APP CORPORATION PTY LTD

JULY 2018

DIDO STREET, SPRING CREEK

ECOLOGICAL OPPORTUNITIES AND CONSTRAINTS ASSESSMENT

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Dido Street, Spring Creek
Ecological Opportunities and Constraints Assessment

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GLOSSARY

*	Denotes exotic species
BAM	Biodiversity Assessment Methodology 2017 that supports the *Biodiversity Conservation Act 2016.*
Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: — Genetic diversity — the variety of genes (or units of heredity) in any population. — Species diversity — the variety of species. — Ecosystem diversity — the variety of communities or ecosystems.
Bioregion (region)	A bioregion defined in a national system of bioregionalisation. The site is in the Sydney Basin Bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway and Cresswell 1995). For this study, the bioregion is the Sydney Basin as defined in the Interim Biogeographic Regionalisation for Australia (Thackway and Cresswell 1995).
Candidate species	Species assessed as having a moderate to high likelihood of occurrence within the subject site.
Critical habitat	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered Ecological Community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation 2004). Critical habitat is listed under the EPBC Act with the Secretary (Department of the Environment and Energy) maintaining a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under Commonwealth legislation.
Cryptic species	An inconspicuous species which can be difficult to identify.
Department of the Environment and Energy	The department develops and implements national policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage and administers the EPBC Act. The Commonwealth Department of Department of the Environment and Energy was previously known as: — Department of the Environment (DoE) — Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) — Department of the Environment, Water, Heritage and the Arts (DEWHA) — Department of Environment and Heritage (DEH) — Department of the Environment and Water Resources (DEWR).
Ecological community	An assemblage of species occupying a particular area.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.
Exotic	Introduced from outside the area (Stralberg, Jongsomjit et al. 2009). Used in the context of this report to refer to species introduced from overseas.
GPS	Global Positioning System – a navigational tool which uses radio receivers to pick up signals from four or more special satellites to provide precise determination of location.

Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic components.
Indigenous	Native to the area: not introduced (Stralberg, Jongsomjit et al. 2009).
Introduced	Not native to the area: not indigenous (Stralberg, Jongsomjit et al. 2009). Refers to both exotic and non-indigenous Australian native species of plants and animals.
Key threatening processes	A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation 2004). Key threatening processes are listed under the BC Act, the FM Act and the EPBC Act. Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant state and Commonwealth legislation.
Likely	Taken to be a real chance or possibility (Department of Environment and Conservation 2004).
Local population	The population that occurs within the site, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated as defined by Department of Environment and Climate Change (2007).
Locality	The area within a 10 kilometre radius of the project site.
Migratory species	Species listed as Migratory under the EPBC Act relating to international agreements to which Australia is a signatory. These include Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the EPBC Act.
Noxious weed	An introduced species listed under the *Noxious Weeds Act 1993*. Under the Act, noxious weeds have specific control measures and reporting requirements.
NSW	New South Wales
Plant community type (PCT)	A NSW plant community type identified using the PCT classification system.
Priorities action statements (PAS)	Priorities action statements outline the broad strategies and detailed priority actions to be undertaken in NSW to promote the recovery of Threatened species, population and ecological communities and manage key threatening processes (Department of Environment and Climate Change 2007).
Project	The proposed property, described in Section 1.
Protected species	Those species defined as protected under the *National Parks and Wildlife Act 1974*. Includes all native animals, as well as all native plants listed on Schedule 13 of the *National Parks and Wildlife Act 1974*.
Recovery plan	A plan prepared under BC Act, FM Act or the EPBC Act to assist the recovery of a threatened species, population or ecological community.
Region	A bioregion defined in a national system of bioregionalisation. The project is located within the Sydney Basin Bioregion as defined in the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell 1995).

Significant	Important, weighty or more than ordinary.
Species richness	Species richness is simply the number of species present in a sample, community, or taxonomic group. Species richness is one component of the concept of species diversity, which also incorporates evenness, that is, the relative abundance of species (Matteson and Langellotto 2010).
Study area	The area in which the project will occur (Figure 1.1): — Lot 2 on DP805229 — Lot 11 on DP810839 — Lot 45 on DP800176 — Lot 30 on DP829815.
Threatened biodiversity	Threatened species, populations or ecological communities as listed under the BC Act, FM Act or the EPBC Act.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as threatened) under the BC Act, FM Act or the EPBC Act. Capitalisation of the terms 'Vulnerable', 'Endangered' or 'Critically Endangered' in this report refers to listing under the relevant state and/or Commonwealth legislation.
Viable local population	A population that has the capacity to live, develop and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (Department of Environment and Climate Change 2007).
Weed	A plant growing out of place or where it is not wanted: often characterised by high seed production and the ability to colonise disturbed ground quickly (Stralberg, Jongsomjit et al. 2009). Weeds include both exotic and Australian native species of plant naturalised outside of their natural range.

ABBREVIATIONS

BC Act	*Biodiversity Conservation Act 2016*
BDAR	Biodiversity Development Assessment Report
BAM	Biodiversity Assessment Methodology (2014)
HA	Hectares
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FM Act	NSW *Fisheries Management Act 1994*
GDEs	Groundwater Dependant Ecosystems
OEH	Office of Environment and Heritage
PCT	Plant Community Type
SAII	Serious and Irreversible Impact
SEARS	Secretary's Environmental Assessment Requirements
TSC Act	NSW *Threatened Species Conservation Act 1995* (BC Act repealed TSC Act).

1 PROJECT BACKGROUND

1.1 PROJECT DETAILS

Boral Resources (NSW) Pty Limited (Boral) and Kiama Municipal Council (KMC) own two adjoining properties to the north of Kiama township and to the south of the Bombo quarries, both of which are owned by Boral and the State of NSW Government and operated by Sydney Trains. The property owned by Boral has been historically retained as buffer land to the operating quarry.

The quarry resources are now depleted and the quarry is due to cease operations in the near future. As a result, the buffer land is now considered surplus to Boral's requirements. Both Boral and KMC wish to develop the land for residential purposes and have sought to jointly engage consultants to prepare a draft Development Control Plan (DCP) for the following properties:

- Lot 2 on DP805229 (34.9 ha) at Dido Street, Kiama owned by Boral
- Lot 11 on DP810839 (78.8 ha) at Glenbrook (Homestead), Bombo owned by KMC
- Lot 45 on DP800176 at Glenbrook Drive, Kiama owned by KMC
- Lot 30 on DP829815 ("paper road" between Lot 11 DP810839).

The above listed properties (study area) are located to the north of Kiama township and to the south of Bombo quarries.

A draft DCP for the subject properties is to be produced to allow them to be developed independently by each respective land owner, whilst integrating all properties into the draft DCP (master plan). The draft DCP will be utilised to form the basis of development application(s) to subdivide the properties. As part of this process, the draft DCP needs to consider various environmental factors associated with subject properties, one of which is an understanding of the potential ecological constraints contained within each property.

To achieve this desired outcome APP Corporation Pty Limited (APP), on behalf of Boral and KMC, has requested WSP provide ecological services to deliver an Ecological Constraints Assessment for the three properties to inform and accompany the draft DCP.

1.2 PURPOSE OF THIS REPORT

The purpose of this Biodiversity Opportunities and Constraints Assessment report is to address biodiversity legislative matters to support a DCP for the listed properties above.

1.3 STUDY AREA CONTEXT

The study area occurs predominately in the suburb of Kiama in the Kiama LGA. The land use within the study area is mainly agricultural use being low intensity grazing. The study area also includes the following lots:

- Lot 2 on DP805229 (3.658 ha) at Dido Street, Kiama owned by Boral
- Lot 11 on DP810839 (78.8 ha) at Glenbrook (Homestead), Bombo owned by KMC
- Lot 45 on DP800176 (1.3 ha) at Glenbrook Drive, Kiama owned by KMC
- Lot 30 on DP829815 (0.3 ha) ("paper road" between Lot 11 DP810839).

Due to historic and ongoing agricultural use and surrounding residential dwellings, the biodiversity values of the study area have been heavily impacted and degraded. The majority of remnant native vegetation is in a disturbed condition.

An overview of the locality and study area context is provided in Figure 1.1.

Map: PS107151_GIS_001_A3	Author: A Labruyere		0 30 60 m 1:2,500 Coordinate system: GDA 1994 MGA Zone 56 Scale ratio correct when printed at A3
Date: 12/06/2018	Approved by: T Jennings		
Data source: Department of Finance, Services and Innovation 2017			

Dido Street, Spring Creek - Ecological Constraints Assessment

Figure 1.1

Locality and study area

2 METHODOLOGY

2.1 PERSONNEL

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

Table 2.1 Contributors and their roles

NAME	QUALIFICATION	ROLE
Troy Jennings	Bachelor Biodiversity Conservation, Masters Wildlife Management, Cert – III Conservation Land Management	Ecologist – reporting
Selga Harrington	Bachelor Science (Hons)	Principal Ecologist – field survey, reporting
Nathan Cooper	Bachelor of Environmental Science, Graduate Diploma Ornithology	Senior Ecologist – field survey, bat call analysis, reporting
Alex Cockerill	Bachelor Science (Hons)	Ecology Executive – technical review
Adam Labruyere	Master of Environmental Engineering Management, Bachelor of Science (Spatial Information Systems)	GIS consultant – map preparation and data management

All work was carried out under the appropriate licences, including a scientific licence as required under Clause 22 of the National Parks and Wildlife Regulations 2002 and Section 132C of the *National Parks and Wildlife Act 1974*, and an Animal Research Authority issued by the Department of Primary Industries (Agriculture).

2.2 NOMENCLATURE

Names of vegetation communities used in this report are based on the Plant Community Types (PCTs) used in the BioNet Vegetation Classification (Office of Environment & Heritage 2017).

These names are cross-referenced with those used for threatened ecological communities listed under the BC Act and/or the EPBC Act. They are also cross-referenced with existing vegetation mapping using dominant species and structure of the communities in:

- Native vegetation of Southeast NSW: A Revised Classification and Map for the Coast and Eastern Tablelands (Tozer, Turner et al. 2010).

Names of plants used in this document follow PlantNet Royal Botanic Gardens (Royal Botanic Gardens 2017) for recent taxonomic changes. Scientific names are used in this report for species of plant. Scientific and common names (where available) are provided in plant lists in appendices. The names of introduced species are denoted with an asterisk (*).

For threatened species of plants, the names used in the OEH Threatened Species Website (Office of Environment and Heritage 2017) are also provided in the tabulated data in appendices where these differ from the names used by PlantNet database.

Names of vertebrate fauna follow the Australian Faunal Directory maintained by the Department of the Environment (Department of Environment and Energy 2017). Common names are used in the report for species of animal. Scientific names are included in species lists found in appendices.

2.3 DESKTOP ASSESSMENT

A desktop study was conducted to identify:

- The likely distribution of vegetation communities, based on previous mapping and aerial photograph interpretation, for targeted field verification
- A list of threatened species and populations of plants to consider during vegetation surveys and habitat assessment
- A list of threatened species and populations of animals and migratory animals to consider during field-based habitat assessment
- Local landscape-scale features of potential significance to biodiversity; e.g. riparian zones and potential wildlife movement corridors.

The desktop study included analysis of the following information sources:

- Topographic map and aerial photographs
- Noxious weed declarations online database NSW Department of Trade and Investment (Department of Primary Industries (Agriculture) 2016) for the Kiama Local Control Authority
- Previous vegetation mapping, ecological studies and other relevant studies of the study area:
  - Flora and Fauna Assessment undertaken by Lesryk Environmental Consultants (LesryK Environmental Consultants 2007)
  - Native vegetation of Southeast NSW: A Revised Classification and Map for the Coast and Eastern Tablelands (Tozer, Turner et al. 2010).

In addition to the literature listed above database searches of threatened species, populations and communities were conducted in the locality and are summarised below in Table 2.2.

Table 2.2 Database searches

DATABASE	SEARCH DATE	AREA SEARCHES	REFERENCE
PlantNet Database	09/01/2018	10 km radius centred on the study area	(Royal Botanic Gardens 2018)
OEH BioNet Atlas of NSW Wildlife	09/01/2018	10 km x 10 km centred on the study area	(Office of Environment & Heritage 2018)
EPBC Protected Matters Search Tool	09/01/2018	10 km x 10 km centred on the study area	(Department of the Environment and Energy 2018)
NSW Department of Primary Industries (Fishing and Aquaculture) threatened Aquatic Fauna Database	09/01/2018	Kiama LGA	(Department of Primary Industries 2018)

2.4 VEGETATION SURVEYS

2.4.1 STRATIFICATION – DESKTOP ANALYSIS OF VEGETATION

Preliminary mapping of vegetation community boundaries was undertaken through analysis of existing vegetation mapping and aerial photograph interpretation.

Analysis of the aerial photographs was used to identify areas of disturbance (e.g. buildings, vehicle tracks, dams and power lines), vegetation structure and likely native versus exotic species composition throughout the study area. This provided an initial definition of vegetation communities into simple structural and disturbance classifications for verification during field surveys.

The stratification included analysis of existing vegetation mapping and aerial photography.

2.4.2 RANDOM MEANDER SURVEY

Random meander surveys are a variation of the transect type survey and were completed in accordance with the technique described by (Cropper 1993), whereby the recorder walks in a random meander throughout the study area recording dominant and key plant species (e.g. threatened species, noxious weeds), boundaries between various vegetation communities and condition of vegetation. The time spent in each vegetation community was generally proportional to the size of the community and its species richness. This survey technique was used to verify vegetation boundaries and stratification from the desktop analysis.

2.4.3 TRANSECT SURVEYS

Parallel transects (approximately 5 m apart) were walked within areas of native plant community types including subtropical rainforest and riparian forest communities to search for threatened species of plant.

2.4.4 VEGETATION INTEGRITY PLOTS

Vegetation integrity plots were undertaken following the Biodiversity Assessment Methodology as required for assessment under the new *Biodiversity Conservation Act 2016* (BC Act) which commenced on 25 August 2017.

Quantitative (quadrat/transect) surveys (Table 2.3 and Figure 2.2) were undertaken as outlined in the methodology contained within the BAM and as described below. Figure 2.1 illustrates the plot layout that was used at each plot site.

Table 2.3 Location and orientation of BAM vegetation integrity plots

PLOT	PCT	VEGETATION	LATITUDE	LONGITUDE	ORIENTATION
B1	659	Bangalay – Old-man Banksia open forest on coastal sands	150.8505	-34.6602	320
C1	1236	Swamp Paperbark – Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion	150.8491	-34.6597	75
R3	1300	Whalebone Tree – Native Quince dry subtropical rainforest on dry fertile slopes, southern Sydney Basin Bioregion	150.8453	-34.6583	350
R5			150.8477	-34.6603	245

Note: Co-ordinate GDA94 Zone 56

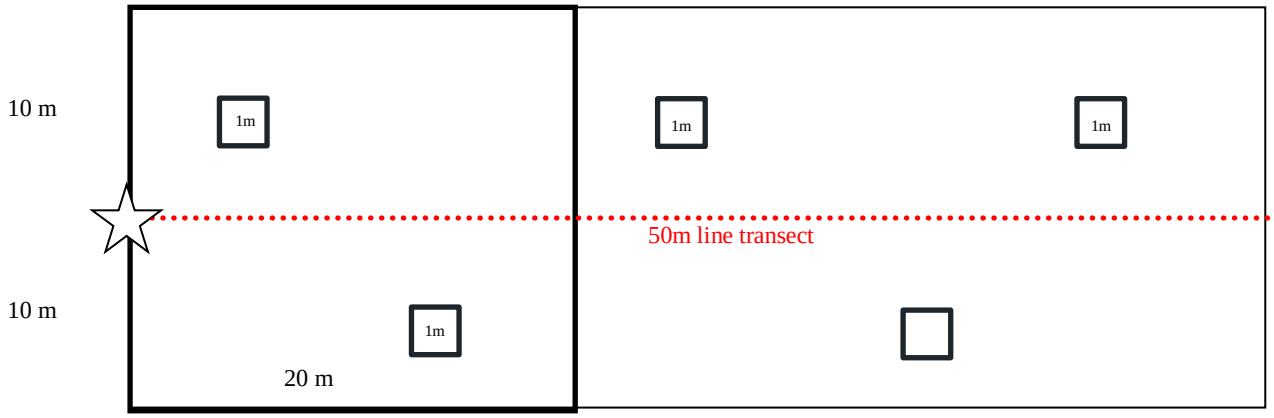


Figure 2.1 Schematic diagram illustrating the layout of the nested 20 x 50 m, 20 x 20 m and 1 x 1 m sub-quadrats used for the assessment of condition attributes at each survey site

The following site attributes were recorded at each survey site:

- **Location** (easting – northing grid type MGA 94, Zone 56).
- **Native and exotic species richness** (within a 400 m^2 quadrat): This consisted of recording all species by systematically walking through each 20 x 20 m quadrat. The cover and abundance (percentage of area of quadrat covered) of each species was estimated. The growth form, stratum/layer and whether each species was native/exotic/high threat weed was also recorded.
- **Number of trees with hollows** (1,000 m^2 quadrat): This was the frequency of hollows within living and dead trees within each 50 x 20 m quadrat. A hollow was only recorded if (a) the entrance could be seen: (b) the estimated entrance width was at least 5 cm across: (c) the hollow appeared to have depth: (d) the hollow was at least 1 m above the ground and the (e) the centre of the tree was located within the sampled quadrat.
- **Number of large trees and stem size diversity** (1,000 m^2 quadrat): tree stem size diversity was recorded by measuring the diameter at breast height (DBH) (i.e.1.3 m from the ground) of living trees (>5 cm DBH) within each 50 x 20 m quadrat. For multi-stemmed living trees, only the largest stem was included in the count. Number of large trees was determined by counting all trees with DBH greater than the DBH large trees for each vegetation formation.
- **Evaluation of regeneration**: This was estimated as the presence/absence of overstorey species present at the site that was regenerating (i.e. saplings with a diameter at breast height ≤5 cm.
- **Total length of fallen logs** (1,000 m^2 quadrat): This was the cumulative total of logs within each 50 x 20 m quadrat with a diameter of at least 10 cm and a length of at least 0.5 m.
- **Litter cover**: This comprised estimating the average percentage groundcover of litter (i.e. leaves, seeds, twigs, branchlets and branches with a diameter <10 cm which is detached from a living plant) from within five 1 x 1 m sub-plots spaced evenly either side of the 50 m central transect.

2.4.4.1 FLORISTIC ANALYSIS

Floristic analysis of vegetation plot data was undertaken to determine the vegetation community and plant community type. This included comparison with OEH Vegetation Information System (VIS) Classification Database (Office of Environment & Heritage 2018).

2.4.4.2 VEGETATION CONDITION CLASS

The vegetation within the study area was firstly assessed to a PCT and then aligned to a vegetation zone which is defined in the BAM as '*an area of native vegetation on the subject land that is the same PCT and has a similar broad condition state'* (Office of Environment & Heritage 2017). A broad condition state infers that the vegetation has a similar tree cover, shrub cover, ground cover, weediness or combinations of these attributes which determine vegetation condition.

The vegetation broad condition states which were applied to vegetation within the study area are summarised in Table 2.4. These factors were defined by using factors such as level of disturbance, weed invasion and resilience.

Table 2.4 Vegetation broad condition states

CONDITION CATEGORY	DESCRIPTION
High	Vegetation still retains the species complement and structural characteristics. The vegetation displays resilience to weed invasion due to intact groundcover, shrub and canopy layers. Native species diversity is relatively high. Weeds may exist in this vegetation type but exhibit <5% foliage cover.
Moderate	Vegetation has retained a native canopy but the understorey and groundcover layers are generally co-dominated by exotic species that exhibit between 5–45% foliage cover. The mid and low stratums may have been structurally modified as a result of previous clearing.
Poor	Vegetation has retained a native canopy or the canopy cover is showing signs of regeneration. The understorey and groundcover layers are generally dominated or co-dominated by exotic species that exhibit between 46–70% foliage cover. Native species diversity is generally relatively low and the mid and low stratums have been structurally modified due to weed incursions or clearing.
Low	Native vegetation generally lacking a native over-storey and where either less than 50% of ground cover vegetation is indigenous species, or greater than 90% of ground cover vegetation is cleared. For native grassland, wetland or herbfield where either less than 50% of ground cover vegetation is indigenous species, or more than 90% of ground cover vegetation is cleared.'

2.5 FAUNA SURVEY

This section outlines the fauna survey effort completed for candidate species which were predicted to have a moderate to high likelihood of occurrence within the study area based on database searches outlined in section 2.3. Threatened fauna surveys completed within the study area were carried out as described below and where applicable, considering the methodology detailed in the NSW Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft) (Department of Environment and Conservation 2004), the Survey Guidelines for Australia's Threatened Birds (Department of Environment Water Heritage and the Arts 2010), the Threatened Species survey and assessment guidelines: field survey and methods for fauna-Amphibians (Department of Environment and Climate Change 2009) and the Survey guidelines for Australia's threatened frogs (Department of the Environment Water Heritage and the Arts 2010).

Targeted fauna surveys for threatened species were undertaken in January 2018. Survey methods are described below and survey effort is illustrated in Figure 2.2.

2.5.1 FAUNA HABITAT ASSESSMENT

Fauna habitat assessments were undertaken to assess the likelihood of threatened species of animal (those species known or predicted to occur within the locality from the literature and database review) occurring within the study area. Fauna habitat assessments were the primary assessment tool in assessing whether threatened species is likely to occur within the study area.

Fauna habitat characteristics assessed included:

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

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

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

2.5.2 DIURNAL BIRD SURVEYS

Eighteen formal 20 minute diurnal bird searches were completed within the study area (Figure 2.2). Bird surveys were completed by actively walking through the nominated site (transect) over a period of 20 minutes. All birds were identified to the species level, either through direct observation or identification of calls. Bird surveys were completed during different times of the day, but generally occurred during morning or late afternoon hours. Birds were also recorded opportunistically during all other surveys.

Where seasonal conditions for some species were not suitable during the timing of onsite investigations, as was the case for endangered blossom nomads such as the Swift Parrot, likelihood of occurrence assessments were conducted by the presence/absence of suitable habitat and its condition.

2.5.3 SPOTLIGHTING (INCLUDING NOCTURNAL SEARCH)

Spotlighting was used to target arboreal, flying and ground-dwelling mammals, as well as, nocturnal birds, reptiles and amphibians. Spotlighting was completed after dusk and completed on foot using high-powered headlamps and hand torches. Sighted animals were identified to the species level.

Spotlighting methodology was also used to completed nocturnal streamside searches for Green and Golden Bell Frog. This involved an experienced surveyor walking through areas identified as potential habitat (i.e. patches of *Phragmites*, ephemeral soaks and adjacent drier perched habitat) along the margins of Spring Creek.

2.5.4 CALL PLAYBACK

Call playback was used to survey for frogs (i.e. Green Golden Bell Frog), nocturnal birds (i.e. Powerful Owl) and nocturnal mammals (i.e. Koala) using standard methods (Debus 1995). Vocalisations of target species were used to facilitate call playback methodology with the primary purpose being to elicit a response from the target species. Call playback was completed after dusk at five locations in the study area around key fauna habitat such as wetlands or remnant vegetation.

For each survey, an initial listening period of 10 to 15 minutes was undertaken, followed by a spotlight search for 10 minutes to detect any animals in the immediate vicinity. The calls of the target species were then played intermittently for five minutes followed by a 10 minute listening period. Calls from (Stewart 1998) were broadcast using a portable media player and megaphone.

2.5.5 MICROCHIROPTERAN BAT SURVEYS

Ultrasonic Anabat bat detection (Titley Electronics) was used to record and identify the echolocation calls of microchiropterans foraging across several native vegetation communities in the study area. Passive monitoring of these survey sites was achieved by setting Anabat bat detectors to record continuously during nocturnal spotlighting transects and call playback within the study area. Bat call analysis was completed by Nathan Cooper (WSP Senior Ecologist), with the presentation of data considering the guidelines of the Australasian Bat Society. Bat call of New South Wales Sydney Basin region (Pennay, Law et al. 2004) was used as a reference collection for bat call identification. Bat call analysis is provided in Appendix E.

2.5.6 KOALA SURVEYS

Targeted searches for the Koala were completed at four locations in the study area and consisted of inspecting feed trees for signs of usage, including Koala pellets and scratches. Koala feed tees species identified in the study area that are consistent with State Environmental Planning Policy 44 – Koala habitat protection (SEPP 44) and the Approved Recovery Plan for the Koala (South Coast/ Central Coast management areas) (Department of Environment and Climate Change 2008) included, *Eucalyptus robusta* (Swamp Mahogany) and *E. quadrangulata* (White-topped Box). At each survey location a modified Spot Assessment Technique methodology was employed, which involved actively searching the ground between the drip-line of the canopy and the trunk of potential feed trees for Koala pellets.

2.5.7 HERPETOFAUNA ACTIVE SEARCH

Herpetofauna active searches during the day and at nights, involved looking for active specimens and eyeshine, turning over suitable ground shelter, such as fallen timber, sheets of iron and exposed rocks, raking debris, and peeling decorticating bark. Specimens were either identified visually, by aural recognition of call (frogs only) or were collected and identified using nomenclature outlined in A Complete Guide to Reptiles of Australia (Wilson and Swan 2013).

Herpetofauna searches were completed by one person over a 30 minute period with all ground shelter returned to their original position.

2.5.8 OPPORTUNISTIC RECORDING OF FAUNA SPECIES AND EVIDENCE OF FAUNA ACTIVITY

Opportunistic sightings of animals were recorded during field surveys. Evidence of animal activity, such as scats, diggings, scratch marks, nests/dreys, burrows etc., was also noted. This provided indirect information on animal presence and activity. During these surveys, a hand-held GPS was used to record the locations of:

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

2.6 LIKELIHOOD OF OCCURRENCE ASSESSMENT

The likelihood of threatened and migratory and threatened species populations occurring within the study area was assessed against the criteria outlined in Table 2.5.

Species subject to likelihood of occurrence assessments were those identified during the desktop and field-based investigations and any additional species considered having the potential to occur in the professional opinion of contributors to this assessment.

Table 2.5 Likelihood of occurrence assessment

LIKELIHOOD OF OCCURRENCE	CRITERIA
Known	The species was observed in the study area either during the current survey or during another recent survey.
High	A species has a high likelihood of occurrence if: — The study area contains or forms part of a large area of high quality suitable habitat — Important habitat elements (i.e. for breeding or important life cycle periods such as winter foraging periods) are abundant within the study area — The species has been recorded recently in similar habitat in the locality — The study area is likely to support a resident population or to contain habitat that is visited by the species during regular seasonal movements or migration.
Moderate	A species has a moderate likelihood of occurrence if: — The study area contains or forms part of a small area of high quality suitable habitat — The study area contains or forms part of a large area of marginal habitat — Important habitat elements (i.e. for breeding or important life cycle periods such as winter foraging periods) are sparse or absent within the study area — The study area is unlikely to support a resident population or to contain habitat that is visited by the species during regular seasonal movements or migration but is likely to be used occasionally during seasonal movements and/or dispersal.
Low	A species has a low likelihood of occurrence if: — Potentially suitable habitat exists but the species has not been recorded recently (previous 10 years) in the locality despite intensive survey (i.e. the species is considered to be locally extinct) — The species is considered to be a rare vagrant, likely only to visit the study area very rarely; e.g. during juvenile dispersal or exceptional climatic conditions (e.g. extreme drought conditions in typical habitat of inland birds).
None	Potentially suitable habitat is absent from the study area.

2.7 CONSERVATION SIGNIFICANCE ASSESSMENT

In order to avoid and minimise impacts of future development on biodiversity values located within the subject site a conservational significance assessment was undertaken. This assessment involved identifying biodiversity values within the subject site and assigning each value a conservational ranking based on a set conservational significance categories and principals. These categories and principals have been used in other broadscale conservational significance assessments of native vegetation in the region.

Categories and principals used to rank biodiversity constraints within the subject site included:

- Presence of threatened ecological communities
- Presence of threatened species and native vegetation that provides habitat for threatened species
- Native remnant vegetation patches (size, connectivity and condition)
- Riparian corridors and buffers
- Remnant vegetation habitat value i.e. core habitat, support for core habitat, urban remnant trees and other remnant vegetation (such as Acacia regrowth)
- Local and regional significance of remnant native vegetation.

The conservational significance assessment identified three conservational significance categories; high, moderate and low. The purpose of these categories was to avoid where possible rezoning areas of high, medium or low ecological for urban development.

All highly disturbed areas with no or limited native vegetation, outside of buffer areas around identified wildlife corridors, have not been assigned to an ecological constraint class. These areas which pose little to no biodiversity restrictions are most suitable for future development.

The conservational significance assessment is described in more detail in Section 5.

2.8 LIMITATIONS

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

Where surveys were conducted outside the optimal time for detecting a species, or field surveys were of limited scope, a precautionary approach was taken and it was assumed that the species was present if suitable habitat was observed.

The data used in the assessment is based on results of the field surveys and are, therefore, merely indicative of the environmental condition of the site at the time of survey, including the presence or otherwise of species. For species where the timing of surveys was not appropriate for detection, a precautionary approach was taken and surveys focussed on detection of areas of potential habitat for these species.

Map: PS107151_GIS_004_A1	Author: A Labruyere		0 30 60 m 1:2,500 Coordinate system: GDA 1994 MGA Zone 56 Scale ratio correct when printed at A3
Date: 8/06/2018	Approved by: S Harrington		
Data source: © Department of Finance, Services & Innovation 2017			

Dido Street, Spring Creek - Ecological Constraints Assessment

Figure 2.2

Flora and fauna survey locations

3 EXISTING ENVIRONMENT

3.1 VEGETATION COMMUNITIES

Desktop analysis of the exiting vegetation mapping and ground-truthing during field surveys identified six vegetation types as being present within the study area. Table 3.1 below lists the vegetation communities, with their extent within the subject site is illustrated in Figure 3.1.

The study area was dominated by grazed grassland. Small remnant patches of rainforest have been retained in the north western area.

The eastern section of the site, adjacent to Spring Creek contains a tract of regenerating vegetation which forms part of a public nature trail. The southern section consists of subtropical rainforest. The northern section was previously cleared, has been mapped as a plantation (Department of Primary Industries 2018) and has been subject to significant restoration including weeding and planting. As a result the vegetation does not align clearly to a NSW PCT and this is indicative only.

Table 3.1 Vegetation communities mapped within the subject site

VEGETATION COMMUNITIES RECORDED WITHIN THE STUDY AREA	NSW PLANT COMMUNITY TYPE ID[1]	THREATENED ECOLOGICAL COMMUNITY	EXTENT (ha)
Whalebone Tree – Native Quince dry subtropical rainforest	1300 – Whalebone Tree – Native Quince dry subtropical rainforest on dry fertile slopes, southern Sydney Basin Bioregion	Yes – Illawarra subtropical rainforest in the Sydney Basin Bioregion, listed as Endangered under the BC Act.	1.6 (1.2 ha in good condition; 0.4 in moderate condition)
Swamp Paperbark – Swamp Oak tall shrubland	1236 – Swamp Paperbark – Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion	Yes – Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, listed under the BC Act	0.6
Bangalay – Old-man Banksia open forest on coastal sands	659 – Bangalay – Old-man Banksia open forest on coastal sands	Yes – Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions	0.6
Phragmites australis and *Typha orientalis* coastal freshwater wetlands	1071 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin Bioregion	Yes – Freshwater wetland on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregion	0.5

VEGETATION COMMUNITIES RECORDED WITHIN THE STUDY AREA	NSW PLANT COMMUNITY TYPE ID[1]	THREATENED ECOLOGICAL COMMUNITY	EXTENT (ha)
Miscellaneous ecosystems			
Acacia regrowth	–	Not listed	0.2
Highly disturbed areas with no or limited native vegetation	–	Not listed	8.5
		Total (ha)	12

(1) Sourced from Vegetation Information System (VIS) Classification 2.1 (Office of Environment and Heritage 2017)

(2) BC Act = *Biodiversity Conservation Act 2016*, EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999.*

3.1.1 WHALEBONE TREE – NATIVE QUINCE DRY SUBTROPICAL RAINFOREST

The study area supports remnants of Whalebone Tree – Native Quince dry subtropical rainforest (PCT 1300) which is consistent with Illawarra subtropical rainforest in the Sydney Basin bioregion, listed as Endangered under the NSW BC Act.

Within the study area this community occurred as a closed forest (Photo 3.1) with canopy height varying from 10 m (in the western section of the site) to 30 m (in the east). The canopy was dominated by *Streblus brunonianus, Alectryon subcinereus, Acacia melanoxylon, Glochidion ferdinandi, Litoria australis, Guioa semiglauca, Eucalyptus fastigata, E. quadrangulata, Brachychiton acerifolius, Podocarpus elatus,* and *Pittosporum undulatum.* The midstorey consisted of sparse shrubs such as *Myrsine variabilis, Notelaea venosa, Wilkiea huegeliana, Maclura cochinensis* as well as juvenile canopy species.

This community occurred in two condition classes within the site:

- The remnant in the east near Spring Creek has been subject to significant restoration including weeding and planting and forms part of a public nature trail. This area is in good condition. Ground cover vegetation in this area was dominated by native species and included *Oplismenus imbecillis, Pellaea falcata, Pseuderanthemum variabile, Asplenium flabellifolium.*
- The small isolated remnants in the western area of the site had lower native species diversity and were subject to ongoing cattle grazing and moderate weed invasion particularly of the groundlayer vegetation. Weeds in this area included *Olea europaea*, Lantana camara*, Ligustrum lucidum**. The ground cover was dominated by introduced and grazing tolerant species including *Sida rhombifolia*, Ehrharta erecta*, Doodia aspera, Pseuderanthemum variable.*

Photo 3.1 Whalebone Tree – Native Quince dry subtropical rainforest (left to right: in west of site; nature trail in east along Spring Creek)

3.1.2 SWAMP PAPERBARK – SWAMP OAK TALL SHRUBLAND

A small area in the north east of the study area in low lying area in the vicinity of Spring Creek supports Swamp Paperbark – Swamp Oak tall shrubland on estuarine flats (PCT 1236), which is recognised as a threatened ecological community under the BC Act.

Within the study area this community (Photo 3.2) is characterised by a tall dense stand of *Melaleuca linariifolia, Casuarina glauca* and *Melaleuca quinquinervia*. The understorey includes a sparse shrub layer including *Glochidion ferdinandi, Alectryon subcinereus, Pittosporum undulatum,* and *Ficus coronata*. The ground cover is sparse and includes *Lomandra longifolia, Oplismenus imbecilis, Asparagus aethiopicus*, Commelina cyanea and Ehrharta erecta*.*

Photo 3.2 Swamp Paperbark – Swamp Oak tall shrubland on estuarine flats with plantings evident in background

3.1.3 BANGALAY – OLD-MAN BANKSIA OPEN FOREST ON COASTAL SANDS

The north east section of the study area includes an area of tall moist forest dominated by *Banksia integrifolia* with an understorey of mesic species (Photo 3.3). This area is mapped as plantation and extensive planting is evident within the area. This vegetation best fits with Bangalay – Old-man Banksia open forest on coastal sands (PCT 659), which is recognised as a Threatened Ecological Community under the BC Act (Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions). It consists of a tall forest of *Banksia integrifolia* with scattered trees including *Casuarina glauca, Eucalyptus robusta, Acacia melanoxylon, Streblus brunonianus* and *Eucalyptus botryoides.* A tall shrub layer was present which included *Acmena smithii, Melaleuca ericifolia, Podocarpus elatus, Livistona australis*. The groundcover was sparse and was dominated by *Dichondra repens, Ehrharta erecta** and *Oplismenus aemulus.*

Photo 3.3 Coast Banksia moist forest

3.1.4 PHRAGMITES AUSTRALIS AND TYPHA ORIENTALIS COASTAL FRESHWATER WETLANDS

Phragmites australis and *Typha orientalis* coastal freshwater wetlands occur along the margins of Spring Creek (Photo 3.4). This community consisted of a tall, dense grassland of *Phragmites australis* with scattered dense patches of *Typha orientalis*. This community had low species diversity but generally also had low weed invasion.

Photo 3.4 *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands

3.1.5 MISCELLANEOUS ECOSYSTEMS

Areas of vegetation unable to be assigned to a recognised NSW PCT due to low native species diversity form miscellaneous ecosystems.

3.1.5.1 ACACIA REGROWTH

An area of acacia regrowth occurred in the north eastern section of the site. This area consisted of a low dense shrubland was dominated by *Acacia longifolia* and *Lantana camara**.

3.1.5.2 HIGHLY DISTURBED AREAS WITH NO OR LIMITED NATIVE VEGETATION

Within the site, highly disturbed areas with no or limited native vegetation, consisted predominantly of grazed exotic grassland with isolated patches of native trees and shrubs as well as patches of weeds such as *Lantana camara**, *Rubus fruiticosus**, *Foeniculum vulgare**.

The ground cover was dominated by grasses and herbs including *Pennisetum clandestinum**, *Bromus catharticus**, *Ehrharta erecta**, *Hypochaeris radicata**, *Solanum nigrum**, *Poa sieberiana* and *Senecio madagascariensis**. Isolated native trees were scattered within the site and included *Glochidion ferdinandi*, *Livistona australis*, *Ficus macrophylla* and *Notelaea venosa*.

Photo 3.5 Highly disturbed areas with no or limited native vegetation – exotic grasslands

Photo 3.6 Highly disturbed areas with no or limited native vegetation – exotic grasslands

3.2 FAUNA HABITATS

The suitability, size and configuration of the fauna habitats correlated broadly with the vegetation communities summarised in Section 3.1. These areas provided habitat for a range of birds, herpetofauna and mammals and were observed to vary in suitability for native fauna from good to poor. Habitat features recorded in the study area generally included those associated with swamp forest and aquatic habitat types along the margins of Spring Creek, sub-tropical rainforest, banksia scrub and cleared land. Fauna habitat types are described below and were assessed under the criteria described in Section 2.5.1.

Historically, land around Spring Creek was heavily cleared for agriculture. In 1992, Kiama Municipal Council commenced restoration works along the Spring Riparian corridor to help protect the catchment, provide a better environment for wildlife, and improve the experience for visitors. Consequently, most vegetation communities do not occur as old-growth forms and important fauna habitat attributes, such as hollows, plentiful fallen timber, connectivity and large patch size are lacking. The general lack of these important habitat attributes reduces the study area's capacity for supporting a wide diversity of local native species, including threatened species, in isolation from other higher quality habitats in the locality. Furthermore, the rehabilitation Spring Creek is managed for public access, with accessible walking trails, concrete footpaths, and presence of domestic animals.

Map: PS107151_GIS_002_A2	Author: A Labruyere		0 30 60 m 1:2,500 Coordinate system: GDA 1994 MGA Zone 56 Scale ratio correct when printed at A3
Date: 8/06/2018	Approved by: S Harrington		
Data source: © Department of Finance, Services & Innovation 2017			

Dido Street, Spring Creek - Ecological Constraints Assessment

Figure 3.1

Vegetation communities and threatened species

3.2.1 RIPARIAN FOREST

Riparian forest occurred along the margins and upper areas of Spring Creek and was dominated by *Casuarina glauca*, with *Melaleuca linariifolia*, *M. quinquinervia* and *E. robusta*. *Casuarina glauca* favours brackish situations and dominated the margin of Spring Creek, where it often formed pure stands with a leaf litter up to 3 cm deep. *Eucalyptus robusta* is a winter flowering eucalypt that has strong flowering events every three years or so. Although *E. robusta* was generally observed to be sparse in the study area, several stands were observed to contain moderate numbers. There is potential that these stands may be used seasonally by nectarivorous birds and bats, including threatened species (e.g. Swift Parrot and Grey-headed Flying-fox) during flowering events.

In the study area, riparian forest retained a relatively simple structure, consisting of canopy trees (from several species) and occasional understorey plants. Such habitat is not well suited to the foraging and nesting requirements for a diversity of birds and the lack of tree hollows further reduced its importance to hollow-dependent arboreal mammals and birds. Nevertheless, riparian forest adjacent to Spring Creek (particularly *C. glauca*) provided characteristics suitable for habitation of a Grey-headed Flying-fox camp (i.e. tall vegetation with exposed canopy branches, close to water and food sources). At the time of survey the camp was estimated to have approximately 2000–3000 individuals roosting within vegetation along the creek.

Photo 3.7 Riparian forest

3.2.2 RAINFOREST

Rainforest habitats in the study area occurred as isolated patches of vegetation; the largest occurring adjacent to Spring Creek where Kiama Municipal Council has been completing rehabilitation works with local native species. Rainforest habitat was generally in moderate to poor condition due to historical clearing and contemporary cattle grazing, fragmentation, small patch size and absence of protective buffers due to adjacent land managed for residential sub-divisions and agricultural tenures. Rainforest habitats in the study area contained several broad-leaved trees providing seasonal fruits for local frugivorous birds and mammals, such as Satin Bowerbird, Lewin's Honeyeater, Australasian Figbird, Pied Currawong and Grey-headed Flying-fox, all of which were ubiquitous in vegetated patches of the study area.

The understorey and canopy provides foraging habitats for insectivorous birds (Brown Gerygone, White-browed Scrubwren, Eastern Yellow Robin) and bats and potential roosting sites for owls. However, trees within rainforest habitats were generally of an insufficient age-class to develop hollows for animals dependent on these resources for shelter and nesting purposes. In addition, the small patch size, fragmented nature, and lack of breeding hollows in the study area, reduces the capacity for owls to be supported in isolation of other habitat in the locality.

In less disturbed areas some fallen timber and rocky substrate occurred which provides some microhabitat for reptiles, invertebrates and small mammals. The rehabilitated rainforest patch along Spring Creek had emergent *E. quadrangulata* and *E. fastigata*, which would provide seasonal foraging resources for nectarivorous birds and bats, including threatened species.

Photo 3.8 Rainforest

3.2.3 AQUATIC HABITAT

The study area incorporated aquatic habitat in the form of the margin/ wetted edge of Spring Creek. Spring Creek, which occurs adjacent to the study area occurs as a brackish lagoon that flows out at Bombo Beach and a freshwater lake. The dominant aquatic habitat in the study area largely consisted of patches of *Phragmites australis*, with small ephemeral ponds dominated by *Typha orientalis*. Such shallow wetland areas provide habitat for herons, egrets, rails, crakes, Purple Swamphen, Australian Reed Warbler and Golden-headed Cisticolla. In addition, the densely vegetated *Phragmites* patches provide potential refuge and foraging substrates for the threatened Australasian Bittern and Green and Golden Bell Frog.

Photo 3.9 Aquatic habitat

3.2.4 EXOTIC GRASSLAND

This habitat occupied most of the study area and was in poor ecological condition due to extensive anthropogenic modification and disturbance, including historical clearing, agricultural practices and contemporary cattle grazing. This habitat retained some scattered shrubs (*Lantana camara*, Rubus fruiticosus*, Foeniculum vulgare**) and isolated native trees (*Glochidion ferdinandi*, *Livistona australis*, *Ficus macrophylla* and *Notelaea venosa*), which provided some foraging and shelter opportunities for more mobile species of animal, including the threatened Grey-headed Flying-fox. Nevertheless, the understorey strata area was highly managed and largely consisted of a variety of exotic grasses and herbaceous species, including *Pennisetum clandestinum*, Bromus catharticus*, Ehrharta erecta*, Hypochaeris radicata*, Solanum nigrum*, Poa sieberiana* and *Senecio madagascariensis**.

Cleared exotic grassland lacked a suite of important habitat attributes that might potentially support a diverse fauna, including hollow trees, fallen timber, rocky outcropping and structural complexity. Therefore, these areas are largely suited to common open country and introduced species of bird (Australian Magpie, Willie Wagtail, Magpie-lark, Red-whiskered Bulbul, European Goldfinch) and introduced mammals (Brown Hare, Fox, European Cattle).

Photo 3.10 Cleared land

3.3 FAUNA SPECIES RECORDED

A total of 81 fauna species were recorded during field investigations which included three amphibians, 65 birds, 11 mammals and two reptiles (Appendix D). Of the 81 fauna species observed nine were introduced species. During field investigations, two threatened species were identified including, Little Bentwing Bat and Grey-headed Flying-fox. A Grey-headed Flying-fox camp was recorded within the riparian vegetation along Spring Creek. In addition to the threatened species identified, one migratory species, Black-faced Monarch, was identified in the study area. Further information on threatened species identified in the study area and others likely to occur within the study area is discussed in section 4 below.

4 THREATENED BIODIVERSITY

Threatened biodiversity (species, populations and communities) are listed under the NSW *Biodiversity Conservation Act 2016* (BC Act), *Fisheries Management Act 1994* (FM Act) or Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This section includes an overview of the threatened biodiversity that has been previously recorded, was recorded during field surveys or is to have moderate to high likelihood of occurrence within the study area.

4.1 THREATENED ECOLOGICAL COMMUNITIES

Four threatened ecological communities under the BC Act have been recorded to occur within the study area (Table 4.1). No patches of native vegetation recorded within the study area meet condition thresholds for any EPBC Act threatened ecological community listings.

Table 4.1 Threatened ecological communities

VEGETATION COMMUNITY	THREATENED ECOLOGICAL COMMUNITY	
	BC ACT	EPBC ACT
Whalebone Tree – Native Quince dry subtropical rainforest (PCT 1300)	Endangered – Illawarra subtropical rainforest in the Sydney Basin Bioregion, listed as Endangered under the BC Act.	–
Swamp Paperbark – Swamp Oak tall shrubland	Endangered – Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, listed under the BC Act.	–
Phragmites australis and *Typha orientalis* coastal freshwater wetlands	Endangered – Freshwater wetland on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregion.	–
Bangalay – Old-man Banksia open forest on coastal sands	Endangered – Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions.	

(1) Sourced from Vegetation Information System (VIS) Classification 2.1 (Office of Environment and Heritage 2017)

(2) BC Act = *Biodiversity Conservation Act 2016*, EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999.*

4.2 THREATENED FLORA SPECIES

One threatened flora species was recorded within the subject site during field surveys conducted as part of this study; *Zieria granulata* (Photo 4.1). Three plants were recorded from within the Whalebone Tree vegetation community as mapped in Figure 3.1.

Photo 4.1 *Zieria granulata*

In addition to *Zieria granulata*, 21 other threatened flora species are known or predicted to occur within a 10 km extent of the study area (Appendix A). Of these, 5 threatened flora species have been identified as recorded or having a moderate to high potential to occur within the study area (Table 4.2).

Table 4.2 Threatened flora species with a moderate – high likelihood of occurrence in the study area

SCIENTIFIC NAME	COMMON NAME	BC ACT[1]	EPBC ACT[2]	OCCURRENCE IN STUDY AREA
Cynanchum elegans	White-flowered Wax Plant	E1	E	Moderate
Daphnandra johnsonii	Illawarra Socketwood	E1		Moderate
Gossia acmenoides	Scrub Ironwood	E2		Moderate
Syzygium paniculatum	Magenta Lilly Pilly	E1	V	Moderate
Zieria granulata	Illawarra Zieria	E1	E	**Recorded**

(1) BC Act status = (E1) Endangered species, (E2) Endangered population

(2) EPBC Act Status = (V) Vulnerable, (E) Endangered.

4.3 THREATENED FAUNA SPECIES

Background investigations identified 67 threatened fauna that have been previously recorded or have the potential to occur within the locality (Appendix C). Of the 67 threatened fauna identified, a total of 23 have a moderate to high likelihood to occur within the study area (Table 4.3). The likelihood of these species occurring within the study area was determined based on field investigations and fauna habitat available.

Table 4.3 Threatened fauna species with a moderate to high likelihood of occurrence in the study area

SCIENTIFIC NAME	COMMON NAME	BC ACT[1]	EPBC ACT[2]	LIKELIHOOD OF OCCURRENCE
Amphibians (1)				
Litoria aurea	Green and Golden Bell Frog	E	V	High
Birds (12)				
Anthochaera phrygia	Regent Honeyeater	CE	CE	Moderate
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V		Moderate
Botaurus poiciloptilus	Australasian Bittern	E	E	High
Burhinus grallarius	Bush Stone-curlew	E		Moderate
Circus assimilis	Spotted Harrier	V		High
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	Ma	High
Hieraaetus morphnoides	Little Eagle	V		High
Lathamus discolor	Swift Parrot	E	CE	Moderate
Ninox strenua	Powerful Owl	V		High
Pandion cristatus	Eastern Osprey	V	M/Ma	High
Petroica phoenicea	Flame Robin	V		Moderate
Rostratula australis	Australian Painted Snipe	E	E	Moderate
Mammals (10)				
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Moderate
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		High
Miniopterus australis	Little Bent-wing Bat	V		**Recorded**
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V		High
Mormopterus norfolkensis	Eastern Freetail-bat	V		Moderate
Myotis macropus	Southern Myotis	V		High
Phascolarctos cinereus	Koala	V	V	Moderate
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	**Recorded**
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		Moderate
Scoteanax rueppellii	Greater Broad-nosed Bat	V		Moderate

(1) V = Vulnerable, E1 = Endangered species, E2 = Endangered population listed under the BC Act

(2) V = Vulnerable, E = Endangered, CE= Critically Endangered, M = Migratory Ma = Marine listed under the EPBC Act.

4.3.1 SPRING CREEK GREY-HEADED FLYING-FOX CAMP

During field investigations, a Grey-headed Flying-fox camp was identified roosting within the riparian forest along Spring Creek in Lot 45 and Lot 11. At the time of survey the camp was estimated to have approximately 2000–3000 individuals roosting within vegetation along the creek. This camp was not identified by previous ecological surveys, however, a number of individual Grey-headed Flying-fox were recorded within Flora and Fauna Assessment undertaken by Lesryk Environmental Consultants in 2007 (LesryK Environmental Consultants 2007).

The National Flying-fox Monitoring Program (Department of the Environment and Energy 2018), which monitors flying-fox populations along the Australian east coast has only recently begun monitoring the Spring Creek camp in 2017. There are a number of known roosting camps within the Illawarra and south coast region, with Bomaderry Creek Camp in Nowra being labelled as the closest 'Nationally Important' flying-fox camp (Department of the Environment and Energy 2018). The Spring Creek Camp has not been labelled as a 'Nationally Important' flying-fox camp to-date.

"The *Draft National Recovery Plan for the Grey-headed Flying-fox Pteropus poliocephalus* (Department of Environment Climate Change and Water NSW 2009) considers the need to reduce conflict around roost camps, whereby a management zone of 300 m from camps be provided to minimise impacts of the camps on the residential community. As the Grey-headed Flying-fox camp along Spring Creek is a recent arrival (estimated occupancy from late 2016, personal communication with several residents) and its long-term status in unknown, a nominal 50 m buffer of the roost camps current estimated boundary is presented in Figure 5.1. This buffer is intended to provide an additional set-back from vegetation along Spring Creek to limit a direct interface of residential development and high conservation vegetation (Figure 5.1) should the flying-fox camp swell. This mapping identifies existing and potential flying-fox habitat to provide guidance on the placement of new homes, schools and hospitals as part of the planning for the site. The intent of this buffer is to improve community capacity to coexist with flying-foxes and minimise the impacts on urban settlements from the existing camp. It is important to minimise the likelihood of future conflict with residents as dispersal of the flying-fox camp would not be recommended as it has a number of potential impacts including affecting the wellbeing of the animals and may lead to injury or death as well as creating further conflict by potentially moving a problem camp onto another community.

A range of management strategies can be employed to minimise the impact of the flying-fox camp on the future residential community including:

- Avoiding placing sensitive receptors such as schools and hospitals within 300 m of the camp
- Providing a buffer around homes to ensure camps do not have direct interface with residential development. This may consist of a cleared area or planted vegetation (excluding feed trees)
- Considering building measures such as double glazed windows and air conditioning for dwellings within buffer zone of the roost camp, if still there at the time of building approval
- Avoiding use of roosting and foraging trees within the precinct, for example in landscaping in street plantings and on residential blocks. Over 100 species have been identified as feed trees (Eby and Law, 2008), in particular native species of Eucalyptus, Melaleuca and Banksia, rainforest trees as well as garden fruit trees.

Photo 4.2 Grey-headed Flying-camp along Spring Creek

4.4 MIGRATORY SPECIES

Migratory species are protected under international agreements to which Australia are a signatory, including Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea-Australia Migratory Bird Agreement (RoKAMBA) and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Migratory species are considered Matters of National Environmental Significance and are protected under the EPBC Act.

Based on field investigations, EPBC Protected Matters area search and other desktop database searches, 26 migratory fauna species were identified that could occur within the locality. One migratory species – Black-faced Monarch was recorded in the study area during field investigations. Based on field investigations and habitat assessments 8 additional migratory species have a moderate to high likelihood to occur within the study area (Table 4.4).

Table 4.4 Migratory species recorded or have a moderate – high potential to occur in study area

SCIENTIFIC NAME	COMMON NAME	EPBC ACT[1]	LIKELIHOOD OF OCCURRENCE
Apus pacificus	Fork-tailed Swift	M	Moderate
Cuculus opatus	Oriental Cuckoo, Himalayan Cuckoo	M	Moderate
Gallinago hardwickii	Latham's Snipe	M	High
Hirundapus caudacutus	White-throated Needletail	M	High
Monarcha melanopsis	Black-faced Monarch	M	**Recorded**
Myiagra cyanoleuca	Satin Flycatcher	M	Moderate
Pandion cristatus	Eastern Osprey	M	High
Plegadis falcinellus	Glossy Ibis	M	Moderate
Rhipidura rufifrons	Rufous Fantail	M	Moderate

(1) M = Migratory listed under the EPBC Act.

4.5 SPRING CREEK

Spring Creek rises in the foothills of Saddleback Mountain, and by the time it reaches the reserve it forms a mixture of fresh and brackish water habitats. The combination of freshwater wetland, remnant rainforest and estuarine wetland makes Spring Creek Wetland significant. Spring Creek Wetland occurs as a SEPP 14 Wetland (State Environmental Planning Policy No. 14 – Coastal Wetland) (Wetland 371), of which the study area occupied a relatively small area in association with one patch of *Phragmites australis* and *Typha oientalis* coastal freshwater wetlands vegetation community. Kiama Municipal Council has an ongoing commitment to manage Spring Creek Wetland for conservation and education, with vegetation communities being regenerated using local endemic species. The re-generation of Spring Creek riparian corridor (transition zone between terrestrial and aquatic environments) will perform a range of important environmental functions, including:

- Providing bed and bank stability and reducing bank and channel erosion
- Protecting water quality by trapping sediment and nutrients
- Providing diversity of habitat for terrestrial, riparian and aquatic flora and fauna
- Providing connectivity between wildlife habitats
- Conveying flood flows and controlling the direction of flood flows
- Providing an interface or buffer between developments and waterways
- Providing passive recreational uses.

In addition, activities carried out on waterfront land are regulated by the *Water Management Act 2000*, which is administered by the NSW Office of Water. Waterfront land includes the bed or bank of any river, lake or estuary and all land within 40 m of the highest bank of the river, lake or estuary. In accordance with the NSW Office of Water Guidelines for Riparian Corridors on Waterfront Land (NSW Office of Water 2012) a recommended riparian corridor buffer of 40 m is recommended from the top of the highest bank of Spring Creek, which is identified on Figure 5.1. There is some flexibility in how this riparian corridors can be used. This includes allowing suitable development within the outer 50 per cent of the corridor as long as this is offset by connecting an equivalent area within the development site.

5 CONSERVATION SIGNIFICANCE AND ECOLOGICAL CONSTRAINTS

Conservation significance mapping of the site was undertaken to facilitate the development of proposed land use zoning. The level of conservation significance has been ranked based on the ecological attributes outlined within Table 5.1.

Mapping of ecological constraints within the subject site is provided in Figure 5.1.

Table 5.1 Ecological constraints ranking and subsequent conservational significance within the subject site

ECOLOGICAL CONSTRAINT RANK AND CONSERVATIONAL SIGNIFICANCE	ECOLOGICAL ATTRIBUTE
High	— Core areas of moderate to high condition native vegetation (irrespective of threatened ecological community listing status); likely to be of high importance to populations of threatened species and/or to have high value for animal movement. — Large, contiguous patches of threatened ecological communities in moderate condition. — All high condition patches of threatened ecological communities. — Areas occupied by populations of Threatened flora species.
Moderate	— Peripheral areas of non-threatened native vegetation in moderate to good condition; likely to be of moderate importance to populations of threatened species and/or to make a moderate contribution to local animal movement. — Medium-sized patches of threatened ecological communities in low condition. — Small low condition areas of threatened ecological communities which are contiguous with moderate and/or high condition patches.
Low	— Low species richness patches of regrowth native plants with low structural diversity; e.g. *Acacia* spp. regrowth with not little or no occurrence of over-storey (e.g. eucalypt) species and artificial dams containing native aquatic vegetation. — Individual over-storey indigenous tree species which do not form part of a contiguous patch of native vegetation; i.e. *Eucalyptus* spp., *Corymbia* spp., *Angophora* spp., and *Syncarpia glomulifera;* these trees may, nonetheless, still be consistent with one or other threatened ecological community listing (e.g. Sydney Turpentine ironbark Forest). — Very small, highly disturbed, isolated patches of threatened ecological communities with minimal native understorey.

5.1 HIGH ECOLOGICAL VALUE

The presence of high conservation significance areas does not necessarily entirely preclude development in these locations. However, these areas are likely to be considered, by Local, State and Commonwealth regulatory authorities, to be the least suitable for residential zoning or future development. Any proposed development that would affect a substantial area identified as having high conservation significance would require significant assessment, mitigation and offsetting with the lowest certainty of potential outcome.

5.1.1 CORE AREAS OF NATIVE VEGETATION AND HABITAT

The core area of continuous native vegetation along Spring Creek is considered to be of high conservation significance because:

- It contains an area of continuous native vegetation which is of sufficient size to support a wide variety of animal species including some threatened species and larger species of native animals which area less likely to persist in smaller and/or fragmented patches of habitat
- It includes areas of mapped SEPP 14 Wetland
- It includes vegetation within 40 m of the top bank of Spring Creek (Class 1 waterway)
- It contains microhabitats that are likely to be important to native animals, including aquatic habitat (frog breeding habitat), riparian vegetation (likely to be suitable for owl roosting), rock crevices and potential bird nesting sites that are more distant from human habitation and associated disturbance
- It supports Threatened species:
  - *Zieria granulata* (Illawarra Zieria)
  - Spring Creek Grey-headed Flying Fox camp.

5.1.2 HIGH VALUE PATCHES OF THREATENED ECOLOGICAL COMMUNITIES

Threatened ecological communities are distinct assemblages of plants and animals that occur together in a particular area, which are threatened with extinction due to significant reductions in extent, degradation and often very restricted distribution. Conservation of threatened ecological communities is particularly important as it helps to protect threatened species, undiscovered and poorly known taxa (e.g. invertebrates and fungi) and the biological processes critical to maintaining a healthy environment.

The contribution of individual areas of threatened ecological communities to conservation is affected by factors including:

- The diversity and relative abundance of native and exotic species within a patch of the community
- Patch size and configuration; i.e. larger patches and patches with high area to edge ratio are less prone to disturbance and less likely to lose component species
- Location with regard to other patches of the same community and patches of other native vegetation communities; areas of a community which are in close proximity to other patches of the same community or other similar communities are more likely to experience positive interactions including seed/spore dispersal, pollen exchange and animal movements.

High value patches of threatened ecological communities are those which:

- Have moderate to high diversity and relative abundance of native plant species and a relatively low diversity and relative abundance of exotic plant species
- Are large and with a high area to edge ratio
- Are moderate in size but located in close proximity to other moderate or large areas of the community and/or other related native vegetation communities.

5.1.3 THREATENED SPECIES/POPULATIONS

Areas which contain substantial populations of threatened plant species are of high conservation significance for such species. Threatened species recorded within the study area to date include:

- *Zieria granulata* (Illawarra Zieria), which is listed as Endangered under the BC and EPBC Acts. Three individuals were recorded (Figure 3.1).
- Spring Creek Grey-headed Flying Fox camp.

5.2 MODERATE ECOLOGICAL VALUE

5.2.1 PERIPHERAL AREAS OF NATIVE VEGETATION AND HABITAT

The peripheral areas of native vegetation, are considered to be of moderate conservation significance because:

- They contain similar habitat to the core (high conservation value) area of the site, however, it is generally in poorer condition due to higher levels of disturbance and associated weed invasion
- They contain a lower diversity and density of microhabitats that are likely to be important to native animals (e.g. aquatic/riparian habitat and rocky outcropping) than the core (high conservation value) area of the site and the habitats they do contain are more likely to be affected by existing human habitation and associated disturbance
- They occur as small patches and are at the periphery of a potential wildlife corridor connecting areas of native vegetation and habitat on the site with the surrounding landscape; they are considered beneficial to local wildlife movement but not essential.

5.2.2 MODERATE VALUE PATCHES OF THREATENED ECOLOGICAL COMMUNITIES

Moderate value patches of threatened ecological communities are those which:

- Have a moderate to low diversity and relative abundance of native plant species and a relatively high diversity and relative abundance of exotic plant species
- Are of moderate size and/or have a relatively low area to edge ratio
- Are small but located in close proximity to other large areas of the community and/or other related native vegetation communities.

5.3 LOW CONSERVATION VALUE

5.3.1 LOW VALUE PATCHES OF NATIVE VEGETATION AND HABITAT

Small, fragmented areas of native vegetation, including isolated trees and patches of regrowth with little other native vegetation, and other highly disturbed areas of native vegetation are considered to be of low conservation significance because:

- They are likely to be marginal as habitat for a variety of native species of animal, including some less disturbance-sensitive threatened species (e.g. Grey-headed flying-fox) due to their low native plant diversity, low structural diversity and high levels of disturbance and associated weed dominance
- They contain a very low diversity and density of microhabitats types that are likely to be important to native animals and the microhabitats they do contain are very likely to be affected by existing human habitation and associated disturbance
- They are at outside of potential wildlife corridors and they are considered be of relatively low benefit to local wildlife movement.

5.3.2 LOW VALUE PATCHES OF THREATENED ECOLOGICAL COMMUNITIES

Low value patches of threatened ecological communities are those which:

- Have a very low diversity and relative abundance of native plant species and a very high diversity and relative abundance of exotic plant species
- Are small in area, consisting of individual, isolated trees and small clumps of trees with a very low area to edge ratio.

5.4 AREAS OF MINIMAL CONSERVATIONAL SIGNIFICANCE

All highly disturbed areas with no or limited native vegetation outside buffer areas have not been assigned an ecological constraints class.

Areas not classified with an ecological constraint class as they exhibit a dense cover of exotic grasses, planted vegetation areas of bare soil, buildings, paved areas and other miscellaneous materials and structures with little or no native vegetation and minimal habitat value. These areas also have a very low habitat structural diversity, generally lack important micro-habitat features and are hence of very low potential value as habitat for threatened species, populations and ecological communities.

Map: PS107151_GIS_003_A1	Author: A Labruyere		0 25 50 m 1:2,121 Coordinate system: GDA 1994 MGA Zone 56 Scale ratio correct when printed at A3
Date: 8/06/2018	Approved by: S Harrington		
Data source: © Department of Finance, Services & Innovation 2017			

Dido Street, Spring Creek - Ecological Constraints Assessment

Figure 5.1

Conservation significance

6 CONCLUSION

This Biodiversity Assessment Report comprises the findings of the desktop investigation and field surveys completed to identify the broad scale distribution of ecological attributes and associated values and constraints in the study area.

6.1 ECOLOGICAL ATTRIBUTES

The key ecological attributes of the study area are as follows:

- The presence of Illawarra subtropical rainforest in the Sydney Basin Bioregion, listed as Endangered under the BC Act. which is listed as an Endangered ecological community under the BC Act (1.6 ha)
- The presence of Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions, listed under the BC Act as an Endangered ecological community (0.6 ha)
- The presence of Freshwater wetland on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregion, listed under the BC Act as an Endangered ecological community (0.5 ha)
- The presence of Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions, listed under the BC Act as an Endangered ecological community (0.6 ha)
- The presence of Spring Creek Wetland and adjacent riparian vegetation which has ecological value in terms of the protection of water quality in the aquatic ecosystems onsite and downstream, this area also provides important habitat for local wildlife and threatened species
- The presence of three individual *Zieria granulata* (Illawarra Zieria) plants listed as Endangered under the BC Act and EPBC Act
- The presence of Grey-headed Flying-fox roosting camp in the riparian forest along Spring Creek
- Two fauna species known/recorded using the habitat attributes in the study area, which include:
  - Little Bentwing-bat (*Miniopterus australis*) listed as Vulnerable under the BC Act
  - Grey-headed Flying-fox (*Pteropus poliocephalus*) listed as Vulnerable under the BC Act and EPBC Act
- Potential habitat for five threatened flora species listed under the BC Act and EPBC Act
- Potential habitat for 23 threatened fauna species listed under the BC Act and EPBC Act.

6.2 ECOLOGICAL OPTIONS AND CONSTRAINTS

Based on the desktop analysis and the field survey, areas have been identified that pose differing constraints to future development over parts of the study area (Figure 5.1). These constraints have been ranked based on specific ecological attributes forming high, moderate and low constraints classes.

The total area of each constraint class is summarised in Table 6.1.

Table 6.1 Ecological constraints and area over the study area.

ECOLOGICAL CONSTRAINT	AREA (ha)
High	2.8
Moderate	0.8
Low	0.3

The presence of high, moderate and low ecological constraint areas does not necessarily entirely preclude development in these locations. However, areas of high conservation value would be considered, by Local, State and Commonwealth regulatory authorities, to be the least suitable for residential zoning. Any proposed development that would affect a substantial area identified as having high, moderate or low conservation significance would require impact assessment, mitigation and offsetting.

Any future land use should aim to restrict substantial development to areas of lower conservation significance, and protect areas of high ecological value within the study area, to avoid significant adverse impact on the ecological values of the locality. Development controls and the implementation of environmental management measures associated with future development of the study area may also provide opportunities to enhance the long-term viability of vegetation and associated habitat and strengthen riparian and habitat linkage with adjoining vegetated areas; thereby leading to long term positive ecological outcomes within the locality.

Should native vegetation require removal, additional investigations may be required to seek approval from the relevant government agencies and determine offsetting requirements. Under the BC Act, biodiversity offsetting is required for residual impacts on biodiversity matters where the biodiversity offsets scheme threshold applies. The biodiversity offset area clearing threshold applies to all proposed native vegetation clearing under biodiversity certification or Part 4 development approval. Areas of low and moderate ecological value are small, isolated and degraded. Based on existing status, offsetting of any clearing of these areas would fulfil the BC Act requirements. Offsetting requirements would be determined as part of the future development approval.

7 LIMITATIONS

7.1 SCOPE OF SERVICES

This report has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and WSP (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

7.2 RELIANCE ON DATA

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

7.3 ENVIRONMENTAL CONCLUSIONS

In accordance with the scope of services, WSP has relied upon the data provided for the preparation of the report. Within the limitations imposed by the scope of services, the surveys and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

7.4 REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the client (and no other party). WSP assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of WSP or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Except as provided below parties other than the client should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

REFERENCES

Cropper, S. C. (1993). Management of Endangered Plants. Melbourne, CSIRO Australia.

Debus, S. J. S. (1995). "Surveys of large forest owls in Northern New South Wales: methodology, calling behaviour and owls responses." Corella **19**(2): 38-50.

Department of Environment and Climate Change (2007). Introducing the NSW threatened species priorities action statement (PAS). Sydney South NSW, Department of Environment and Climate Change,.

Department of Environment and Climate Change (2007). Threatened species assessment guidelines. The assessment of significance. Hurstville, Department of Environment and Climate Change.

Department of Environment and Climate Change (2008). Recovery Plan for the Koala (Phascolarctos cinereus) (Approved). Sydney, Department of Environment and Climate Change**:** 124.

Department of Environment and Climate Change (2009). Threatened species survey and assessment guidelines: field survey methods for fauna – Amphibians, Department of Environment and Climate Change.

Department of Environment and Conservation (2004). Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft). Hurstville, Department of Environment and Conservation.

Department of Environment and Energy (2017). "Australian Faunal Directory." Retrieved 10 January, 2017, from https://biodiversity.org.au/afd/home.

Department of Environment Climate Change and Water NSW (2009). Draft National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus* Sydney, Department of Environment Climate Change and Water NSW.

Department of Environment Water Heritage and the Arts (2010). Survey guidelines for Australia's threatened birds – Guidelines for detecting birds listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999.

Department of Primary Industries (2018). "Threatened Aquatic Fauna Database Search." from http://pas.dpi.nsw.gov.au/Species/Species_byRegion.aspx.

Department of Primary Industries (Agriculture) (2016). "Noxious Weed Declarations Web Site – NSW Weed Wise." Retrieved 4 March, 2016, from http://weeds.dpi.nsw.gov.au/.

Department of the Environment and Energy (2018). "National Flying-fox Monitoring Program – Interactive Flying-fox Web Viewer." from http://www.environment.gov.au/biodiversity/threatened/species/flying-fox-monitoring.

Department of the Environment and Energy (2018). "Protected Matters Search Tool." from http://www.environment.gov.au/topics/about-us/legislation/environment-protection-and-biodiversity-conservation-act-1999/protected.

Department of the Environment Water Heritage and the Arts (2010). Survey guidelines for Australia's threatened frogs – guidelines for detecting frogs listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. W. Department of the Environment, Heritage and the Arts, Department of the Environment, Water, Heritage and the Arts.

LesryK Environmental Consultants (2007). Ecological assessment of a proposed residential development – Dido Street, Kiama, NSW. Report prepared on behalf of: Boral Ltd. Bundeena, NSW, LesryK Environmental Consultants.

Matteson, K. C. and G. A. Langellotto (2010). "Determinates of inner city butterfly and bee species richness." Urban Ecosyst: 1-15.

NSW Office of Water (2012). Controlled Activities On Waterfront Land: Guidelines for Riparian Corridors on Waterfront Land. Sydney, Department of Primary Industries – Office of Water.

Office of Environment & Heritage (2017). "BioNet Vegetation Classification ". from http://www.environment.nsw.gov.au/research/Visclassification.htm.

Office of Environment & Heritage (2017). Draft Biodiversity Assessment Method. Sydney, Office of Environment and Heritage for the NSW Government.

Office of Environment & Heritage (2018). "Bionet Atlas of NSW Wildlife." 2018, from http://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx.

Office of Environment & Heritage (2018). "BioNet Vegetation Classification 2.1." 2018, from http://www.environment.nsw.gov.au/research/Visclassification.htm.

Office of Environment and Heritage (2014). BioBanking Assessment Methodology 2014. Sydney.

Office of Environment and Heritage (2017). "Threatened species, populations and communities database." from http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/browse_geo.aspx.

Office of Environment and Heritage (2017). "Vegetation Information System (VIS) Classification 2.1." 2017, from http://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx.

Pennay, M., et al. (2004). Bat calls of NSW. Region based guide to the echolocation calls of microchiropteran bats. Sydney, New South Wales Department of Environment and Conservation and State Forests of New South Wales.

Royal Botanic Gardens (2017). "Plantnet – The Plant Information Network System of Botanic Gardens Trust." from http://plantnet.rbgsyd.nsw.gov.au/.

Royal Botanic Gardens (2018). "Plantnet – The Plant Information Network System of Botanic Gardens Trust Version 2.0." 2018, from http://plantnet.rbgsyd.nsw.gov.au/.

Stewart, D. (1998). Australian Frog Calls: Subtropical East. Mullumbimby, Nature Sound.

Stralberg, D., et al. (2009). "Re-Shuffling of Species with Climate Disruption: A No-Analog Future for California Birds?" PLoS ONE **4**(9): e6825.

Thackway, R. and I. D. Cresswell (1995). An Interim Biogeographic Regionalisation of Australia. Canberra, Australian Nature Conservation Agency.

Thackway, R. and I. D. Cresswell (1995). An Interim Biogeographic Regionalisation of Australia. Canberra, Australian Nature Conservation Agency.

Tozer, M., et al. (2010). "Native Vegetation of southeast NSW: a revised classification and map for the coast and tablelands." Cunninghami **11**(3).

APPENDIX A

THREATENED FLORA LIKELIHOOD

A1 THREATENED FLORA LIKELIHOOD

Table A.1 Flora likelihood of occurrence

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Acacia bynoeana	Bynoes Wattle	V	E1	Occurs south of Dora Creek-Morisset area to Berrima and the Illawarra region and west to the Blue Mountains. It grows mainly in heath and dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with Corymbia gummifera, Eucalyptus haemastoma, E. gummifera, E. parramattensis, E. sclerophylla, Banksia serrata and Angophora bakeri.	PMST	Low – Preferred habitat not present
Boronia deanei		V	V	Occurs from Lithgow district to Nalbaugh National Park where it grows in wet heath, often at the margins of open forest adjoining swamps or along streams.	PMST	Low – Preferred habitat not present
Caladenia tessellata	Thick Lip Spider Orchid	V	E1	Occurs south of Swansea where it grows on clay loam or sandy soils. Prefers low open forest with a heathy or sometimes grassy understorey. Within NSW, currently known from two disjunct areas; one population near Braidwood on the Southern Tablelands and three populations in the Wyong area on the Central Coast. Previously known also from Sydney and South Coast areas.	PMST	Low – Preferred habitat not present
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Occurs south from the Gibraltar Range, chiefly in coastal districts but also extends on to tablelands. Grows in swamp-heath and drier forest on sandy soils on granite & sandstone. Occurs in small, localised colonies most often on the flat plains close to the coast but also known from some mountainous areas growing in moist depressions and swampy habitats.	PMST	Low – Preferred habitat not present

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Cynanchum elegans	White-flowered Wax Plant	E	E1	Occurs from the Gloucester district to the Wollongong area and inland to Mt Dangar where it grows in rainforest gullies, scrub and scree slopes. This species typically occurs at the ecotone between dry subtropical forest/woodland communities.	Bionet, PMST	**Moderate**
Daphnandra johnsonii	Illawarra Socketwood		E1	Confined to the Illawarra (below 150 m alt) where it is usually found in subtropical Rainforest mostly on rocky sites along gullies and creeks. Sometimes found in disturbed areas or in moist Eucalypt forest in association with Eucalyptus tereticornis, E. pilularis, E.quadrangulata or Casuarina cunninghamiana.	Bionet, PMST	**Moderate**
Genoplesium baueri	Bauers Midge Orchid	E	V	Grows in dry sclerophyll forest and moss gardens over sandstone. The species has been recorded from locations between Ulladulla and Port Stephens. About half the records were made before 1960 with most of the older records being from northern Sydney suburbs. The species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments.	PMST	Low – Preferred habitat not present
Gentiana wingecarribiensis	Wingecarribee Gentian	E	CE	Occurs in Wingecarribee Swamp where it grows in Sphagnum hummocks and small open patches in dense juncus/sedge communities. Occurs within 10-15 m of the swamp margin where it grows in the ecotone between sedgeland and surrounding grassland.	PMST	Low – Preferred habitat not present

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Gossia acmenoides	Scrub Ironwood		E2	Known from Shellharbour, Wollongong and Kiama LGAs and encompasses all occurrences south of the Georges River. This population is the southernmost occurrence of the species and is approximately 175 km from the nearest population to the north in the Hunter region of NSW. Found in subtropical and dry rainforest on the ranges and coastal plain of eastern Australia. Estimated less than 100 mature plants, through approximately 30 sites. Occurring often as a single individual or small group. Flowers late spring to early autumn.	Bionet	**Moderate**
Haloragis exalata subsp. exalata		V	V	Found in the south coast, central coast and north west slopes botanical regions where it appears to require protected and shaded damp situations in riparian habitats.	PMST	Low – Preferred habitat not present
Irenepharsus trypherus	Illawarra Irene	E	E1	Occurs between Wollongong and the Shoalhaven River where it grows in gullies on the coast and escarpment. Specifically, it is known to occur within Moist Box-Red foothills forest.	PMST	Low – Preferred habitat not present
Melaleuca biconvexa	Biconvex Paperbark	V	V	Occurs as disjunct populations in coastal New South Wales from Jervis Bay to Port Macquarie, with the main concentration of records is in the Gosford/Wyong area. Grows in damp places, often near streams, or low-lying areas on alluvial soils of low slopes or sheltered aspects.	PMST	Low – Preferred habitat not present

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Pelargonium sp. Striatellum (G. W. Carr 10345), syn. Pelargonium sp., Pelargonium sp. 1	Omeo Stork's-bill	E	E1	Known from only 4 locations in NSW, with three on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. The only other known population is at Lake Omeo, Victoria. It occurs at altitudes between 680 to 1030 m. It is known to occur in the local government areas of Goulburn-Mulwaree, Cooma-Monaro, and Snowy River, but may occur in other areas with suitable habitat; these may include Bombala, Eurobodalla, Palerang, Tumbarumba, Tumut, Upper Lachlan, and Yass Valley local government areas. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities. It occurs with Serrated Tussock (Nassella trichotoma) and Curly Sedge (Carex bichenoviana), and less commonly with Creeping Hopbush (Dodonaea procumbens) and a bog-sedge (Schoenus nitens) on sandy soils or gravelly soils or amongst rocks.	PMST	Low – Preferred habitat not present
Pimelea spicata	Spiked Rice-flower	E	E1	This species occurs in two disjunct areas: in coastal districts from Lansdowne to Shellharbour, and in Cumberland Plain Woodland inland to Penrith. In western Sydney it grows on Wianamatta Shales in Greybox – Ironbark Woodland with Bursaria spinosa and Themeda australis. In the Illawarra, it occurs on well structured clay soils in grassland or open woodland.	Bionet, PMST	Low – Preferred habitat not present
Prasophyllum affine	Kinghorn Point Leek Orchid	E	E1	Occurs south of the Sydney region where it grows in heath, avoiding swampy habitats. Prefers grey-brown silty soils.	PMST	Low – Preferred habitat not present
Pterostylis gibbosa		E	E1	Occurs in the southern part of the Central Coast region with a disjunct population in the Hunter Valley. Grows among grass in sclerophyll forest. In the Illawarra it grows in Coastal Grassy Red Gum Forest and in Lowland Woolybutt-Melaleuca forest.	PMST	Low – Preferred habitat not present

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Solanum celatum			E1	Restricted to an area from Wollongong to just south of Nowra, and west to Bungonia. Majority of records are prior to 1960 and the majority of populations are likely to have been lost to clearing. Grows on hills and slopes in eucalypt woodland; commonly found after fire or disturbance.	Bionet	Low – Preferred habitat not present
Syzygium paniculatum	Magenta Lilly Pilly	V	E1	Occurs between Bulahdelah and St Georges Basin where it grows in subtropical and littoral rainforest on sandy soils or stabilized dunes near the sea. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	PMST	**Moderate**
Thelymitra kangaloonica		CE		It is found in swamps in sedgelands over grey silty grey loam soils. Only known to occur on the southern tablelands of NSW in the Moss Vale / Kangaloon / Fitzroy Falls area at three swamps that are above the Kangaloon Aquifer.	PMST	Low – Preferred habitat not present
Thesium australe	Austral Toadflax	V	V	Grows in grassland or woodland often in damp sites. It is a semi-parasitic herb and hosts are likely to be Themeda australis and Poa spp.	PMST	Low – Preferred habitat not present
Zieria granulata	Illawarra Zieria	E	E1	Occurs in the Kiama district from Bass Point to Foxground and west to near Albion Park where it grows on dry rocky ridges in sclerophylll forest to rainforest margins. Typically it occurs on dry ridge tops and rocky outcrops with shallow volcanic soils. Less frequently found on the moist slopes of the Illawarra escarpment and in low-lying areas on Quaternary sediments. Occurs in a range of communities including Melaleuca armillaris Tall Shrubland, Illawarra Subtropical Rainforest and Illawarra Lowlands Grassy Woodland.	Bionet, PMST	**Recorded**

Note: Habitat descriptions sourced from OEH BioNet database and Scientific Determinations for each species.

(1) V = Vulnerable, E = Endangered, CE = Critically Endangered under the EPBC Act

(2) V = Vulnerable, E1 = Endangered, E2 = Endangered population, CE = Critically Endangered species under the BC Act

APPENDIX B

RECORDED FLORA

B1 FLORA RECORDED

SPECIES (SCIENTIFIC NAME – COMMON NAME)	EXOTIC
Acacia melanoxylon – Blackwood	
Acacia suaveolens – Sweet Wattle	
Acetosella vulgaris – Sorrel, Sheep Sorrel	*
Acmena smithii – Lilly Pilly	
Ageratina adenophora – Crofton Weed	*
Alchornea ilicifolia – Native Holly	
Alectryon subcinereus – Wild Quince	
Alphitonia excelsa – Red Ash	
Anthoxanthum odoratum – Sweet Vernal Grass	*
Apium leptophyllum – Slender Celery	*
Araujia sericifera – Moth Vine	*
Aristida sp. –	
Asparagus aethiopicus – Asparagus Fern	*
Asplenium australasicum –	
Asplenium flabellifolium – Necklace Fern	
Backhousia myrtifolia – Grey Myrtle	
Banksia ericifolia – Heath Banksia	
Banksia integrifolia –	
Bidens pilosa – Cobblers Pegs	*
Bothriochloa macra – Red Grass	
Brachychiton acerifolius – Illawarra Flame Tree	
Breynia oblongifolia – Coffee Bush	
Bromus catharticus – Prairie Grass	*
Callistemon salignus – Willow Bottlebrush	
Calochlaena dubia – Common Ground Fern	
Cayratia clematidea – Slender Grape	
Celastrus australis – Staff Vine	
Centaurium tenuiflorum –	*
Centella asiatica – Pennywort	*
Ciclospermum leptophyllum – Slender Celery	*

SPECIES (SCIENTIFIC NAME – COMMON NAME)	EXOTIC
Cinnamomum camphora – Camphor Laurel	*
Cirsium vulgare – Spear Thistle	*
Clerodendrum tomentosum –	
Commelina cyanea – Native Wandering Jew	
Commersonia fraseri – Brush Kurrajong	
Conyza bonariensis – Flaxleaf Fleabane	*
Crinum pedunculatum – Swamp Lily	
Croton verreauxii – Native Cascarilla	
Cryptocarya glaucescens – Jackwood	
Cyperus sp. –	
Dactylis glomerata – Cocksfoot	*
Delairea odorata – Cape Ivy	*
Dendrocnide excelsa – Giant Stinging Tree	
Desmodium gunnii –	
Dianella caerulea var. producta –	
Dichelachne rara –	
Dichondra repens – Kidney Weed	
Diospyros australis – Black Plum	
Doodia aspera – Prickly Rasp Fern	
Doryphora sassafras – Sassafras	
Duboisia myoporoides – Corkwood	
Echinopogon caespitosus –	
Ehretia acuminata –	
Ehrharta erecta – Panic Veldtgrass	*
Elaeocarpus reticulatus – Blueberry Ash	
Endiandra sieberi – Hard Corkwood	
Eucalyptus botryoides – Bangalay	
Eucalyptus fastigata – Brown Barrel	
Eucalyptus quadrangulata – White-topped Box	
Eucalyptus robusta – Swamp Mahogany	
Euphorbia peplus – Petty Spurge	*
Eustrephus latifolius – Wombat Berry	
Ficus coronata – Creek Sandpaper Fig	

SPECIES (SCIENTIFIC NAME – COMMON NAME)	EXOTIC
Ficus macrophylla –	
Foeniculum vulgare – Fennel	*
Geitonoplesium cymosum – Scrambling Lily	
Geranium homeanum –	
Glochidion ferdinandi – Cheese Tree	
Glycine clandestina –	
Gomphocarpus fruticosus – Narrow-leaved Cotton Bush	*
Guioa semiglauca –	
Helicia glabriflora –	
Hibbertia dentata – Twining Guinea Flower	
Hibbertia scandens – Climbing Guinea Flower	
Hibiscus heterophyllus –	
Hibiscus heterophyllus subsp. heterophyllus – Native Rosella	
Holcus lanatus – Yorkshire Fog	*
Hydrocotyle sibthorpioides –	
Hypochaeris radicata – Catsear	
Ipomoea cairica –	*
Ipomoea sp. –	*
Isolepis inundata –	
Juncus usitatus –	
Lantana camara – Lantana	*
Legnephora moorei – Round-leaf Vine	
Leptospermum polygalifolium –	
Leptospermum trinervium –	
Leucopogon juniperinus –	
Ligustrum lucidum – Large-leaved Privet	*
Ligustrum sinense – Small-leaved Privet	*
Lindsaea linearis – Screw Fern	
Livistona australis – Cabbage Palm	
Lolium perenne – Perennial Ryegrass	*
Lomandra longifolia – Spiny-headed Mat-rush	
Lonicera japonica – Japanese Honeysuckle	*
Ludwigia peploides subsp. montevidensis – Water Primrose	*

SPECIES (SCIENTIFIC NAME – COMMON NAME)	EXOTIC
Maclura cochinchinensis – Cockspur Thorn	
Melaleuca armillaris –	
Melaleuca ericifolia –	
Melaleuca linariifolia –	
Melaleuca styphelioides – Prickly-leaved Tea Tree	
Melia azedarach – White Cedar	
Microlaena stipoides –	
Microlaena stipoides var. stipoides –	
Notelaea venosa – Veined Mock-olive	
Ochna serrulata – Mickey Mouse Plant	*
Olea europaea – Common Olive	*
Omalanthus sp. –	*
Oplismenus imbecillis – Creeping Beard Grass	
Oxalis sp. –	
Pandorea pandorana – Wonga Wonga Vine	
Parsonsia straminea – Common Silkpod	
Paspalum dilatatum – Paspalum	*
Paspalum distichum – Water Couch	*
Pellaea falcata – Sickle Fern	
Pennisetum clandestinum – Kikuyu Grass	
Persicaria decipiens – Slender Knotweed	
Persicaria hydropiper – Water Pepper	
Phragmites australis – Common Reed	
Pittosporum multiflorum – Orange Thorn	
Pittosporum spinescens – Wallaby Apple	
Pittosporum undulatum – Sweet Pittosporum	
Plantago lanceolata – Lambs Tongues	
Poa sieberiana –	
Prunus spp. –	*
Pseuderanthemum variabile – Pastel Flower	
Ranunculus repens – Creeping Buttercup	*
Rapistrum rugosum – Turnip Weed	*
Ricinus communis – Castor Oil Plant	*

SPECIES (SCIENTIFIC NAME – COMMON NAME)	EXOTIC
Rosa sp. –	*
Rubus fruiticosus – Blackberry complex	*
Rubus rosifolius – Rose-leaf Bramble	*
Rumex brownii – Swamp Dock	
Sarcomelicope simplicifolia –	
Sarcopetalum harveyanum – Pearl Vine	
Senecio madagascariensis – Fireweed	*
Senna pendula – Easter Cassia	*
Sida rhombifolia – Paddys Lucerne	*
Sigesbeckia orientalis –	
Smilax australis – Sarsaparilla	
Smilax glyciphylla – Sweet Sarsparilla	
Sporobolus africanus – Parramatta Grass	
Stephania japonica –	
Sticherus flabellatus – Umbrella Fern	
Streblus brunonianus –	
Syncarpia glomulifera – Turpentine	
Taraxacum officinale – Dandelion	*
Tasmannia insipida – Brush Pepperwood	
Toona ciliata – Red Cedar	
Tradescantia fluminensis – Wandering Jew	*
Trema aspera – Native Peach	
Trifolium repens – White Clover	
Tristaniopsis laurina – Kanuka	
Typha orientalis – Broad-leaved Cumbungi	
Typha spp. –	
Urtica incisa – Stinging Nettle	
Verbena bonariensis – Purpletop	*
Veronica plebeia – Trailing Speedwell	
Vulpia sp. –	*
Wilkiea huegeliana – Veiny Wilkiea	
Zantedeschia aethiopica – Arum Lily	
Zieria granulata – Illawarra Zieria	Threatened

B2 PLOT DATA

B2.1 PLOT LOCATION AND STRUCTURE DATA

PLOT	R3	R5	B1	C1
EASTING				
NORTHING				
ORIENTATION	350	245	320	75
PLOT SIZE	20 x 20	20 x 20	20 x 20	20 x 20
BAM Attributes 20x50m plot				
Stem classes				
80+				
50-79		3	2	1
30-49	Y	Y	Y	Y
20-29	Y	Y	Y	Y
10-19	Y	Y	Y	Y
5-9	Y	Y	Y	Y
<5	Y	Y	Y	Y
Hollows	0	0	0	0
Length logs (m)	0	0	49	6
BAM Attributes 1x1 plot (%)				
Litter (%)	77	97	72	61

B2.2 SPECIES COMPOSITION

B2.2.1 PLOT R3

Dido St Kiama, Plot R3			**Covers**	**Native**	Trees	Shrubs	Grass	Forb	Fern	Other	**Exotic**	HighThreat
Sheet version: 20170224.1531			**# spp**	**Count**	Count	Count	Count	Count	Count	Count	**Count**	Count
			34	**26**	5	6	4	2	4	5	**8**	5
Species	**Cover**	**Abundance**	**Sum cover**	**Sum**	Sum	Sum	Sum	Sum	Sum	Sum	**Sum**	Sum
			44.8	**89.2**	50.2	36.7	0.5	0.3	0.9	0.6	**1.6**	1.3
Pellaea falcata	0.5	50	EG						0.5			
Doodia aspera	0.2	30	EG						0.2			
Lantana camara	0.2	20	HT									0.2
Pseuderanthemum variabile	0.2	40	FG					0.2				
Sticherus flabellatus	0.1	20	EG						0.1			
Lindsaea linearis	0.1	50	EG						0.1			
Parsonsia straminea	0.1	1	OG							0.1		
Glochidion ferdinandi	3	1	TG		15							
Acacia melanoxylon	3	1	TG		20							
Maclura cochinchinensis	0.1	1	OG							0.1		
Notelaea venosa	8	20	SG			10						
Pittosporum undulatum	5	4	SG			20						

Dido St Kiama, Plot R3			**Covers**	**Native**	Trees	Shrubs	Grass	Forb	Fern	Other	**Exotic**	HighThreat
Sheet version: 20170224.1531			**# spp**	**Count**	Count	Count	Count	Count	Count	Count	**Count**	Count
			34	**26**	5	6	4	2	4	5	**8**	5
Species	**Cover**	**Abundance**	**Sum cover**	**Sum**	Sum	Sum	Sum	Sum	Sum	Sum	**Sum**	Sum
			44.8	**89.2**	50.2	36.7	0.5	0.3	0.9	0.6	**1.6**	1.3
Persicaria hydropiper	0.1	2	FG					0.1				
Asparagus aethiopicus	0.5	20	HT									0.5
Cyperus spp.	0.1	10	GG				0.1					
Eustrephus latifolius	0.1	20	OG							0.1		
Geitonoplesium cymosum	0.1	2	OG							0.1		
Ochna serrulata	0.1	1	HT									0.1
Microlaena stipoides	0.1	20	GG				0.1					
Oplismenus imbecillis	0.2	20	GG				0.2					
Conyza bonariensis	0.1	4	EX								0.1	
Bidens pilosa	0.1	4	EX								0.1	
Ageratina adenophora	0.4	20	HT									0.4
Solanum nigrum	0.1	1	EX								0.1	
Calochlaena dubia	0.2	5	OG							0.2		
Acetosella vulgaris	0.1	1	HT									0.1
Juncus spp.	0.1	1	GG				0.1					
Podocarpus elatus	5	3	TG		5							

Dido St Kiama, Plot R3			**Covers**	**Native**	Trees	Shrubs	Grass	Forb	Fern	Other	**Exotic**	HighThreat
Sheet version: 20170224.1531			**# spp**	**Count**	Count	Count	Count	Count	Count	Count	**Count**	Count
			34	**26**	5	6	4	2	4	5	**8**	5
Species	**Cover**	**Abundance**	**Sum cover**	**Sum**	Sum	Sum	Sum	Sum	Sum	Sum	**Sum**	Sum
			44.8	**89.2**	50.2	36.7	0.5	0.3	0.9	0.6	**1.6**	1.3
Pittosporum multiflorum	0.5	1	SG			0.5						
Alchornea ilicifolia	0.2	4	SG			0.2						
Streblus brunonianus	10	5	TG		10							
Commersonia fraseri	2	2	SG			2						
Ficus macrophylla	0.2	1	TG		0.2							
Alectryon subcinereus	4	1	SG			4						

B2.2.2 PLOT R5

Dido St Kiama, Plot R5			**Covers**	**Native**	Trees	Shrubs	Grass	Forb	Fern	Other	**Exotic**	HighThreat
Sheet version: 20170224.1531			**# spp**	**Count**	Count	Count	Count	Count	Count	Count	**Count**	Count
			22	**19**	8	7	1	1	0	2	**3**	2
Species	**Cover**	**Abundance**	**Sum cover**	**Sum**	Sum	Sum	Sum	Sum	Sum	Sum	**Sum**	Sum
			29.9	**29.6**	21.1	7.7	0.1	0.1	0	0.6	**0.3**	0.2
Podocarpus elatus	5	3	TG		5							
Eucalyptus fastigata	5	2	TG		5							
Syncarpia glomulifera	4	3	TG		4							
Livistona australis	0.5	4	OG							0.5		
Acmena smithii	1	2	TG		1							
Zieria granulata	0.5	1	SG			0.5						
Microlaena stipoides	0.1	5	GG				0.1					
Ehrharta erecta	0.1	10	HT									0.1
Eucalyptus quadrangulata	5	2	TG		5							
Alectryon subcinereus	0.5	1	SG			0.5						
Melia azedarach	0.5	2	TG		0.5							
Pittosporum undulatum	5	3	SG			5						
Ficus coronata	0.5	2	SG			0.5						
Pandorea pandorana	0.1	1	OG							0.1		

Dido St Kiama, Plot R5			**Covers**	**Native**	Trees	Shrubs	Grass	Forb	Fern	Other	**Exotic**	HighThreat
Sheet version: 20170224.1531			**# spp**	**Count**	Count	Count	Count	Count	Count	Count	**Count**	Count
			22	**19**	8	7	1	1	0	2	**3**	2
Species	**Cover**	**Abundance**	**Sum cover**	**Sum**	Sum	Sum	Sum	Sum	Sum	Sum	**Sum**	Sum
			29.9	**29.6**	21.1	7.7	0.1	0.1	0	0.6	**0.3**	0.2
Callistemon salignus	1	1	SG			1						
Dendrocnide excelsa	0.1	1	TG		0.1							
Asparagus aethiopicus	0.1	2	HT									0.1
Bidens pilosa	0.1	5	EX								0.1	
Pseuderanthemum variabile	0.1	1	FG					0.1				
Tasmannia insipida	0.1	5	SG			0.1						
Wilkiea huegeliana	0.1	2	SG			0.1						
Streblus brunonianus	0.5	1	TG		0.5							

B2.2.3 PLOT B1

Dido St Kiama, Plot B1			**Covers**	**Native**	Trees	Shrubs	Grass	Forb	Fern	Other	**Exotic**	HighThreat
Sheet version: 20170224.1531			**# spp**	**Count**	Count	Count	Count	Count	Count	Count	**Count**	Count
			20	**14**	7	1	1	3	0	2	**6**	5
Species	**Cover**	**Abundance**	**Sum cover**	**Sum**	Sum	Sum	Sum	Sum	Sum	Sum	**Sum**	Sum
			53.6	**52**	43.1	5	0.1	2.6	0	1.2	**1.6**	1.4
Banksia integrifolia	20	7	TG		20							
Eucalyptus robusta	10	6	TG		10							
Dichondra repens	2	1000	FG					2				
Ehrharta erecta	1	100	HT									1
Acmena smithii	5	5	TG		5							
Livistona australis	0.2	2	OG							0.2		
Acacia melanoxylon	2	1	TG		2							
Sigesbeckia orientalis	0.1	10	FG					0.1				
Ochna serrulata	0.1	1	HT									0.1
Bidens pilosa	0.2	10	EX								0.2	
Lonicera japonica	0.1	3	HT									0.1
Podocarpus elatus	5	4	TG		5							
Melaleuca linariifolia	5	4	SG			5						
Oplismenus aemulus	0.1	10	GG				0.1					

Dido St Kiama, Plot B1			**Covers**	**Native**	Trees	Shrubs	Grass	Forb	Fern	Other	**Exotic**	HighThreat
Sheet version: 20170224.1531			**# spp**	**Count**	Count	Count	Count	Count	Count	Count	**Count**	Count
			20	**14**	7	1	1	3	0	2	**6**	5
Species	**Cover**	**Abundance**	**Sum cover**	**Sum**	Sum	Sum	Sum	Sum	Sum	Sum	**Sum**	Sum
			53.6	**52**	43.1	5	0.1	2.6	0	1.2	**1.6**	1.4
Pandorea pandorana	1	2	OG							1		
Asparagus aethiopicus	0.1	4	HT									0.1
Casuarina glauca	0.1	1	TG		0.1							
Lantana camara	0.1	1	HT									0.1
Commelina cyanea	0.5	2	FG					0.5				
Streblus brunonianus	1	1	TG		1							

B2.2.4 PLOT C1

Dido St Kiama, Plot C1			**Covers**	**Native**	Trees	Shrubs	Grass	Forb	Fern	Other	**Exotic**	HighThreat
Sheet version: 20170224.1531			**# spp**	**Count**	Count	Count	Count	Count	Count	Count	**Count**	Count
			27	**21**	3	8	2	3	1	4	**6**	6
Species	**Cover**	**Abundance**	**Sum cover**	**Sum**	Sum	Sum	Sum	Sum	Sum	Sum	**Sum**	Sum
			138.9	**66.3**	27.1	31.1	5.2	2.3	0.1	0.5	**72.6**	72.6
Casuarina glauca	25	30	TG		25							
Melaleuca linariifolia	15	10	SG			15						
Ligustrum sinense	0.1	1	HT									0.1
Lonicera japonica	0.1	2	HT									0.1
Geranium homeanum	0.2	30	FG					0.2				
Tradescantia fluminensis	2	500	HT									2
Hibbertia scandens	0.1	1	OG							0.1		
Lomandra longifolia	5	20	GG				5					
Ficus coronata	0.2	2	SG			0.2						
Commelina cyanea	2	300	FG					2				
Ehrharta erecta	70	1000	HT									70
Melaleuca quinquenervia	2	3	TG		2							
Apium spp.	0.1	20	FG					0.1				
Alectryon subcinereus	0.1	1	SG			0.1						

Dido St Kiama, Plot C1			**Covers**	**Native**	Trees	Shrubs	Grass	Forb	Fern	Other	**Exotic**	HighThreat
Sheet version: 20170224.1531			**# spp**	**Count**	Count	Count	Count	Count	Count	Count	**Count**	Count
			27	**21**	3	8	2	3	1	4	**6**	6
Species	**Cover**	**Abundance**	**Sum cover**	**Sum**	Sum	Sum	Sum	Sum	Sum	Sum	**Sum**	Sum
			138.9	**66.3**	27.1	31.1	5.2	2.3	0.1	0.5	**72.6**	72.6
Livistona australis	0.2	1	OG							0.2		
Asparagus aethiopicus	0.2	3	HT									0.2
Pittosporum undulatum	0.5	1	SG			0.5						
Bromus diandrus	0.2	20	HT									0.2
Asplenium flabellifolium	0.1	20	EG						0.1			
Melaleuca styphelioides	15	10	SG			15						
Cayratia clematidea	0.1	10	OG							0.1		
Oplismenus aemulus	0.2	50	GG				0.2					
Eustrephus latifolius	0.1	10	OG							0.1		
Myrsine variabilis	0.1	2	SG			0.1						
Wilkiea huegeliana	0.1	1	SG			0.1						
Helicia glabriflora	0.1	1	SG			0.1						
Endiandra sieberi	0.1	1	TG		0.1							

APPENDIX C

THREATENED FAUNA LIKELIHOOD

C1 THREATENED FAUNA LIKELIHOOD

Table C.1 Fauna likelihood of occurrence

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Amphibians (3)						
Heleioporus australiacus	Giant Burrowing Frog	V	V	Exists as two distinct populations: a northern population on the sandstone geology of the Sydney Basin, from Wollemi National Park in the north, south to Jervis Bay; and a southern population in disjunct pockets from about Narooma south into eastern Victoria. In the northern population there is a marked preference for sandstone ridgetop habitat and broader upland valleys where the frog is associated with small headwater and slow flowing to intermittent creeklines. The vegetation is typically woodland, open woodland and heath and may be associated with 'hanging swamp' seepage lines and where small pools form from collected water. Also observed occupying artificial ponded structures such as fire dams, gravel 'borrows', detention basins and box drains that have naturalised and are surrounded by undisturbed habitat. In the southern population, records appear to be associated with Devonian igneous and sedimentary formations and Ordovician metamorphics and are generally from more heavily timbered areas. It is absent from areas that have been cleared for agriculture or for urban development. Breed in summer and autumn in burrows in the banks of small creeks.	PMST	Low – no suitable habitat identified within study area

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Litoria aurea	Green and Golden Bell Frog	V	E1	This species occurs in fragment patches near coastal locations from Vic to south of the NSW-QLD border. For breeding it utilises a wide range of waterbodies, including both natural and man-made structures, such as marshes, dams and stream sides, and ephemeral wetlands. It is found in small pockets of habitat in otherwise developed areas and can occur in disturbed sites. There is a clear preference for sites with a complexity of vegetation structure and terrestrial habitat attributes which include extensive grassy areas and an abundance of shelter sites such as rocks, logs, tussock forming vegetation and other cover used for foraging and shelter. Over-wintering shelter sites may be adjacent to or some distance away from breeding sites but the full range of possible habitat used is not yet well understood.	Bionet, PMST	**High** – potential habitat surrounding Spring Creek Wetland. Records in surrounding area in 1997-2000. Despite no recent records (<5 years) Spring Creek Wetland provides habitat for this species.
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	V	V	Distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest near Wyong, south to Buchan in north-eastern Victoria. It appears to be restricted to sandstone woodland and heath communities at mid to high altitude. It forages both in the tree canopy and on the ground, and it has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats.	PMST	Low – no suitable habitat identified within study area

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Birds (44)						
Actitis hypoleucos	Common Sandpiper	M		The Common Sandpiper frequents a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity. It is mostly encountered along muddy margins or rocky shores and rarely on mudflats. It has been recorded in estuaries and deltas of streams, banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The muddy margins utilised by the species are often narrow, and may be steep. The species is often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags. Roost sites are typically on rocks or in roots or branches of vegetation, especially mangroves. The species is known to perch on posts, jetties, moored boats and other artificial structures, and to sometimes rest on mud or 'loaf' on rocks.	Bionet, PMST	Low – marginal habitat adjacent to study area (Spring Creek Wetland), irregular occurrences in wetland cannot be discounted.
Anthochaera phrygia (syn. Xanthomyza phrygia)	Regent Honeyeater	CE	CE	Occurs mostly in box-ironbark forests and woodland and prefers wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with *Casuarina cunninghamiana* and *Amyema cambagei* are important for feeding and breeding. Spotted Gum and Swamp Mahogany forests are also important feeding areas in coastal areas. Important food trees include *Eucalyptus sideroxylon* (Mugga Ironbark), *E. albens* (White Box), *E. melliodora* (Yellow Box) and *E. leucoxylon* (Yellow Gum).	PMST	**Moderate** – Although no records exist in the locality, important winter flowering eucalypt (*Eucalyptus robusta*) occurs in riparian forest along Spring Creek. Species could occur during irregular seasonal movements to coastal habitats under suitable conditions.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Apus pacificus	Fork-tailed Swift	M		Breeds in the northern hemisphere, wintering south to Australia. It is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground. It mostly occurs over inland plains but sometimes above foothills or in coastal areas over cliffs, beaches, islands and well out to sea. It also occurs over towns and cities. It mostly occurs over dry and/or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh, grassland, spinifex sandplains, farmland and sand-dunes. It sometimes occurs above forests. It probably roosts aerially, but has occasionally been observed to land.	PMST	**Moderate** – however, species only likely to use aerial spaces above study area during summer migratory movements.
Arenaria interpres	Ruddy Turnstone	M		Occurs at beaches and coasts with exposed rock, stony or shell beaches, mudflats, exposed reefs and wave platforms.	Bionet	Low – no available habitat in study area.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Artamus cyanopterus cyanopterus	Dusky Woodswallow		V	The Dusky Woodswallow is widespread in eastern, southern and southwestern Australia. In New South Wales it is widespread from coast to inland, including the western slopes of the Great Dividing Range and farther west. It is sparsely scattered in, or largely absent from, much of the Upper Western region. Often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests. At sites where Dusky Woodswallows are recorded the understorey is typically open with sparse eucalypt saplings, acacias and other shrubs, including heath. The ground cover may consist of grasses, sedges or open ground, often with coarse woody debris. Birds are also often observed in farm land, usually at the edges of forest or woodland or in roadside remnants or wind breaks with dead timber. In western New South Wales this species is primarily associated with River Red Gum/Black Box/Coolibah open forest/woodland associated with larger river/creek systems and is less common and far more patchily distributed in other communities such as mallee and cypress-pine woodland.	Bionet	**Moderate** – potential foraging habitat in study area.
Botaurus poiciloptilus	Australasian Bittern	E	E1	Occurs in shallow, vegetated freshwater or brackish swamps. Requires permanent wetlands with tall dense vegetation, particularly bulrushes and spikerushes. When breeding, pairs are found in areas with a mixture of tall and short sedges but will also feed in more open territory.	Bionet, PMST	**High** – previously recorded along Spring Creek and suitable extant habitat present in study area.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Burhinus grallarius	Bush Stone-curlew		E1	Found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber. In coastal areas, structurally similar elements of tidal and estuarine communities (Casuarina woodlands, saltmarsh and mangroves) provide suitable habitat. Nesting sites are frequently located in relatively open areas, where ground cover is extremely low and/or sparse including native vegetation and mown lawns, ploughed paddocks and paddocks cut for hay, dirt and gravel roads, seaweed on sand beach, playing fields, and vacant lots.	Bionet	**Moderate** – marginal habitat present in riparian forest adjacent to Spring Creek, however area subject to frequent disturbance by general public and unleashed pets.
Calidris (Crocethia) alba	Sanderling	M	V	The Sanderling occurs in coastal areas around Australia. Inland records have occurred in most states of singles or small groups, birds probably on migration. In Australia, the species is almost always found on the coast, mostly on open sandy beaches exposed to open sea-swell, and also on exposed sandbars and spits, and shingle banks, where they forage in the wave-wash zone and amongst rotting seaweed. Sanderlings also occur on beaches that may contain wave-washed rocky outcrops. Less often the species occurs on more sheltered sandy shorelines of estuaries, inlets and harbours. Rarely, they are recorded in near-coastal wetlands, such as lagoons, hypersaline lakes, saltponds and samphire flats. There are rare inland records from sandy shores of ephemeral brackish lakes and brackish river-pools.	Bionet	Low – no available habitat in study area.
Calidris acuminata	Sharp-tailed Sandpiper	M		Occurs in a variety of habitats: tidal mudflat, mangrove swamps, saltmarshes, shallow fresh, brackish, salt inland swamps and lakes; flooded and irrigated paddocks, sewage farms and commercial saltfields.	PMST	Low – however, marginal foraging habitat present adjacent to study area (Spring Creek Wetland), irregular occurrences in wetland cannot be discounted.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Calidris canutus	Red Knot	EM		In Australasia the Red Knot mainly inhabit intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. They are occasionally seen on terrestrial saline wetlands near the coast, such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks, but rarely use freshwater swamps. They rarely use inland lakes or swamps.	PMST	Low – no available habitat in study area.
Calidris ferruginea	Curlew Sandpiper	M	E1	Occurs in inter-tidal mudflats of estuaries, lagoons, mangrove channels and also around lakes, dams, floodwaters and flooded saltbush surrounding inland lakes.	PMST	Low – however, marginal foraging habitat present adjacent to study area (Spring Creek Wetland), irregular occurrences in wetland cannot be discounted.
Calidris melanotos	Pectoral Sandpiper	M		In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species frequents coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. It is usually found in coastal or near coastal habitat but occasionally further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. It has also been recorded in swamp overgrown with lignum. They forage in shallow water or soft mud at the edge of wetlands.	PMST	Low – however, marginal foraging habitat present adjacent to study area (Spring Creek Wetland), irregular occurrences in wetland cannot be discounted.
Circus assimilis	Spotted Harrier		V	Occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Occurs in grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. Preys on terrestrial mammals (e.g. bandicoots, bettongs, and rodents), birds and reptile, occasionally insects and rarely carrion.	Bionet	**High** – potential foraging habitat in study area. Records <5 years in locality.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Cuculus opatus (syn. Cuculus saturatus)	Oriental Cuckoo, Himalayan Cuckoo	M		A non-breeding migrant to Australia, it often inhabits rainforest, vine thickets, wet sclerophyll forest and open woodland and sometimes occurs in mangroves, wooded swamps and as vagrants in gardens. The population trend appears to be stable.	PMST	**Moderate** – potential habitat in study area. May occur during seasonal movements.
Dasyornis brachypterus	Eastern Bristlebird	E	E1	The habitat of the Eastern Bristlebird is characterised by low dense vegetation. Fire is a feature of all areas where known populations occur. Given the poor flight ability of the species it is though that few individuals survive the passage of fire, survival is dependant on the availability of fire refuges and recolonisation may be relatively slow. The bird is cryptic and camouflaged and rarely seen but may be detected by its distinctive, loud calls. Confined to NSW/Queensland border region, Illawarra region and NSW/Victorian border region.	PMST	Low – no available habitat in study area.
Egretta sacra	Eastern Reef Egret	M		Found in marine and estuarine habitats of mainland, islands and atolls. Prefers the rocky shorelines and reef mainlands in tropical Australia. Also found on intertidal areas of estuarine mudflats, mangrove-lined shores, rivers, creeks and beaches (gravel and mud). Sheltered sandy beaches rocky promontories are also used. Breed on islands, coral cays and rocky islets near intertidal habitats suitable for feeding.	Bionet	Low – marginal habitat in study area. Preferred habitat not in study area. Irregular occurrences in Spring Creek Wetlands cannot be discounted.
Epthianura albifrons	White-fronted Chat		E2	The White-fronted Chat occupies foothills and lowlands below 1000 m above sea level. In New South Wales the White-fronted Chat occurs mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state. Along the coastline, White-fronted Chats are found predominantly in saltmarsh vegetation although they are also observed in open grasslands and sometimes in low shrubs bordering wetland areas. The population in the Sydney Metropolitan Catchment Management Authority region is listed as Endangered.	Bionet	Low – marginal habitat in study area. Irregular occurrences in Spring Creek Wetlands cannot be discounted.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Gallinago hardwickii	Latham's Snipe	M		Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed.	Bionet, PMST	**High** – potential habitat in study area associated with Spring Creek Wetland.
Haematopus fuliginosus	Sooty Oystercatcher		V	The Sooty Oystercatcher is found on rocky headlands, rock shelves, exposed reefs with rock pools, beaches and muddy estuaries. The species forages on exposed intertidal rocky shorelines at low tide. It breeds almost exclusively on offshore islands, and occasionally on isolated promontories during spring and summer. They nest on the ground in amongst rocks, seaweed, shells and pebbles.	Bionet	Low – no available habitat in study area.
Haematopus longirostris	Australian Pied Oystercatcher		E1	Occurs in undisturbed beaches, sandpits, sandbars, tidal mudflats, estuaries and coastal islands. Occasionally found on rocky reefs, shores, rock stacks, brackish or saline wetlands and also in grassy paddocks, golf courses or parks near coast. Eggs are laid in shallow scrape in sand on open beach or among low growth behind beach.	Bionet	Low – no available habitat in study area.
Haliaeetus leucogaster	White-bellied Sea-Eagle	M	V	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs.	Bionet	**High** – potential habitat available in study area.
Hieraaetus morphnoides	Little Eagle		V	The Little Eagle is distributed throughout the Australian mainland occupying habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring. Prey includes birds, reptiles and mammals, with the occasional large insect and carrion. Preys on birds, reptiles and mammals, occasionally adding large insects and carrion. Most of its former native mammalian prey species in inland NSW are extinct and rabbits now form a major part of the diet.	Bionet	**High** – potential foraging habitat in study area.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Hirundapus caudacutus	White-throated Needletail	M		Widespread in eastern and south-eastern Australia. In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. It is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground. Because they are aerial, it has been stated that conventional habitat descriptions are inapplicable, but there are, nevertheless, certain preferences exhibited by the species. Although they occur over most types of habitat, they are probably recorded most often above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy, but they are less commonly recorded flying above woodland. They also commonly occur over heathland, but less often over treeless areas, such as grassland or swamps. When flying above farmland, they are more often recorded above partly cleared pasture, plantations or remnant vegetation at the edge of paddocks. In coastal areas, they are sometimes seen flying over sandy beaches or mudflats and often around coastal cliffs and other areas with prominent updraughts, such as ridges and sand-dunes.	Bionet, PMST	**High** – however species only likely to use aerial spaces above study area during summer migratory movements.
Hydroprogne caspia (syn. Sternia caspia)	Caspian Tern	M		The Caspian Tern is found in sheltered coastal embayments preferring sandy or muddy margins. Also found in near-coastal or inland terrestrial wetlands. It forages in open wetlands, preferring sheltered shallow water near the margins. It usually breeds in low islands, cays, spits, banks, ridges, beaches of sand or shell, terrestrial wetlands and stony or rocky islets or banks and occasionally among beach-cast debris above the high-water mark or at artificial sites, including islands in reservoirs, or on dredge-spoil. Generally roosting occurs on bare exposed sand or shell spits, banks or shores.	Bionet	Low – no suitable habitat available in study area.
Irediparra gallinacea	Comb-crested Jacana		V	Occurs in floating vegetation of permanent well-vegetated wetlands and dams. Walks on floating plants. Occasionally feeds along muddy wetland margins on east coast of NSW.	Bionet	Low – no suitable habitat available in study area.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Lathamus discolor	Swift Parrot	CE	E1	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts including the Sydney region, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland Australia it is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants, and for sites with flowering Acacia pycnantha, is indicated. Sites used vary from year to year.	Bionet, PMST	**Moderate** – Although few records exist in the locality, important winter flowering eucalypt (*Eucalyptus robusta*) occurs in riparian forest along Spring Creek. Species could occur during seasonal autumn/winter movements to mainland Australia under suitable conditions.
Limosa lapponica baueri	Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit	VM		The Bar-tailed Godwit (both subspecies combined) has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria. The migratory Bar-tailed Godwit (western Alaskan) does not breed in Australia. Occurs mainly in coastal habitats in coastal habitats which include large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It also has been recorded in coastal sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms and coral reef-flats.	PMST	Low – however, marginal foraging habitat present adjacent to study area (Spring Creek Wetland); irregular occurrences in wetland cannot be discounted.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri)	CEM		The Bar-tailed Godwit has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria. The migratory Bar-tailed Godwit (northern Siberian) does not breed in Australia. Occurs mainly in coastal habitats in coastal habitats which include large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It also has been recorded in coastal sewage farms and saltworks, saltlakes and brackish wetlands near coasts, sandy ocean beaches, rock platforms and coral reef-flats.	PMST	Low – however, marginal foraging habitat present adjacent to study area (Spring Creek Wetland); irregular occurrences in wetland cannot be discounted.
Monarcha melanopsis	Black-faced Monarch	M		Occurs in rainforests, eucalypt woodlands, coastal scrubs, damp gullies in rainforest, eucalypt forest and in more open woodland when migrating.	PMST	**Recorded**.
Monarcha trivirgatus	Spectacled Monarch	M		Occurs in the understorey of mountain/lowland rainforests, thickly wooded gullies and waterside vegetation. Migrates to NE NSW in summer to breed.	PMST	Low – although records for this species occur on the South Coast of NSW, the study area generally occurs outside the species typical southern distributional limit around Port Stephens, NSW.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Myiagra cyanoleuca	Satin Flycatcher	M		Widespread in eastern Australia. In Queensland, it is widespread but scattered in the east. In NSW, they are widespread on and east of the Great Divide and sparsely scattered on the western slopes, with very occasional records on the western plains. In Victoria, the species is widespread in the south and east, in the area south of a line joining Numurkah, Maldon, the northern Grampians, Balmoral and Nelson. Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. Satin Flycatchers mainly inhabit eucalypt forests, often near wetlands or watercourses. They generally occur in moister, taller forests, often occurring in gullies. They also occur in eucalypt woodlands with open understorey and grass ground cover, and are generally absent from rainforest. In south-eastern Australia, they occur at elevations of up to 1400 m above sea level, and in the ACT, they occur mainly between 800 m above sea level and the treeline.	PMST	**Moderate** – potential habitat in study area.
Neophema chrysogaster	Orange-bellied Parrot	ZM	E1	Orange-bellied Parrot breeds in the south-west of Tasmania and migrates in autumn to spend the winter on the mainland coast of south-eastern South Australia and southern Victoria. Typical winter habitat is saltmarsh and strandline/foredune vegetation communities either on coastlines or coastal lagoons. Spits and islands are favoured but they will turn up anywhere within these coastal regions. The species can be found foraging in weedy areas associated with these coastal habitats or even in totally modified landscapes such as pastures, seed crops and golf courses. Diet mainly comprises seeds and fruits of sedges and salt-tolerant coastal and saltmarsh plants. Occasionally, flowers and stems are eaten. Orange-bellied Parrots are known to forage among flocks of Blue-winged Parrots. It is expected that NSW habitats may be being more frequently utilised than observations suggest.	PMST	Low – no available habitat in study area

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Ninox connivens	Barking Owl		V	Occurs in dry sclerophyll woodland. In the south west it is often associated with riparian vegetation while in the south east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season.	Bionet	Low – marginal habitat available in study area.
Ninox strenua	Powerful Owl		V	A sedentary species with a home range of approximately 1000 hectares it occurs within open eucalypt, Casuarina or Callitris pine forest and woodland. It often roosts in denser vegetation including rainforest of exotic pine plantations. Generally feeds on medium-sized mammals such as possums and gliders but will also eat birds, flying-foxes, rats and insects. Prey are generally hollow dwelling and require a shrub layer and owls are more often found in areas with more old trees and hollows than average stands.	Bionet	**High** – potential foraging habitat available in study area in association with riparian forest; particularly including Grey-headed Flying-fox camp along Spring Creek.
Numenius madagascariensis	Eastern Curlew	CEM		Inhabits coastal estuaries, mangroves, mud flats and sand pits. It is a migratory shorebird which generally inhabits sea and lake shore mud flats, deltas and similar areas, where it forages for crabs and other crustaceans, clam worms and other annelids, molluscs, insects and other invertebrates. Its migration route ranges from its wintering grounds in Australia to its breeding grounds in northern China, Korea and Russia.	PMST	Low – however, marginal foraging habitat present adjacent to study area (Spring Creek Wetland), irregular occurrences in wetland cannot be discounted.
Numenius phaeopus	Whimbrel	M		Migrates to Taiwan, Philippines, PNG, and a race breeding in NE Siberia is found on the north and south-eastern coastlines of Australia. Juveniles arrive to Australia from spring to early summer. Usually only juveniles remain in Australia but very occasionally adults in breeding plumage may be seen in Australian winters.	Bionet	Low – however, marginal foraging habitat present adjacent to the study area. Irregular occurrences in Spring Creek Wetlands cannot be discounted.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Pandion cristatus (syn. P. haliaetus)	Eastern Osprey	M	V	Generally a coastal species, occurring in estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons, rock cliffs and stacks. Sometimes ascends larger rivers to far inland. Builds nests high in tree, on pylon or on ground on islands. Feeds on fish.	Bionet, PMST	**High** – potential foraging habitat in association with Spring Creek Wetland occurs adjacent to the study area. However, riparian forest along Spring Creek may provide suitable nesting platform.
Petroica phoenicea	Flame Robin		V	In NSW the Flame Robin breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats. In winter lives in dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees. In winter, occasionally seen in heathland or other shrublands in coastal areas. Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgelands at high altitudes. The Flame Robin forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other woody debris. The robin builds an open cup nest of plant fibres and cobweb, which is often near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank.	Bionet	**Moderate** – potential habitat in study area, potential to occur during seasonal altitudinal movements.
Plegadis falcinellus	Glossy Ibis	M		It feeds in very shallow water and nests in freshwater or brackish wetlands with tall dense stands of emergent vegetation (e.g. reeds or rushes) and low trees or bushes. It shows a preference for marshes at the edges of lakes and rivers, as well as lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and irrigated cultivation. It less often occurs in coastal locations such as estuaries, deltas, saltmarshes and coastal lagoons. Roosting sites are often large trees that may be far from water. The nest is a platform of twigs and vegetation usually positioned less than 1 m above water in tall dense stands of emergent vegetation (e.g. reeds or rushes), low trees or bushes over water.	Bionet	**Moderate** – potential habitat in association with Spring Creek Wetlands. Potential to occur during seasonal movements.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Rhipidura rufifrons	Rufous Fantail	M		Occurs in a range of habitats including the undergrowth of rainforests/wetter eucalypt forests/gullies, monsoon forests paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks and gardens. When migrating they may also be recorded on farms, streets and buildings. Migrates to SE Australia in October-April to breed, mostly in or on the coastal side of the Great Dividing Range.	PMST	**Moderate** – potential habitat available in study area
Rostratula australis (syn. R. benghalensis)	Australian Painted Snipe (Painted Snipe)	E	E1	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as *Eucalyptus camaldulensis* (River Red Gum), *E. populnea* (Poplar Box) or shrubs such as *Muehlenbeckia florulenta* (Lignum) or *Sarcocornia quinqueflora* (Samphire). Feeds at the water's edge and on mudflats on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest.	PMST	**Moderate** – potential habitat in association with Spring Creek Wetlands. Potential to occur during nomadic movements.
Sterna hirundo	Common Tern	M		A non-breeding migrant to Australia, occurring mainly on the east coast and inhabiting marine, pelagic and coastal habitats. Mostly oceanic but often recorded in bays, harbours and estuaries and occasionally in coastal wetlands. Roosting occurs on unvegetated intertidal sandy ocean beaches, shores of estuaries, lagoons and sand bars.	Bionet	Low – however, marginal foraging habitat present adjacent to the study area. Irregular occurrences in Spring Creek Wetlands cannot be discounted.
Sternula albifrons	Little Tern		E1	Little Terns inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets. They nest on sand-spits, sandbanks, ridges or islets in these habitats or gently sloping sandy ocean beaches and occasionally in sand-dunes.	Bionet, PMST	Low – however, marginal foraging habitat present adjacent to the study area. Irregular occurrences in Spring Creek Wetlands cannot be discounted.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Tringa nebularia	Common Greenshank	M		Occurs in a range of inland and coastal environments. Inland, it occurs in both permanent and temporary wetlands, billabongs, swamps, lakes floodplains, sewage farms, saltworks ponds, flooded irrigated crops. On the coast, it occurs in sheltered estuaries and bays with extensive mudflats, mangrove swamps, muddy shallows of harbours and lagoons, occasionally rocky tidal ledges. It generally prefers wet and flooded mud and clay rather than sand.	PMST	Low – however, marginal foraging habitat present adjacent to the study area. Potential to occur in Spring Creek Wetlands during seasonal movements.
Fish (3)						
Epinephelus daemelii	Black Cod	V	V	Adult black cod are usually found in caves, gutters and beneath bomboras on rocky reefs. They are territorial and often occupy a particular cave for life. Small juveniles are often found in coastal rock pools, and larger juveniles around rocky shores in estuaries. Black cod are opportunistic carnivores, eating mainly other fish and crustaceans. They can change from one colour pattern to another in just a few seconds. They are usually black in estuaries and banded around clear water reefs. Black cod are apparently slow growing. Smaller fish are mostly females, but they generally change sex to become males at around 100-110 cm in length.	PMST	Low – no suitable habitat identified within study area
Macquaria australasica	Macquarie Perch	E		Macquarie Perch are found in the Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury/Nepean and Shoalhaven catchments. Macquarie Perch are found in both river and lake habitats; especially the upper reaches of rivers and their tributaries. It prefers clear water and deep, rocky holes with lots of cover. As well as aquatic vegetation, additional cover may comprise of large boulders, debris and overhanging banks. Spawning occurs just above riffles (shallow running water).	PMST	Low – no suitable habitat identified within study area

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Prototroctes maraena	Australian Grayling	V		Occurs in streams and rivers on the eastern and southern flanks of the Great Dividing Range, from Sydney, southwards to the Otway Ranges of Victoria and in Tasmania. The species is found in fresh and brackish waters of coastal lagoons, from Shoalhaven River in NSW to Ewan Ponds in South Australia. The Australian Grayling is diadromous, spending part of its lifecycle in freshwater and at least part of the larval and/or juvenile stages in coastal seas. Adults (including pre spawning and spawning adults) inhabit cool, clear, freshwater streams with gravel substrate and areas alternating between pools and riffle zones such as the Tambo River, which is also known to have granite outcrops. The species has also been associated with clear, gravel-bottomed habitats in the Mitchell and Wonnangatta Rivers (Victoria) and in a muddy-bottomed, heavily silted habitat in the Tarwin River (Victoria). The species has been found over 100 km upstream from the sea.	PMST	Low – no suitable habitat identified within study area
Mammals (16)						
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Occurs in moderately wooded habitats, mainly in areas with extensive cliffs and caves and roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins. Breeding habitat (maternity roosts) is located in roof domes in sandstone caves. Thought to forage below the forest canopy for small flying insects.	PMST	**Moderate** – potential habitat for the species was recorded within the study area.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Dasyurus maculatus maculatus	Spotted-Tailed Quoll	E	V	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold. Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland, and despite its occurrence in riparian areas, it also ranges over dry ridges. Nests in rock caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods.	Bionet, PMST	Low – marginal habitat identified within study area. Study area highly fragmented and isolated from extensive remnant patches.
Falsistrellus tasmaniensis	Eastern False Pipistrelle		V	Usually roosts in tree hollows in higher rainfall forests. Sometimes found in caves (Jenolan area) and abandoned buildings. Forages within the canopy of dry sclerophyll forest. It prefers wet habitats where trees are more than 20 metres high.	Bionet	**High** – species recorded during previous site investigation in 2007.
Isoodon obesulus	Southern Brown Bandicoot	E	E1	Occurs in a variety of habitats in south-eastern Australia, including heathland, shrubland, dry sclerophyll forest with heathy understorey, sedgeland and woodland. Many of the habitats are prone to fire.	PMST	Low – no suitable habitat identified within study area
Miniopterus australis	Little Bentwing-bat		V	Distributed along the east coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. Found in moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub. Generally found in well-timbered areas. Roosts in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.	-	**Recorded**.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat		V	Eastern Bentwing-bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Hunt in rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, Melaleuca forests and open grasslands.	Bionet	**High** – potential foraging habitat in study area.
Mormopterus (Micronomus) norfolkensis	Eastern Freetail-bat		V	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures.	-	**Moderate** – potential habitat for the species was recorded within the study area.
Myotis macropus	Southern Myotis, Large-footed Myotis		V	Found in most habitat types in association with streams and permanent waterways usually at low elevations in flat or undulating landscapes from northern areas of Western Australia, and the Northern Territory, down the entire east coast and the southern coast of Australia to just west of the Victoria/South Australia border and inland along the Murray River. Roosts in caves, tree hollows, in clumps of dense vegetation (e.g. Pandanus), mines, tunnels, under bridges, road culverts and stormwater drains often in abandoned, intact Fairy Martin nests. Roost sites are strongly associated with bodies of water where this species commonly feeds on aquatic insects, shrimp and small fish at the water surface, however, aerial foraging for other insects is also known. Breeding habitat likely to coincide with roosting habitat.	Bionet	**High** – potential habitat for the species was recorded within the study area.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Petauroides volans	Greater Glider	V		The Greater Glider has a restricted distribution in eastern Australia, from the Windsor Tableland in north Queensland to central Victoria, with an elevated range from sea level to 1200m above sea level. The species is largely restricted to eucalypt forests and woodlands, with a diet comprising of eucalypt leaves and occasional flowers. It is found in abundance in montane eucalypt forest with relatively old trees and an abundance of hollows. It also favours forests with a diversity of eucalypts to cater for seasonal variation in food abundance.	PMST	Low – no suitable habitat identified within study area. No old growth woodland and within highly fragmented landscape.
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	Occurs in inland and sub-coastal south eastern Australia where it inhabits rock slopes. It has a preference for rocks which receive sunlight for a considerable part of the day. Windblown caves, rock cracks or tumbled boulders are used for shelter. Occur in small groups or "colonies" each usually separated by hundreds of metres.	PMST	Low – no suitable habitat identified within study area
Phascolarctos cinereus	Koala	V	V	The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. Inhabits eucalypt woodlands and forests. Koalas Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. The preferred tree species vary widely on a regional and local basis. Some preferred species include Forest Red Gum (*Eucalyptus tereticornis*), Grey Gum (*E. punctata*). In coastal areas, Tallowwood (*E. microcorys*) and Swamp Mahogany (*E. robusta*) are important food species, while in inland areas White Box (*E. albens*), Bimble Box (*E. populnea*) and River Red Gum (*E. camaldulensis*) are favoured. Hawks Nest and Tea Gardens Population and population in the Pittwater LGA listed as Endangered under the NSW BC Act.	Bionet, PMST	**Moderate** – although few records exist in the locality and the study area is highly fragmented from extensive patches of vegetation, riparian forest along Spring Creek contained two Koala feed tree species, including *Eucalyptus robusta* and *Eucalyptus quadrangulata*.

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland)	V	V	Disjunct distribution along coastal south-east Australia from near Gladstone in Queensland, to south-west Victoria and in Tasmania. Found from sea level up to 1500 metres in altitude generally in areas with rainfall greater than 760 millimetres. In NSW, it is found throughout coastal and subcoastal areas. Occurs in a range of habitats: coastal forest and woodland with a moderately dense heathy understorey, dense coastal scrubs or heath, wet and dry sclerophyll forest and sub-tropical, warm temperate and cool temperate rainforest of the eastern slopes and highlands. Often associated with gullies and forest ecotones. Open areas are used for foraging while areas of dense groundcover or understorey provide areas for shelter and protection from predators. Relatively thick ground cover is a major habitat requirement and it seems to prefer areas with light sandy soils. Feeds at dusk on roots, tubers, fungi, insects and their larvae and other soft bodied animals in the soil. Moves up and down slope as food resources become seasonally available.	PMST	Low – marginal habitat identified within study area. Study area highly fragmented and isolated from extensive remnant patches.
Pseudomys novaehollandiae	New Holland Mouse	V		The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes. Due to the largely granivorous diet of the species, sites where the New Holland Mouse is found are often high in floristic diversity, especially leguminous perennials.	PMST	Low – no suitable habitat identified within study area

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria. However, only a small proportion of this range is used at any one time, as the species selectively forages where food is available. As a result, patterns of occurrence and relative abundance within its distribution vary widely between seasons and between years. At a local scale, the species is generally present intermittently and irregularly. At a regional scale, broad trends in the distribution of plants with similar flowering and fruiting times support regular annual cycles of migration. Whilst Brisbane, Newcastle, Sydney and Melbourne are occupied continuously, elsewhere, during spring, Grey-headed Flying-foxes are uncommon south of Nowra and widespread in other areas of their range. The species is widespread throughout their range in summer, whilst in autumn it occupies coastal lowlands and is uncommon inland. In winter, the species congregates in coastal lowlands north of the Hunter Valley and is occasionally found on the south coast of NSW (associated with flowering Spotted Gum Corymbia maculata) and on the northwest slopes (generally associated with flowering White Box Eucalyptus albens or Mugga Ironbark E. sideroxylon). Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines.	Bionet, PMST	**Recorded** – roosting camp within riparian habitat along Spring Creek

SCIENTIFIC NAME	COMMON NAME	EPBC ACT	BC ACT	HABITAT	DATA SOURCE	LIKELIHOOD OF OCCURRENCE
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat		V	This species is widespread through tropical Australia and migrates to southern Australia in summer. Occurs in eucalypt forest where it feeds above the canopy and in mallee or open country where it feeds closer to the ground. Generally a solitary species but sometimes found in colonies of up to 10. It roosts and breeds in tree hollows but has also been recorded roosting under exfoliating bark, in burrows of terrestrial mammals, in soil cracks and under slabs of rock and in the nests of bird and sugar gliders.	-	**Moderate –** potential foraging habitat in study area.
Scoteanax rueppellii	Greater Broad-nosed Bat		V	The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically it forages at a height of 3-6 metres but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings.	Bionet	**Moderate** – potential habitat for the species was recorded within the study area.
Reptiles (1)						
Hoplocephalus bungaroides	Broad-headed Snake	V	E1	A nocturnal species that occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer.	PMST	Low – no available habitat in study area.

Note: Habitat descriptions sourced from OEH BioNet database and Scientific Determinations for each species.

(1) V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory, VM = Vulnerable Migratory, EM = Endangered Migratory, CEM = Critically Endangered Migratory under the EPBC Act

(2) V = Vulnerable, E1 = Endangered, E4 = Presumed Extinct species under the BC Act.

APPENDIX D

RECORDED FAUNA

D1 FAUNA RECORDED

SCIENTIFIC NAME	COMMON NAME	NATIVE (N) OR INTRODUCED (I)	BC ACT[1]	EPBC ACT[2]
Amphibians (3)				
Litoria fallax	Eastern Dwarf Tree Frog	N		
Crinia signifera	Common Eastern Froglet	N		
Limnodynastes peronii	Striped Marsh Frog	N		
Birds (65)				
Acanthiza lineata	Striated Thornbill	N		
Acanthiza nana	Yellow Thornbill	N		
Acanthiza pusilla	Brown Thornbill	N		
Acanthorhynchus tenuirostris	Eastern Spinebill	N		
Acrocephalus australis	Australian Reed-Warbler	N		
Ailuroedus crassirostris	Green Catbird	N		
Anas castanea	Chestnut Teal	N		
Anas superciliosa	Pacific Black Duck	N		
Anthochaera carunculata	Red Wattlebird	N		
Anthochaera chrysoptera	Little Wattlebird	N		
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo	N		
Carduelis carduelis	European Goldfinch	I		
Chroicocephalus novaehollandiae	Silver Gull	N		
Circus approximans	Swamp Harrier	N		
Cisticola exilis	Golden-headed Cisticola	N		
Coracina novaehollandiae	Black-faced Cuckoo-shrike	N		
Corvus coronoides	Australian Raven	N		
Cracticus torquatus	Grey Butcherbird	N		
Cygnus atratus	Black Swan	N		
Dacelo novaeguineae	Laughing Kookaburra	N		
Dicaeum hirundinaceum	Mistletoebird	N		
Egretta garzetta	Little Egret	N		
Egretta novaehollandiae	White-faced Heron	N		

SCIENTIFIC NAME	COMMON NAME	NATIVE (N) OR INTRODUCED (I)	BC ACT[1]	EPBC ACT[2]
Eolophus roseicapillus	Galah	N		
Eopsaltria australis	Eastern Yellow Robin	N		
Eudynamys orientalis	Eastern Koel	N		
Fulica atra	Eurasian Coot	N		
Gallinula tenebrosa	Dusky Moorhen	N		
Gerygone mouki	Brown Gerygone	N		
Glossopsitta concinna	Musk Lorikeet	N		
Grallina cyanoleuca	Magpie-lark	N		
Gymnorhina tibicen	Australian Magpie	N		
Hirundo neoxena	Welcome Swallow	N		
Malurus cyaneus	Superb Fairy-wren	N		
Megalurus gramineus	Little Grassbird	N		
Meliphaga lewinii	Lewin's Honeyeater	N		
Microcarbo melanoleucos	Little Pied Cormorant	N		
Monarcha melanopsis	Black-faced Monarch	N		M
Neochmia temporalis	Red-browed Finch	N		
Oriolus sagittatus	Olive-backed Oriole	N		
Pachycephala pectoralis	Golden Whistler	N		
Pardalotus punctatus	Spotted Pardalote	N		
Passer domesticus	House Sparrow	I		
Pelecanus conspicillatus	Australian Pelican	N		
Phalacrocorax carbo	Great Cormorant	N		
Phalacrocorax sulcirostris	Little Black Cormorant	N		
Phalacrocorax varius	Pied Cormorant	N		
Platycercus elegans	Crimson Rosella	N		
Porphyrio porphyrio	Purple Swamphen	N		
Psophodes olivaceus	Eastern Whipbird	N		
Ptilonorhynchus violaceus	Satin Bowerbird	N		
Pycnonotus jocosus	Red-whiskered Bulbul	I		
Rhipidura albiscapa	Grey Fantail	N		
Rhipidura leucophrys	Willie Wagtail	N		
Scythrops novaehollandiae	Channel-billed Cuckoo	N		

SCIENTIFIC NAME	COMMON NAME	NATIVE (N) OR INTRODUCED (I)	BC ACT[1]	EPBC ACT[2]
Sericornis frontalis	White-browed Scrubwren	N		
Sericornis magnirostra	Large-billed Scrubwren	N		
Sphecotheres vieilloti	Australasian Figbird	N		
Strepera graculina	Pied Currawong	N		
Streptopelia chinensis	Spotted Dove	I		
Sturnus tristis	Common Myna	I		
Threskiornis molucca	Australian White Ibis	N		
Trichoglossus haematodus	Rainbow Lorikeet	N		
Turdus merula	Common Blackbird	I		
Zosterops lateralis	Silvereye	N		
Mammals (11)				
Bos taurus	European Cattle	I		
Chalinolobus gouldii	Gould's Wattled Bat	N		
Chalinolobus morio	Chocolate Wattle Bat	N		
Lepus capensis	Brown Hare	I		
Miniopterus australis	Little Bentwing-bat	N	V	
Mormopterus ridei	Ride's Free-tailed Bat	N		
Nyctophilus sp.	Long-eared Bat	N		
Pteropus poliocephalus	Grey-headed Flying-fox	N	V	V
Scotorepens orion	Eastern Broad-nosed Bat	N		
Vespadelus vulturnus	Little Forest Bat	N		
Vulpes vulpes	Fox	I		
Reptiles (2)				
Eulamprus quoyii	Eastern Water-skink	N		
Lampropholis delicata	Dark-Flecked Garden Sunskink	N		

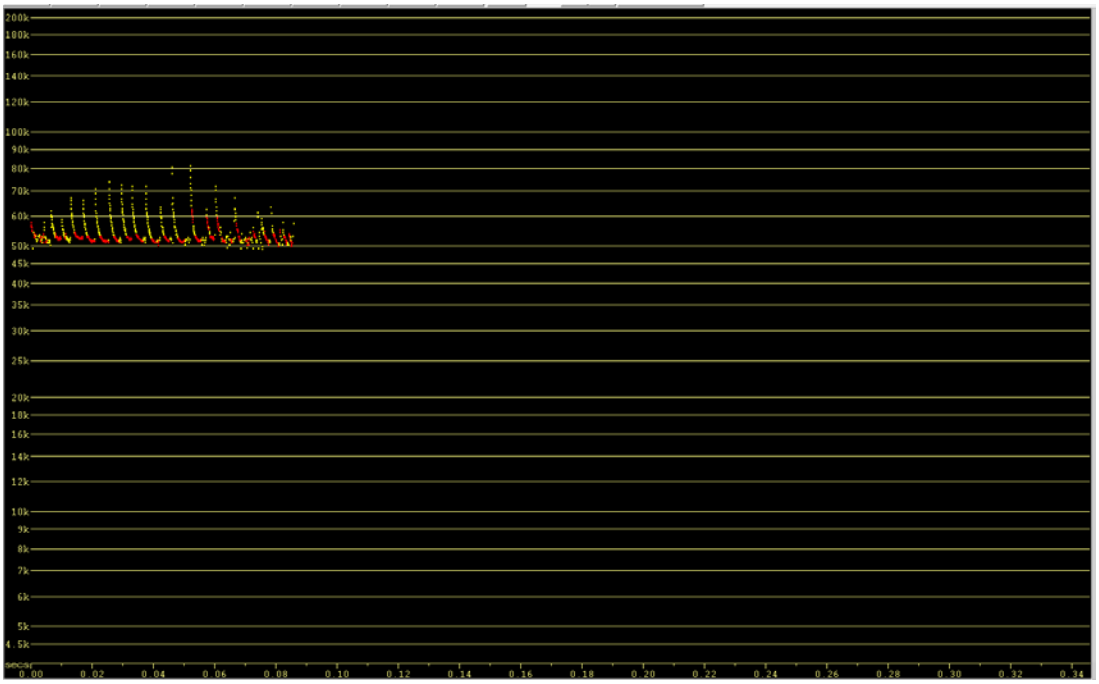
(1) V = Vulnerable under the Biodiversity Conservation Act 2016

(2) M = Migratory, V = Vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999.

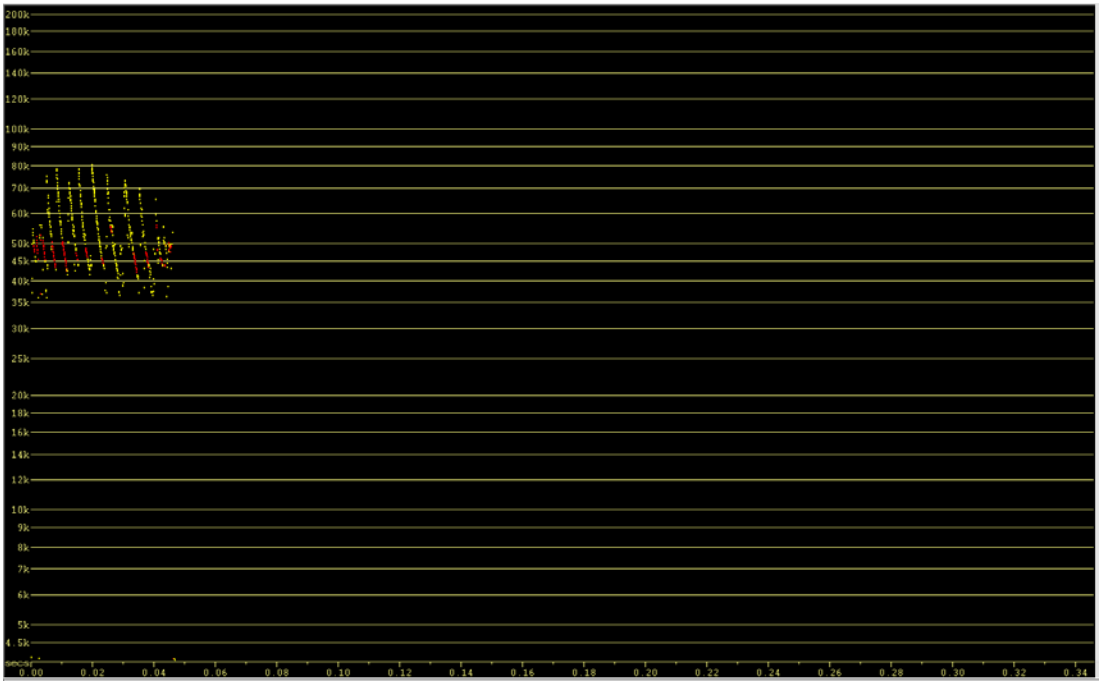
APPENDIX E

BAT CALL ANALYSIS

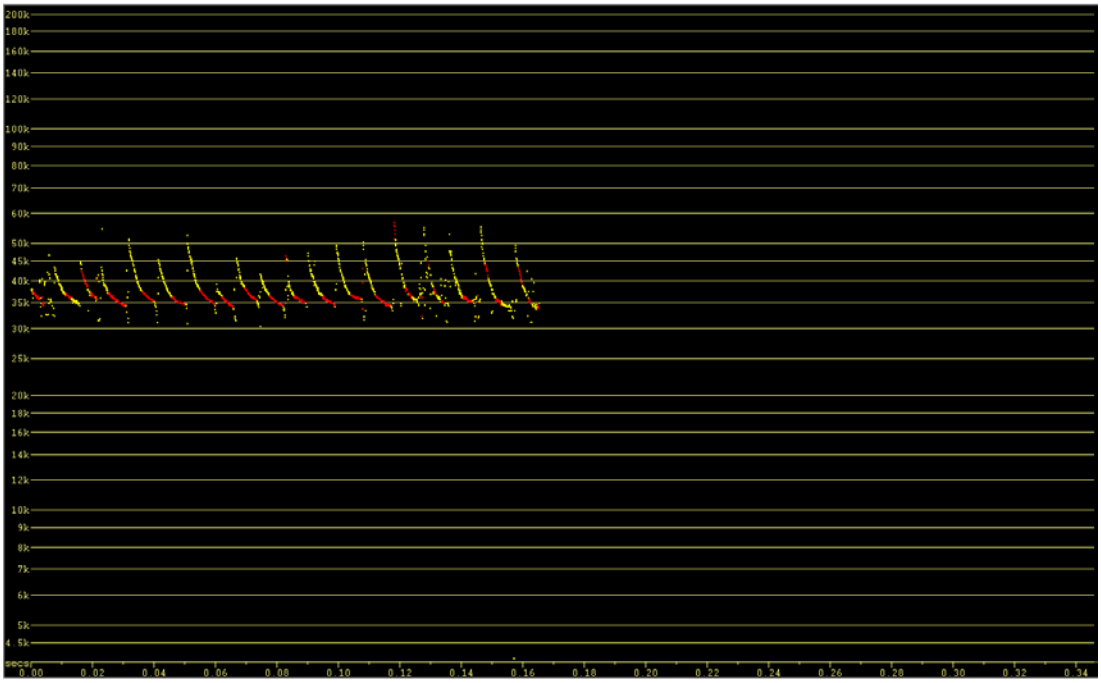
E1 REPRESENTATIVE BAT CALL SEQUENCES



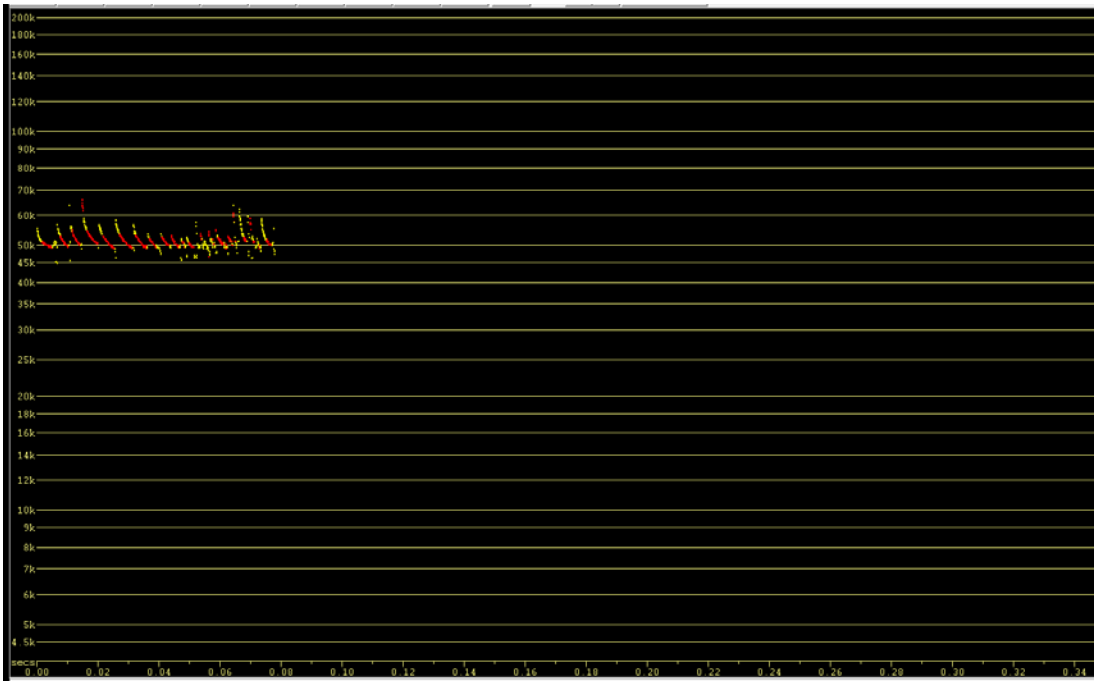
Little Forest Bat (*Vespadelus vulturnus*)



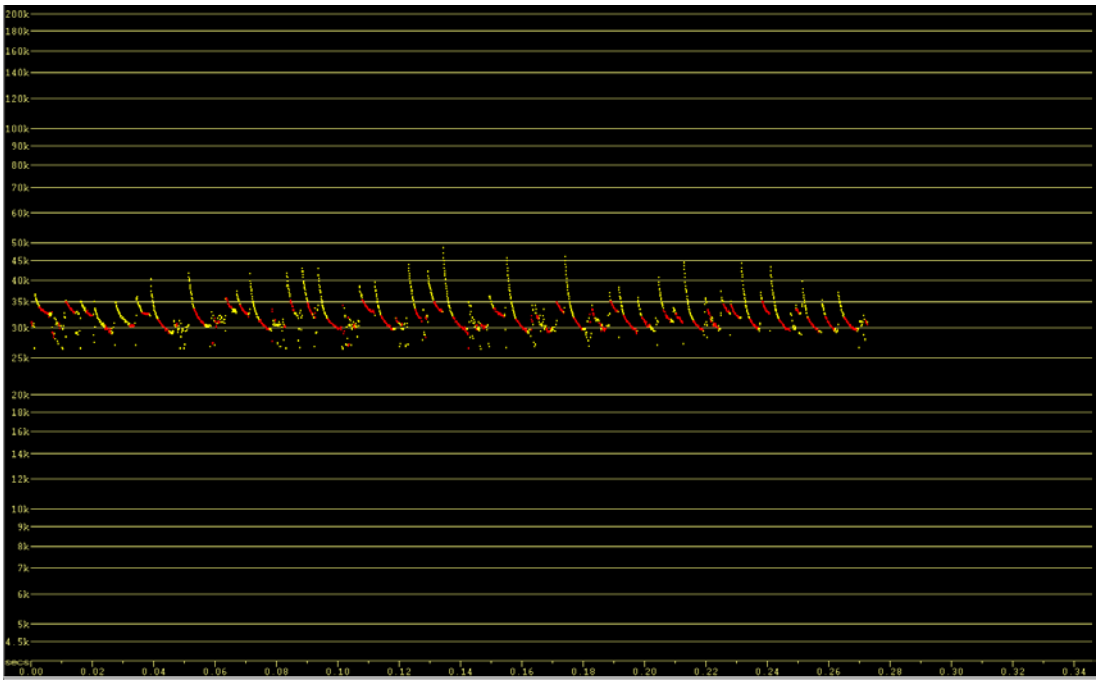
Long-eared Bat (*Nyctophilus* sp.)



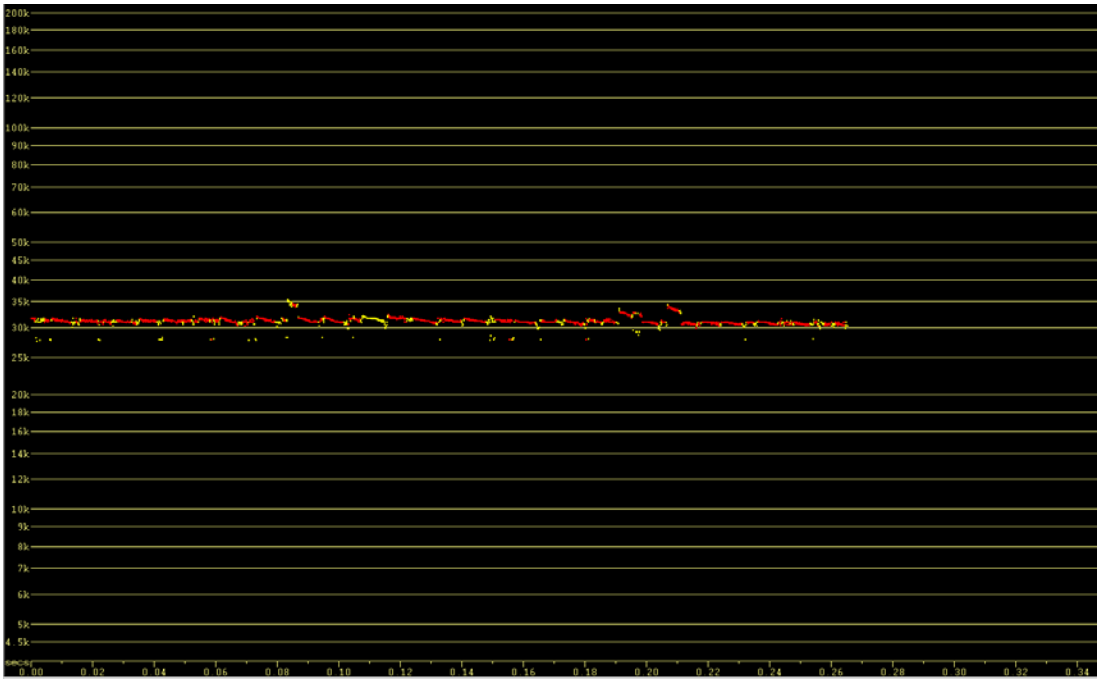
Eastern Broad-nosed Bat (*Scotorepens orion*)



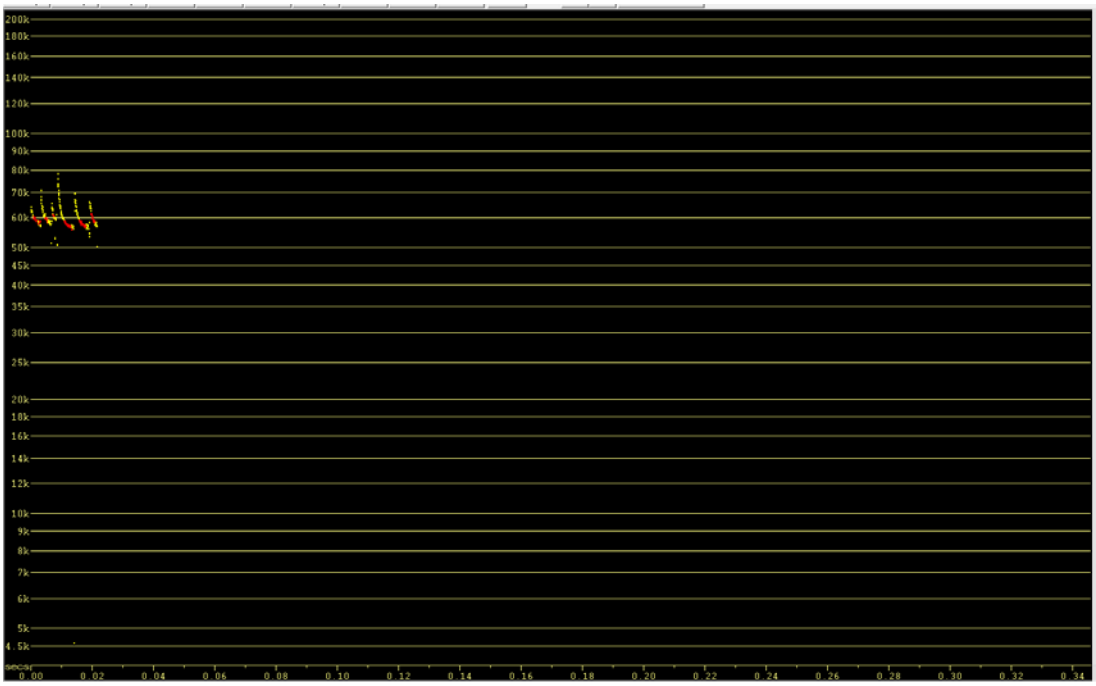
Chocolate Wattled Bat (*Chalinolobus morio*)



Gould's Wattled Bat (*Chalinolobus gouldii*)



Ride's Free-tailed Bat (*Mormopterus ridei*)



Little Bentwing-bat (*Miniopterus australis*)

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