unless otherwise specified) for the purpose of database searches is the area of land within a 10 km radius of the site.

1.3 Location and access

The URA is located approximately six kilometres from the Shoalhaven City Council chambers. The site is bordered by Moss Vale Rd on its south, Princes Highway to the east, rural lands to the north-east, and Cambewarra Range Nature Reserve to the north-west. Access is via Moss Vale Rd onto Bell's Lane which crosses north to south, with Abernethy's Lane crossing the site east to west

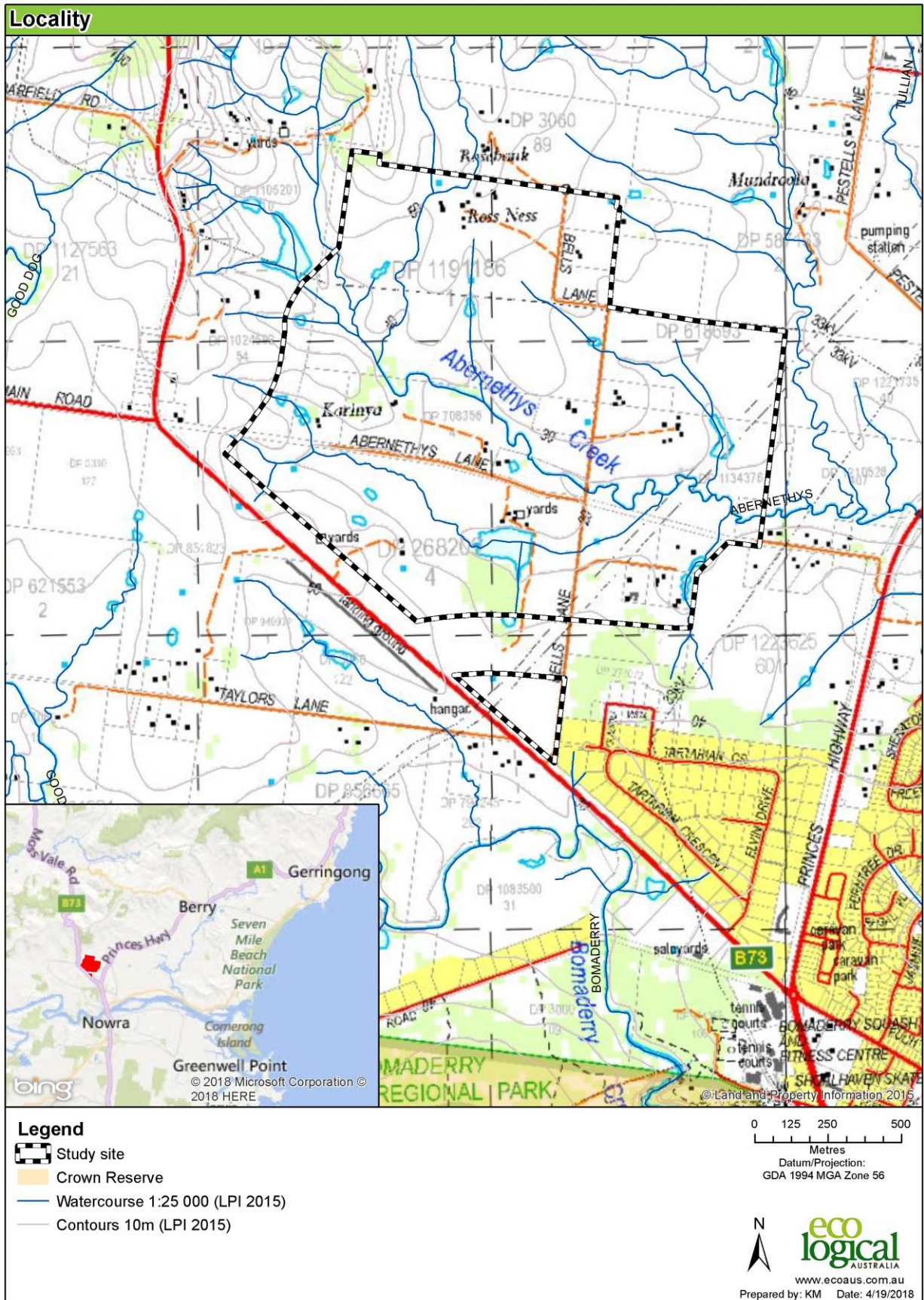


Figure 1: Location of the Moss Vale Rd URA

2 Methods

2.1 Database review

A review of relevant information was undertaken prior to the commencement of the field study, which involved:

- a) Reviewing vegetation mapping of the study site / area (OEH 2013).
- b) Searching the Atlas of NSW Wildlife (BioNet) for threatened flora and threatened fauna species recorded in the locality (OEH 2017a).
- c) Searching the EPBC Act Protected Matters Search Tool in the locality (**Appendix C**).
- d) Reviewing aerial photography (Google Earth, NearMaps, SIX Viewer) and topographic maps of the study site / area.

2.2 Field survey

2.2.1 General information

The primary field survey was undertaken on the 10th and 16th November 2017 by a senior ecologist. All forest remnants were systematically traversed by foot, with survey of scattered trees, dams and paddocks undertaken via random meander on foot or slowly driving in a 4WD over the area.

Weather conditions are summarised in Table 2:

Table 2: Weather data during survey

Date	Min/Max. Temp °C	Rain (24 hours)	Max. wind and direction
10/11/2017	10.3 – 24.4	0 mm	33 km / h Easterly
16/11/2017	11.6 – 26.9	0 mm	41 km / h North-easterly

2.2.2 Vegetation

2.2.2.1 Vegetation community identification

Existing vegetation community mapping for the site (OEH 2013) was reviewed prior to planning fieldwork. This mapping only covered the larger remnants on site within the open paddocks and small patches of native vegetation unmapped.

Consequently, the field survey consisted of the following:

- Preliminary desktop stratification of remnant vegetation via review of aerial photographs based on OEH (2013), topography and condition.
- Field traverses of preliminary vegetation polygons to verify floristics, structure and condition. As the remnant vegetation is limited in extent and the majority of the site is largely pasture, the Random Meander technique documented by Cropper (1993) was used across the study site in general, to document the flora species present, including those of conservation significance, and the location and extent of vegetation communities.

A total of 12 hours was spent on this activity.

The floristic information was used to correlate the site vegetation with VIS-Classification (OEH 2017c) database (<http://www.environment.nsw.gov.au/research/Visclassification.htm>) to identify the Plant Community Types (PCTs).

2.2.2.2 Threatened Ecological Communities

Threatened Ecological Communities (TECs) listed under the Commonwealth EPBC Act and / or NSW BC Act were assessed for presence on site via correlation of the floristic and structural characteristics of the site vegetation, as well as factors such as topography and soil landscapes, with the diagnostic criteria of the TEC listings.

2.2.2.3 Threatened species and Endangered Populations

The database review determined that eight threatened species and one Endangered Population have been recorded in the locality, with most clustered in remnant vegetation in the North Nowra and Bomaderry areas (OEH 2017a).

A targeted survey for threatened plants detectable at this time of year of the surveys was made of all major remnants of vegetation, and the riparian zones of Abernethy's Creek and the main tributaries where native vegetation had not been reduced to pasture with scattered trees.

Survey of the intact and modified dry sclerophyll patches consisted of an ecologist walking belt-transects 5-10 m apart (depending on density of undergrowth such as lantana), covering all potential habitat.

Survey of the riparian zones consisted of walking both sides of the watercourse and inspecting all remnant native riparian vegetation. *Syzygium paniculatum* was the primary target of this survey. All major dams were also checked via inspecting the edges to confirm that no threatened aquatic plants were present.

A total of 8 hours was spent on targeted flora surveys.

2.2.2.4 Weed density assessment

To provide a preliminary benchmark of the condition of the E2 zones, and hence an indication of their recovery potential and level of management required, a rapid assessment was undertaken using a Braun-Blanquet (Wikum and Shanholtzer 1978) methodology. This simple methodology assigns total weed cover (in terms of projected foliage cover) over a sample area to a series of classes.

This scale was based on visual assessment of exotic plant cover within 20 x 20 m quadrats scored to the following percentage intervals:

- <5% cover: very high condition
- >5–24%: high condition
- >25-49 %; moderate condition
- >50–74%: low condition
- >75–100%: very low condition

The stratum with the highest score was used to characterise the area of vegetation. Plot locations were selected to enable condition continuums to be identified i.e. to show where condition varied along the mostly linear E2 zones.

2.2.2.5 Nomenclature

Most of the plant species names in this report are the current names published in the Flora of NSW (Harden 1990-1993). The taxonomic names have been supplemented with common names obtained from various sources. The scientific and conservation significance of individual plant species was established with reference to Briggs and Leigh (1996) and the EPBC Act in the national context; and to the TSC Act in the state context.

2.2.3 Fauna survey

The range of fauna survey techniques used was limited due to the following:

- Almost all remnant native vegetation will be retained within the E2 zones.
- The site and study area has long been used for pastoralism, and native vegetation is limited to small remnants with at best poor connectivity to other habitats. This marginal connectivity plus extreme edge effects is a major constraint on biodiversity (Lindenmayer and Fisher 2006).
- The majority of hollow-bearing trees which are likely to be used by threatened fauna are retained within E2 zones.

Consequently, fauna survey for this assessment included:

- Incidental direct observations during the survey.
- Secondary evidence detected via incidental observation and targeted searches.
- Habitat analysis via inspection of the site.
- Habitat evaluation and potential occurrence assessment.

2.2.3.1 Habitat analysis

Fauna occurrence is influenced by vegetation type, physiognomy and *in situ* substrates, as well as disturbance history and connectivity (DEC 2004, Lindenmayer and Fisher 2006, Davey 1984, Recher et al 1995, Barret et al 1994, Watson et al 2003, etc.), and hence an analysis of habitat components can indicate habitat quality and support value, and thus likely fauna assemblages.

A habitat assessment also has a key role in predicting threatened fauna likely to occur in the study area, which is required to be undertaken for the associated statutory assessments and address the limitations of ecological surveys (DECC 2007, DEC 2004).

The habitat components targeted for census include the type of vegetation present, the presence/absence of rock habitats, tree hollows, ponds, streams, wetlands, foraging substrates and other features likely to attract threatened fauna.

The site and immediate surrounds within accessible portions of the study area were searched to identify habitat components, which were recorded and described.

2.2.3.2 Diurnal opportunistic surveys

Opportunistic fauna surveys involved observations of animal activity during the survey period. Birds were surveyed by direct observation or call detection during incidental encounter, stopping to actively listen/search for birds where dense undergrowth was encountered, and active inspection of dams, tree hollows and dense foliage for roosting birds e.g. owls.

Any reptiles encountered were identified by sight or captured and photographed for identification via references. Frogs calling at the time were also identified by reference to a call library / professional knowledge.

This information provided short-term data on fauna occurrences in the area for the particular season (DEC 2004).

2.2.3.3 Secondary evidence

Secondary evidence surveys primarily consisted of searching tree crowns for potential nests (e.g. of raptors), inspecting the entrances around dens for scats, bones and tracks (as well as distinctive odours).

Targeted scat searches were also undertaken under the few Koala food trees on site. The trunks of hollow-bearing trees were inspected for scratches which may indicate use, and large hollows and dense canopies were inspected with binoculars to potentially detect roosting owls.

2.2.4 Potential occurrence assessment

As per DECC (2007), threatened flora and fauna are considered for potential to occur based on the following:

- Local records.
- Regional distribution.
- Preferred habitat and ecology.
- Site/study area habitat (condition, carrying capacity, extent and connectivity).
- Disturbance history, recovery actions and threats.

The assessment is provided in **Appendix A**.

Five categories for the likelihood of occurrence of species are used in this report, as defined below:

- “yes” = the species was or has been observed on the subject land and/or study area.
- “likely” = a medium to high probability that a species uses the study area or immediate surrounds due to suitable habitat, connectivity and local records.
- “possible” = some suitable habitat (often a remnant or degraded area) for a species occurs on the site and/or study area but is insufficient to meet the species needs for more than short term opportunistic foraging or marginal fringe of home range; or is very degraded/disturbed often with high levels of threat, and hence likelihood of occurrence is thus low.
- “unlikely” = a very low to unlikely probability that a species uses the study area or immediate surrounds due to habitat condition, threats, poor connectivity and/or lack of habitat suitability.
- “no” = habitat within the study area or immediate surrounds is completely unsuitable for the species.

Those species with potential to occur are required to be subject to impact assessment in section 6.

2.2.5 Survey limitations

The total flora species list of an area is usually much greater than can be detected in such a short time and it can be influenced by factors such as: size of the property, fire history, time since disturbance, life cycle stage/dormancy (particularly orchids and annuals), and presence of reproductive material (DEC 2004). The fauna detected during the survey period are a guide to the native fauna present but are by

no means a definitive list of all the species occurring in the study area given the limited survey techniques used and expended time.

Targeted surveys for some orchids was limited by survey timing (e.g. *Genoplesium baueri*), however survey occurred in early January which coincided with known flowering of *Cryptostylis hunteriana* (reference sites in Callala recorded flower in January). As detailed in **section 3.4.3** and **Appendix 1**, other cryptic orchids recorded in the SCC LGA are not considered likely potential occurrences hence seasonal survey is not considered a limitation.

Overall, given the objectives of the assessment, the techniques used in this investigation are considered adequate and relevant to gather the data necessary to adequately assess the impacts of the future development on threatened flora and their habitat; and the identified limitations are offset by objectively considering the potential for species to occur when suitable habitat, connectivity, local records, etc., occur, as per DEC (2004) and applying the Principle of Uncertainty where data is limited.

Nevertheless, the techniques used in this investigation are considered adequate to gather the data necessary to identify potential ecological constraints to the proposal; and the identified limitations are offset by objectively considering the potential for species to occur when suitable habitat, connectivity, local records, etc., occur, as per DEC (2004).

3 Existing environment

3.1 Current landuses

The majority of the URA has been previously cleared for agricultural use. The site currently comprises large rural landholdings and smaller lifestyle allotments, generally with each containing a single dwelling plus farm and outbuildings. Cows, horses and alpaca were observed on a number of properties during the field survey.

Existing infrastructure within the URA includes three key roads: Moss Vale Rd provides access to the URA from the southern side, while Bells Lane runs north – south through the site and Abernethy's Lane runs east – west within the site. There is no sewerage or water infrastructure present, apart from private systems associated with each landholding.

An electrical reticulation network services the existing dwellings via large high-voltage transmission lines with an associated easement, which run north – south across the south-east corner of the site. A section of the high-pressure Eastern Gas Pipeline (EGP) and an associated easement cross the site in the same alignment.

3.1.1 SLEP Zoning

As shown in **Figure 2**, four zonings occur within the URA. Not all of the land within the URA is zoned R1, General Residential, for urban use. The lands along the watercourses which traverse east – west and north – south are zoned E2, Environmental Conservation; while small blocks of RE1, Public Recreation, and B1, Neighbourhood Centre, occur in the southern half of the URA. The objectives and permissible uses of each zone are detailed in Table 3.

Table 3: Land zonings which occur in the URA

Zone	Objectives	Permissible uses with consent	Approx. area in URA
R1 General Residential	To provide for the housing needs of the community; to provide for a variety of housing types and densities; to enable other land uses that provide facilities or services to meet the day to day needs of residents.	Home occupations*, attached dwellings, boarding houses, community facilities, dwelling houses, neighbourhood shops, residential flat buildings, seniors housing	159 Ha
B1 Neighbourhood Centre	To provide a range of small-scale retail, business and community uses that serve the needs of people who live or work in the surrounding neighbourhood.	Business premises, centre-based childcare facilities, community facilities, medical centres, neighbourhood shops, shop top housing	2.3 Ha
B7 Business Park	To provide a range of office and light industrial uses; to encourage employment opportunities; and to enable other land uses that provide facilities or services to meet the day to day needs of workers in the area.	Building identification signs; Bulky goods premises; Business identification signs; Child care centres; Garden centres; Hardware and building supplies; Kiosks; Light industries; Markets;	5.68 Ha

Zone	Objectives	Permissible uses with consent	Approx. area in URA
		Neighbourhood shops; Office premises; Passenger transport facilities; Respite day care centres; Roads; Warehouse or distribution centres	
RE1 Public Recreation	To enable land to be used for public open space or recreational purposes; to provide a range of recreational settings and activities and compatible land uses; to protect and enhance the environment for recreational purposes.	Kiosks, recreation centres	2.6 Ha
E2 Environmental Conservation	To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values; to prevent development that could destroy, damage or otherwise have an adverse effect on those values.	Aquaculture; bed and breakfast accommodation; boat sheds; dwelling houses; eco-tourist facilities; emergency services facilities; environmental facilities; environmental protection works; home businesses; recreation areas; research stations; roads; sewerage systems; water recreation structures; water supply systems	97 Ha

* denotes use permissible without consent

3.2 Physical attributes

3.2.1 Topography

The site falls over land broadly described as undulating, with a broad amphitheatre rising from Abernethy's Creek which joined by a smaller tributary, runs west to east across the central part of the URA. Elevation ranges from RL20 m AHD in the south-east rising to RL50 in the south near Moss Vale Rd, and up to RL70m in the north-west corner which rises to the Cambewarra Range.

Numerous dams have been established on the site, ranging from a few hundred square metres, to a dam about 1.8 ha which is largely included in an E2 zone.

Abernethy's Creek and a number of other minor watercourses on site are also subject to 1:100 ARI, and these areas are largely encapsulated in the E2 zones.

3.2.2 Geology and soils

The underlying geology of the site is Palaeozoic Berry siltstone, which dominates the soil landscapes above the floodplain. Hazelton (1992) maps the derived soils as the Coolangatta erosional soil landscape at the 1:100 000 scale. These soils range from lithosols on crests and upper slopes to brown earths mid slope, down to red and yellow podzolics on lower slopes and in drainage lines.

Hazelton maps the floodplain as the Shoalhaven fluvial soil landscape. Soils across this landscape vary widely with local geomorphology and interfaces with other landscapes. Prairie soils dominate levees of larger watercourses, with yellow and red podzolics on terraces. True alluvial soils and gleyed podzolic (Potential Acid Sulfate Soils) occur on the floodplain.

Hashimoto and Troedson (2008) map soil landscapes at the 1:25 000 scale as follows (see **Figure 3**):

- Qap: Quaternary undifferentiated floodplain, associated with Abernethy's Creek and its higher order tributaries.
- Qpat: Pleistocene alluvial terrace which dominates the north-east of the site.

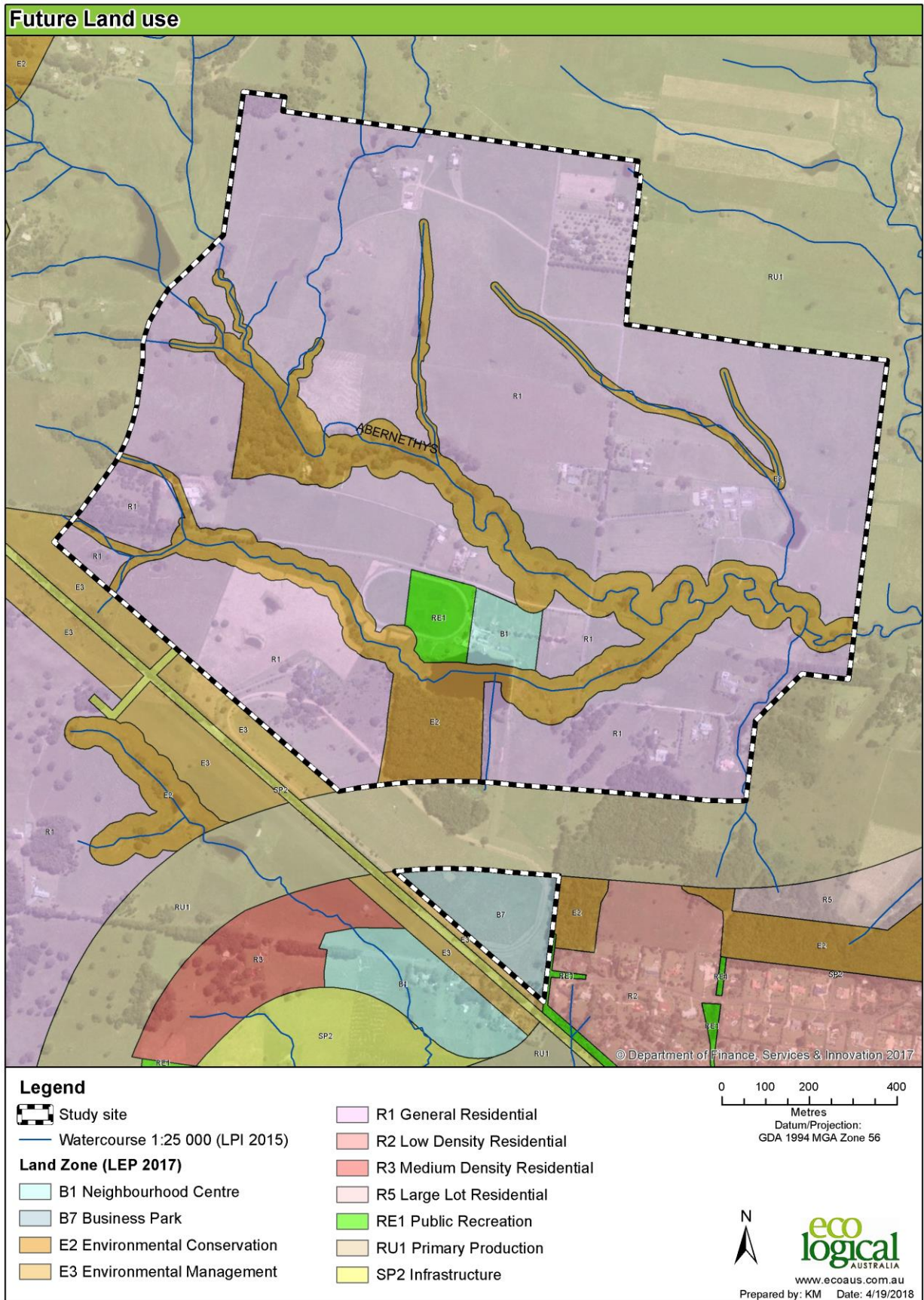


Figure 2: SCC LEP zoning of the site

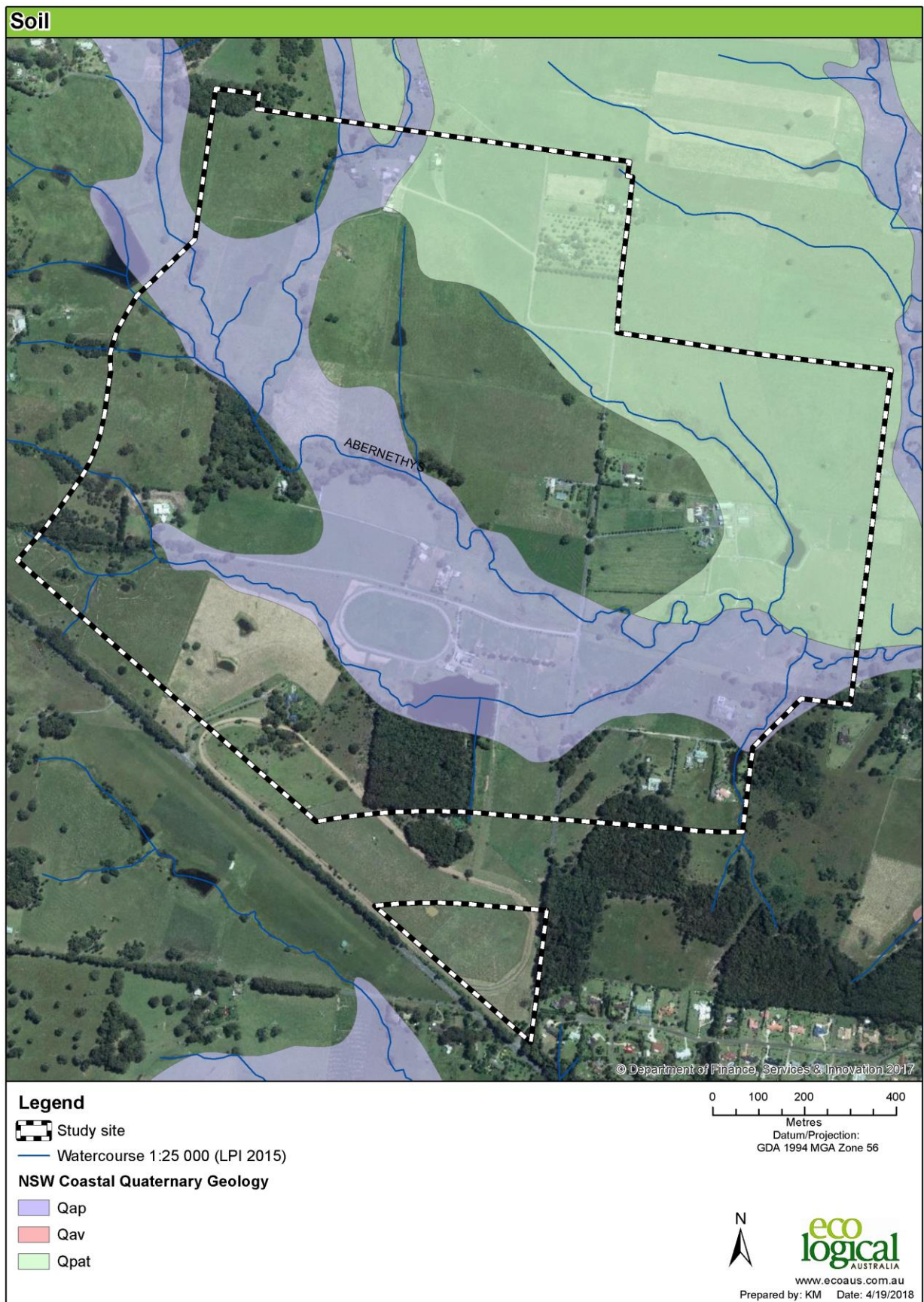


Figure 3: Quaternary soil landscape mapping

3.2.3 Fire history

The remnant vegetation on site shows no signs of fire for well over 10-20 years e.g. no charcoal. The development of mesophylllic undergrowth in several remnants further indicated this very low fire frequency.

Despite this, fuels loads are generally not significant in part due to the structure and floristics of the vegetation, grazing pressure and limited size of the remnants.

This lack of fire may have also contributed to changes in floristics and structure (e.g. lack of disturbance regimes preferred by some species, and lack of germination triggers for others).

3.3 Wetlands

3.3.1 Groundwater Dependiant Ecosystems

Groundwater Dependent Ecosystems (GDEs) are defined as: *'Ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater.'* (Kuginis et al 2012).

Therefore, GDEs include any ecosystem that uses groundwater at any time or for any duration in order to maintain its composition and condition. This dependence on groundwater however can be variable, ranging from partial and infrequent dependence i.e. seasonal or episodic; to total (entire/obligate), continual dependence (Kuginis et al 2012). It should be noted however that the demarcation between groundwater dependent terrestrial vegetation, wetlands and base-flow dependent systems can be difficult, with the three community types often representing a continuum of habitat (Kuginis et al 2012).

GDEs occur in almost every environment across the landscape including terrestrial dry land, freshwater, marine and subterranean environments. Groundwater dependent vegetation and wetlands on the coastal plains in the study area can include paperbark swamp forests and woodlands distributed across coastal dunes and floodplains, swamp heaths and swamp sclerophyll forests and woodlands, swamp scrubs and heaths that occur on coastal dunes and swampy areas and swamp shrublands (Kuginis et al 2012).

A desktop search was conducted via the Atlas of Groundwater Dependent Ecosystems (<http://www.bom.gov.au/water/groundwater/gde/map.shtml>). This database records known occurrences of GDEs.

No aquatic or subterranean GDEs are mapped within the site (Figure 5 and Figure 6). Three areas of mostly moderate potential terrestrial GDEs are modelled to occur within the study site (Figure 6). Terrestrial GDEs are terrestrial ecosystems dependent on the subsurface presence of groundwater accessed by the plant roots.

The nature of the mapping limits site interpretation, however correlation with Figure 6 suggests the lower areas correlate with the Spotted Gum forest on Lot 4 DP268209, which is not a true GDE vegetation type. The upper area shown as a GDE roughly correlates with vegetation along Abernethy's Creek, which includes riparian vegetation which would be a true terrestrial GDE.

3.3.2 SEPP 14 Coastal Wetlands

There are no SEPP 14 Coastal Wetlands on the site.

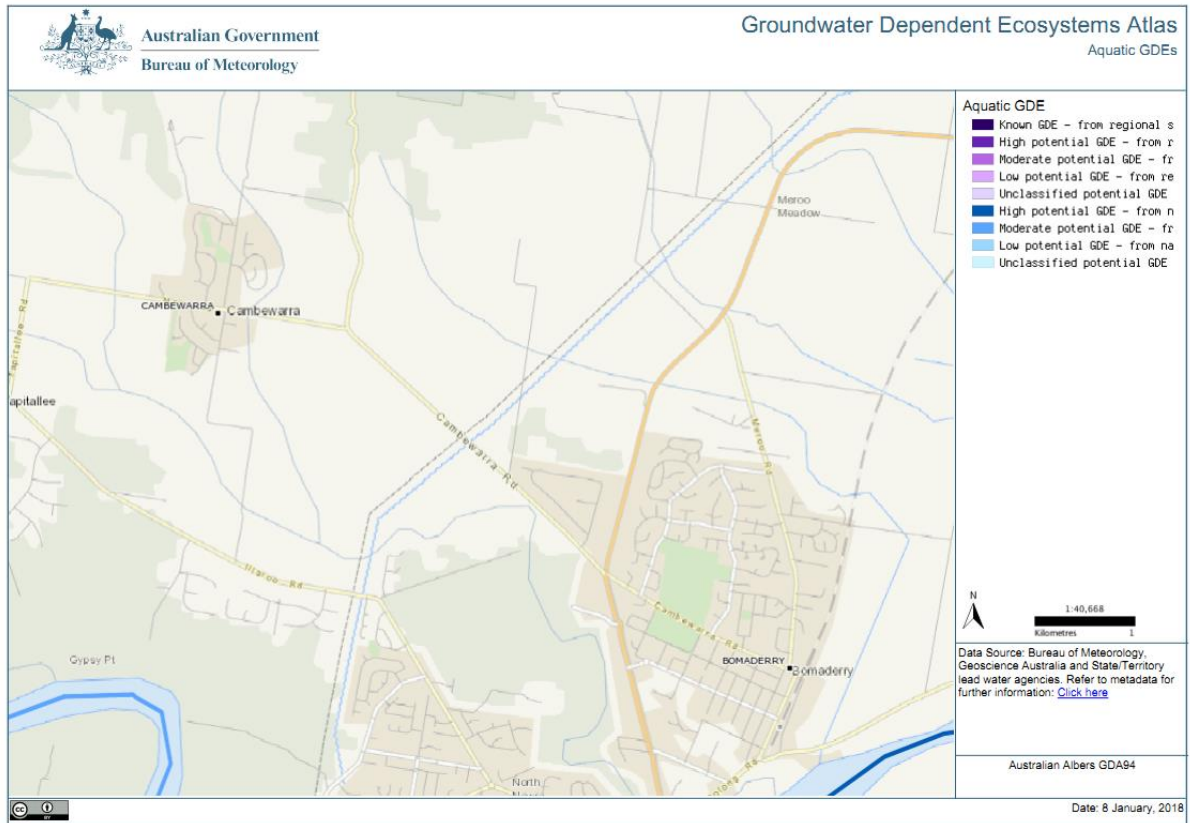


Figure 4: Local aquatic Groundwater Dependent Ecosystems

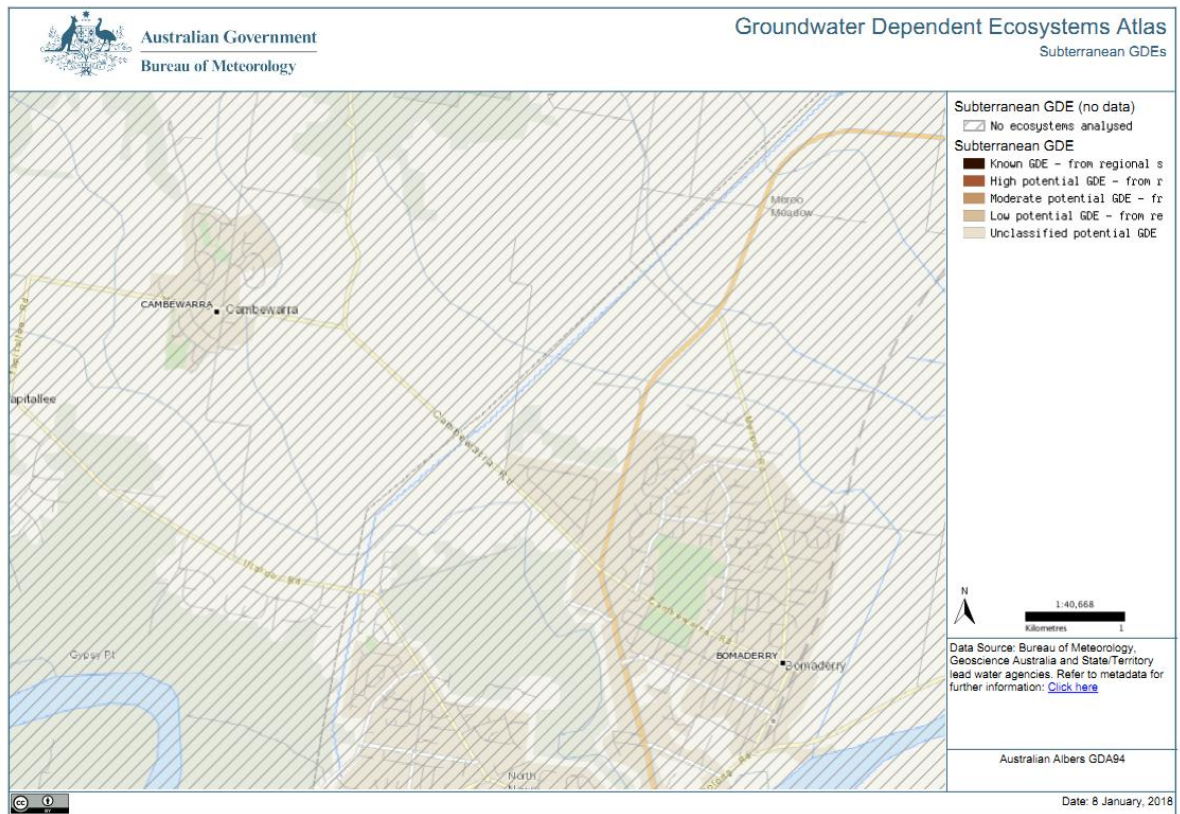


Figure 5: Local subterranean Groundwater Dependent Ecosystems

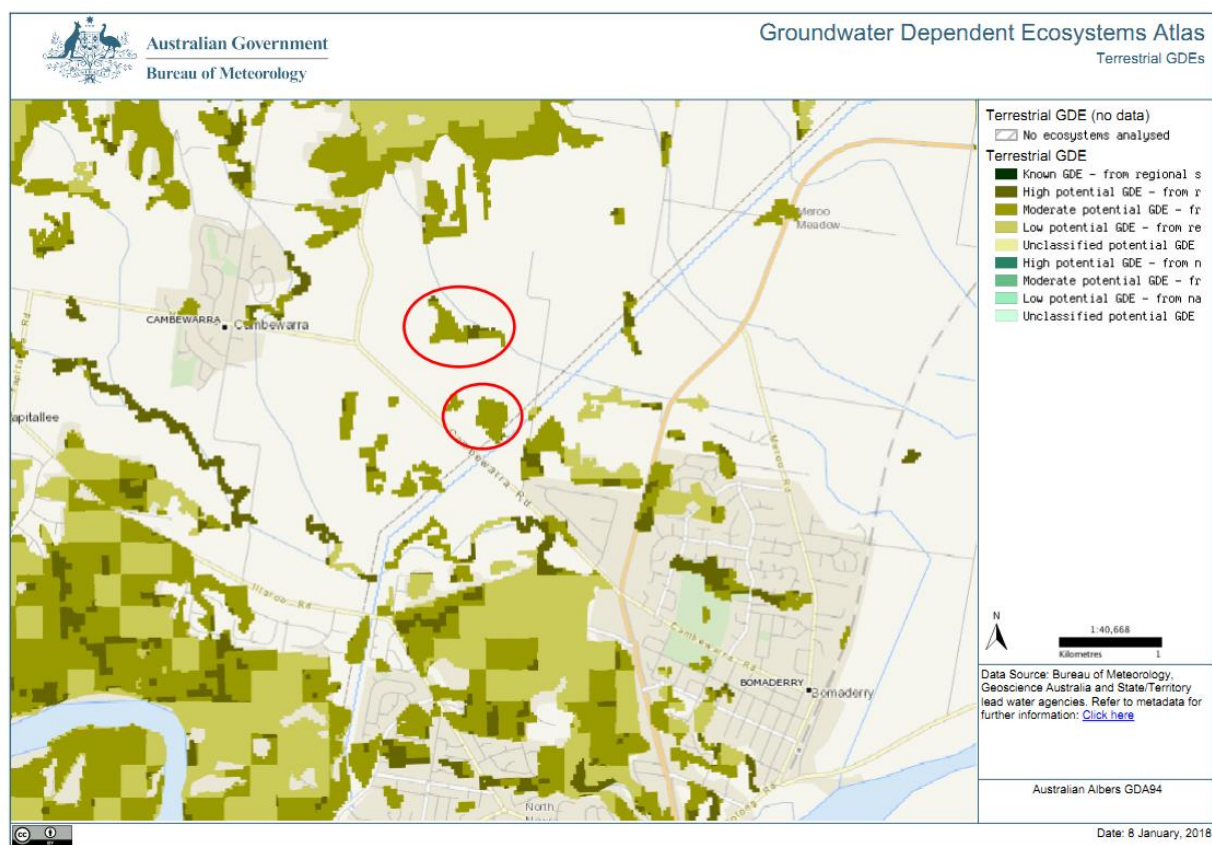


Figure 6: Local terrestrial Groundwater Dependent Ecosystems

3.4 Flora

3.4.1 Vegetation communities of the site

The site vegetation communities in term of distribution, floristics and condition reflect the long-term use of the area for pastoralism. All vegetation remnants contain a simplified assemblage of the original native ecosystems, often dominated by regrowth.

Historically the land appears likely to have been largely dominated by PCT 1206 (Table 4) with Spotted Gum being the dominant canopy tree, with canopy associates and undergrowth varying with edaphics. The riparian zones have been highly degraded, with the original associations likely to have been a transition of PCT 1245 *Sydney Blue Gum x Bangalay - Lilly Pilly moist forest*, via a wet sclerophyll forest/rainforest/ecotone, to a swamp forest community, based on remnant species present and occurrence of PCTs in similar situations in the locality.

A description of the vegetation communities confirmed during the field survey are detailed in the tables on the following pages, and their extent shown in Figure 7:

- 1206 *Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion* (Table 4)
- 1245 *Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion* (Table 5)
- Pasture / Agricultural woodland / Ornamentals / Lawns (Table 6)
- Aquatic vegetation (Table 7)

3.4.1.1 PCT 1206 Spotted Gum – Blackbutt shrubby open forest

Table 4: PCT 1206 on site

PCT	1206 Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin Bioregion and northern South East Corner Bioregion
Biometric	SR641 Spotted Gum - Blackbutt shrubby open forest on the coastal foothills, southern Sydney Basin and northern South East Corner
Location	<p>Found on Berry siltstone (readily visible in creek cuttings in the upper section of Abernethy's Creek), originally covered the property aside from alluvial areas. Now limited to the few intact and modified remnants on site. Represented by scattered remnant trees within elements of groundcover and small patches comprising a handful of trees in the pastoral area.</p> <p>Occurs on hill crests to footslopes, and in first order streams.</p>
Description	<p>(a) Canopy:</p> <p>Dominated by <i>Corymbia maculata</i> (Spotted Gum) with less common associates <i>Eucalyptus paniculata</i> subsp. <i>paniculata</i> (Grey Ironbark), <i>E. globoidea</i> (White Stringybark) and <i>E. saligna</i> (Sydney Blue Gum). <i>E. pilularis</i> (Blackbutt) occurs very rarely.</p> <p>Structure is very tall open forest 20-28 m high. The canopy generally consisted of even-aged immature regrowth trees with a mix of mature to senescent trees, with crowns separate and Projected Foliage Cover (PFC) of 50-80%. Diameter at Breast Height (DBH) ranged from 30-120 cm.</p> <p>The intact stands in central and south-eastern Lot 4 DP268209 are characterised by predominantly even-aged regrowth 30-40 years old, although the western remnant has numerous senescent trees and stags. The small regrowth stand at the western end of Abernethy's Lane has a line of near senescent trees in the Crown Rd, surrounded by young regrowth. The modified stand in the corner of Lot 4 DP 708356 / Lot 1 DP 1191186 is predominantly senescent trees with very little recruitment. The stand in the north-west corner of Lot 1 DP1191186 is predominantly immature regrowth.</p> <p>(b) Understorey:</p> <p>Varies if fenced off or accessible by cattle.</p> <p>In the two intact remnants on Lot 4 DP268209, this stratum is generally 5-10 m tall and dominated by a small tree layer of Spotted Gum 5-20 m high with about 50 % PFC. <i>Syncarpia glomulifera</i> (Turpentine) and <i>Melaleuca styphelioides</i> occur rarely – the latter on the footslope. <i>Acacia binervia</i> and <i>Pittosporum undulatum</i> may also be locally common as small trees comprising recent regrowth. A number of young common pioneer rainforest species may also occur in low abundance.</p> <p>In the medium condition area on Lot 4 around the western and southern side of the dwelling, this stratum is patchy regrowth with about 30 % PFC. Most common species are young Spotted Gum and Turpentine, as well as juvenile White Stringybark.</p> <p>In the disturbed remnants (particularly Lot 4 DP708356 / Lot 1 DP 1191186), this stratum (if present) consists of suppressed or some young Spotted Gum and Turpentine, with some common rainforest pioneers subject to grazing impacts.</p>

(c) Shrub Layer:

Varies if fenced off or accessible by cattle. Cattle graze anything edible and hence affect floristics and structure, as most evident on Lot 1.

In the main remnant east of the dwelling Lot 4 DP268209, this stratum is very patchy, with 0-50% PFC, and height 0.5-4m high. Dominated by *P. undulatum*, *Acacia longifolia*, *A. binervia*, and *Bursaria spinosa* (Blackthorn), with patches of *Pittosporum multiflorum* (Orangethorn) and *Daviesia ulicifolia*. This layer is well developed in the south-east remnant on Lot 4 and in the strip within the unformed section of west Abernethy's Lane.

In the medium condition area on Lot 4 DP268209 around the western and southern side of the dwelling, this stratum is well developed with 50-60% PFC. Dominant species are *Daviesia ulicifolia* with young canopy species and Turpentine, *Acacia binervia*, *Exocarpos cupressiformis* (Cherry Ballart), *A. longifolia*, *Acacia mearnsii* (Black Wattle), *Pittosporum undulatum*, *P. revolutum* (Rough Pittosporum), *Pimelia stricta*, and *Melaleuca styphelioides*.

In the disturbed forest in the corner of Lot 4 DP708356 / Lot 1 DP 1191186 and in the north-west remnant on Lot 1 DP1191186, this stratum is largely absent or dominated by *Lantana camara* (Lantana*), with scattered or patches of *Bursaria spinosa* and scattered *P. undulatum*.

(d) Groundcover:

Varies if fenced off or accessible by cattle.

In the intact remnants on Lot 4 DP268209, the groundcover is very sparse with PFC ranging from 0-50%. *Entolasia stricta* is dominant, with *E. marginata*, *Lomandra longifolia*, *Dianella caerulea*, *Pratia purpescens* (Whiteroot), *Microlaena stipoides* (Weeping Grass), *L. longifolia* and *Lepidosperma concavum*.

The medium condition area in the corner of Lot 4 DP708356 / Lot 1 DP 1191186 is dominated by *E. marginata* with *E. stricta* with *Aristidia vagans*, *Centella asiatica* (Gotu Kola), *Themedia australis* (Kangaroo Grass), Weeping Grass, Whiteroot, *Lomandra multiflora*, and the same common weeds as the disturbed areas.

In areas exposed to grazing on Lot 1, this stratum is maintained very low by grazing and has a high weed content. Cover ranges from 30 – 90 % with some areas being bare earth or covered in leaf litter. Dominant species in the disturbed remnants on Lot 1 comprise Weeping Grass, Gotu Kola, *Plantago lanceolata* (Plantago*), *Sida rhombifolia* (Paddies Lucerne*), *Hypochaeris radicata* (Catsear*), Whiteroot, *Bidens pilosa* (Cobblers Tack*), *Sporobolus africanus* (Parramatta Grass*), *Senecio madagascariensis* (Fireweed*) and *Lolium perenne* (Common Ryegrass*).

	<p>(e) Lianas, scramblers:</p> <p>Varies if fenced off or accessible by cattle.</p> <p><i>Marsdenia rostrata</i> is typically the dominant climber, dominating the shrub layer and groundcover over most of the intact remnant on Lot 4 DP268209. <i>Parsonsia straminea</i> (Monkey Rope) is also common and is particularly locally common with <i>Marsdenia rostrata</i> in the unformed upper end of Abernethy's Lane. <i>Pandora pandoreana</i> (Wonga Wonga Vine) is also common, often in juvenile form. Other common scramblers are <i>Desmodium varians</i>, <i>Tylophora barbata</i>, <i>Glycine clandestina</i>, <i>Geitonoplesium cymosum</i> (Scrambling Lily) and <i>Eustrephus latifolius</i> (Wombat Berry).</p> <p>Scramblers are rare to absent in grazed areas and the medium condition area in the corner of Lot 4 DP708356 / Lot 1 DP 1191186, consisting of <i>Tylophora barbata</i>, <i>Geitonoplesium cymosum</i>, <i>Desmodium varians</i>, <i>Glycine clandestina</i>, and Wombat Berry.</p> <p>(f) Epiphytes and mistletoe:</p> <p>No epiphytes. Mistletoe (<i>Amyema</i> spp.) only noted in the disturbed remnant in southern side of Lot 1.</p>
Condition	<p>Varies with access by cattle as detailed above. Weed content is limited to the edges generally, with the medium condition stand in the corner of Lot 4 DP708356 / Lot 1 DP 1191186 having a high weed content in the groundcover. Lantana is the key weed (see section 3.4.2).</p>
Comments	<p>OEH (2013) map the remnants as PCT 1212 Spotted Gum - Grey Ironbark - Woollybutt grassy open forest on coastal flats, southern Sydney Basin Bioregion and South East Corner Bioregion to 694 Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin or 1079 Red Bloodwood - Blackbutt - Spotted Gum shrubby open forest on coastal foothills, southern Sydney Basin. These other PCTs have common elements to PCT 1206, but the site lacks Woollybutt and Bangalay, and Red Bloodwood is very rare; and the least disturbed remnants demonstrate the shrubby mesophyllic undergrowth characteristic of this PCT.</p>

3.4.1.2 PCT 1245 Sydney Blue Gum x Bangalay – Lilly Pilly moist forest

Table 5: PCT 1245 in the site riparian zones

PCT	1245 Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion.
Biometric	SR652 Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin.
Distribution	This PCT appears likely to have once dominated the riparian zones and probably the floodplains overall, perhaps with a variable ecotone with PCT 1232 Swamp Oak floodplain swamp forest, Sydney Basin Bioregion and South East Corner Bioregion or PCT 1231 Swamp Mahogany swamp sclerophyll forest on coastal lowlands of the Sydney Basin Bioregion and South East Corner Bioregion; but is now only present as extremely simplistic remnant vegetation comprising a narrow fragmented ribbon along Abernethy's Creek, down to single trees with limited native groundcover, and very small remnant patches and single trees on the floodplain.
Description	<p>(a) Canopy:</p> <p>Along Abernethy's Creek, this community has previously been largely cleared with regrowth dominated by <i>Melaleuca styphelioides</i> (Prickly Paperbark), with <i>Glochidion ferdinandi</i> (Cheese Tree), <i>Syzygium smithii</i> (Brush Cherry), <i>S. australe</i> (Lilly Pilly) and <i>Melia azedarach</i> (White Cedar) the other most common species now present. In upper sections, some young Spotted Gum occur where the stream width is very narrow. The top of banks is dominated by Spotted Gum with rare Grey Ironbark. Sydney Blue Gum or Sydney Blue Gum x Bangalay hybrid are more common in remnants in the south-east. Turpentine also occurs rarely.</p> <p>Structure is very tall open forest 12-25 m high. The canopy generally and consisted of even-aged trees to a mix of mature to senescent trees, with crowns separate and Projected Foliage Cover (PFC) of 0-80%. Diameter at Breast Height (DBH) ranged from 30-120 cm, with senescent trees occasional.</p>
	<p>(b) Understorey:</p> <p>Varies with position. Most often restricted to the top of banks where retained as line of trees. Most often present in complete absence of canopy.</p> <p>In the more intact sections in upper Abernethy's Creek, generally consists of a few younger Spotted Gum and Prickly Paperbark, altering to <i>Ficus coronata</i> (Sandpaper Fig), with Sweet Pittosporum, Cheese Tree, Brush Cherry, <i>S. australe</i> and <i>Melia azedarach</i> as clumps or scattered trees. A few <i>Livistona australis</i> (Cabbage Palms) and infrequent <i>Cryptocarya glaucescens</i> (Jackwood) occur in lower remnant sections. Height ranges from 5-10 m.</p> <p><i>Salix babylonica</i> (Weeping Willow*) is common in lower sections of Abernethy's Creek and its northern tributary.</p>

	<p>(c) Shrub Layer:</p> <p>In the main section along Abernethy Creek, is largely absent or dominated by Lantana and patches of <i>Rubus fruticosus</i> (Blackberry), with scattered or patches of Blackthorn, Sandpaper Fig and scattered pioneer rainforest species such as Sweet Pittosporum and Cheese Tree.</p>
	<p>(d) Groundcover:</p> <p>Sparse under dense cover or in lantana, ranging to pasture and weed species, to small patches dominated by wetland plants.</p> <p>Almost all of mid and lower sections having been cleared, are dominated by <i>Pennisetum clandestinum</i> (Kikuyu*). Aside from this, wetland plants generally dominate the lower portions of the creek and channel where the understorey is open or absent. Native species most common are <i>Carex appressa</i> (Tussock Sedge), <i>Juncus usitatus</i>, <i>Carex fascicularis</i> (Tassel Sedge), <i>Sagittaria platyphylla</i> (Slender Arrow-head*), <i>Typha orientalis</i>, <i>T. domingensis</i>, <i>Eleocharis sphacelata</i>, <i>Ranaculus inundatus</i> (River Buttercup), <i>Ludwigia peploides</i>, <i>Persicaria decipiens</i> and <i>P. strigosa</i>. Patches of <i>Zantedeschia aethiopica</i> (Arum Lily*) also occur in Abernethy's Creek.</p>
	<p>(e) Lianas, scramblers:</p> <p>Patchy, with <i>Pandora pandoreana</i> forming some dense cover over remnant patches of the rainforest understorey. At times <i>Tylophora barbata</i>, <i>Glycine clandestina</i>, and Wombat Berry occur.</p>
	<p>(f) Epiphytes: Absent.</p>
Condition	No key weeds but Slender Arrow-head is widespread. Arum Lily and Willows are subject to a general Biosecurity Duty under the <i>Biosecurity Act 2015</i> .
Comments	This PCT has been largely cleared with only very degraded remnants remaining. Floristic diversity is very simple.

3.4.1.3 Pasture / Agricultural woodland / Ornamentals / Lawns

Table 6: Pasture

PCT	Pasture - Highly degraded forms of PCT 1206 and 1245 and possibly other PCTs, reduced to non-viable single trees or > 50 % cover of exotic species in groundcover.
Distribution	Dominates the study site outside of the intact and semi-intact riparian zones and wet sclerophyll forest remnants. Includes ornamental plantings of trees to groundcovers in yards around dwellings and along the lanes.
Description	<p>(a) Canopy / understorey:</p> <p>In paddocks, consists of remnant Spotted Gums, very rarely other species such as White Stringybark, Sydney Blue Gum and Grey Ironbark.</p> <p>In riparian zones, comprises Prickly-leaved Paperbarks and Weeping Willow may occur. In a highly disturbed drainage line west of the dwelling on Lot 1 DP1191186, a patch of White Cedar occur in local abundance.</p> <p>Variable around dwellings. Lot 2 DP 582036 has been systematically planted with a mix of exotic ornamentals such as <i>Liquidambar styraciflua</i> (Liquid Amber*) to a line of non-indigenous <i>Eucalyptus microcorys</i> (Tallowwood). Most gardens are less densely planted or have privacy screening plantings, often of <i>Cupressus</i>* spp.</p>
	<p>(b) Shrub Layer:</p> <p>Largely absent in paddocks. Where present occurs in degraded riparian zones as lantana, Blackberry, Blackthorn and <i>Solanum</i> spp.</p> <p>Around house yards, consists of edible fruits such as lemons and peaches, a range of hedges, and various exotic ornamentals.</p>
	<p>(c) Groundcover:</p> <p>Dominated by a variable mix of Kikuyu, Parramatta Grass, Fireweed, <i>Paspalum dilatatum</i> (Common Paspalum), and a suite of common agricultural weeds with few native herbs.</p> <p>Generally, 100 % PFC, mostly maintained < 10 cm but up to 30 – 40 cm where cattle have been excluded.</p>
	(d) Lianas, scramblers: Absent
	(e) Epiphytes: Absent.
Condition	Highly modified. No or minimal recruitment of native species. Effectively considered cleared land under the Biodiversity Assessment Method.
Comments	This 'community' covers a range of habitats extremely modified by a long history of pastoralism including pasture improvement. It has no value for threatened flora but contains degraded TECs and / or their habitat. Key habitat features are hollow-bearing trees.

3.4.1.4 Miscellaneous aquatic vegetation

Table 7: Miscellaneous aquatic vegetation

PCT	Not applicable - vegetation is either in artificial habitat (i.e. dams) or is the vestiges of the original riparian community, although a distinct patch in the north-east tributary could be classed as PCT 781 Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion.
Distribution	<p>Dams and most riparian zones across the site. Where not present in a riparian zone, the original wetland vegetation has been displaced by pasture or the area is bare ground.</p> <p>When present in a riparian zone, these plants are restricted to the channel with pasture or bare ground (due to shadowing) adjacent.</p>
Description	<p>(a) Emergents:</p> <p>Dam vegetation consists of Slender Arrow-head*, <i>Typha orientalis</i>, <i>Isolepis prolifer</i>, <i>T. domingeris</i>, <i>Eleocharis sphacelata</i>, River Buttercup, <i>Juncus usitatus</i>, <i>Persicaria decipiens</i> and <i>P. strigosa</i>.</p> <p>Channels are lined with <i>Typha</i> spp. which may dominate the channel and ponds at times, Slender Arrow-head*, River Buttercup, <i>Juncus usitatus</i>, <i>Persicaria decipiens</i> and <i>P. strigosa</i>. Tussock Sedge and Tassel Sedge is common in the middle sections of Abernethy's Creek. <i>Baumea articulata</i> and <i>Isolepis prolifer</i> (Budding Clubrush) dominates a distinct sedgeland in a localised broadening of the channel in the north-east tributary, and also below the large dam</p>
	<p>(b) Floating:</p> <p>Generally, only found in pools along Abernethy's Creek. Limited to some <i>Ludwigia peploides</i> and <i>Azolla</i> spp.</p> <p>A dam adjacent to the remnant on Lot 4 DP268209 is dominated by <i>Nelumbo</i> spp. (Lotus), which must have been introduced for aesthetics.</p>
	<p>(c) Submerged:</p> <p>Limited to some <i>Potamogeton crispus</i> (Curley Pondweed) in two deep pools (possibly both excavated in-channel dams) in Abernethy's Creek.</p>
Condition	Dams on Lot 1 with cattle access are grazed with banks heavy cultivated by traffic. Several dams have no aquatic vegetation. The riparian zones with no terrestrial vegetation have native vegetation only in the deepest portions of the channel where near permanent water occurs or scouring is prevalent.
Comments	This 'community' covers a range of habitats extremely modified by a long history of pastoralism including pasture improvement. It has no value for threatened flora, but the channels contain degraded TECs and / or their habitat.

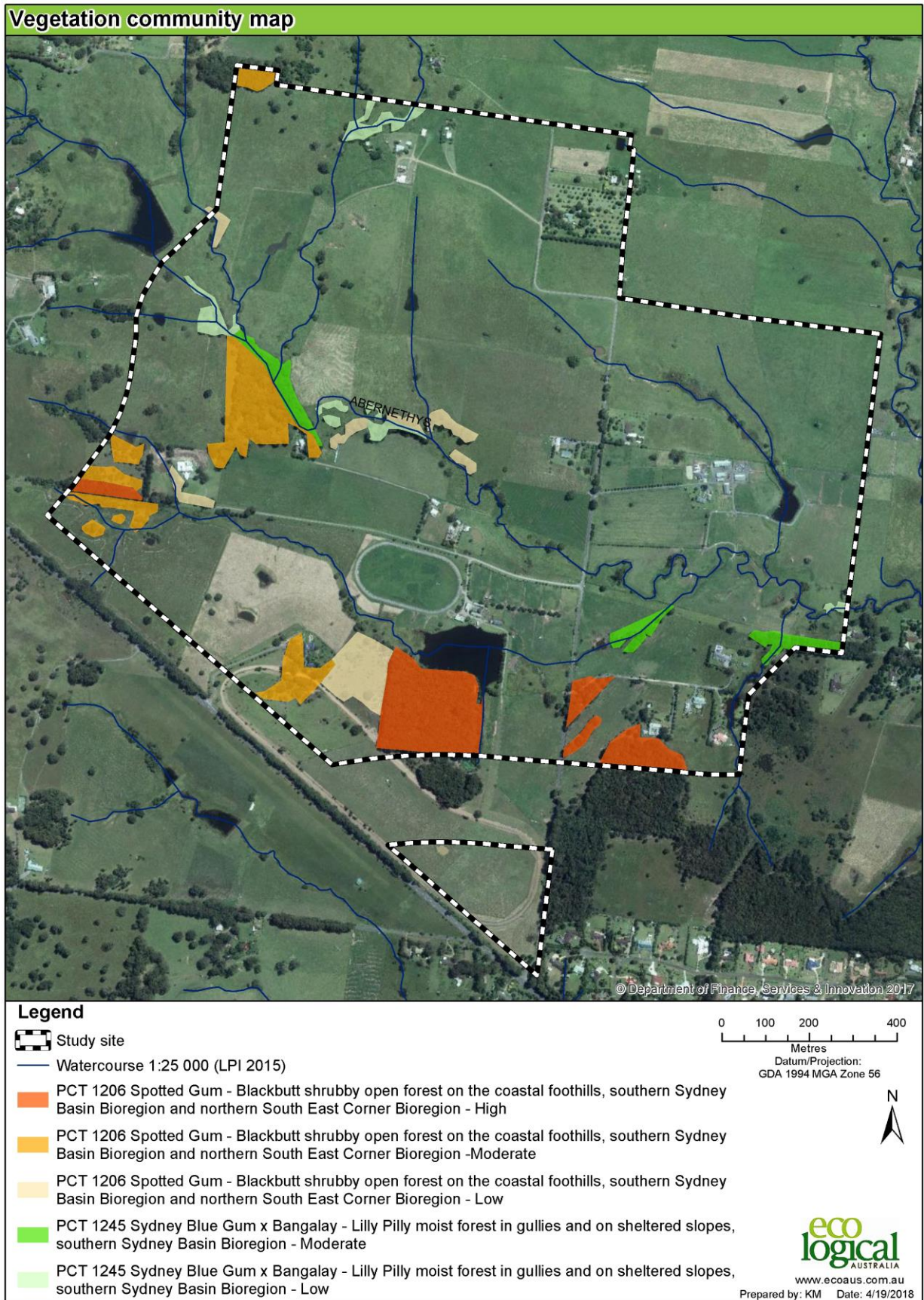


Figure 7: PCTs on the site



Photo 1: Derived parkland of PCT1206 in E2 on Lot 4 DP708356



Photo 2: PCT1206 in north-west corner of Lot 1 DP1191186



Photo 3: Upper middle section of Abernethy's Creek PCT1245



Photo 4: Patch of remnant PC1245 on Lot 4 DP268209 east of Bells Lane.



Photo 5: Example of pasture



Photo 6: Wetland within 1st order stream on Lot 7 DP618693

3.4.2 Condition and weeds

3.4.2.1 Key Weeds

The following species are listed as Weeds of National Environmental Significance (WoNS) or under the NSW *Biosecurity Act 2015* identified in the South East Regional Weed Management Plan (SELLS 2017):

Table 8: Key weeds on site

Name	WoNS	Biosecurity Act	Abundance / distribution on site	Biosecurity obligations
<i>Asparagus africanus</i> (Climbing Asparagus)	No	Yes	Small patch and some individuals in northern foot of main remnant on Lot 4 DP268209; and some plants in medium condition remnant on Lot 4 DP 708356.	General biosecurity duty. North Shoalhaven falls into core infestation area outside the exclusion zone. A person must not import into the State or sell.
<i>Ageratina riparia</i> (Mistflower)	No	Yes	Common in patches along Abernethy Creek.	General biosecurity duty to prevent, eliminate or minimise any biosecurity risk.
<i>Salix babylonica</i> (Weeping Willow*)	No	Yes	Common in lower sections of Abernethy's Creek and its northern tributary.	General biosecurity duty to prevent, eliminate or minimise any biosecurity risk.
<i>Senecio madagascariensis</i> (Fireweed)	Yes	Yes	All pasture.	General biosecurity duty. North Shoalhaven falls into core infestation area outside the exclusion zone. Species to be managed in accordance with published weed management plan.
<i>Lantana camara</i> (Lantana)	Yes	Yes	Edges of some forest remnants and riparian zones, and undergrowth of remnants where cattle have access.	General biosecurity duty. Shoalhaven falls into core infestation area outside the exclusion zone. Species to be managed in accordance with published weed management plan. A person must not import into the State or sell.
<i>Salix babylonica</i>	Yes	No	Locally common in lower Abernethy's Creek with a local stand in the north-east tributary.	General biosecurity duty. A person must not import into the State or sell.
<i>Ligustrum sinense</i>	No	Yes	Few plants in Abernethy Creek	General biosecurity duty to prevent, eliminate or

Name	WoNS	Biosecurity Act	Abundance / distribution on site	Biosecurity obligations
(Small-leaved privet)				minimise any biosecurity risk.
<i>Ligustrum lucidum</i> (Broad-leaved privet)	No	Yes	Single plant in intact remnant on Lot 4 DP268209.	General biosecurity duty to prevent, eliminate or minimise any biosecurity risk.
<i>Rubus fruticosus</i> aggregate (Blackberry)	Yes	Yes	Common along riparian zones, especially first order streams converted to pasture. Some patches up to 100 m ²	General biosecurity duty to prevent, eliminate or minimise any biosecurity risk. Subject to local management plans. A person must not import into the State or sell.
<i>Zantedeschia aethiopica</i> (Arum Lily*)	No	Yes	Middle and lower section of Abernethy's Creek.	General biosecurity duty to prevent, eliminate or minimise any biosecurity risk.

3.4.2.2 E2 zone condition assessment

The project brief required a condition assessment to be undertaken primarily to identify weed management liability of the E2 zones i.e. whether restoration to an entirely natural ecosystem could be cost prohibitive due to weed content. As detailed in **section 2.2.2.4**, a rapid assessment was undertaken using the Braun-Blanquet (Wikum and Shanholtzer 1978) methodology, with the BAM methodology potentially employed to quantify and qualify condition (if required) during future DAs.

Figure 8 shows that the overwhelming majority of the E2 zone is in very low (high content of exotic species over all strata) condition. The dominant weed is Kikuyu due to the fact most of the E2 zones along the creeks and drainage lines have been historically cleared and in part or all but the channel converted to pasture.

Key weeds such as Lantana and Blackberry are generally localised and relatively amenable to control at their current level of infestation e.g. via herbicide application including initial treatments with strategically timed follow-ups to control regrowth and recruitment. Similarly, Willows are also considered readily controlled and hence these weeds overall are not a major impediment to rehabilitation of the E2 zones.

Kikuyu however poses a challenge as it is fast growing and competes with plantings; and when rank, suppresses regeneration from seedbanks and seed dispersal. The options to control this weed include:

- Mass removal: Usually via scalping – where the upper soil horizon is removed (with the supported grass and other weeds), and the bare soil is mass planted with native plants with periodic herbicide application to control regrowth;
- Herbicide and slashing: Herbicide works best when the plant is actively growing, hence if the grass is rank, it is best slashed or burnt first, and the regrowth subject to intensive spraying to kill the plant. The dead plants are left in situ as mulch and minimise other weeds propagating, and tubestock planted to establish a rapid cover and shade out the grass and other weeds. Periodic spot spraying is required to suppress regrowth and invasion.

- Intensive spraying, intensive maintenance and mass planting: This more traditional approach and involves a series of thorough herbicide application events over several months to ensure at least 90 % die off, followed by mass planting in an attempt to shade it out. A similar method is to mow / slash close to the ground as possible after die off, followed by mass planting native overstorey, and suppressing the grass via periodic mowing or herbicide, allowing the plantings to mature and shade the weed out.

The choice of method depends on timeframes set for the rehabilitation works and milestones.



Figure 8: Braun-Blanquet condition assessment

The objectives to rehabilitate (work with ecological processes to regenerate the original vegetation community) or reconstruct (completely artificially create the vegetation community in an attempt to restore the ecological processes) the E2 will thus have to consider the resilience of the vegetation (i.e. what intrinsic capacity does the area have to regenerate with minimal intervention, and role of edge effects), the likelihood of success, and the costs of achieving that outcome (AABR 2013).

The preliminary assessment suggests that resilience is low where pasture has essentially replaced the former riparian communities, especially on the floodplains, and hence reconstruction not rehabilitation will be required here to re-establish a native ecosystem, if that is the objective. Some of these areas may be best used for other purposes consistent with the zoning e.g. public open space consisting of managed areas with landscaping based on natives but not attempting to restore the original ecosystem.

Other areas such as the E2 on Lot 4 DP68209, and the E2 on Lot 1 DP1191186 consisting of the upper middle section of Abernethy's Creek and the adjacent hill crest have demonstrated resilience and can more readily be managed to achieve conservation objectives of the LEP zoning.



Photo 7: 1st order watercourse on Lot 1 DP1191186 mapped in E2



Photo 8: Upper end of 1st order watercourse on Lot 1 DP1191186 mapped in E2



Photo 9: Typical section of mid and lower Abernethy's Creek (Lot 4 DP708356) in E2 zone

3.4.3 Threatened flora

3.4.3.1 Survey results

No threatened flora species were observed.

BioNet (2017) shows a record of *Zieria baeuerlenii* (Bomaderry Zieria) in the cleared southern end of the site from 1989. The identification is certified by the Royal Botanical Gardens, however the description refers to the habitat as a dry rocky slope on Nowra sandstone within undisturbed *Eucalyptus punctata* woodland. This record is clearly geographically inaccurate with the actual record being to the south in the known restricted habitat in Bomaderry.

3.4.3.2 Potential occurrences

Potential occurrences of locally recorded threatened flora are evaluated in **Appendix A**. The only species with some potential to occur may have been *Cryptostylis hunteriana*, however after targeted survey and considering the failure to detect even common species of orchids, this cryptic species is not considered a potential occurrence.

3.4.4 Threatened Ecological Communities

Threatened Ecological Communities (TECs) include Critically Endangered Ecology Communities (CEECs), Endangered Ecological Communities (EECs) and Vulnerable Ecological Communities (VECs) listed under the EPBC Act or TSC Act.

3.4.4.1 Commonwealth

No TECs listed under the EPBC Act occur on site.

3.4.4.2 New South Wales

PCT 1206 is not a TEC as it does not meet the floristic or habitat criteria of any Final Determination and is not recognised in the PCT database as a TEC (BioNet 2017).

PCT 1245 is not recognised as conforming to any TEC (BioNet 2017), however much of the remnant vegetation mapped as this PCT on site falls on alluvial soil landscapes. Legal precedents and the Final Determinations have clarified that all vegetation on coastal floodplains is a TEC (*Gales Holdings Pty Limited v Tweed Shire Council [2008] NSWLEC 209*, *Motorplex (Australia) Pty Limited v Port Stephens Council [2007] NSWLEC 74*).

As noted in section 3.4.1, the extent of modification of the vegetation on the floodplain is such that it is very difficult to identify the original vegetation communities, which may have been different associations than present. The PCT classification is based on the 'best fit' of the current species assemblage, hence may not indicate the original assemblage given the majority of existing vegetation is common understory to groundcover covers common to a number of communities and edaphic situations.

Presence of Flooded Gum plus Bangalay x Sydney Blue Gum hybrids on site plus rare occurrences of Forest Red Gum and *Angophora floribunda* localised to the alluvial soil landscape, plus presence of many understorey, groundcover, shrub and vine species listed in the Final Determination suggest that an intergrade form of the TECs *Riverflat Eucalypt Forest on Coastal Floodplains* and *Swamp Sclerophyll Forest on Coastal Floodplains* may have occurred depending on local relief and position in the catchment. Such intergrades are recognised in all the Final Determinations (e.g. NSWSC 2004a, 2004b).

Applying the Precautionary Principle, therefore, all areas of PCT 1245 on alluvial soil landscapes are mapped as the TEC - *Riverflat Eucalypt Forest on Coastal Floodplains*.

Currently, the only precisely definable TEC on site is *Freshwater Wetlands on Coastal Floodplains*. This TEC appears to be a derived form – occupying the central channel of the watercourses which have undoubtedly altered via erosion and sedimentation since clearing of the original vegetation. Such changes may have seen shallowing of former channels, with removal of forest allowing colonisation due to increased solar access (such plants are absent where the riparian zone is enclosed by forest and streamflow is permanent due to a rocky substrate). As detailed in **Tables 4 and 7** and shown in **Photos 6, 10 and 14**, this vegetation is generally restricted to the channel with pasture grasses and weeds dominating most of the habitat. For this reason, the TEC is mapped as low (high weed infestation, very simplistic, highly impacted by stock, low floristic diversity / structural integrity) and moderate (medium weed infestation, medium impact by stock, medium floristic diversity / structural integrity) condition.



Figure 9: TSC Act EECs on site



Photo 10: Moderate condition Freshwater Wetland EEC (Lot 7 DP618693)



Photo 11: Low condition Freshwater Wetland EEC (Lot 7 DP618693)

3.5 Terrestrial fauna

3.5.1 Fauna habitat evaluation

3.5.1.1 General

Table 9: Habitat evaluation summary

Habitat component	site	Threatened species values
Logs and debris	<p>Logs and debris are limited to a number of large logs in the intact remnant of PCT1206 on Lot 4 DP268209, which consists of a number of large collapsed stags and one recently fallen large hollow-bearing tree. Many have small to large hollows.</p> <p>Largely absent or within smaller sections with no significant hollows. No logs outside remnants.</p> <p>Limited debris in watercourses – nothing suitable for significant refugia by fauna.</p> <p>No significant debris piles in paddocks, etc.</p>	<p>Logs in the largely intact remnant of PCT1206 on Lot 4 DP268209 have generic potential as Quoll den sites but the extremely limited extent of habitat, very poor connectivity and location well east of any significant remnant of habitat which could support this species indicates unlikely to be used. Logs would provide refugia for common species of mammals, frogs and reptiles, including species important for ecosystem maintenance e.g. bandicoots.</p>
Burrowing substrate	<p>Burrows very common along Abernethy's Creek where soil is deep. Wombat burrows common where riparian vegetation provides cover.</p>	<p>No significant value as foxes likely to be present and exclude Quoll</p>
Leaf litter	<p>Limited along Abernethy's Creek.</p>	<p>No significant values for Giant Burrowing Frog or fungi-dependant fossorial species.</p>
Groundcover	<p>Maintained very low in all areas accessed by cattle in remnant vegetation, except for some degraded riparian zones where stock excluded and tall rank Kikuyu is present with some native sedges.</p> <p>Pasture maintained low by stock.</p> <p>No significant seed sources.</p>	<p>No potential for threatened rodents or small dasyurids. Small mammal diversity likely to be limited perhaps to Bush Rats and perhaps Antechinus in larger forest remnants, with House Mice and Black Rat likely to dominate small mammal niches. Likely limited abundance due to low quality habitat hence constraint on raptors.</p>
Rocky outcrops, shelves, etc.	<p>Rock walls exposed in cut-away banks along mid-section of Abernethy's Creek but no cavities.</p>	<p>No potential for Quoll den sites. Poor reptile habitat.</p>
Culverts, caves, cliffs, abandoned structures	<p>No caves or cliffs.</p> <p>Some old sheds and silos may support roosting of some microchiropteran bats.</p>	<p>No potential roosts for obligate bat species in the study area.</p>
Nectar sources	<p>Spotted Gum is most important nectar source as it flowers in winter-spring. Flooded Gum may also flower in mid-summer to mid-autumn which overlaps with Red Bloodwood, with Blackbutt flowering in summer. Turpentine flowers in spring.</p> <p><i>M. styphelioides</i> flowers in summer, but is a less significant nectar source.</p> <p>No significant banksias present. Flowering wattles provide a minor nectar source mostly for birds and gliders, as well as insect.</p>	<p>Suitable trees for Grey-headed Flying Fox and Yellow-bellied Glider. Spotted Gum is also potentially suitable for the migratory Swift Parrot.</p> <p>Periodic abundance of honeyeaters would support raptors such as Square-tailed Kites.</p> <p>Dense flowering attracting insects would also provide prey for threatened Microchiropteran bats.</p>

Habitat component	site	Threatened species values
Sap and gum sources	Red Bloodwood, Spotted Gum, Rough-barked Apple and Flooded Gum are preferred species listed in the Yellow-bellied Glider Recovery Plan (NPWS 2003). Wattles present but only <i>A. mearnsii</i> is a listed preferred gum species.	Range of potential sap sources for Yellow-bellied Gliders, but no evidence of usage by this species. Small sap incisions noted – considered likely to be Sugar Gliders which can persist in more marginal habitats compared to Squirrel and Yellow-bellied Gliders.
Koala browse species	Tallowwood and Swamp Mahogany present but appear to all be planted as ornamentals.	No evidence of Koala presence, and historically, appears unlikely to have been Potential Koala Habitat, hence Koalas unlikely to have an association with the site.
Allocasuarinas	Absent	No preferred food species for Glossy Black Cockatoo (Vulnerable – TSC Act). Considered unlikely to be used by this threatened species.
Fruiting species	Rainforest species limited to limited White Cedar Lilly Pilly, Sandpaper Fig, Five-leaf Watervine and Blueberry Ash – only low abundance and not sufficient to attract threatened frugivores.	No significant habitat for threatened rainforest pigeons. At best minor supplementary food source for Grey-headed Flying Fox.
Tree hollows and decortivating bark	<p>Figure 10 shows 137 hollow-bearing trees mapped on site. These are largely contained within the E2 zones which contain most of the remnant vegetation. Others are isolated paddock trees long left for shade for stock.</p> <p>Hollow size is predominantly small to medium, with a number of large hollows potentially suitable for large birds.</p> <p>Blackbutt and Sydney Blue Gum are the main decortivating bark species. No significant accumulations within boughs was noted. Other species flake and offer only foraging habitat for macroinvertebrates.</p>	<p>Hollows may be present that Microchiropteran bats may use for all stages of their lifecycle.</p> <p>Hollows suitable for small to medium sized birds are abundant, and are well occupied by common rosellas and lorikeets, as well as the exotic Indian Myna. Non-indigenous native birds were also noted and likely to breed on site. The likelihood of a threatened small to medium sized threatened bird breeding on site is considered low however due to competition with conspecifics and isolation from sufficient foraging habitat. Edge effects (e.g. nest predation) would also be an issue.</p> <p>Large hollows potentially of sufficient internal dimensions for forest owls and the Glossy Black Cockatoo are present. The latter is considered unlikely to breed on site due to isolation from foraging habitat. The likelihood of a large forest owl such as the Masked or Powerful Owl breeding is minimal given distance from sufficient foraging habitat and hence additional energy expense, as well as risk of nest predation by Brushtail Possums.</p>
Passerine bird habitat	Best in the intact remnant on Lot 4 DP268209 due to variety of shrub layer and open ground, with other remnants having limited shrub stratus or restricted to lantana or along riparian zone. Most of the site is however hostile to small birds due to pasture and dominance by medium sized woodland species including aggressive species i.e. Noisy Miner.	<p>Limited abundance and diversity of prey species for raptors, may increase in flowering seasons for short periods.</p> <p>No preferred habitat for grassy woodland species.</p> <p>No suitable habitat for cover dependant species e.g. Eastern Bristlebird.</p>

Habitat component	site	Threatened species values
Aquatic	<p>Constituted by dams and creeks.</p> <p>Dams range from having no aquatic or fringing vegetation to fringed with emergent macrophytes and floating aquatic plants. Water quality varied from highly turbid with suspended clay due to stock trampling, to lightly turbid and near rainwater quality. Suitable for common waterfowl and frogs.</p> <p>The riparian zones were generally highly eroded due to stock access, as evident by high levels of sedimentation and frequent bank erosion, hence deep permanent pools were all but absent – a few pools in lower Abernethy Creek surrounded by pasture, with a small in-stream dam in the mid-section. These supported fish (Plague Minnow observed) and possibly tortoise. Other areas had some channels 1-2 metres wide with water. Some riparian zones had extensive macrophytes, with the unnamed tributary in the northeast having an 'oasis' of wetland habitat which offered the best frog habitat on site via being a broad area of dense macrophytes, grading to a channel dominated by Cumbungi. Unfortunately, this 'oasis' is isolated by the downstream dam and pastoralisation of the upper and lower riparian zone, and only common pastoral woodland frogs are likely to be present.</p>	<p>No suitable habitat for threatened waterfowl such as Australian Bittern – dams too small and open; riparian zone too small.</p> <p>No significant potential for Giant Burrowing Frog – no preferred breeding habitat and refuge habitat highly modified.</p> <p>Dams not considered likely to be used by Green and Golden Bell Frog due to:</p> <ul style="list-style-type: none"> • Site is isolated by extensive pastoral land, the Princes Highway and estuarine creeks and river from known Green and Golden Bell Frog habitat. • All potential habitat is artificial, and not adjacent to natural source habitat i.e. a wetland. • Lack of overwintering habitat outside fringing habitat around some dams. • Extreme predation risk due to limited refugia and isolation of habitats. <p>The larger dams offer some potential Southern Myotis but prey potential would be limited due to low quality aquatic habitat.</p>
Estuarine, beach and rocky foreshores and headlands	Absent in study area.	Not applicable
Prey abundance and diversity	<p>Likely to be low abundance and diversity of small terrestrial mammals (e.g. rodents and Antechinus) due to historical isolation of habitat on site and limited undergrowth habitat, as well as edge effects.</p> <p>Bandicoots present as diggings were noted.</p> <p>Small common reptiles and frogs would also be present.</p> <p>Passerine bird diversity would vary with seasonal food source flows e.g. nectar, with peaks in summer with canopy and understorey flowering.</p> <p>Suitable arboreal fauna habitat for Sugar Glider and common possums, however remnant size and isolation is a key limitation on population viability – likely to have seen historical decline in diversity of arboreal species, and periodic crashes of site populations. Dispersal would be very high risk and hence site likely to be an ecological sink for such species.</p>	<p>Potential passerine bird prey species likely to be common and abundant but varying in season.</p> <p>Limited diversity of prey for owls.</p>

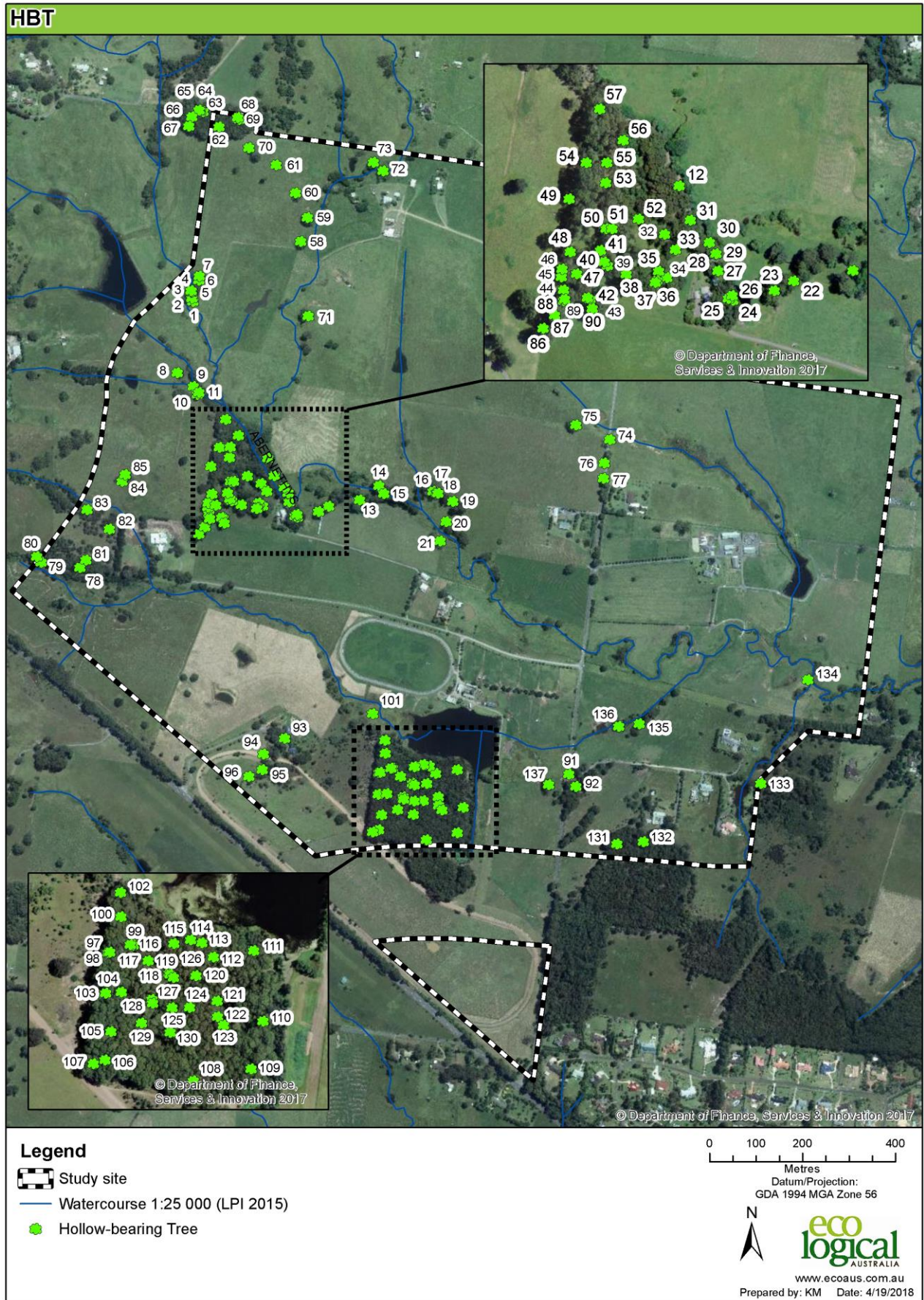


Figure 10: Hollow-bearing trees on site



Photo 12: Nest box on Lot 4 DP708356



Photo 13: Typical dam within pasture

3.5.2 Connectivity

3.5.2.1 Regional corridors

Regional corridors are typically >500m wide and provide a link between major and/or significant areas of habitat in the region. Ideally, they are of sufficient size to provide habitat in their own right and at least twice the width of the average home range area of fauna species identified as likely to use the corridor (Scotts 2002).

Corridors of this magnitude occur west of the study area in remnant forest largely within conservation reserves and State Forests, falling over rugged terrain unsuitable for pastoralism. The latter has seen clearing of native vegetation from the floodplains and footslopes east and southwest of Cambewarra Mountain; and north of Cambewarra Mountain in the Kangaroo Valley.

Thus, while there is very good connectivity at the landscape scale to the western hinterland, there is minimal hinterland to coastal connectivity north of the Shoalhaven River, and limited connectivity north-east from Cambewarra Mountain to Barren Grounds. Populations of non-flying species in reserves near the coast (e.g. Yellow-bellied Glider) are thus isolated and extremely vulnerable to catastrophic extinction.

In this context, the site does not play any role in a regional corridor context.

3.5.2.2 Local corridors and habitat links

Local corridors provide connections between remnant patches of habitat and landscape features. Due to their relatively small area and width (they may be <50m), these corridors are subject to edge effects (Scotts 2002, Lindenmayer and Fisher 2006). Habitat links are evaluated in this report as links from habitat on-site directly to similar habitat on adjacent land. These would be used by fauna, which depend solely or at least partially on the site for all of their lifecycle requirements, and/or dispersal (Lindenmayer and Fisher 2006).

Portions of the site has some local corridor values, but in general none of these provide critical links between major source habitats to maintain biodiversity at the landscape scale.

The remnant and largely modified riparian and adjoining largely modified wet sclerophyll forests along Abernethy's Creek are generally a very low quality local corridor, with linkage reduced in the upper and lower limits to single scattered trees for arboreal species, and the stream channel with limited native aquatic vegetation (especially upstream where pools only occur after rain). Connectivity is only sufficient for very mobile and habitat generalist species.

The best local corridor occurs in the south-east where an irregular shaped remnant of forest just protrudes onto the site, but mostly occurs on adjoining land. This remnant (about 20 ha west of Princes Highway) is the largest remnant in the study area and tentatively links to a series of smaller remnants east of the highway. It also has a very tentative connection via vegetation in the road reserve along Moss Vale Rd and then a narrow band of riparian vegetation along Bomaderry Creek to Bomaderry Creek Regional Park to the south. Due to the limited size of the remnant, very poor connectivity to other major remnants, very high edge to volume ratio and associated impacts of edge effects, this corridor is of limited value other than to habitat generalists and highly mobile fauna.

The network of riparian zones over the site and study area offers at best a marginal corridor for frogs due to the historical clearing of the landscape including virtually all of the lower riparian zones and conversion to improved pasture. Cover is extremely limited in all but the 3rd order streams, where some channels are thickly lined with Cumbungi and have a series of pools. The central north-east tributary has the best

development of this vegetation, interlinking the large dam at the junction with a 1st order stream to the small distinct wetland upstream. While the locally recorded Green and Golden Bell Frog has been recorded moving across broadly similar landscapes after major breeding events such as that which occurred over 2010 to 2014 (Daly 2014), the site is > 10 km west from known habitat and separated by both Broughton Creek (estuarine), the Princes Highway, and an even more intensively modified (cropping land) landscape. Given this and lack of likely source habitat on site (the large dams comprise the largest extent of permanent habitat), it is very unlikely that a population of this endangered frog could be present.

3.5.3 Detected fauna species

The following table (Table 10) lists all fauna detected by the survey:

Table 10: Fauna detected by the survey

Class	Scientific name	Common name	Legal Status
Birds	<i>Ardea ibis</i>	Cattle Egret	Protected
	<i>Sturnus vulgaris</i>	*Common Starling	Exotic
	<i>Eolophus roseicapillus</i>	Galah	Protected
	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	Protected
	<i>Anas castanea</i>	Chestnut Teal	Protected
	<i>Ardea cinerea</i>	Grey Heron	Protected
	<i>Anas superciliosa</i>	Pacific Black Duck	Protected
	<i>Chenonetta jubata</i>	Australian Wood Duck	Protected
	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	Protected
	<i>Platycercus elegans</i>	Crimson Rosella	Protected
	<i>Platycercus eximius</i>	Eastern Rosella	Protected
	<i>Alisterus scapularis</i>	Australian King Parrot	Protected
	<i>Eudynamys orientalis</i>	Common Koel	Protected
	<i>Eurystomus orientalis</i>	Oriental Dollarbird	Protected
	<i>Manorina melanocephala</i>	Noisy Miner	Protected
	<i>Acridotheres tristis</i>	*Indian Myna	Exotic
	<i>Cracticus torquatus</i>	Grey Butcherbird	Protected
	<i>Acrocephalus australis</i>	Australian Reed Warbler	Protected
	<i>Gymnorhina tibicen</i>	Australian Magpie	Protected
	<i>Corvus coronoides</i>	Australian Raven	Protected
	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	Protected
	<i>Hirundo neoxena</i>	Welcome Swallow	Protected
	<i>Zosterops lateralis</i>	Silvereye	Protected
	<i>Rhipidura leucophrys</i>	Willie Wagtail	Protected

Class	Scientific name	Common name	Legal Status
	<i>Grallina cyanoleuca</i>	Australian Magpie-lark	Protected
	<i>Malurus cyaneus</i>	Superb Fairy-wren	Protected
	<i>Anhinga novaehollandiae</i>	Australasian Darter	Protected
Amphibians	<i>Crinia signifera</i>	Common Eastern Froglet	Protected
	<i>Litoria fallax</i>	Dwarf Tree Frog	Protected
Reptiles	<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	Protected
	<i>Chelodina longicollis</i>	Eastern Long-necked Turtle	Protected
	<i>Physignathus lesueurii</i>	Eastern Water Dragon	Protected
	<i>Lampropholis delicata</i>	Grass Skink	Protected
	<i>Eulamprus quoyii</i>	Eastern Water Skink	Protected
Mammals	<i>Vombatus ursinus</i>	Common Wombat	Protected
	<i>Macropus giganteus</i>	Eastern Grey Kangaroo	Protected
	<i>Wallabia bicolor</i>	Swamp Wallaby	Protected
	<i>Trichosurus vulpecula</i>	Common Brushtail Possum	Protected
	<i>Vulpes vulpes</i>	*Red Fox	Exotic
	<i>Lepus europaeus</i>	*European Hare	Exotic

3.5.4 Known significant fauna

No threatened fauna were detected by this survey.

3.5.5 Potentially occurring significant fauna

3.5.5.1 EPBC Act

All threatened and migratory fauna recorded or predicted to occur in the locality (excluding marine mammals, reptiles and birds due to lack of habitat in the study area) were reviewed for potential to occur in **Appendix A**. This review determined the following threatened and migratory species may potentially occur in the study area due to suitable habitat.

- Critically Endangered: *Lathamus discolor* (Swift Parrot).
- Vulnerable species: *Pteropus poliocephalus* (Grey-headed Flying Fox).
- Migratory birds: *Hirundapus caudacutus* (White-throated Needletail), *Myiagra cyanoleuca* (Satin Flycatcher).

3.5.5.2 BC Act

All threatened fauna (excluding marine mammals, reptiles and birds) recorded or predicted to occur in the locality were reviewed for potential to occur in **Appendix A** as per DECC (2007) requirements.

This review determined that 13 threatened fauna species listed under the BC Act may potentially occur in the study area due to suitable habitat on the site and in the study area. The following table summarises where they may occur, and the significance of the site habitats.

Table 11: Potentially occurring threatened fauna

Name	Potential habitats	Usage / Significance
Eastern Bent-wing Bat	Forest remnants and larger derived woodland remnants	Foraging seasonally around main remnants. Potential for short term non-breeding roosts in hollow-bearing trees.
Eastern False Pipistrelle	Forest remnants and larger derived woodland remnants	Foraging seasonally for around main remnants. Potential for roosts in hollow-bearing trees.
East-coast Freetail Bat	Forest remnants and larger derived woodland remnants	Foraging seasonally for around main remnants. Potential for roosts in hollow-bearing trees.
Gang-gang Cockatoo	Forest habitats – specifically the patches of PCT1206.	Generic foraging habitat in intact forest remnants. Potential nesting hollows but likely subject to high competition.
Greater Broad-nosed Bat	Forest remnants and larger derived woodland remnants	Foraging seasonally for around main remnants. Potential for roosts in hollow-bearing trees.
Grey-headed Flying Fox	All areas with nectar producing trees.	Foraging only, when flowering occurs, using site as minute part of seasonally variable range.
Masked Owl	Forest remnants and larger derived woodland remnants	Foraging around main remnants. Unlikely to nest.
Powerful Owl	Forest remnants and larger derived woodland remnants	Foraging around main remnants. Unlikely to nest.
Southern Myotis	Roosts in tree hollows and foraging over dams.	Potential to regularly use large dams on site and tree hollows for roosting.
Square-tailed Kite	Forest and derived woodland habitats.	Mostly marginal potential foraging habitat as limited prey abundance and diversity.
Swift Parrot	Forest and derived woodland habitats.	Low chance of rare visitation during non-breeding migration.
Varied Sittella	Forest remnants.	Likely only as dispersing birds as forest remnants are poorly connected to other remnants and insufficient in size to maintain a viable population.
Yellow-bellied Sheath-tail Bat	Forest remnants and larger derived woodland remnants	Foraging seasonally around main remnants. Potential for roosts in hollow-bearing trees.

3.6 Fisheries and aquatic habitat

3.6.1 Watercourse characteristics

As detailed in section 3.2.1 and shown in **Figure 2**, Abernethy's Creek is the dominant watercourse on site, comprising a 3rd order stream, with the three tributaries (south-west, south-east and north-east) on site being 2nd order streams. Other 2nd order streams link off the study area to the north-west off Lot 1 DP1191186.

In the 3rd order stream (Abernethy's Creek), the streambank width varies from two to three metres top of bank to top of bank with steeply incised banks, to 10-30 m top of bank (mid-section west of Bells Lane). The channel is generally well defined and often aggraded (especially the upper mid-section which cuts under the bedrock of the adjacent hill), one to three metres deep and one to twenty metres wide (it braids into two channels around a small island near the existing dwelling on Lot 4 DP708356). There are deep and / or broad pools sporadically from near the north-west limits to its exit off-site, but these are most common from just below high energy section just upstream of the dwelling on Lot 1 DP1191186. Pools increase in depth and frequency within about 50 m west of Bells Lane, with several deep, small pools with tentative connection via a series of incised channels and localised scour pools (latter appear permanent due to depth). An in-stream dam with a pumping station provides the largest pool on Lot 4 DP708356.

Aside from shortly after local rainfall events, the creek is ephemeral only and subject to short term high velocity flood flows. Water quality appears to be good with low to medium turbidity due to fine clay suspensions, but clarity is sufficient to allow diatomic algae, benthic algae and submerged aquatic plants to prosper within the pools from the mid-section down. The substrate varies from bedrock and gravel in the upper mid-section where it cuts a steep slope of the adjacent hill on Lot 1 DP1191186, to soil in the mid and lower reaches and the uppermost reaches.

The north-east tributary on Lot 7 DP618693 has very deeply incised banks along most of its middle and upper length until Bells Rd, and the substrate is soil only. Water is present only in the mid-section above the large dam which dominates this stream. Above the dam is a well-defined, but heavily vegetated channel about two metres wide, which links to a localised broad, shallow wetland that was probably originally a deep pool, subsequently infilled with sediment and now an in-stream wetland. Water here is shallow and low quality due to high levels of decaying organic matter (i.e. highly tannin stained, indications of low dissolved oxygen and low pH, very high bacterial levels) but this may be due to lack of recent rainfall, with conditions improving with flushing.

The south-west tributary which falls on Lot 4 DP268209 has a channel with variable definition, from a near deltaic like structure below the largest dam on the property which bisects this watercourse, to a well-defined channel in its lower and middle to upper middle length. Above the dam, the channel is generally shallow (<30 cm) and about one to three metres wide, and heavily vegetated with grasses and / or sedges. Water at the time of the survey was limited to a few centimetres and appeared highly tannin stained, and probably had an acid pH due to decaying organic matter. The large dam which bisects this watercourse is permanent but had a very high turbidity and hence low clarity. Submerged plants were not noted and floating plants were very limited. Depth is at least 1.5-2 m judging by the height of the dam wall.

All other watercourses on site are dry with no pools, apart from the upper limit of the 2nd order tributary in the north-northwest, which has a deep scour, possibly excavated, near the northern boundary. This pool was highly turbid with very high levels of suspended clay, hence algae growth was minimal, but lack of bacterial surface scum or blue-green algae suggested good water quality otherwise. Some deep scours

occur in this watercourse but all were dry at time of survey and with poor channel connectivity, are unlikely to support native fish.

3.6.2 Aquatic habitat values

As detailed above, Abernethy's Creek has the best habitat for fish in addition to macroinvertebrates due to the presence of a number of pools and some channels which appear to be near permanent.

The pools in all streams are however small: a few square metres, hence carrying capacity is a severe constraint on the diversity of fish which may be present. The large instream dam on the south-west tributary could support the greatest diversity of fish.

A targeted survey was not undertaken, but the exotic pest species *Gambusia affinis* (Plague Minnow) were observed in the two in-stream dams and several pools. Macroinvertebrates are most likely to be constituted by aquatic stages of insect larvae.

3.6.3 Fisheries habitat classifications

3.6.3.1 Freshwater fish community status

NSW DPI Fisheries (DPIF) have assessed and mapped fisheries habitat in NSW in terms of freshwater fish community status, which is a rating of the condition in terms of expectedness, nativeness and recruitment. Communities were rated over a spectrum of very good to very poor (Riches et al 2016).

The expectedness indicator is the proportion of native species now found compared to the historical assemblage. Nativeness refers to the proportion of native versus alien fish species found. Recruitment represents the recent reproductive activity of the native fish community within each altitude zone.

The 3rd order stream component of Abernethy's Creek up to the junction with the 2nd order stream in the north-west as 'fair' in term of freshwater fish community status, as shown in **Figure 11**.

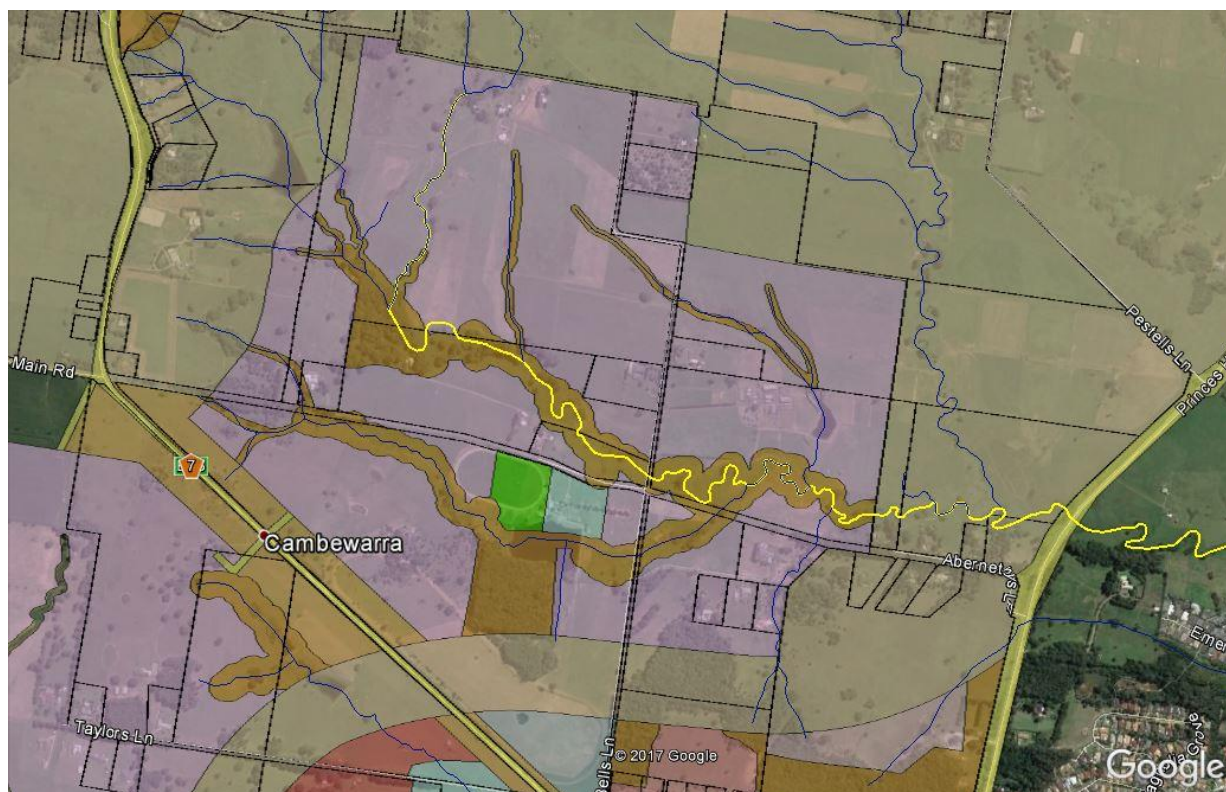


Figure 11: DPIF freshwater fish community status

3.6.3.2 Key fish habitat

DPIF have defined 'key fish habitats' (KFH) as habitats crucial to the survival of native fish stocks. This definition includes marine, estuarine and freshwater habitats, but excludes artificial aquatic habitats and natural waterways which are predominantly dry or otherwise have limited habitat value (Fairfull 2013).

Under the guidelines, Abernethy's Creek would probably qualify as a Type 1 highly sensitive key fish habitat, although it has only a limited area of gravel beds, but most of the channel has native aquatic plants. The key 2nd order tributaries in the north-east and south-west have some elements of Type 1 habitat in lower to mid sections to Type 2 moderately sensitive key fish habitat, with Type 3 in the upper sections. All 1st order and the 2nd order in the north-west would be Type 3 minimally sensitive key fish habitat.

3.6.3.3 Waterway classification

Freshwater and brackish waterways are also classified in terms of functionality of the watercourse (Fairfull 2013). In NSW, the type of crossing needed for a waterway is decided by the waterway class.

Waterway class is determined by factors that include hydraulic geometry, frequency of stream flow, presence of aquatic habitat, presence of threatened species, and connection to adjacent aquatic habitats. Under the classification system used by NSW DPI, Abernathys Creek would be defined as a Class 2 waterway. Class 2 waterways have the following characteristics:

'Non-permanently flowing (intermittent) stream, creek or waterway (generally named' with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Freshwater aquatic vegetation is present. Type 1 and 2 habitats present.' Fairfull 2013- Policy and Guideline for fish habitat conservation and management.

The lower reaches of second order tributaries may also qualify as Class 2 habitat (ELA 2018) but the upper reaches of these, and the remainder of the waterways on site are Class 3 or Class 4 waterways because they flow only after rain and have ill-defined channels.

A number of crossings currently occur over Abernethy's Creek and the main 2nd order streams. Some include culverts whereas others are causeways designed to fall under peak flows. Some may pose barriers to aquatic fauna, and they are expected to be removed as part of the future development. Preferred crossing types relative to waterway class are listed as follows (Fairfull 2013):

- Class 1: Bridge, arch structure or tunnel.
- Class 2: Bridge, arch structure, culvert or ford.
- Class 3: Culvert or ford.
- Class 4: Culvert, causeway or ford.

3.6.4 Threatened species, populations and communities

The DPIF (2018) Spatial Data Portal does not record any threatened species or population as known or likely to occur in the study area.

No Endangered Ecological Communities (EECs) listed under the Act match vegetation or aquatic habitat on site or in the study area.



Photo 14: Minor crossing in lower section of Abernethy's Creek



Photo 15: Bell's Lane crossing of Abernethy's Creek



Photo 16: Largest natural pool in lower section of Abernethy's Creek

4 Impact assessment

4.1 Direct impacts

4.1.1 Clearing

The main direct impact of the development is the clearing of native vegetation. In the absence of a detailed lot layout, and assuming that all native vegetation on land zoned B1, R1 or RE1 is to be cleared, the area of vegetation types affected will be as shown in Table 15; the area of TECs affected will be as shown in Table 16 and Figure 13; and the number of hollow-bearing trees affected will be as shown in Table 17 and Figure 12. It should be noted that the wildlife corridors/VRZs indicated in the draft masterplan (current as of March 2nd 2018) occupy a larger area than the E2 zone, and that the impacts of clearing for the proposal are therefore likely to be less than those indicated in **Tables 12-14**.

The E2 zones capture a little over half of the native vegetation present, including most of the vegetation in moderate or high condition (**Table 15**). The E2 zones also contain 76.8% of the TEC present on the site (**Table 16**), and 61% of the hollow-bearing trees (**Table 17**).

Table 12. Area of vegetation communities (ha) in each Land Zone (LZN) class

LZN Code	LZN Class	PCT 1206 Low	PCT 1206 Moderate	PCT 1206 High	PCT 1245 Low	PCT 1245 Moderate	Total
B1	Neighbourhood Centre	0	0	0	0	0	0
B7	Business Park	0	0	0	0	0	0
E2	Environmental Conservation	0.97	2.71	4.29	1.04	1.50	10.51
R1	General Residential	2.29	3.56	2.67	0.82	0.68	10.02
RE1	Public Recreation	0	0	0	0	0	0
Total		3.26	6.27	6.96	1.86	2.18	20.53

Table 13. Area of TECs (ha) in each Land Zone (LZN) class. FWCF = Freshwater Wetland on Coastal Floodplain; REFCF = River Flat Eucalypt Forest on Coastal Floodplain.

LZN Code	LZN Class	FWCF Low	FWCF Moderate	REFCF	Area (Ha)
B1	Neighbourhood Centre	0	0	0	0
B7	Business Park	0	0	0	0
E2	Environmental Conservation	2.62	0.98	2.54	6.15
R1	General Residential	0.03	0.30	1.50	1.83
RE1	Public Recreation	0.02	0	0	0.02
Total		2.68	1.28	4.04	8.01

Table 14. Number of hollow-bearing trees (HBT) in each Land Zone (LZN) class.

LZN Code	LZN Class	HBT
B1	Neighbourhood Centre	0
B7	Business Park	0
E2	Environmental Conservation	84
R1	General Residential	46
Total		137

4.1.2 Mortality during clearing

Clearing operations could result in the injury or death of animals sheltering in the vegetation to be cleared; this applies particularly to any animals sheltering in tree hollows during clearing.

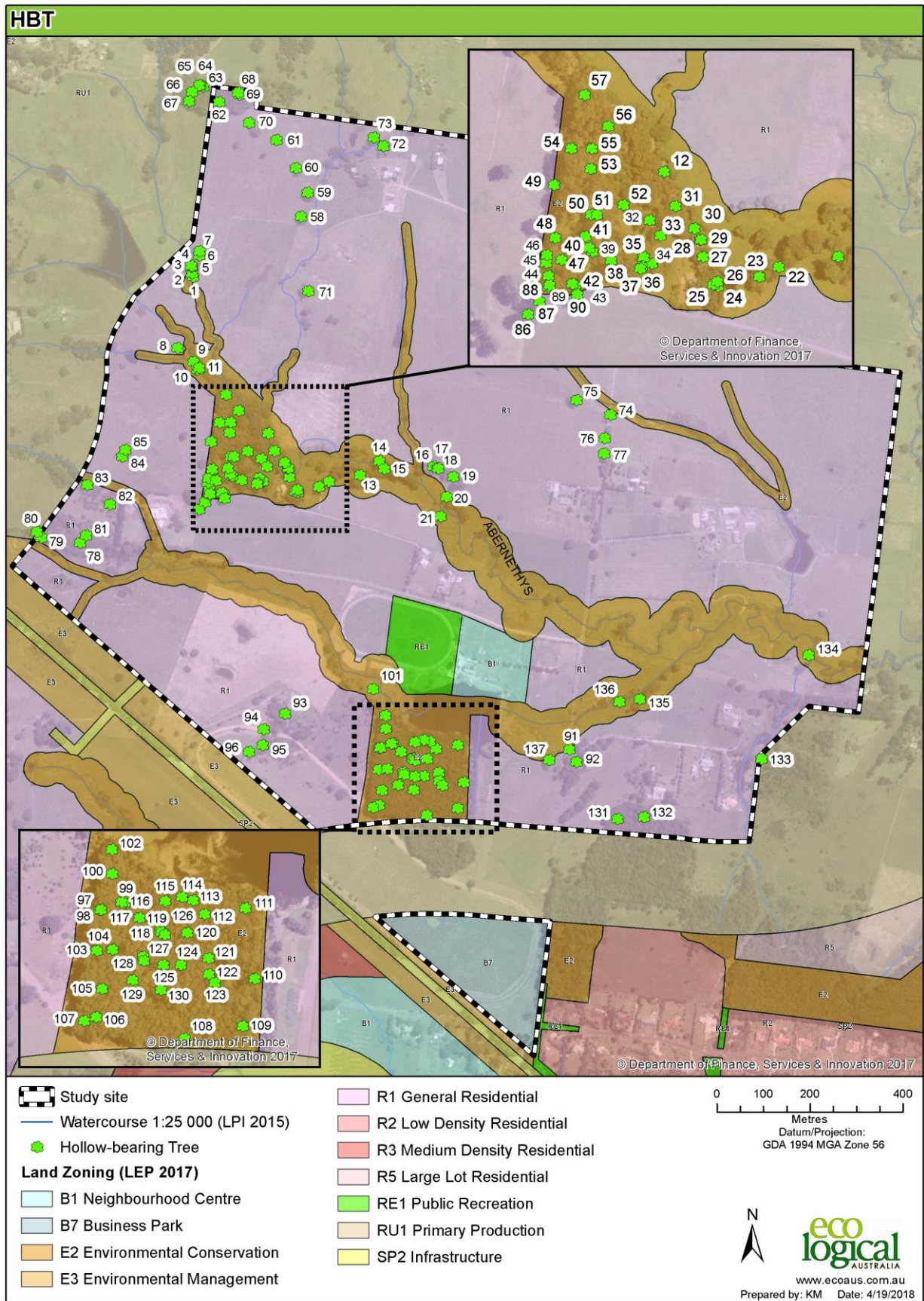


Figure 12: LEP zonings and hollow-bearing trees

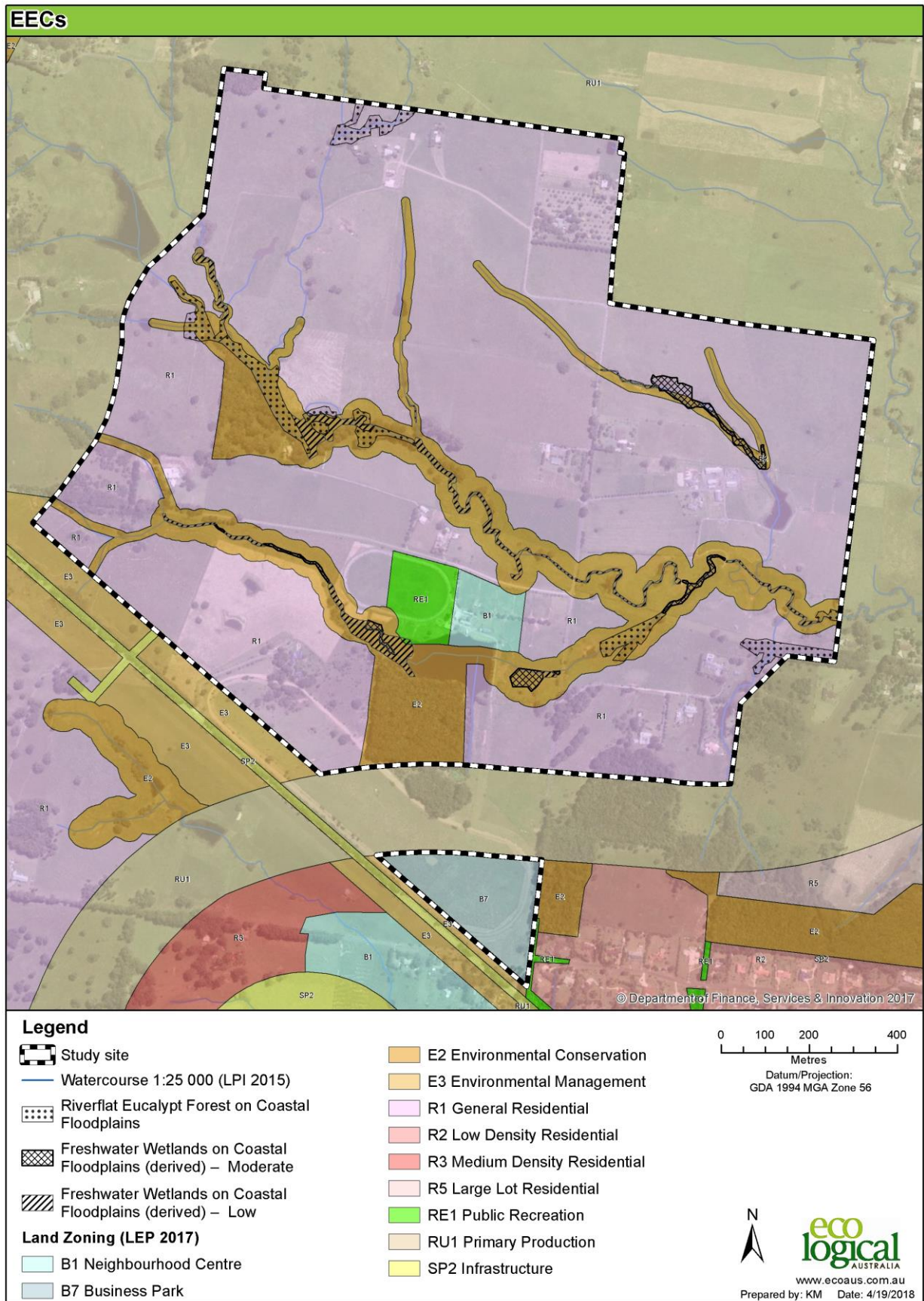


Figure 13: LEP zonings and EECs

4.1 Indirect impacts

The proposed action could have the following indirect impacts:

4.1.1 Changes to hydrological regimes

The conversion of an agricultural landscape to residential, with the replacement of pasture by impervious surfaces such as concrete and tarmac, has the potential to alter hydrological regimes at, and downstream of the site. In particular, the infiltration of water into watercourses after rain is likely to be faster, leading to higher, shorter peaks and greater variation in flow. Given the highly modified nature of Abernethy Creek downstream, changes to hydrological regimes are unlikely to have a major impact on native flora or fauna.

4.1.2 Fragmentation

The small amount of native vegetation to be cleared, together with the conversion of an agricultural landscape into a residential one, could result in some habitat fragmentation, whereby areas of native vegetation decline in value due to decreasing area and/or increasing isolation from other habitat. The consolidation of green space in the E2 zones, together with the revegetation of VRZs along watercourses, should mean that the proposed action will result in only minor fragmentation, or even an increase in habitat connectivity across the landscape.

4.1.3 Erosion and sedimentation

The exposure of bare soil during construction, and long-term changes to run-off patterns associated with the conversion of an agricultural landscape into a residential one, could result in increased erosion and sedimentation at, and downstream of, the site.

4.1.4 Anthropogenic disturbance (noise, lighting etc.)

Anthropogenic disturbance such as noise and lighting have potential to impact on fauna during construction and operation of the development. Given the site's location in an agricultural landscape, with several roads nearby, the animals using the site are likely to have some tolerance of noise and light.

4.1.5 Introduction of weeds

The development has the potential to introduce weeds to the site, on vehicle tyres or machinery, or through garden plantings during the operational phase. Given the prevalence of exotic species across the site, this impact is unlikely to be major.

4.1.6 Introduction of diseases

The development has the potential to introduce diseases to the site, during both construction and operational phases. The main concerns are *Phytophthora cinnamomi* and myrtle rust (both plant pathogens) and the Chytrid fungus, which is lethal to frogs.

4.1.7 Predation by domestic pets

Pets such as cats and dogs, which may be kept by future residents, may prey on wildlife at and near the site. The species most likely to be affected are terrestrial fauna, such as lizards, frogs and small mammals, and small birds that are active on or near the ground.

4.1.8 Vehicle collisions

The increase in traffic associated with the development is likely to result in an increased risk of collisions with wildlife. This risk would be greatest where roads cross wildlife corridors.

5 Mitigation measures

5.1 Avoidance and minimisation of impacts

As part of the rezoning process, it is understood that the riparian zones and remnant vegetation were considered constraints and included within E2 zones to protect these areas.

5.2 Mitigation of impacts

To further ameliorate the potential impacts of the future urban development and to improve environmental outcomes, the following recommendations for impact mitigation and amelioration are provided.

5.2.1 Masterplan design

The following general design principles are provided for the masterplan:

- Minimise vehicular crossings of the major E2 riparian zones (i.e. the central branch of Abernethy's Creek) and ensure that these crossings facilitate wildlife movement.
- Have the E2 zone separated from residences within the R1 zone by roads. The road reserve provides a setback that form part of the APZ, but also discourages impacts such as yard extensions into public reserves, dumping greenwastes, and storage of caravans and boats, which sees modification of habitat and weed infestation, etc.
- Use crossings which also function as fauna underpasses. A colony of wombats occur in Abernethy Creek, and as detailed in **section 5.2.8**, these are at high risk of vehicle strike in future development, as may macropods which are likely to occupy the riparian zones and utilise public space for grazing. Crossings of riparian zones thus should not pose a risk of being a barrier or vehicle strike risk.

5.2.2 Vegetated Riparian Zones

5.2.2.1 General provisions

Under the *Water Management (WM) Act 2000*, vegetated riparian zones (VRZs) are required to be established along all watercourses. A VRZ comprises a core riparian zone (CRZ) and a buffer zone.

The zone widths are as follows:

- 1st order stream: 10 m wide either side of channel.
- 2nd order stream: 20 m wide either side of channel.
- 3rd order stream: 30 m wide either side of channel.
- 4th order stream: 40 m wide either side of channel.

Any aspect of the development such as roads, infrastructure, asset protection zones (APZs) and recreational areas that intrudes into the outer 50 % of the VRZ requires offsetting in another portion of the VRZ, ensuring that the average width of the VRZ is achieved over the section of watercourse within the site (DPI 2012).

The VRZs have been designated in the current zoning, and these are to be revegetated in line with the WM Act guidelines.

It should be noted that a recent Flood Study and Riparian Lands Review (Rhelm 2018) demonstrates that there is a variance between the provisions of the SLEP (2014) and the updated requirements for riparian corridors under the Water Management Act, 2000.

5.2.2.2 Streams with low value for restoration

There are a number of 1st order streams and even 2nd order streams which have limited value in attempting to restore to a fully structured native vegetation community e.g. the two first order streams and adjacent part of the 2nd order in the south-west corner of Lot 4 DP268209, the 1st and 2nd order streams running north-south across Lot 1 DP1191186, and much of the north-east tributary.

These riparian zones are essentially pasture and have no or at best minimal value as fish habitat. Furthermore, with the relatively narrow width of the VRZ combined with these narrow watercourses, edge effects will largely undermine ecological values of restored native vegetation e.g. weed invasion.

Restoration of these riparian zones will thus be cost ineffective and have limited chance of reaching rehabilitation goals. Effort is best spent on focusing on the higher ecological value floodplain habitats along the watercourses with wider buffers and established channels.

5.2.3 TEC and VRZ rehabilitation

Under a Vegetation Management Plan, the following is to be undertaken:

- All key environmental weeds (see **Table 8**) are to be eliminated.
- The VRZ / E2 land which falls on alluvial soils will be revegetated as per DPI requirements. The target community will vary with edaphics, but should target the TEC – *Riverflat Eucalypt Forest on Coastal Floodplains* to a coastal floodplain rainforest community which potentially have previously existed in the riparian zones. To minimise bushfire risk and APZs, canopy species of *Eucalyptus*, *Corymbia* and *Angophora* should be planted at low density with a dense rainforest understory aimed to be established where the TEC – *Riverflat Eucalypt Forest on Coastal Floodplains* is desired.
- In localised areas where soil is prone to waterlogging and where wetland species currently predominate, this habitat is to be retained, with an ecotonal planting of species suitable for the edaphics of the location planted. Where suitable conditions occur and native wetland species are absent, exotic vegetation should be encouraged to be superceded by native wetland species.
- Areas of the VRZ / E2 land on non-alluvial soils will be planted with species to match PCT 1206 or 1245 where relevant.

5.2.4 Erosion and sediment control

Standard erosion and sedimentation controls are to be implemented during the construction phase.

Willow Trees are an environmental weed and can contribute to bank erosion. These are to be removed, and works undertaken to stabilise any areas of bank erosion. Exclusion of stock will be the key measure to reduce bank erosion.

5.2.5 Watercourse crossings

In NSW, the type of crossing needed for a waterway is decided by the waterway class. This is determined by factors that include hydraulic geometry, frequency of stream flow, presence of aquatic habitat, presence of threatened species, and connection to adjacent aquatic habitats. Under the classification system used by NSW DPI, Abernathys Creek would be defined as a Class 2 waterway.

The lower reaches of second order tributaries may also qualify as Class 2 habitat (ELA 2018) but the upper reaches of these, and the remainder of the waterways on site are Class 3 or Class 4 waterways because they flow only after rain and have ill-defined channels.

Class 2 waterways require either a bridge, arch structure, culvert, or ford depending on their size. Hydrological conditions and flood modelling should also be considered. While bridges are preferred, the type of structure acceptable can be determined by whether the waterway contains threatened species, or is ecologically significant at the site or upstream.

While it may be possible to negotiate the choice of crossing structure with DPI Fisheries, it is likely that bridges will be needed at eight locations in the project area (**Figure 14**). DPI Fisheries may accept a downgrading of some bridges to box culverts, since there are no known migrating native fish species in Abernathys Creek (although longfinned and shortfinned eels are likely), nor is there any significant fish habitat in the tributaries of Abernathys Creek. Likewise, of the seven culverts suggested below, some could be downgraded to causeways where hydrological and flood modelling allow.

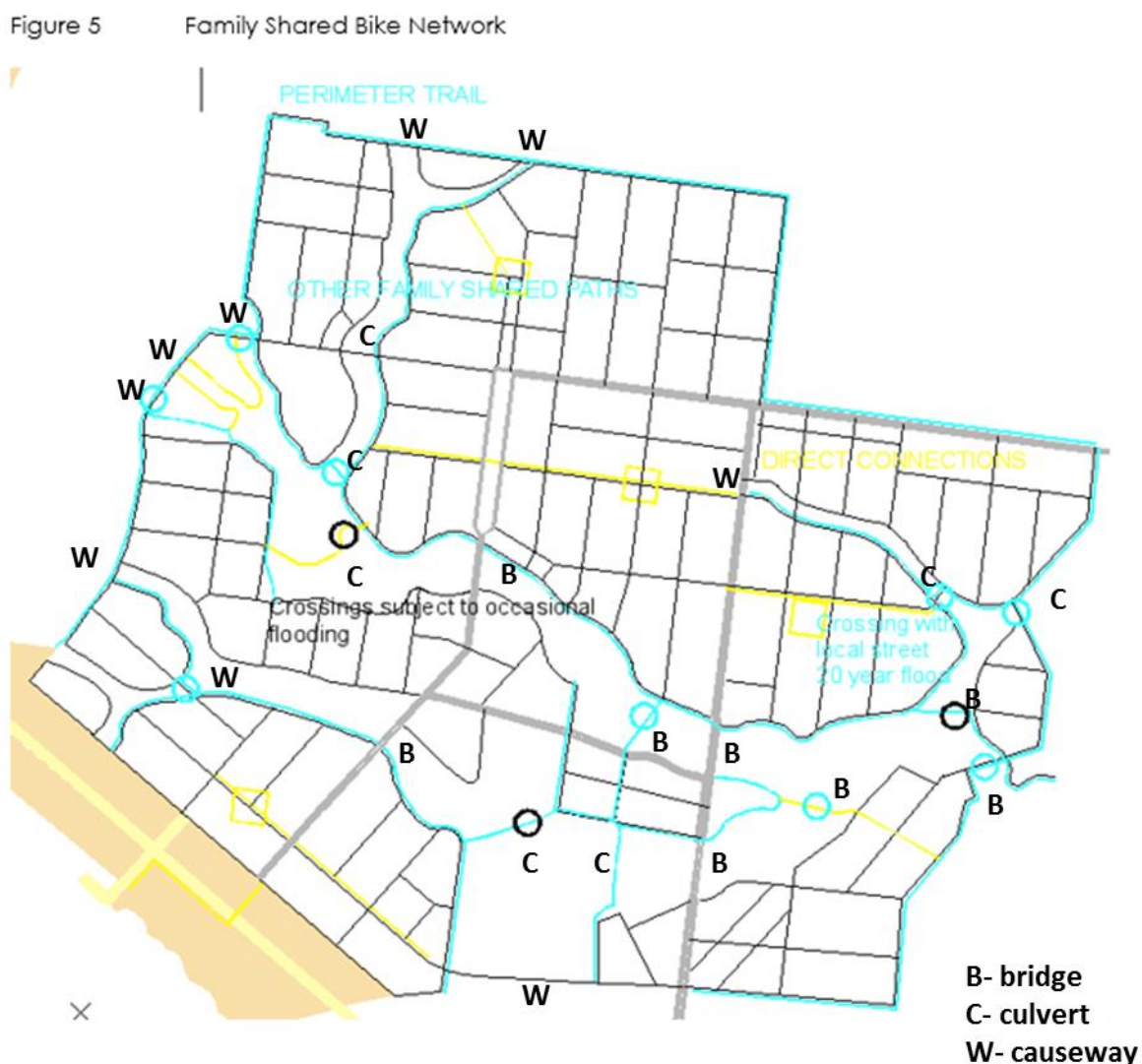


Figure 14. Watercourse crossing types likely to be required

5.2.6 Environmental weed control

Under the NSW *Biosecurity Act 2015*, eight weeds have been identified to fall under the 'general biosecurity duty' (see **section 3.4.2**).

Where these fall into the E2 zones, they are to be eliminated during works under the VMP. Plants outside the E2 zone will eventually be eliminated by development of the R1 and other development zones.

Weeds could potentially be introduced via imported road base materials and construction vehicles. Standard hygiene practices in the following section will also control this risk.

5.2.7 Pathogen management

Phytophthora cinnamomi is present in the SCC local government area and could be transported to the site. This pathogen could adversely impact the existing vegetation and future plantings.

Appropriate wash down and weed-propagule removal protocols are applicable for any construction vehicles and equipment being moved on-site during the construction phase. Imported road construction materials must be from certified *Phytophthora cinnamomi* free. Any machinery which has recently worked in a 'wet' site such as a wetland, stormwater treatment structure, floodplain, etc., must similarly be washed down with water containing anti-fungal chemicals (e.g. bleach) before entering the site. This will help protect against importing Chytrid.

5.2.8 Public access to E2 zones

The E2 zones will have use for public recreation, mostly in the form of cycleways / pathways. These are to be located to avoid / minimise fragmentation and indirect impacts (e.g. walking dogs along these pathways will leave scents which can cause avoidance of habitat by native fauna). Broad areas of remnants and E2 zones should be skirted where practical to maintain interior habitat and minimise the intrusion of edge effects associated with encapsulation of remnant habitat within urban development.

Pathways which pass through remnants or revegetation areas should be fenced along this section with at least three stand plastic coated plain wire to discourage informal path making and intrusion. Plantings of pungent leaved or thorny plants such as *Lomandra longifolia*, Orangethorn and Blackthorn along the edges is encouraged as either an alternative or supplementary measure.

5.2.9 Wildlife and vehicle collision risk

Crossings of the revegetated riparian zones will introduce the risk of wildlife and vehicle collisions. To mitigate this risk, crossing design should consider double function as an underpass. This may need to be supported by barrier fencing (e.g. as wings adjacent to the crossing on the edge of the VRZ) to funnel such fauna under the crossings e.g. wombats.

5.2.10 Habitat augmentation

Forty-six hollow-bearing trees fall into the R1 area. These should be retained where consistent with safety; arborist assessment may be required to identify any unsound trees that require removal. Where tree removal is required for safety reasons, the trunks and large limbs (>20 cm diameter) are to be re-used as coarse woody debris in the riparian E2 zones, in line with Fairfull (2013). They should be placed in locations where they are unlikely to be washed downstream and result in flooding.

5.2.11 Fauna protection during clearing

Future development will see loss of habitat which may contain fauna at critical lifecycle stages e.g. nesting birds in dense undergrowth or hollow-bearing trees. The risk of mortality can be mitigated by avoiding

clearing during likely breeding periods, undertaking a preliminary inspection and delaying works until young have left the nest / hollow, or employing a suitably qualified person to direct removal of such habitat components and manage fauna welfare. The hollow-bearing trees proposed to be removed may contain fauna at the time of clearing. Such fauna may be placed under stress, injured or killed during felling via:

- Being nocturnal or in torpor, and unable to escape prior to the tree falling.
- Collapse of the hollow when it impacts the ground.
- Collision with internal walls or via being thrown out when the tree falls.
- Being present as young e.g. eggs.

In general, any hollow bearing tree removal must be undertaken via a method that will minimise the risk of injury/mortality of potentially denning/roosting fauna within the limitations of Occupational Health and Safety (OH&S) Guidelines. Undertaken with due care, this practice can demonstrably avoid mortality of common and threatened species during felling of hollow-bearing trees, thereby substantially reducing the potential significance of development impacts. The following general guidelines are recommended:

- Hollow-bearing trees should ideally be removed via use of an excavator with a harvester head or tree sheers. These devices allow 'soft felling', but are limited to small to medium sized trees due to engineering and WH&S constraints.
 - Alternatively, an arborist may climb the tree and inspect the hollows first, felling the tree if hollows are confirmed to be vacant or blocking the hollows to prevent occupation if the hollow can be absolutely confirmed to be vacant and not risk trapping of fauna, and the tree felled at a later date.
 - If not too large and heavy and it is safe and practical to do so, hollows in limbs with fauna may potentially be blocked to prevent the fauna exiting, lopped, and lowered to the ground via ropes to allow fauna to be handled safely, but it is not practical or recommended for an arborist to remove fauna from hollows while in the tree. Similarly, inspection with a crane using a man-box is an option, but again removing fauna such as arboreal mammals poses significant WH&S issues and hence is not recommended.
- An ecologist must be present during felling of the hollow bearing trees to monitor clearing, capture any resident animals injured or not evacuating, and undertake appropriate emergency actions if required e.g. transport animal to veterinary treatment (care at proponent's cost) or care by a wildlife carer (with a donation by proponent to cover all carer and treatment costs).
- Hollows are to be immediately inspected once the tree is felled (within OH&S guidelines) for injured individuals or abandoned offspring, and appropriate measures undertaken.
- If hollows cannot be safely cleared of fauna and /or verified to be vacant, the fallen tree must either be allowed to sit overnight, or may be sectioned by chainsaw to clear hollows of fauna if the ecologist deemed necessary for fauna welfare.

Rehabilitated animals are required to be released back at the site or the nearest habitat.

5.2.12 Artificial lighting

Residential lighting is to avoid excessive light spill into areas of retained trees or other vegetation to reduce impacts to nocturnal fauna. This is most important for dwellings which back onto retained forest remnants and adjacent street lighting.

This can be achieved via not directing external lighting towards retained habitat, especially hollow-bearing trees; and use of 'environmental' lighting e.g. sensor lighting, focussed shade covers, etc.

5.2.13 Measures to minimise changes to hydrological regimes

The development should incorporate measures to minimise the impacts of changes to hydrological regimes at, and downstream of, the site.

5.2.14 Measures to minimise predation by domestic pets

The development should incorporate measures to minimise the impacts of predation by domestic pet

6 Statutory framework

6.1 EPBC Act – Matters of National Environmental Significance

The following is an overview assessment, with future Development Applications required to address the legislative requirements current at the time

6.1.1 Threatened species and ecological communities

The site and study area do not contain any threatened ecological communities listed under the EPBC Act. No threatened flora were recorded, but the best potential habitat will be retained, with weed control to be implemented under a Vegetation Management Plan.

The Grey-headed Flying Fox (Vulnerable) is the threatened fauna species most likely to occur. This animal would occur in small numbers generally, feeding on seasonally flowering canopy trees. The site and study area does not contain known roosting habitat, with the nearest camps known to occur at Bomaderry and Berry. The future development of the site will see the loss of approximately 7.58 ha of potential foraging habitat in the form of small forest remnants on Lot 4 DP2682089 and in the road reserve and regrowth adjacent to Lot 54 and north-west corner of Lot 4; the portion of the remnant in the north-west corner of Lot 1 DP1191186; plus smaller clumps, scattered trees and a range of landscape plantings over the site in general. This will see the loss of preferred forage species including Spotted Gum, but this loss will be offset via replanting of the E2 zone with species which are preferred food species e.g. figs.

Relative to the extent of foraging habitat within range of the two camps, the proposed action has no capacity to place an important population of this species at risk of extinction.

The Critically Endangered Swift Parrot has been recorded three times in the locality (along the coast), from 1984 to 2014 (OEH 2017a). There is thus a small chance that non-breeding migrants could forage on site if Spotted Gum were flowering at the time they were in the locality. The future development of the site should have minimal negative impact on this potential as the majority of current potential habitat will be retained in the E2 zones, and Noisy Miners and Indian Mynas are already present. No barriers or significantly elevated risk of collision will be created, and the bird does not breed on the mainland.

Hence referral to the Department of the Environment and Energy is unlikely to be required for any threatened species or ecological community.

6.1.2 Migratory species

The following migratory species were considered potential occurrences in the study area and would be potentially impacted by the activity:

- Aerial foragers: Fork-tailed Swift, White-throated Needletail.

These species breed in Asia and migrate to Australia during the austral Summer, ranging across much of the continent and spending most of their time in flight, where they hunt for aerial insects high above the land. They may descend to earth at nightfall; radio-tracked birds have been shown to roost in trees.

The Fork-tailed Swift and White-throated Needletail are likely to forage in the air above the site occasionally, particularly in advance of summer storms. The proposal is likely to have only minor impacts on these species; the conversion of paddock to residential areas may result in a diminution of the amount of insect prey available; alternatively, through the planting of trees and shrubs, it may augment prey availability. Clearing of remnant native vegetation may also result in a decrease in potential roost sites

(i.e. trees); however, over time the revegetation of riparian zones will probably lead to an increase in the number of trees at the site.

Referral to the Commonwealth under the EPBC Act is unlikely to be required for these species.

6.1.3 Other Matters

The proposal is considered unlikely to affect any Commonwealth land, Commonwealth Heritage Places or Listed Marine Species in the locality. A referral to the Commonwealth under the EPBC Act is therefore unlikely to be required on any Other Matters.

6.2 Biodiversity Conservation Act 2016

The following is an overview assessment of the new provisions based on information and understanding at the time, with future Development Applications required to address the legislative requirements current at the time.

6.2.1 Overview

As of August 25th 2017, the *Threatened Species Conservation Act 1995* was superseded by the NSW *Biodiversity Conservation Act 2016* (BC Act) and the associated *Biodiversity Conservation Regulation 2017*. The full implementation of the Act commenced from the 25th February 2018 for Shoalhaven LGA.

For Development Applications (DAs) under Part 4 of the *Environmental Planning and Assessment Act* (EP&A) 1979, there are now several triggers for an assessment under the Biodiversity Assessment Methodology (BAM) and hence the need to secure offset credits via the Biodiversity Offset Scheme (BOS) may be required. These are:

- Clearing of a prescribed area limit of native vegetation designated for the minimum lot size for the LEP zoning of the subject land.
- Clearing of land mapped as having Sensitive Biodiversity Values (SBV land).
- Determined as likely to have a significant impacted after assessment under the Five Part Tests.

As shown in **Figure 15**, the only land on site mapped as having Sensitive Biodiversity Value Land is the riparian zone of Abernethy's Creek. Any clearing in this area is a trigger of the Biodiversity Offset Scheme (BOS) and hence a BAM assessment, however such clearing is unlikely other than for crossings.

For the remainder of the site, the BC Act will be applied differently for various Development Applications, depending on the extent of native vegetation cleared.

As the land to be developed is zoned R1 with minimum lot size of less than 1 ha, the BAM will apply to any proposal involving clearing of a minimum of 0.25 ha of native vegetation. Native vegetation is defined under s. 60B of the *Local Land Services Amendment Act 2016* as follows:

1. For the purposes of this Part, native vegetation means any of the following types of plants native to New South Wales:
 - a. trees (including any sapling or shrub or any scrub),
 - b. understorey plants
 - c. groundcover (being any type of herbaceous vegetation)
 - d. plants occurring in a wetland.
2. A plant is native to New South Wales if it was established in New South Wales before European settlement. The regulations may authorise conclusive presumptions to be

made of the species of plants native to New South Wales by adopting any relevant classification in an official database of plants that is publicly accessible.

3. For the purposes of this Part, native vegetation extends to a plant that is dead or that is not native to New South Wales if:
 - a. the plant is situated on land that is shown on the native vegetation regulatory map as category 2 – vulnerable regulated land, and
 - b. it would be native vegetation for the purposes of this Part if it were native to New South Wales.

Hence disturbed areas such as a paddock with clusters of trees may still comprise native vegetation. Cleared areas dominated by pasture with no trees or shrubs may be deemed not native and hence cleared land if it meets the following criteria under the BAM:

- (a) The native vegetation that comprises the groundcover is:
 - i. < 50% of the cover of indigenous species of vegetation, and;
 - ii. not less than 10% of the area is covered with vegetation (whether dead or alive), and;
 - iii. the assessment is made at the time of year when the proportion of the amount of indigenous vegetation in the area to the amount of non-indigenous vegetation in the area is likely to be at its maximum.

Future development on Lot 4 DP268209 and Lot 1 DP1191186 is likely to trigger the area of clearing threshold due to removal of remnant and mixed regrowth vegetation. Smaller remnant vegetation (partly within Crown road reserve) on Lot 2 DP1191186 and Lot 54 DP1024592 may possibly also trigger off the area threshold if groundcover meets the above threshold combined with the remnant and regrowth trees.

The remainder of the site will be subject to the Five Part Tests. However, with the limited habitat values in these areas and lack of evidence to indicate threatened species are present, a significant impact and hence entry into the BOS is unlikely.

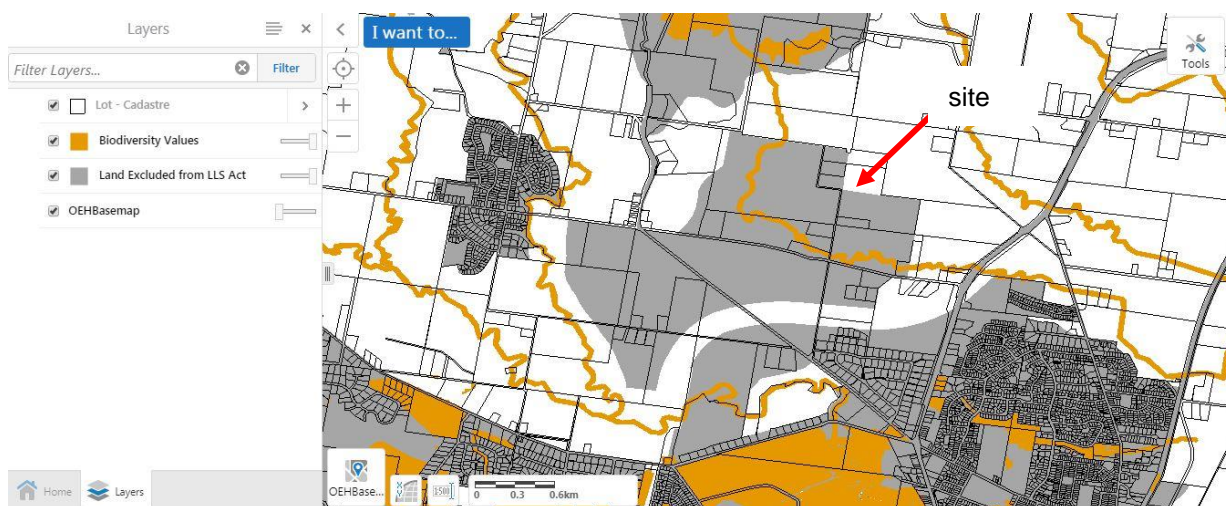


Figure 15: Sensitive Biodiversity Value lands mapping

(source: <https://www.lmbc.nsw.gov.au/Maps/index.html?viewer=BOSETMap>)

6.2.2 Ecosystem credits, species credits and dual credits

Future development on the site may require some or all of these credits, depending on the outcomes of the BAM assessment.

These credits are defined as follows (OEH 2017b).

- Ecosystem credit: Biodiversity credits created or required for the impact on general biodiversity values and some threatened species; that is, for biodiversity values except threatened species or populations that require species credits.
- Species credit: Biodiversity credit created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates.
- Dual credit species: Species which require both ecosystem and species credits as they rely on specific habitat components e.g. tree hollows and caves.

The full list of credits per category is available in the Threatened Species Profile Database.

In addition to ecosystem credits to offset loss of the PCTs, species credits may be required for developments which trigger the BOS. **Table 15** lists likely species and potential dual credit species relevant to the site:

Table 15: Species and dual credit species

Species	Common name	Credit type
<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	Species
<i>Myotis macropus</i>	Southern Myotis	Species
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	Dual
<i>Lathamus discolor</i>	Swift Parrot	Dual
<i>Lophoictinia isura</i>	Square-tailed Kite	Dual
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	Dual
<i>Ninox strenua</i>	Powerful Owl	Dual
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Dual
<i>Tyto novaehollandiae</i>	Masked Owl	Dual
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	Dual
<i>Hieraaetus morphnoides</i>	Little Eagle	Dual

Some targeted survey for species credit species may be required for future Development Applications.

6.2.3 Serious and Irreversible Impacts

Serious and Irreversible Impacts (SAIL) are a new criterion the consent authority under Part 4 DA's must consider. Furthermore, local development can not be approved by Council if there is a SAIL. The consent authority must determine if the proposal's residual impacts after avoid or mitigation measures have been undertaken are serious and irreversible. SAIL's are defined for a discrete list of TECs and threatened species (OEH 2017d).

6.3 NSW Fisheries Management Act 1994 / 1997

As detailed in section 3.6, the main watercourses on site have identified fisheries values, but not for threatened species, populations or ecological communities, hence no further statutory assessment is required i.e. Five Part Tests under amendments of the *Biodiversity Conservation Act 2016*.

Permits will however be required under ss200 and 201 for crossings of the watercourses, and appropriate structures will need to be used to allow free fish passage. Existing barriers will be removed which should improve fish habitat connectivity, and such works may need a permit under ss199-201.

6.4 SEPP 44

6.4.1 Introduction

State Environmental Planning Policy no. 44 – Koala Habitat Protection (SEPP 44) is a planning policy that “*aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure a permanent free-living population over their present range and reverse the current trend of Koala population decline*”.

SEPP 44 requires the identification of Potential and Core Koala Habitat on development sites and planning areas, and the preparation of a Koala Plan of Management (KPOM) if Core Koala Habitat is found. SEPP 44 also allows local governments to prepare LGA wide Koala management plans referred to as Comprehensive Koala Plans of Management (CKPoM).

6.4.2 Potential Koala Habitat

The identification of an area of land as Potential Koala Habitat is determined by the presence of primary koala-food tree species. These species are listed under Schedule 2 of SEPP 44: Koala Habitat Protection. Potential Koala Habitat is defined as areas where the tree species listed under Schedule 2 constitute at least 15% of the total number of trees in the upper and lower strata of the tree component.

The Schedule 2 Primary Preferred food species occurring in the SCC LGA are: *Eucalyptus punctata* (Grey Gum), *E. microcorys* (Tallowwood), *E. robusta* (Swamp Mahogany), *E. tereticornis* (Forest Red Gum) and *E. viminalis* (Manna Gum).

The definition “an area of land” is interpreted as the land to which the development application applies (if it exceeds 1ha in area, together with any land in the same ownership).

The only Schedule 2 species on site are planted Tallowwoods on Lot 2 DP582036 which cover an area larger than one hectare; and a few planted Swamp Mahogany and / or Tallowwoods along the driveway to the dwellings on Lot 2 DP1191186 and Lot 4 DP268209.

The plantings on Lot 2 are sufficient to meet the area and composition requirement to qualify as Potential Koala Habitat. While these are plantings, the SEPP does not differentiate between native or planted natives, and Koalas are well known to use planted trees even in urban woodland settings.

6.4.3 Core Koala Habitat

Under SEPP 44, Core Koala Habitat is defined as “an area of land with a resident population of Koalas, as evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a Koala population” (Source: *State Environment Planning Policy No. 44 - Koala Habitat Protection*).

Koalas are not an intrinsic ecological feature of the Local Government Area (LGA) due to a range of interrelated factors such as low fertility soils, clearing of the native vegetation containing food trees from the more fertile soils, fire, hunting, disease, and loss of connectivity. Most records come from the western hinterland e.g. Budjong Vale area. There is a record near Cambewarra over 100 years old and another near Shoalhaven Heads from the 1940s, though a recent sighting of a Koala crossing the Princess Highway at Jaspers Brush is interesting (OEH 2017a).

The Schedule 2 food trees were checked for Koala use via a routine check for scats as well as direct inspection of the trees. No scats or Koalas were found.

Given that until these plantings were established in the last 20 years approximately, there was no Potential Koala Habitat on site; the lack of records indicating a Koala population in proximity to the site; the location of the habitat on the easternmost periphery of site and isolated by pasture; and the site itself contains only small fragments of remnant forest with very poor connectivity to potential source habitat in the west: it is very unlikely that Koalas occur.

In regards to the identified attributes of Core Koala Habitat, the following is provided:

- 1) *“Breeding females (that is, females with young)”*: While not specifically targeted via survey, no breeding activity was recorded, nor has evidence of such activity ever been recorded on site or in the study area, and does not appear to occur in the locality.
- 2) *“Recent sightings and historical records of a Koala population”*: Koalas have not been reported by landowners and are not shown on available databases. The complete lack of any Koala records as road kills also strongly suggests the lack of a population given traffic along the Princes Highway and Kangaroo Valley Rd.

Given the above, the site is not considered likely to contain Core Koala Habitat, hence a Koala Plan of Management is not required.

6.5 State Environmental Planning Policy (Vegetation in Non-Rural Area) 2017

State Environmental Planning Policy (Vegetation in Non-Rural Area) 2017 (the Vegetation SEPP) forms part of the reforms under the BC Act and *Local Land Services Amendment Act 2016*.

The Vegetation SEPP will apply to the R1 and E2 zones on the site post-development for non-DA works. The SEPP would only be triggered if clearing of native vegetation were to exceed the Biodiversity Offset Scheme thresholds or involve Sensitive Biodiversity Value Lands. If not, clearing approval will fall under the SLEP 2014 Development Control Plan.

6.6 SLEP 2014

The site is not mapped under the Terrestrial Biodiversity, Wetlands or Native Vegetation Protection layers, hence the relevant clauses of the SLEP do not apply.

Riparian Lands and Watercourses are mapped on site, and hence clause 7.6 of the SLEP will be considered in future DAs and the area specific DCP.

Post-development, any proposal to remove vegetation which is not part of a DA and not triggering off the Vegetation SEPP will require approval from SCC under the Chapter G4 of the DCP, or provisions under the area-specific DCP, as per clause 5.9 of the SLEP. Such approval may include the need for a Five Part Test under the BC Act.

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Motorplex (Australia) Pty Limited v Port Stephens Council [2007] NSWLEC 74

Appendix A Likelihood of occurrence table

Threatened flora and fauna are considered for potential to occur based on the following:

- Local records.
- Regional distribution.
- Preferred habitat and ecology.
- Site/study area habitat (condition, carrying capacity, extent and connectivity).
- Disturbance history, recovery actions and threats.

Five categories for the likelihood of occurrence of species are used in this report, as defined below:

- “yes” = the species was or has been observed on the subject land and/or study area.
- “likely” = a medium to high probability that a species uses the study area or immediate surrounds due to suitable habitat, connectivity and local records.
- “possible” = some suitable habitat (often a remnant or degraded area) for a species occurs on the site and/or study area, but is insufficient to meet the species needs for more than short term opportunistic foraging or marginal fringe of home range; or is very degraded/disturbed often with high levels of threat, and hence likelihood of occurrence is thus low.
- “unlikely” = a very low to unlikely probability that a species uses the study area or immediate surrounds due to a combination of habitat condition, threats, poor connectivity and/or lack of habitat suitability.
- “no” = habitat within the study area or immediate surrounds is completely unsuitable for the species.

FLORA

Table 16: Potential occurrence assessment – flora

Flora						
Scientific Name	Common Name	Records	NSW BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Acacia bynoeana</i>	Bynoe's Wattle	MNES: predicted	E1	V	Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include Red Bloodwood, Scribbly Gum, Parramatta Red Gum, Saw Banksia and Narrow-leaved Apple.	Unlikely: Preferred habitat mostly absent from the site, and lack of associated species.
<i>Asterolasia elegans</i>	-	MNES: predicted	E1	E	Occurs on Hawkesbury sandstone. Found in sheltered forests on mid- to lower slopes and valleys. The canopy at known sites includes <i>Syncarpia glomulifera</i> subsp. <i>glomulifera</i> (Turpentine), <i>Angophora costata</i> (Smooth-barked Apple), <i>Eucalyptus piperita</i> (Sydney Peppermint), <i>Allocasuarina torulosa</i> (Forest Oak) and <i>Ceratopetalum gummiferum</i> (Christmas Bush). Ecological knowledge about this species is very limited.	Unlikely: Preferred geology and habitat mostly absent from the site, and lack of associated species.
<i>Cryptostylis hunteriana</i>	Leafless Tongue-orchid	3 MNES: predicted	V	V	<i>Cryptostylis hunteriana</i> is known from a range of vegetation communities including swamp-heath and woodland (DECC 2007), where it appears to prefer open areas in the understorey.	Targeted survey failed to detect even common orchid species; <i>C. hunteriana</i> is therefore considered unlikely to occur at the site.
<i>Cynanchum elegans</i>	White-flowered Wax Plant	MNES: predicted	E1	E	Occurs in dry rainforest; littoral rainforest; <i>Leptospermum laevigatum</i> - <i>Banksia integrifolia</i> subsp. <i>integrifolia</i> (Coastal Tea-tree– Coastal	No: Outside of known distribution and predominantly cleared habitat within site unlikely to support this species.

Flora						
Scientific Name	Common Name	Records	NSW BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					Banksia) coastal scrub; <i>Eucalyptus tereticornis</i> (Forest Red Gum) or <i>Corymbia maculata</i> (Spotted Gum) open forest and woodland; and <i>Melaleuca armillaris</i> (Bracelet Honey myrtle) scrub. Restricted to eastern NSW, from Brunswick Heads on the north coast to Gerroa in the Illawarra region, and as far west as Merriwa in the upper Hunter River valley.	
<i>Eucalyptus langleyi</i>	Albatross Mallee	9	V	V	Present as Mallee shrubland on poorly-drained, shallow, sandy soils on sandstone.	Unlikely: Preferred habitat absent, and site is predominantly cleared. Although preferred sandy soils are present in some parts of the site, these are moderately deep.
<i>Genoplesium baueri</i>	Yellow Gnat-orchid	21 MNES: predicted	E	E	Known from coastal areas from northern Sydney to the South Coast. Previous records from the Hunter Valley and Nelson Bay are now thought to be erroneous. Grows in heathland, shrubby woodland and open forest on shallow sandy soils, sand loams, and on well-drained sandy and gravelly soils. In the Shoalhaven, relatively large populations are known from Scribbly Gum, Red Bloodwood, Silvertop Ash and Black She-oak dominated communities.	Unlikely: Many local records but vegetation community across the majority of the site does not offer suitable habitat. Record to north-east from 1972 hence considered to have limited validity.
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	MNES: predicted	V	V	Occurs in heath and shrubby woodland to open forest on sandy or light clay soils usually over thin shales. Flowering has been recorded between July to December as well as April-May. Flowers are insect-pollinated and seed dispersal is limited.	No: No local records and the site is predominantly cleared. Limited seed dispersal and lack of local records make the species unlikely to occur in the site.

Flora						
Scientific Name	Common Name	Records	NSW BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Haloragis exalata</i> <i>subsp. exalata</i>	Wingless Raspwort, Square Raspwort	MNES: predicted	V	V	Occurs in protected and shaded damp situations in riparian habitats. Flowering specimens in NSW are recorded from November to January.	No: No local records and the site is predominantly cleared. Limited suitable habitat and lack of local records make the species unlikely to occur in the site.
<i>Hibbertia stricta</i> <i>subsp. furcatula</i>	-	19	E1	-	Occurs in dry eucalypt forest and woodland. Flowers in spring and summer, yet also noted as July to about December and 'winter to summer'.	Unlikely: One of two known populations in vicinity of Nowra, but unsuitable geology in the site. Site is predominantly cleared but species may be present in forested areas.
<i>Irenepharsus trypherus</i>	Delicate Cress, Illawarra Irene	MNES: predicted	E1	E	Occurs in moist sclerophyll forest, <i>Backhousia myrtifolia</i> (Ironwood) thickets, and rainforest, on steep rocky slopes near cliff lines and ridge tops.	No: Lack of suitable habitat and associated species in the site, and records in the locality.
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	MNES: predicted	V	V	<i>Melaleuca biconvexa</i> occurs in coastal districts and adjacent tablelands from Jervis Bay north to the Port Macquarie district. It grows in damp places on fertile soils often near streams (PlantNet 2011).	No: Recorded in Tomerong and Woollamia areas but no suitable habitat or geology within study area and unlikely to occur.
<i>Melaleuca deanei</i>	Deane's Melaleuca	MNES: predicted	V	V	Occurs in heath on sandstone. Flowers appear in summer but seed production appears to be small and consequently the species exhibits a limited capacity to regenerate.	No: Lack of suitable habitat in the site and no local records.
<i>Pimelea spicata</i>	Spiked Rice- flower	MNES: predicted	E1	E	Grows in well-structured clay soils. <i>Eucalyptus moluccana</i> (Grey Box) communities and in areas of ironbark on the Cumberland Plain. Coast Banksia open woodland or coastal grassland in the Illawarra. Found in two disjunct areas; the Cumberland Plain (Marayong and Prospect Reservoir south to Narellan and Douglas Park) and	No: Outside of known distribution and no suitable habitat or geology within the site.

Flora						
Scientific Name	Common Name	Records	NSW BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					the Illawarra (Landsdowne to Shellharbour to northern Kiama).	
<i>Pterostylis gibbosa</i>	Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood	MNES: predicted	E	E	Known from a small number of populations in the upper Hunter Valley (Milbrodale), the Illawarra region (Albion Park and Yallah) and near Nowra (DECC 2007). Plants grow in a variety of woodland and open forest communities with shallow rocky soils.	Unlikely: Close to known range near Nowra but the site is predominantly cleared. Lack of suitable geology and limited potential habitat means the species is unlikely to occur in the site.
<i>Pterostylis pulchella</i>	Pretty Greenhood	1 MNES: predicted	V	V	Occurs on cliff faces close to waterfalls and creek banks, and mossy rocks alongside running water.	Unlikely: One record in the locality but lack of suitable habitat within the site means the species is unlikely to occur.
<i>Pterostylis vernalis</i>	Halbury Rustyhood	MNES: predicted	E4A	CE	Heath and heathy forest on shallow soil over sandstone sheets. Naturally patchy distribution within species' range as it is restricted to sections of rock shelf where there is only a thin layer of soil and particular hydrological conditions. Habitat often contains mossy beds. During summer the above-ground parts of the plant wither and it persists as a dormant tuber underground. Five known populations to the west and southwest of the Nowra area on the NSW south coast.	Unlikely: No local records and lack of suitable heath habitat within the site.

Flora						
Scientific Name	Common Name	Records	NSW BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Rhizanthella slateri</i>	Eastern Underground Orchid	MNES: predicted	E	E	An underground orchid with a whitish, fleshy underground stem to 15 cm long and 15 mm diameter (DECC 2007). Occurs from south-east Queensland to south-east NSW. In NSW, currently known from fewer than 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. Habitat requirements are poorly understood and no particular vegetation type has been associated with the species, although it is known to occur in sclerophyll. Well-documented population at Bulahdelah was in sandy loam soils derived from granite.	Unlikely: No local records.
<i>Solanum celatum</i>	-	3	E1	-	Occurs in rainforest clearings and wet sclerophyll forests. Flowers August to October and produces fruit December to January.	Unlikely: some local records but no suitable habitat within site.
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	MNES: predicted	E1	V	<i>Syzygium paniculatum</i> naturally occupies a narrow coastal area between Bulahdelah and Conjola State Forests in NSW. Recorded on sandy soils derived from sandstone or aeolian. Some records also on floodplains and creek banks. Predominantly sand soils. Associated with littoral rainforest dominated by <i>Ficus obliqua</i> , <i>Elaeodendron australe</i> , <i>Podocarpus elatus</i> and <i>Acmena smithii</i> in some areas.	Unlikely: Associated habitat type not present and the site is predominantly cleared.
<i>Thelymitra kangaloonica</i>	Kangaloon Sun Orchid	MNES: predicted	E4A	CE	Occurs in swamps in sedgeland over grey silty grey loam soils. Thought to be a short-lived perennial, flowering in late October and early November.	No: No suitable swamp or sedgeland habitat within the site and lack of local records.

Flora						
Scientific Name	Common Name	Records	NSW BC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Thesium australe</i>	Austral Toadflax	MNES: predicted	V	V	Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. In eastern NSW it is found in very small populations scattered along the coast, and from the Northern to Southern Tablelands. Often found in association with <i>Themeda australis</i> (Kangaroo Grass). A root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass. Flowers in spring.	Unlikely: The site is located more than 15 km from the coast and contains no potential woodland habitat.
<i>Triplarina nowraensis</i>	Nowra Heath-myrtle	172 MNES: predicted	E1	E	Occurs in moist heath on poorly drained, gently sloping sandstone shelves or along creek lines underlain by Nowra Sandstone. Known from three populations to the immediate west of Nowra, a fourth 18km south-west of Nowra in the Boolijong Creek Valley, and a fifth north of the Shoalhaven River on the plateau above Bundanon.	Unlikely. Many records in the locality and sandstone geology is present in some parts of the site. However, the degraded condition of potential habitat at the site means that this species is unlikely to be present.
<i>Xerochrysum palustre</i>	Swamp Everlasting, Swamp Paper daisy	MNES: predicted	P	V	Occurs in or on the margins of swamps and bogs which are often dominated by heaths.	No: No local records and lack of suitable heath, swamp and bog habitat in the site.
<i>Zieria baeuerlenii</i>	Bomaderry Zieria	117 MNES: predicted	E1	E	Occurs in shrubby open forest, shrubby woodland or closed scrub on skeletal sandy loam on a rocky plateau.	Unlikely. The degraded condition of potential habitat at the site means that this species is unlikely to be present.
<i>Zieria tuberculata</i>	Warty Zieria	1	V	V	Occurs in heath amongst rocky outcrops, rain forest edges, tall forest and shrubland. The flowers appear from late winter to spring.	No: No suitable habitat present in the site.

FAUNA

Exclusively marine reptiles, birds and mammals listed in the MNES Protected Matters report and BioNet search are not listed due to lack of habitat on site or impact of the proposal on their ecology or habitats. Similarly, marine and aquatic fish and seaweed listed under the NSW FM Act 1994 are also not assessed.

Table 17: Potential occurrence assessment – fauna

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
BIRDS						
<i>Anthochaera phrygia</i>	Regent Honeyeater	MNES: predicted	CE	CE	Occurs mostly in dry box-ironbark eucalypt woodland and dry sclerophyll forest associations, wherein they prefer the most fertile sites available. The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). <i>E. robusta</i> and <i>C. maculata</i> are key food sources on the coast.	Unlikely: no records in the locality and the species is extremely rare.
<i>Burhinus grallarius</i>	Bush Stone-curlew	2	E1	-	In NSW, it occurs in lowland grassy woodland and open forest. Feed mainly at night on frogs, fish, yabbies, spiders, insects and snails. Feeding platforms may be constructed over deeper water from reeds trampled by the bird. Breeding occurs in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds.	Unlikely: The site is predominantly cleared, although small remnant patches of open forest are present in the south. The species may occasionally utilise the site as part of a much wider foraging range due to the presence of local records.
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	10	V	-	Generally found in NSW from the southeast coast to the Hunter region, and inland to the Central Tablelands and southwest slopes. During summer, inhabits heavily timbered and mature wet sclerophyll forests and alpine woodlands; wintering at lower altitudes in drier more open eucalypt forests and woodlands,	Possible

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					particularly box-ironbark assemblages. Often found in woodland, farms and suburbs in autumn/winter.	
<i>Calyptrorhynchus lathamii</i>	Glossy Black-Cockatoo	154	V	-	Associated with a variety of forest types containing <i>Allocasuarina</i> species, usually reflecting the poor nutrient status of underlying soils (Environment Australia 2000; NPWS 1997; DECC 2007). Nests in trees with large hollows (Environment Australia 2000).	Unlikely: very few <i>Allocasuarina</i> on site.
<i>Circus assimilis</i>	Spotted Harrier	1	V	-	Occurs in grassy open woodland, inland riparian woodland, grassland, shrub steppe, agricultural land and edges of inland wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months.	Unlikely: Lack of suitable habitat within the site means that the species is unlikely to occur.
<i>Daphoenositta chrysoptera</i>	Varied Sittella	8	V	-	Sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands, with a nearly continuous distribution in NSW from the coast to the far west (Higgins and Peter 2002; Barrett <i>et al.</i> 2003). It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and <i>Acacia</i> woodland. Feeds on arthropods gleaned from crevices in rough or decortivating bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	Possible.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	9 MNES: predicted	E1	E	Associated with dense, low vegetation including sedgeland, heathland, swampland, shrubland, sclerophyll forest and woodland, and rainforest, as well as open woodland with a healthy understorey.	Unlikely: Some local records and suitable riparian habitat in the site, but as it is predominantly cleared unsuitable habitat for this species it is unlikely that it will occur in the site.
<i>Epthianura albifrons</i>	White-fronted Chat	3	V	-	Occurs in saltmarsh vegetation, open grasslands and sometimes low shrubs bordering wetland areas. Have been observed breeding from late July through to early March, with 'open-cup' nests built in low vegetation or mangroves.	No: Lack of suitable habitat within the site means that the species is unlikely to occur.
<i>Falco subniger</i>	Black Falcon	1	V	-	Found in woodland, shrubland and grassland, especially riparian woodland and agricultural land. Often associated with streams or wetlands. Black Falcons nest in winter to late spring in the old stick nests of corvids or sometimes other raptor species. These tend to be located at the top of emergent trees in woodland, particularly riparian woodland.	Unlikely: Lack of suitable habitat within the site means that the species is unlikely to occur.
<i>Glossopsitta pusilla</i>	Little Lorikeet	1	V	-	Gregarious, usually foraging in small flocks, often with other species of lorikeet feeding primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes. Mostly occurs 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. In south-east Queensland	Possible: known to feed on flowering Spotted Gums

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					(Smyth <i>et al.</i> 2002), were more likely to occupy forest sites with relatively short to intermediate logging rotations (15–23 years) and sites that have had short intervals (2.5– 4 years) between fires.	
<i>Grantiella picta</i>	Painted Honeyeater	MNES: predicted	V	V	Occurs in Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus <i>Amyema</i> . Insects and nectar from mistletoe or eucalypts are occasionally eaten. Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.	No: Lack of preferred habitat and fruiting mistletoe in the site, and lack of local records.
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	8	V	-	Widespread in NSW along the coast, rivers, inland rivers and major wetlands. Feed on fish, waterbird, freshwater turtles and also known to take Flying Foxes. Needs large trees, usually emergent with dead branches for roosting, within range of water. Breeds from June to January with eggs laid June to September.	Unlikely: No potential foraging or nesting habitat within the site. At best may fly over foraging along adjacent coast.
<i>Ixobrychus flavicollis</i>	Black Bittern	2	V	-	Occurs in both terrestrial and estuarine wetlands generally in areas of permanent water and dense vegetation (DECC 2007). In areas with permanent water it may occur in flooded grassland, forest, woodland, rainforest and mangroves (DECC 2007).	Unlikely: Permanent water in the form of one wetland and man-made dams occur in the site. Lack of dense vegetation makes species unlikely to occur except as a rare visitor.
<i>Lathamus discolor</i>	Swift Parrot	3	E1	CE	Migrates to mainland in autumn, where it forages on eucalypts. Box-ironbark habitat in drainage lines, and coastal forest in NSW is	Possible: Spotted Gum occurs on site as the dominant tree species and is locally abundant in the locality. Three records

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					thought to provide critical food resources during periods of drought or low food abundance elsewhere (MacNally et al. 2000). Preferred food species include <i>Corymbia maculata</i> , <i>Eucalyptus tereticornis</i> , <i>E. robusta</i> and <i>Banksia integrifolia</i> .	occur from 1984-2014 on the coast, suggesting the LGA is subject to visitation during migration if flowering occurs at the time.
<i>Lophoictinia isura</i>	Square-tailed Kite	15	V	-	Open forests and woodlands in coastal and sub-coastal areas. Forages low over, or in, canopy for eggs, nestlings, passerines, small vertebrates and invertebrates. Large home range (>100km ²). Large stick nest in high fork of living tree. Breeds July-December. Lays 2-3 eggs with 1-2 birds fledging after 100days. Appears to be adapting to an abundance of passerines in well-vegetated outer fringes of cities. Observed foraging in residential areas of Port Macquarie. Probably migrates to northern Australia in winter. (Debus 1998, NSW NPWS 2000)	Possible: Extensive potential foraging habitat in locality but more limited in the site. Low value roosting habitat within the site but potentially too low for nesting. Most likely to utilise the site as part of a much broader range given extensive home range of this species.
<i>Neophema chrysogaster</i>	Orange-bellied Parrot	MNES: predicted	CE	CE	Nests in hollows in eucalypt trees growing adjacent to feeding plains. Feeds in sedgelands, coastal saltmarshes and dunes, or beach-front vegetation.	Unlikely: No sedgeland or preferred feeding habitat within the site. Conservation status and lack of local records however suggests very unlikely to occur.
<i>Ninox strenua</i>	Powerful Owl	17	V	-	Powerful Owls are associated with a wide range of wet and dry forest types with a high density of prey, such as arboreal mammals, large birds and flying foxes. Large trees with hollows at least 0.5m deep are required for shelter and breeding. Very large territory (500-5000ha).	Possible: Previous records in the locality and likely to periodically roam into vegetated areas of the site to forage on possums and gliders.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Numenius madagascariensis</i>	Eastern Curlew	1 MNES: predicted	-	CE	Summer migrant to Australia in August – May. Primarily coastal distribution in NSW, with some scattered inland records. Occurs in estuaries, bays, harbours, inlets and coastal lagoons, intertidal mudflats or sandflats, ocean beaches, coral reefs, rock platforms, saltmarsh, mangroves, freshwater/brackish lakes, saltworks and sewage farms.	Unlikely: No potential estuary habitat in the site.
<i>Pachycephala olivacea</i>	Olive Whistler	5	V	-	Mostly inhabits wet forests above about 500m. Forage in trees and shrubs and on the ground, feeding on berries and insects. Make nests of twigs and grass in low forks of shrubs.	Unlikely: Few records in the locality but the site is located in a floodplain and is therefore unlikely to be used regularly by this species.
<i>Pandion cristatus</i>	Eastern Osprey	2	V	-	Occurs on rocky shorelines, islands, reefs, mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water. Breed from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.	Unlikely: No suitable habitat in the site.
<i>Petroica boodang</i>	Scarlet Robin	1	V	-	Found in dry eucalypt forests and woodlands, and occasionally in mallee, wet forest, wetlands and tea-tree swamps. Feed on small insects and other invertebrates which are taken from the ground, or off tree trunks and logs; they sometimes forage in the shrub or canopy layer. Mainly breed between July and January. This species' nest is an open cup made of plant fibres and cobwebs and is built in the fork	Unlikely: The habitat at the site is unsuitable.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					of tree usually more than 2 metres above the ground; nests are often found in a dead branch in a live tree, or in a dead tree or shrub.	
<i>Stictonetta naevosa</i>	Freckled Duck	1	V	-	Occurs in freshwater swamps and creeks, lakes, reservoirs, farm dams and sewage ponds. Generally rest in dense cover during the day, usually in deep water. Feed at dawn and dusk and at night on algae, seeds and vegetative parts of aquatic grasses and sedges and small invertebrates.	Unlikely: Freshwater creek habitat is found in the site, but lack of dense cover and deep water around waterbodies mean this species is unlikely to occur.
<i>Thinornis rubricollis</i>	Hooded Plover	1	E4A	V	Found on sandy ocean beaches, tidal bays and estuaries, rock platforms, rocky or sand-covered reefs, and small beaches in lines of cliffs. Also use near-coastal saline and freshwater lakes and lagoons.	No: No suitable habitat in the site.
<i>Tyto novaehollandiae</i>	Masked Owl	1	V	-	The Masked Owl is associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland and especially the ecotone between wet and dry forest, and non-forest habitat. It is known to utilise forest margins and isolated stands of trees within agricultural land and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained.	Possible: Limited foraging habitat within the site due to lack of tall forests. Likely to occur in the locality, and periodically roam into the remnant patches of forest on the site to forage on possums and gliders.
<i>Tyto tenebricosa</i>	Sooty Owl	2	V	-	Occurs in dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests. Roosts by day in the hollow of a tall forest tree or in heavy vegetation; hunts by night for small ground mammals or tree-dwelling mammals such as the <i>Pseudocheirus peregrinus</i> (Common Ringtail Possum) or	Unlikely: Lack of suitable habitat within the site means that the species is unlikely to occur.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					<i>Petaurus breviceps</i> (Sugar Glider). Nests in very large tree-hollows.	
AMPHIBIA						
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	7 MNES: predicted	V	V	Forages in woodlands, wet heath, dry and wet sclerophyll forest. Associated with semi-permanent to ephemeral sand or rock based streams (Ehmann 1997), where the soil is soft and sandy (Environment Australia 2000).	Unlikely: the streams at the site are unsuitable for this species.
<i>Litoria aurea</i>	Green and Golden Bell Frog	3 MNES: predicted	E1	V	This species has been observed utilising a variety of natural and man-made waterbodies (Pyke & White 1996) such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands and billabongs, stormwater detention basins, farm dams, bunded areas, drains, ditches and any other structure capable of storing water (DEC 2007). Fast flowing streams are not utilised for breeding purposes by this species. Preferable habitat for this species includes attributes such as shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading (DEC 2007). Large permanent swamps and ponds exhibiting well-established fringing vegetation (especially bulrushes— <i>Typha</i> sp. and spikerushes— <i>Eleocharis</i> sp.) adjacent to open grassland areas for foraging are preferable (Ehmann 1997; Robinson 1994). Ponds that are typically inhabited tend to be free from predatory fish such as	Unlikely: Few records in the locality. Known populations to the east of the site, but dispersal into site limited by an estuarine stream and other barriers.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					Mosquito Fish (<i>Gambusia holbrooki</i>) (DEC 2007).	
<i>Litoria littlejohni</i>	Littlejohn's Tree Frog, Heath Frog	MNES: predicted	V	V	Occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops.	Unlikely: No local records and unsuitable density of vegetation around watercourses found in the site.
<i>Mixophyes balbus</i>	Stuttering Frog, Southern Barred Frog	MNES: predicted	E1	V	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor. Breed in streams during summer after heavy rain. Eggs are laid on rock shelves or shallow riffles in small, flowing streams.	Unlikely: no local records and habitat unsuitable.
MAMMALS						
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	7	V	-	In NSW it extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes. Occurs in rainforest, sclerophyll forest (including Box-Ironbark), woodland and heath. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes. Also eats soft fruits and insects. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum dreys or thickets of vegetation. Young can be born whenever food sources are available, however most births occur between late spring and early autumn. Frequently spends time in torpor especially in winter.	Unlikely: Some records in the locality but only a small amount of isolated potential habitat is present in the site.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat, Large Pied Bat	5 MNES: predicted	V	V	Occurs in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 1998; DECC 2007). Roosts in caves, rock overhangings and disused mine shafts, and is associated with rock outcrops and cliff faces (Churchill 1998; DECC 2007).	Unlikely: Very limited potential foraging habitat due to the site being predominantly cleared, and no potential roost sites.
<i>Dasyurus maculatus maculatus</i>	Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	9 MNES: predicted	V	E	Inhabits a range of forest communities including wet and dry sclerophyll forests, coastal heathlands and rainforests, more frequently recorded near the ecotones of closed and open forest within 200km of the coast.	Unlikely: Lack of suitable habitat within the site means that the species is unlikely to occur.
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	2	V	-	A large vespertilionid which feeds on moths and insects. Known to roost in caves, abandoned buildings, but mostly in tree hollows in higher rainfall forested areas. It is suspected that some populations migrate in winter from higher altitudes to coastal areas, or may simply enter torpor. Prefers tall forests (>20 m high) and extensive movements (e.g. 12 km recorded between foraging and roost sites).	Possible: Tree hollows in study area could offer roosting habitat.
<i>Isodon obesulus obesulus</i>	Southern Brown Bandicoot	MNES: predicted	E	E	Associated with heath, coastal scrub, sedgeland, heathy forests, shrubland and woodland on well drained, infertile soils, within which they are typically found in areas of dense ground cover.	Unlikely: No suitable habitat within the site. Appears locally extinct with recent re-introduction into Booderee National Park.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Macropus parma</i>	Parma Wallaby	1	V	-	Occurs in moist eucalypt forest, rainforest margins and occasionally drier eucalypt forest. Typically feed at night on grasses and herbs in more open eucalypt forest and the edges of nearby grassy areas. During the day they shelter in dense cover.	Unlikely: Habitat at site too patchy and isolated to support this species.
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	6	V	-	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). Will utilise caves, old mines and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1995).	Possible: No roosting habitat within the site with the possible exception of farm buildings. May occasionally forage over agricultural land and in remnant forest patches as part of a broader habitat.
<i>Mormopterus norfolkensis</i>	East-coast Freetail-bat	5	V	-	Associated with dry eucalypt forest and woodland, but may occur over rocky rivers in rainforest and wet sclerophyll forest. Primarily roosts in hollows or behind loose bark in mature eucalypts, but also found in disused buildings and other novel roost sites (Environment Australia 2000; Allison & Hoyer 1998).	Possible.
<i>Myotis (Macropus) macropus</i>	Southern Myotis	5	V	-	Occurs in a range of habitats including mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodlands, as long as they are close to water (Churchill 1998). Roosting is most commonly associated with caves but often found in culverts and under bridges (wooden and other).	Possible: The site contains a number of watercourses with surrounding vegetation and permanent open waterbodies in the form of dams.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Petaurus australis</i>	Yellow-bellied Glider	150	V	-	Found in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Den, often in family groups, in hollows of large trees. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein.	Unlikely: High number of local records but the species is unlikely to occur in the vegetated remnants in the site due to its isolation.
<i>Petauroides volans</i>	Greater Glider	MNES: predicted	-	V	The Greater Glider is an arboreal nocturnal marsupial, largely restricted to eucalypt forests and woodlands. It is primarily folivorous, with a diet mostly comprising eucalypt leaves, and occasionally flowers (Kehl & Borsboom 1984; Kavanagh & Lambert 1990; van der Ree <i>et al.</i> , 2004). It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows (Andrews <i>et al.</i> , 1994; Smith <i>et al.</i> , 1994, 1995; Kavanagh 2000; Eyre 2004; van der Ree <i>et al.</i> , 2004; Vanderduys <i>et al.</i> , 2012). The distribution may be patchy even in suitable habitat (Kavanagh 2000). The greater glider favours forests with a diversity of eucalypt species, due to seasonal variation in its preferred tree species (Kavanagh 1984).	Unlikely: No local records. The species is unlikely to occur in the vegetated remnants in the site due to its isolation.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	1 MNES: predicted	E1	V	Occurs on rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges. Browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night.	No: No suitable rocky habitat in the site.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Phascolarctos cinereus</i>	Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)	1 MNES: predicted	V	V	Associated with both wet and dry eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70% with eucalyptus food trees (Reed et al. 1990).	No: Preferred browse species only present as a result of ornamental plantings – site naturally did not contain Koala habitat, and lack of evidence to indicate a local Koala population in the study area.
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo (SE mainland)	MNES: predicted	V	V	Associated with dry coastal heath and dry and wet sclerophyll forests (Strahan 1998) with dense cover for shelter and adjacent more open areas for foraging (Menkhorst & Knight 2004).	Unlikely: Lack of habitat with suitable understorey required by this species in the site.
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	MNES: predicted	-	V	Found in open heathlands, woodlands and forests with a heathland understorey, vegetated sand dunes. It is a social animal, living predominantly in burrows shared with other individuals.	Unlikely: Lack of habitat with suitable understorey required by this species in the site.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	40 MNES: predicted	V	V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Churchill 1998; Eby 1998). Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (Churchill 1998).	Possible: Potential foraging habitat at the site.
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat	1	V	-	Found in most habitats, and is dependent on suitable hollow-bearing trees to provide roost sites (Environment Australia 2000).	Possible.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	4	V	-	Associated with moist gullies in mature coastal forest or rainforest, east of the Great Dividing Range (Churchill 1998) tending to be more frequently located in more productive forests (Hoye & Richards 1998).	Possible: Marginal habitat present.
REPTILES						
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	MNES: predicted	E1	V	Occurs in dry and wet sclerophyll forests, riverine forests, coastal heath swamps, rocky outcrops, heaths, grassy woodlands. Largely confined to Triassic and Permian sandstones within the coast and ranges in an area within approximately 250 km of Sydney.	No: No suitable rocky sandstone habitat located within the site.
LISTED MIGRATORY SPECIES						
<i>Actitis hypoleucos</i>	Common Sandpiper	MNES: predicted	-	M	Summer migrant to Australia in August – May. In NSW, widespread along coastline and also occurs in many areas inland. Occurs in coastal wetlands and some inland wetlands, especially muddy margins or rocky shores. Also estuaries and deltas, lakes, pools, billabongs, reservoirs, dams and claypans, mangroves.	Unlikely: Limited foraging, roosting or nesting habitat located within the site.
<i>Apus pacificus</i>	Fork-tailed Swift	MNES: predicted	-	M	Varied habitat with a possible tendency to more arid areas but also over coasts and urban areas (Simpson & Day 1999).	Possible: May occasionally forage over site and locality as part of wider range.
<i>Arenaria interpres</i>	Ruddy Turnstone	MNES: predicted	-	M	Summer migrant to most coastal regions, with occasional records inland, including in NSW. Occurs in tidal reefs and pools; pebbly, shelly and sandy shores; mudflats; inland shallow	Unlikely: No suitable habitat at the site.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					waters; sewage ponds, saltfields; ploughed ground.	
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	MNES: predicted	-	M	Summer migrant to Australia in August – April. Widespread in most regions of NSW, especially in coastal areas, but sparse in the south-central Western Plain and east Lower Western Regions. Occurs in shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation.	Unlikely: No suitable habitat at the site.
<i>Calidris alba</i>	Sanderling	MNES: predicted	-	M	Occur along the NSW coast, with occasional inland sightings. Arrives from September and leaves by May (some may overwinter in Australia). Found in coastal areas on low beaches of firm sand, near reefs and inlets, along tidal mudflats and lagoons; rarely recorded in near-coastal wetlands.	No: No suitable habitat in the site.
<i>Calidris ferruginea</i>	Curlew Sandpiper	MNES: predicted	-	M	Occurs along the entire coast of NSW, and sometimes in freshwater wetlands in the Murray-Darling Basin. Occurs in littoral and estuarine habitats, including intertidal mudflats, non-tidal swamps, lakes and lagoons on the coast and sometimes inland.	No: No foraging, roosting or nesting habitat located within the site.
<i>Calidris melanotos</i>	Pectoral Sandpiper	MNES: predicted	-	M	Summer migrant to Australia in September – June. Widespread but scattered in NSW. East of the Great Divide, recorded from Casino and Ballina, south to Ulladulla. West of the Great Divide, widespread in the Riverina and Lower Western regions. Occurs in shallow fresh to saline wetlands, including coastal lagoons, estuaries, bays, swamps, lakes, inundated	No: No foraging, roosting or nesting habitat located within the site.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.	
<i>Calidris ruficollis</i>	Red-necked Stint	MNES: predicted	-	M	Summer migrant to Australia, widespread coastal and inland NSW. Tidal mudflats, saltmarshes, sandy and shelly beaches, saline and freshwater wetlands, saltfields, sewage ponds.	Unlikely: No suitable habitat at the site.
<i>Calidris tenuirostris</i>	Great Knot	MNES: predicted	-	M	Migrates to Australia from late August to early September. Most birds return north in March and April, however some individuals may stay over winter in Australia. Forages for invertebrates such as bivalve molluscs, gastropods, polychaete worms and crustaceans. Occurs in intertidal mudflats or sandflats, including inlets, bays, harbours, estuaries and lagoons.	No: No suitable habitat in the site.
<i>Calonectris leucomelas</i>	Streaked Shearwater	MNES: predicted	-	M	Regular summer visitor south to Wollongong, less common further south. Breeds on Islands off Japan and Korea, migrating south November-May.	No: No foraging, roosting or nesting habitat located within the site.
<i>Charadrius bicinctus</i>	Double-banded Plover	MNES: predicted	-	M	Found in both coastal and inland areas. During the non-breeding season (Feb to Aug), it is common in eastern and southern Australia. Found on beaches, bays and inlets, exposed reefs and rock platforms, harbours, margins of fresh or saline terrestrial wetlands such as lakes, lagoons and swamps; shallow estuaries, rivers, saltmarsh, grasslands, pasture. Sometimes associated with coastal lagoons,	No: No foraging, roosting or nesting habitat located within the site.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					inland saltlakes, saltworks, seagrass beds, kelp beds.	
<i>Charadrius mongolus</i>	Greater Sand Plover, Large Sand Plover	MNES: predicted	-	M	Summer migrant to Australia. Found around the entire coast but in NSW most common on north coast. Rarely recorded south of the Shoalhaven estuary, and there are few inland records. Almost entirely coastal in NSW, using sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats, sandy beaches, coral reefs and rock platforms.	No: No foraging, roosting or nesting habitat located within the site.
<i>Charadrius veredus</i>	Oriental Plover, Oriental Dotterel	MNES: predicted	-	M	Regular summer migrant to Australia, recorded all states including coastal NSW. Occurs in open plains, ploughed land, inland swamps, tidal mudflats, claypans, coastal marshes, grassy airfields, playing fields, lawns.	Unlikely: Limited suitable habitat in the site.
<i>Cuculus optatus</i> (<i>Cuculus saturatus</i>)	Oriental Cuckoo, Horsfield's Cuckoo	MNES: predicted	-	M	Monsoon forests, rainforest edges, leafy trees in paddocks, river flats, roadsides, mangroves and islands are all listed as habitat utilised by the species.	Unlikely: Rare visitor to locality; limited suitable habitat on site.
<i>Gallinago hardwickii</i>	Latham's Snipe, Japanese Snipe	MNES: predicted	-	M	A variety of permanent and ephemeral wetlands, preferring open fresh water wetlands with nearby cover (Marchant and Higgins 1999).	Unlikely: Limited suitable habitat at the site.
<i>Hirundapus caudacutus</i>	White-throated Needletail	MNES: predicted	-	M	Prefers wooded areas (Marchant & Higgins 1993; Simpson & Day 1999). Roosts in dense foliage of canopy trees and may seek refuge in tree hollows during inclement weather (Marchant & Higgins 1993).	Possible: May occasionally forage over site or roost in forested remnants.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	MNES: predicted	-	M	Occur occasionally on the southern Australian coast. In NSW, mainly recorded in Hunter River estuary, with birds occasionally reaching the Shoalhaven estuary. There are few records for inland NSW. Found in sheltered parts of the coast such as estuarine sandflats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs.	No: No foraging, roosting or nesting habitat located within the site.
<i>Limosa lapponica</i>	Bar-tailed Godwit	MNES: predicted	-	M	Summer migrant to Australia. Widespread along the coast of NSW, including the offshore islands. Also numerous scattered inland records. Occurs in intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons, bays, seagrass beds, saltmarsh, sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms, and coral reef-flats. Rarely inland wetlands, paddocks and airstrips.	No: No foraging, roosting or nesting habitat located within the study area.
<i>Limosa limosa</i>	Black-tailed Godwit	MNES: predicted	-	M	Arrives in August and leaves in March. In NSW, most frequently recorded at Kooragang Island, with occasional records elsewhere along the coast, and inland in the Murray-Darling Basin, on the western slopes of the Northern Tablelands and in the far north-western corner of the state. Occurs mainly in coastal habitats such as intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays as well as coastal sewage farms and saltworks, salt lakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms and coral reef flats.	No: No foraging, roosting or nesting habitat located within the study area.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
<i>Monarcha melanopsis</i>	Black-faced Monarch	MNES: predicted	-	M	Rainforest and eucalypt forests, feeding in tangled understorey (Blakers et al. 1984).	Unlikely: Very limited preferred habitat located within the site.
<i>Monarcha trivirgatus</i>	Spectacled Monarch	MNES: predicted	-	M	Associated with wet forests and mangroves (Simpson & Day 1999).	Unlikely: No preferred habitat located within the site.
<i>Motacilla flava</i>	Yellow Wagtail	MNES: predicted	-	M	Regular summer migrant to mostly coastal Australia. In NSW recorded Sydney to Newcastle, the Hawkesbury and inland in the Bogan LGA. Found in swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land, lawns.	Unlikely: No preferred habitat located within the site.
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	MNES: predicted	-	M	In NSW, widespread on and east of the Great Divide and sparsely scattered on the western slopes, with very occasional records on the western plains. Occurs in Eucalypt-dominated forests, especially near wetlands, watercourses, and heavily-vegetated gullies. Breeding occurs in NSW between November and March.	Possible: Limited preferred habitat of eucalypt forests near wetlands and watercourses located within the site.
<i>Numenius madagascariensis</i>	Eastern Curlew	MNES: predicted	-	M	Intertidal coastal mudflats, coastal lagoons and sandy spits (DEH 2005a).	No: No foraging, roosting or nesting habitat located within the site.
<i>Numenius phaeopus</i>	Whimbrel	MNES: predicted	-	M	Summer migrant to Australia. Found along almost the entire coast of NSW; scattered inland records. Found in estuaries, mangroves, tidal flats, coral cays, exposed reefs, flooded paddocks, sewage ponds, grasslands, sports fields, lawns.	No: No foraging, roosting or nesting habitat located within the site.
<i>Pandion haliaetus</i>	Osprey	MNES: predicted	-	M	Common around the northern NSW coast, and uncommon to rare from coast further south.	No: No foraging, roosting or nesting habitat located within the site.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					Some records from inland areas. Occurs on rocky shorelines, islands, reefs, mouths of large rivers, lagoons and lakes.	
<i>Pluvialis fulva</i>	Pacific Golden Plover	MNES: predicted	-	M	Regular widespread summer migrant to Australia, including coastal NSW, Lord Howe and Norfolk Island. Found in estuaries, mudflats, saltmarshes, mangroves, rocky reefs, inland swamps, ocean shores, paddocks, sewage ponds, ploughed land, airfields, playing fields.	No: No foraging, roosting or nesting habitat located within the site.
<i>Rhipidura rufifrons</i>	Rufous Fantail	MNES: predicted	-	M	Occurs in rainforest, dense wet eucalypt and monsoon forests, paperbark and mangrove swamps and riverside vegetation (Morcombe 2004).	No: No foraging, roosting or nesting habitat located within the site.
<i>Tringa brevipes</i>	Grey-tailed Tattler	MNES: predicted	-	M	Summer migrant to Australia. In NSW, distributed along most of the coast from the Qld border, south to Tilba Lake. More heavily distributed along coastal regions north of Sydney. Found in sheltered coasts with reefs and rock platforms or intertidal mudflats; intertidal rocky, coral or stony reefs; shores of rock, shingle, gravel or shells; embayments, estuaries and coastal lagoons; lagoons and lakes; and ponds in sewage farms and saltworks.	No: No foraging, roosting or nesting habitat located within the site.
<i>Tringa glareola</i>	Wood Sandpiper	MNES: predicted	-	M	Summer migrant to Australia. In NSW, recorded east of the Great Divide, from Stratheden and Casino, south to Nowra and elsewhere, mostly from the Riverina, but also from the Upper and Lower Western Regions. Occurs in well-vegetated, shallow, freshwater	No: No foraging, roosting or nesting habitat located within the site.

Scientific Name	Common Name	Records	NSW TSC Act	EPBC Act	Habitat Associations	Likelihood of Occurrence
					wetlands, such as swamps, billabongs, lakes, pools and waterholes; inundated grasslands; floodplains; irrigated crops; sewage ponds; reservoirs; large farm dams; bore drains; rarely brackish wetlands and saltmarsh.	
<i>Tringa nebularia</i>	Common Greenshank	MNES: predicted	-	M	Summer migrant to Australia in September – April. Recorded in most coastal regions of NSW; also widespread west of the Great Dividing Range, especially between the Lachlan and Murray Rivers and the Darling River drainage basin, including the Macquarie Marshes, and north-west regions. Occurs in terrestrial wetlands (swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans, saltflats, sewage farms and saltworks dams, inundated rice crops and bores) and sheltered coastal habitats (mudflats, saltmarsh, mangroves, embayments, harbours, river estuaries, deltas, lagoons, tidal pools, rock-flats and rock platforms).	No: No foraging, roosting or nesting habitat located within the site.
<i>Tringa stagnatilis</i>	Marsh Sandpiper, Little Greenshank	MNES: predicted	-	M	Summer migrant to Australia. Recorded in all regions of NSW but especially the central and south coasts and (inland) on the western slopes of Great Divide and western plains. Found in swamps, lagoons, billabongs, salt pans, saltmarshes, estuaries, pools on inundated floodplains, intertidal mudflats, sewage farms and saltworks, reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes.	No: No foraging, roosting or nesting habitat located within the site.

Appendix B : Flora species list

Table 18: Site recorded flora species

Scientific Name	Common Name	PCT 1206	PCT 1245	Pasture	Dams / Riparian
<i>Acacia binervia</i>	Coast Myall	X	X		
<i>Acacia longifolia</i>	Sydney Golden Wattle	X	X		
<i>Acacia longifolia</i>	Sydney Golden Wattle	X			
<i>Acacia mearnsii</i>	-	X	X		
<i>Acacia mearnsii</i>	Black Wattle	X	X		
<i>Acacia terminalis</i>	Sunshine Wattle	X			
<i>Acmena smithii</i>	Brush Cherry	X	X		
<i>Adiantum aethiopicum</i>	Common maidenhair	X	X		
<i>Adiantum formosum</i>	Giant Maidenhair	X	X		
<i>Ageratina riparia</i>	*Mistflower		X		
<i>Allocasuarina littoralis</i>	Black She-oak	X			
<i>Amyema</i> spp.	Mistletoe				
<i>Anagallis arvensis</i>	*Scarlet Pimpernel		X	X	
<i>Andropogon virginicus</i>	*Whisky Grass	X		X	
<i>Angophora floribunda</i>	Rough-barked Apple	X			
<i>Anredera cordifolia</i>	*Madeira vine		X		
<i>Araujia sericifera</i>	*Moth Vine		X		
<i>Aristida vagans</i>	Threeawn Speargrass	X	X	X	
<i>Axonopus fissifolius</i>	*Narrow-leaved Carpet Grass	X	X	X	
<i>Azolla</i> spp.	Azolla		X		X
<i>Bidens pilosa</i>	*Cobbler's Tack	X	X	X	
<i>Billardiera scandens</i>	Apple Berry	X	X		

Scientific Name	Common Name	PCT 1206	PCT 1245	Pasture	Dams / Riparian
<i>Bolboschoenus caldwellii</i>	-				X
<i>Breynia oblongifolia</i>	Coffee Bush	X	X		
<i>Briza major</i>	*Large Shivery Grass			X	
<i>Briza minor</i>	*Shivery Grass	X	X	X	
<i>Bromus willdenowii</i> (formerly <i>B. catharticus</i>)	*Prairie Grass	X	X	X	
<i>Bursaria spinosa</i>	Blackthorn	X	X	X	
<i>Bursaria spinosa</i>	Native Blackthorn	X	X	X	
<i>Calochlaena dubia</i>	False Bracken	X			
<i>Carduus tenuiflorus</i>	*Winged Thistle		X	X	
<i>Carex appressa</i>		X	X	X	X
<i>Carex longibrachiata</i>	Bergalia Tussock	X	X	X	X
<i>Cassinia aculeata</i>	Dolly Bush	X			
<i>Cassytha</i> spp.	Devil's Twine	X			
<i>Centella asiatica</i>	Gotu kola	X	X		
<i>Cirsium vulgare</i>	*Spear Thistle				
<i>Clematis aristata</i>	Forest Clematis		X		
<i>Clerodendrum tomentosum</i>	-	X	X		
<i>Commelina cyanea</i>	Scurvy Weed		X		
<i>Conyza</i> spp.	*Fleabane	X	X	X	
<i>Corymbia gummifera</i>	Red Bloodwood	X			
<i>Corymbia maculata</i>	Spotted Gum	X	X	X	
<i>Daviesia ulicifolia</i>	Gorse Bitter-pea	X			
<i>Desmodium varians</i>	Slender Tick-trefoil	X			
<i>Dianella caerulea</i> var. <i>caerulea</i>	A Blue Flax Lily	X			
<i>Dichelachne micrantha</i>	Shorthair Plumegrass	X	X	X	
<i>Dichondra repens</i>	Kidney Weed	X	X	X	

Scientific Name	Common Name	PCT 1206	PCT 1245	Pasture	Dams / Riparian
<i>Diospyros australis</i>	Black Plum	X	X		
<i>Doodia aspera</i>	Rasp Fern	X			
<i>Echinopogon</i> sp.	Hedgehog Grass	X			
<i>Ehrharta erecta</i>	*Panic Veldgrass	X	X		
<i>Entolasia marginata</i>	Bordered Panic	X			
<i>Entolasia stricta</i>	Wiry Panic	X			
<i>Erythrina crista-galli</i>	* Cockspur coral tree				
<i>Erythrina x sykesii</i>	*Coral Tree			X	
<i>Eucalyptus globoidea</i>	White Stringybark	X	X		
<i>Eucalyptus microcorys</i>	Tallowwood			X	
<i>Eucalyptus paniculata</i> subsp. <i>paniculata</i>	Grey Ironbark	X	X		
<i>Eucalyptus pilularis</i>	Blackbutt	X			
<i>Eucalyptus robusta</i>	Swamp Mahogany			X	
<i>Eucalyptus saligna</i> x <i>botryoides</i>	Sydney Blue Gum complex	X	X		
<i>Eucalyptus tereticornis</i>	Forest Red Gum	X			
<i>Eustrephus latifolius</i>	Wombat Berry	X	X		
<i>Exocarpos cupressiformis</i>	Native Cherry	X			
<i>Ficus coronata</i>	Sandpaper Fig		X		
<i>Ficus macrophylla</i>	Moreton Bay Fig	X			
<i>Geitonoplesium cymosum</i>	Scrambling Lily	X	X		
<i>Glochidion ferdinandi</i>	Cheese Tree	X	X		
<i>Glycine clandestina</i>	Common Glycine	X	X		
<i>Goodenia ovata</i>	Hop-Goodenia	X			
<i>Guioa semiglauca</i>	Guioa	X	X		
<i>Hibbertia obtusifolia</i>	-	X			
<i>Holcus lanatus</i>	*Yorkshire Fog	X	X	X	

Scientific Name	Common Name	PCT 1206	PCT 1245	Pasture	Dams / Riparian
<i>Hymenanthera dentata</i>	Tree Violet		X		
<i>Hypochaeris radicata</i>	*Catsear	X	X	X	
<i>Imperata cylindrica</i>	Blady grass		X		
<i>Juncus usitatus</i>	Tussock Rush		X	X	X
<i>Kennedia rubicunda</i>		X			
<i>Kunzea ambigua</i>	Tickbush	X			
<i>Lachnagrostis filiformis</i>	Coast Blowngrass	X	X		
<i>Lastreopsis acuminata</i>	Shieldfern		X		
<i>Ligustrum lucidum</i>	*Broad-leaved Privet	X			
<i>Ligustrum sinense</i>	*Small-leaved Privet		X		
<i>Lolium perenne</i>	*Common Ryegrass	X	X	X	
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush	X	X		
<i>Ludwigia</i> spp.	Ludwigia		X		X
<i>Marsdenia rostrata</i>	Common Milk Vine	X	X		
<i>Melaleuca quinquenervia</i>	Broad-leaved Melaleuca		X		
<i>Melaleuca styphelioides</i>	Prickly-leaved Melaleuca		X	X	X
<i>Microlaena stipoides</i>	Weeping Grass	X	X		
<i>Modiola caroliniana</i>	Red-flowered Mallow		X	X	
<i>Morus</i> spp.	Mulberry		X		
<i>Myrsine variabilis</i>	Muttonwood	X	X		
<i>Notelaea longifolia</i>	Native Olive				
<i>Opismenus aemulus</i>	Australian Basket Grass	X	X		
<i>Opismenus imbecillis</i>	Creeping Beard Grass	X	X		

Scientific Name	Common Name	PCT 1206	PCT 1245	Pasture	Dams / Riparian
<i>Oplismenus imbecillis</i>	Basket Grass	X	X		
<i>Ottelia ovalifolia</i>			X		X
<i>Ozothamnus diosmifolius</i>	White Dogwood				
<i>Pandorea pandorana</i>	Wonga Wonga Vine	X	X		
<i>Parsonsia straminea</i>	Monkey Rope	X	X		
<i>Paspalum distichum</i>	Water Couch			X	X
<i>Pellaea falcata</i>	-	X			
<i>Pennisetum clandestinum</i>	*Kikuyu	X	X	X	
<i>Persicaria decipiens</i>			X		X
<i>Persicaria hydropiper</i>	Smartweed		X	X	X
<i>Persicaria strigosa</i>			X		X
<i>Persoonia linearis</i>	Narrow-leaved Geebung	X			
<i>Phytolacca octandra</i>	*Inkweed		X		
<i>Pimelea linifolia</i>	Slender Rice Flower				
<i>Pinus elliotii</i>	*Slash Pine	X			
<i>Pittosporum multiflorum</i>	Orangethorn	X	X		
<i>Pittosporum undulatum</i>	Sweet Pittosporum	X	X		
<i>Pittosporum revolutum</i>	Rough Pittosporum	X	X		
<i>Plantago lanceolata</i>	*Plantago / Lambs Tongue	X	X	X	
<i>Poa annua</i>	*Annual Poa		X	X	
<i>Pratia purpurascens</i>	White Root	X	X		
<i>Prunus persica</i>	*Peach (edible)		X		
<i>Pteridium esculentum</i>	Common Bracken Fern	X			

Scientific Name	Common Name	PCT 1206	PCT 1245	Pasture	Dams / Riparian
<i>Ranunculus repens</i>	Creeping Buttercup				
<i>Rubus fruticosus</i> aggregate	*Blackberry	X	X	X	X
<i>Rubus moluccana</i>	Native Raspberry		X		
<i>Rumex brownii</i>	*Swamp Dock		X	X	
<i>Rumex crispus</i>	*Curled Dock		X	X	
<i>Rytidosperma racemosum</i>	Wallaby Grass	X	X	X	
<i>Senecio madagascariensis</i>	*Fireweed	X	X	X	X
<i>Sida rhombifolia</i>	*Paddies Lucerne	X	X	X	
<i>Solanum linnaeanum</i>	*Apple of Sodom	X		X	
<i>Solanum mauritianum</i>	*Native Tobacco		X		
<i>Solanum nigrum</i>	*Black Nightshade		X	X	
<i>Sporobolus africanus</i>	*Parramatta Grass	X	X	X	
<i>Syagrus romanzoffiana</i>	*Cocos Palm		X	X	
<i>Syncarpia glomulifera</i>	Turpentine	X	X		
<i>Syzygium australe</i>	Lily Pilly	X	X	X	
<i>Themeda australis</i>	Kangaroo Grass	X	X		
<i>Trifolium repens</i>	*White Clover		X	X	
<i>Typha orientalis</i>	Narrow-leaved Cumbungi		X		X
<i>Urtica urens</i>	*Stinging Nettle		X		
<i>Verbena bonariensis</i>	*Purpletop	X	X	X	
<i>Verbena rigida</i>	*Veined Verbena				
<i>Viola hederacea</i>	Native Violet		X		
<i>Zantedeschia aethiopica</i>	*Arum Lily		X		

* denotes introduced species



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