RBWI Pty Ltd ATF RBWI Unit Trust

Clover Hill Subdivision

Ecology Assessment

March 2019

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1. Introduction

1.1 Overview

GHD Pty Ltd (GHD) has been engaged by RBWI Pty Ltd ATF RBWI Unit Trust to complete a biodiversity assessment to support a Development Application (DA) for the proposed subdivision of Lot 1 DP 558196 (the Clover Hill Estate) within Calderwood, NSW (the proposal). The proposal includes subdivision of Lot 1 DP 558196 into 141 conventional residential lots, one homestead lot as well as the associated civil infrastructure works required to support the residential development. The site is shown on Figure 1 The proposal site including the layout of residential lots is shown on Figure 2 A Statement of Environmental Effects (SEE) (RBWI Pty Ltd 2017) and associated DA was submitted to Shellharbour Council (council) for approval under the NSW *Environment Protection and Assessment Act 1979* (EPA Act) in 2017. The SEE included a Vegetation Clearance and Fauna Management Plan (GHD 2017) to facilitate clearing of vegetation at the site as the majority of the site is approved for development under the Concept Plan approval MP09_0082. However, a preliminary assessment of the DA by council recommended a biodiversity assessment be completed in accordance with information contained in an email to the applicant dated 20 April 2018 even though the R1 lands are approved for development.

This biodiversity assessment is a specialist appendix to support the DA. It assesses the potential for impacts on biodiversity values at the site within the R1 and E3 zoned lands, with particular emphasis on threatened ecological communities, populations and species listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act) and *Matters of National Environmental Significance* (MNES) listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.2 Proposal description

The Clover Hill estate is located within the Calderwood Urban Release Area and as such is part of the approved Part 3A Major Project Concept Plan (MP09 _0082) for the development. The concept plan currently allows for residential neighbourhoods within lands identified as R1 General Residential zone which cover most of Clover Hill Estate. There is also a small parcel of E3 Environmental Management zone which occurs primarily in the northern corner of the site (refer to Figure 2).

In accordance with the Part 3A Major Project Concept Plan (MP09 _0082), the R1 General Residential zone is approved for clearing. This report focuses on biodiversity values and impact assessment associated within the R1 General Residential zone of the Clover Hill Estate.

The proposed subdivision within the Clover Hill estate will include 141 conventional residential lots and one homestead lot. The proposed subdivision will occur in 4 stages:

- Stage 1- Subdivision of the existing ‘Blissett House’ and curtilage into a separate ‘homestead’ Lot.
- Stage 2- Subdivision of 38 residential allotments in the south-west of the Lot.
- Stage 3- Subdivision of 74 residential allotments.
- Stage 4- Subdivision of 26 residential allotments, including permitted dwelling associated with the E3 land in the north of the Lot.

GHD understands a dwelling is permitted associated with the E3 land with the preferred location selected as this area is generally cleared and does not require the removal of any canopy trees. Management of the E3 land will be subject to a detailed Vegetation Management Plan (VMP) and will include restoration of approximately 1 ha of Forest Red Gum – Thin-leaved Stringybark grassy woodland back to full structure and clearing and/or managing the remaining 0.4 ha of the E3 land consistent with bushfire risk management and recommendations as identified in the Calderwood Concept Plan approval. Managing the E3 lands to restore a maximum of 1 ha of full structured vegetation is required so as not to create a bushfire threat for surrounding housing.

1.3 Scope of Assessment

The aim of this Biodiversity assessment report is to:

- Describe the existing environment within the site vegetation communities, fauna habitats and flora and fauna species known or likely to occur.
- Assess the value and conservation significance of native vegetation and habitats in the site and the likelihood of occurrence of threatened biota based on the habitats present.
- Compile a list of threatened biota previously recorded or predicted to occur in the locality and assess their potential to occur at the site.
- Assess the likely impacts on threatened biota from the proposed development within the R1 and E3 zone.
- Recommend mitigation measures to reduce impacts on biodiversity values.
- Provide concluding statements regarding the likely significance of impact of the proposed development on threatened biota or EPBC Act MNES or the requirement or otherwise for further assessment or approvals at the State or federal level.

1.4 Terms and definitions

The following terms are used in this report:

The proposal site	The R1 General Residential zone located within Lot 1 DP 558196 at 81 Escarpment Road, Calderwood, NSW as shown on Figure 1.
Study area	Lot 1 DP 558196 at 81 Escarpment Road, Calderwood, NSW as shown on Figure 1.
The proposal	The proposed development within Lot 1 DP 558196 as shown on Figure 1.
Locality	The area within a 10 km radius of the Lot 1 DP 558196.
Threatened biota	Threatened species, populations and communities that are listed under the TSC Act, FM Act and/or the EPBC Act.
Biodiversity Assessment Method 2016 (BAM)	The assessment method established under the BC Act that determine credits created, credits required and the circumstances that improve or maintain biodiversity values.

Paper Size A4

0 12.5 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Proposal site
- Study area
- Cadastre
- Watercourse

The Trustee for RBWI Unit Trust
Clover Hill Residential Development
Ecology Assessment

Job Number	21-27415
Revision	2
Date	12 Mar 2019

Site location

Figure 1

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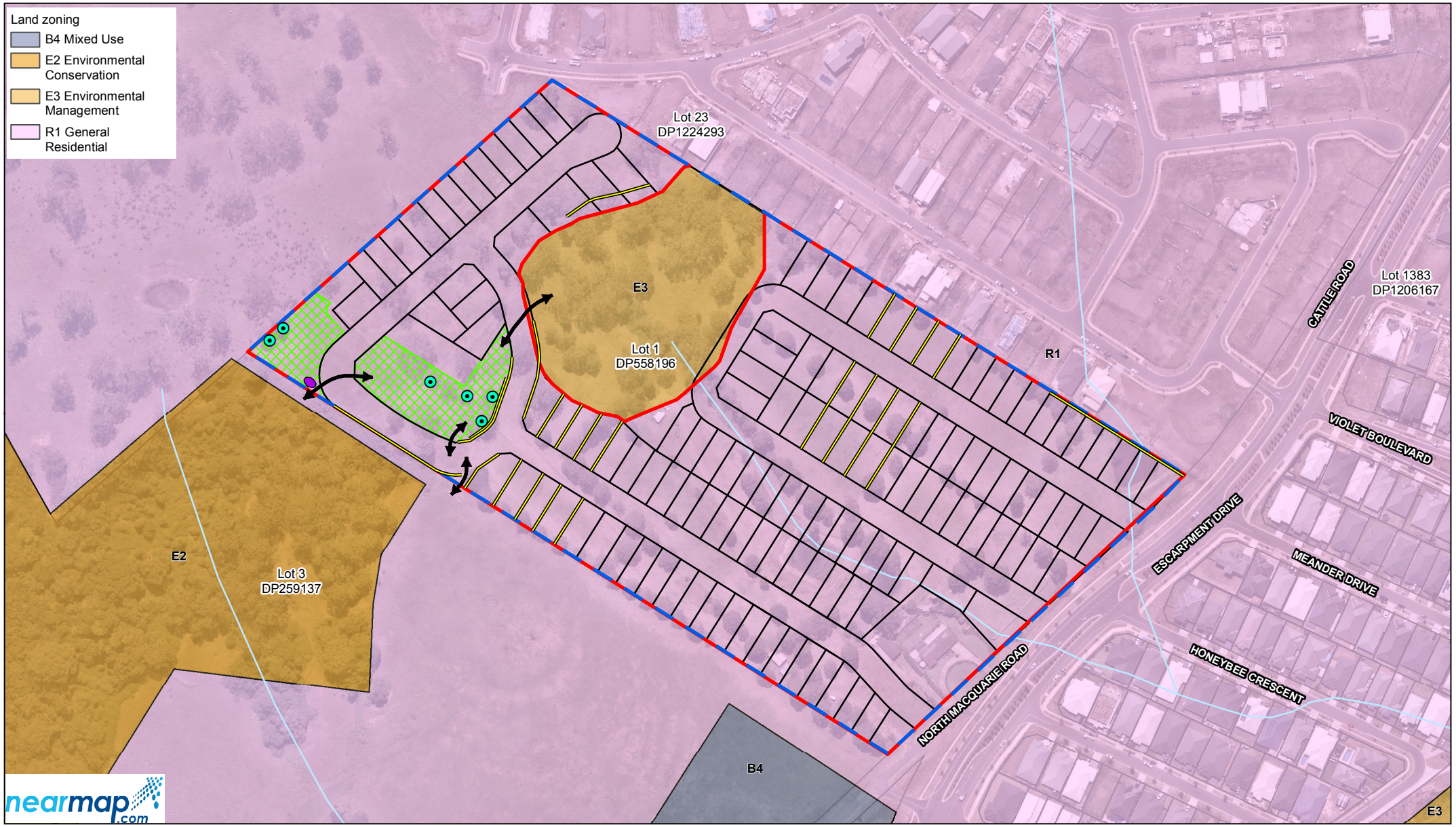
Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com.au

Data source: LPI: DTDB / DCDB, 2017; Nearmap: Aerial Imagery Extracted 20190312; Geoscience Australia: 250k Topographic Data Series 3, 2006. Created by: fmackay



Paper Size A4

0 12.5 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Proposal site
- Study area
- Cadastre
- Watercourse
- Proposed subdivision
- Proposed retaining wall
- Habitat passage ramp
- Habitat enhancement area
- Proposed assemblage of different sized boulders
- Proposed nest boxes

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Ecology Assessment

Job Number 22-19002
Revision 2
Date 12 Mar 2019

Site layout and land zoning

Figure 2

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Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com.au

Data source: LPI: DTDB / DCDB, 2017; Nearmap: Aerial Imagery Extracted 20190312; DPE: LEP Land zoning, 2016. Created by: fmackay

2. Legislative context

2.1 NSW legislation

2.1.1 Environmental Planning and Assessment Act 1979 (EPA Act)

The EPA Act forms the legal and policy platform for proposal assessment and approval in NSW and aims to, inter alia, 'encourage the proper management, development and conservation of natural and artificial resources'. All development in NSW is assessed in accordance with the provisions of the EPA Act and EPA Regulation 2000.

The proposed Calderwood Urban Development Project was originally assessed as a Part 3A (repealed) Major Project under the EPA Act. The Minister for Planning determined the Calderwood Urban Development Project Concept Plan MP09_0082 on 8 December 2010 which includes the proposed "Clover Hill Estate". The project is now considered State Significant Development (SSD) under the EPA Act.

The Part 3A approved Concept Plan provides for 4,800 dwellings and 50 hectares of mixed use/employment land to be used for a range of retail, commercial, business and light industrial uses. The approved development includes an open space master plan, riparian corridor network and the retention of land with identified significant or contributory biodiversity for environmental conservation and/or environmental management purposes.

The relevant planning controls are set under State Environmental Planning Policy (State Significant Precincts) 2005, which is a recognised Environmental Planning Instrument under the EPA. Development approvals for specific stages of works within the broader Calderwood Urban Development Project are now assessed under Part 4 of the EPA Act in accordance with the conditions associated with the Concept Approval (MP09_0082).

As such, the proposal, as an activity that requires consent, is to be determined under Part 4 of the Act and Council is the 'consent authority' for the purposes of the Act.

2.1.2 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) was passed by NSW Parliament in November 2016 and came into effect on 25 August 2017. The BC Act repeals the TSC Act, the *Nature Conservation Trust Act 2001* and parts of the *National Parks and Wildlife Act 1974* (NPW Act). As a result, the matters relating to the listing of threatened species, threatened ecological communities, key threatening processes, biodiversity impact assessment, offsetting and related offences are now contained within the BC Act.

However, this DA is being assessed under the BC Act Transitional Arrangements which allow local development applications under Part 4 of the EPA Act that have utilised the former TSC Act assessment scheme to be lodged within three months of 25 August 2017.

2.1.3 Threatened Species Conservation Act 1995 (TSC Act)

The *Threatened Species Conservation Act 1995* (TSC Act) was repealed on 25 August 2017 however, as described above, the BC Regulation includes transitional arrangements that mean that the TSC Act continues to apply to the proposal and to this biodiversity assessment.

The TSC provides the statutory framework for biota of conservation significance in NSW. The Act aims to, inter alia, 'conserve biological diversity and promote ecologically sustainable project'. It provides for:

- The listing of threatened species, populations and ecological communities, with endangered species, populations and communities listed under Schedule 1, critically endangered species and communities listed under Schedule 1A, vulnerable species and communities listed under Schedule 2.
- The listing of Key Threatening Processes (under Schedule 3).
- The preparation and implementation of Recovery Plans and Threat Abatement Plans.

The TSC Act has been addressed in the current assessment through:

- Desktop review to determine the threatened species, populations or ecological communities (threatened biota) listed under the Act that have been previously recorded within the locality of the site and consequently could occur subject to the habitats present.
- Completion of plot/transect surveys in accordance with the Biodiversity Assessment Methodology (BAM).
- Targeted field surveys for threatened biota.
- Assessment of potential impacts on threatened biota.
- Identification of suitable impact mitigation and environmental management measures for threatened biota, where required.

2.1.4 Biosecurity Act 2015

The *Biosecurity Act 2015* provides the statutory framework to protect the NSW economy, environment and community from the negative impact of pests, diseases and weeds.

The primary object of the Act is to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers.

In NSW, all plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.

Environmental weed species were recorded during field surveys. Priority weeds that would require consideration under the Biosecurity Act are listed in Table 4-2. These priority weeds would require management during construction of the proposal and control once the residential subdivision has been established.

2.2 Commonwealth legislation

2.2.1 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The purpose of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is to ensure that actions likely to cause a significant impact on 'matters of national environmental significance' undergo an assessment and approval process. Under the EPBC Act, an action includes a Project, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things. An action that 'has, will have or is likely to have a significant impact on a matter of national environmental significance' (MNES) is deemed to be a 'controlled action' and may not be undertaken without prior approval from the Australian Minister for the Environment.

The EPBC Act identifies MNES as:

- World heritage properties
- National heritage places
- Wetlands of international importance (Ramsar Wetlands)
- Threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mining)
- A water resource, in relation to coal seam gas development and large coal mining development.

The significance of impacts of an activity on MNES is assessed according to the DEE EPBC Act significant impact criteria. If a significant impact is likely, the project would need to be referred to the Minister for the Environment. Offsets are required for approvals under the EPBC Act where the impacts of a proposed action on MNES are significant and cannot be reasonably avoided or mitigated. Where offsets are required, the proponent should discuss offset options with DEE and submit a biodiversity offset strategy, which describes the proposed offset and demonstrates how it will compensate for any residual impact on the MNES. DEE has its own offsets policy (*Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPaC 2012)) and associated offsets calculator that may be used to calculate offsets required for a project.

3. Methods

3.1 Desktop assessment

3.1.1 Database searches

A desktop assessment was undertaken to identify threatened flora and fauna species, populations and ecological communities listed under the TSC Act and FM Act, and MNES listed under the EPBC Act that may be affected by the proposal. Database records pertaining to the site and locality (i.e. within a 10 km radius of the site) were reviewed and included:

- NSW OEH Wildlife Atlas database for records of threatened species listed under the TSC Act (OEH 2018a; data downloaded on 6 June 2018)
- Department of the Environment (DoE) Protected Matters Online Search Tool for MNES listed under the EPBC Act and predicted to occur in the locality (DoE 2018a; database queried on 6 June 2018)
- Department of Primary Industries (DPI) *Fish communities and threatened species distributions of NSW* (DPI 2016; queried 6 June 2018) for threatened species listed under the FM Act
- e-Spade NSW Soil and Land Information online mapping database (OEH 2018b)
- Priority weed declarations for Shellharbour LGA (DPI 2018)

The habitat resources present at the site (determined during the site inspection) were compared with the known habitat associations/requirements of the relevant threatened and migratory biota identified by the desktop review.

3.1.2 Literature review

A review of the following ecological assessments previously undertaken within the Clover Hill Estate was also undertaken:

- Eco Logical Australia (2010) Calderwood Urban Development Project; *Flora and fauna assessment under Part 3A of the Environmental Planning and Assessment Act, 1979 Final Report*
- GHD (2017a) Clover Hill Subdivision; *Vegetation Clearance and Fauna Management Plan*
- GHD (2017b) Clover Hill Subdivision *Drainage Line Assessment*

These documents were reviewed to identify any relevant information to the current proposal. Particular emphasis was given to the identification of any MNES or threatened biota within the proposal footprint or immediate vicinity, as well as identification of particular habitat or vegetation types relevant to the proposal.

3.2 Field survey

3.2.1 Overview

Field surveys of the Clover Hill estate was conducted for two days by Gary Leonard (GHD) and Brendan Ryan (OMVI Ecological) on 28 and 29 May 2018 within the study area shown on Figure 2. The field surveys focussed on the identification of vegetation types, the presence and extent of threatened ecological communities within the site and an assessment of the habitats present for threatened biota.

3.2.2 Terrestrial flora survey

Vegetation mapping

Native vegetation within the study area was mapped based on observed species composition and vegetation structure according to the classification of Specht (1970). The Vegetation Information System (VIS) was used to assign the most appropriate Plant Community Type (OEH 2018c). This was done using the species composition, vegetation integrity and structural attributes recorded during the field survey. All vegetation communities were then mapped using aerial photographic interpretation within a geographical information system (GIS) as guided by the field survey results.

Vegetation within the site was assessed against identification criteria for State and Commonwealth listed threatened ecological communities (critically endangered ecological communities (CEECs), endangered ecological communities (EECs) and vulnerable ecological communities (VECs)). Vegetation and habitats were compared with descriptions provided in published threatened species profiles and management plans.

Vegetation integrity survey plots

Plot surveys were conducted on site with reference to the BAM. The site value was determined by assessing ten attributes used to assess function, composition and structure of vegetation within a 50 metre X 20 metre plot. These attributes were then assessed against benchmark values. Benchmarks are quantitative measures of the range of variability in condition in vegetation with relatively little evidence of alteration, disturbance or modification by humans since European settlement (DECC, 2009).

All flora species within a 20 metre x 20 metre quadrat nestled within the 50 m x 20 m plot were identified according to the nomenclature of the Royal Botanic Gardens and Domain Trust (2018). Each species identified was allocated a growth form group and designated as either native, exotic or high threat exotic in accordance with lists provided by OEH.

Three plots were sampled within the single native vegetation type in the study area. The location of survey plots is shown on Figure 3.

The overall condition of vegetation was assessed through general observation and comparison against the PCT condition benchmark data as well as using parameters such as species diversity, history of disturbance, weed invasion and canopy health.

Illawarra Lowlands Grassy Woodland survey

The field survey was undertaken in areas thought to support Illawarra Lowlands Grassy Woodland to collect floristic and structural vegetation data to determine which (if any) patches of this vegetation meet the criteria of:

- Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion, listed as a EEC under the NSW TSC Act
- Illawarra and South Coast Lowland Forest and Woodland, listed as a CEEC under the Commonwealth EPBC Act

The diversity of native understorey species is key to determining whether vegetation is consistent with the EPBC Act listed Illawarra and South Coast Lowland Forest and Woodland CEEC. Vegetation within areas thought to support Illawarra and South Coast Lowland Forest and Woodland was compared to the condition thresholds presented in, to determine if any patches constitute the EPBC Act listed threatened ecological community.

Table 3-1 Condition thresholds for Illawarra and South Coast Lowland Forest and Woodland (taken from TSSC, 2016)

Category and rationale	Thresholds
A. High condition class A larger patch with good quality native understorey and/or many large trees	Minimum patch size is at least 2 ha; AND ≥ 50% of the perennial understorey vegetation cover is made up of native species. OR At least 6 native understorey plant species per 0.5 ha/ten trees that have DBH ≥60cm or have hollows
OR	
B. High condition class A patch with very good quality native understorey with a species rich ground layer.	The patch size is ≥ 0.5 ha; AND ≥ 70% of the perennial understorey vegetation cover is made up of native species. AND At least 10 native species in the understorey
OR	
C. Moderate condition class A patches with good quality native understorey.	The patch size is ≥ 0.5 ha; AND ≥ 50% of the perennial understorey vegetation cover is made up of native species; AND At least 6 native understorey plant species per 0.5 ha
OR	
D. Moderate condition class A patch that makes other important ecological contributions.	The patch size is ≥ 0.5 ha in size; AND ≥ 30% of the perennial understorey vegetation cover is made up of native species; AND the patch is contiguous with another patch of native vegetation (at least 1 ha in area) OR the patch has at least one large locally indigenous tree (at least 50 cm DBH, or at least one tree with hollows.

Targeted threatened flora surveys

Targeted surveys were undertaken for threatened flora species which could potentially occur within the study area given known distributions, previous records in the locality and habitat requirements for each species. Random meander transects, according to the methods of Cropper (1993), were focused in areas of proposed impact in potentially suitable habitat and within immediately adjoining vegetation. Given that some target species are naturally cryptic, an assessment of habitats present and their suitability for potentially occurring threatened flora species was undertaken for cryptic species.

3.2.3 Terrestrial fauna survey

Techniques used for fauna surveys within the study area aimed to assess habitat values present for potentially occurring threatened species (as identified in Appendix A). Detailed descriptions of survey techniques are outlined below. All observations were recorded on proforma field data sheets.

Fauna habitat assessment

General fauna habitat assessments were undertaken throughout the study area, including active searches for potential shelter, basking, roosting, nesting and/or foraging sites. Specific habitat features and resources such as water bodies, food trees, the density of understorey vegetation, the composition of ground cover, the soil type, presence of hollow-bearing trees, leaf litter and ground debris were noted.

Indicative habitat criteria for targeted threatened species (i.e. those determined as having the potential to occur within the study area following the desktop review) were identified prior to fieldwork. Habitat criteria were based on information provided in OEH and DoE threatened species profiles, field guides, and the knowledge and experience of GHD field ecologists. Habitat assessment assists in the compilation of a comprehensive list of fauna that are predicted within the vicinity of the study area, rather than relying solely on single event surveys that are subject to seasonal limitations and may only represent a snapshot of assemblages present.

Habitat assessments included identification of the presence of the following habitat resources:

- Trees with bird nests or other potential fauna roosts
- Burrows, dens and warrens
- Hollow-bearing trees and logs which provide refuge, nest and den sites for a range of threatened fauna species
- Distinctive scats or latrine sites, owl white wash and regurgitated pellets under roost sites
- Tracks or animal remains
- Evidence of activity such as feeding scars, scratches and diggings
- Specific food trees and evidence of foraging
- Leaf litter and fallen timber were inspected for reptile habitat
- Presence of potential habitat for threatened frog species.

The locations and quantitative descriptions of significant habitat features were captured with a handheld GPS unit and photographed where appropriate.

Spotlighting, call playback and stag watch surveys

Spotlighting, call playback and stag watch surveys were conducted to identify nocturnal birds and mammals and also frogs which may utilise the study area. Spotlighting and call playback was restricted to the northern portion of the study area where treed vegetation was present. Surveys comprised the following:

- Call playback

Call playback was undertaken for one night. Calls of the Barking Owl (*Ninox connivens*), Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*), Squirrel Glider (*Petaurus norfolcensis*) and Greater Glider (*Petauroides volans*) were broadcast in woodland areas. Calls were broadcast through a 15 watt megaphone for a minute each with gaps of about a minute between the call of each species. Calls were then repeated. A quiet listening period of ten minutes was held prior to and following call playback. Potential roost sites were scanned with a spotlight.

- Spotlighting

Spotlighting targeting nocturnal birds and mammals and frogs was conducted over one night. Spotlighting was undertaken by two ecologists. The survey lasted between 2-3 hours. Surveys were carried out in the larger woodland patch within treed vegetation and along waterbodies.

- Stag watch

Stag watching was undertaken at one stage for 20 minutes prior to dusk until 20 minutes after dusk. Any emergent fauna was recorded.

Microchiropteran bat surveys

Microbat ultrasonic echolocation call recordings (Anabat surveys) were undertaken using two Anabat units over one night. One Anabat was placed at a dam in the south east corner of the study area where fixed recordings were taken. Another Anabat was carried throughout spotlighting surveys in treed vegetation in the north of the site and recordings were not fixed to a location. The location of the fixed Anabat location is provided on Figure 3. A total of ~5 hours from one night of recording (all locations combined) was completed.

Calls were identified using zero-crossing analysis and AnalookW software (version 4.1t, Chris Corben 2015) by visually comparing the time-frequency graph and call characteristics (e.g. characteristic frequency and call shape) with reference calls and/or species call descriptions from published guidelines. *The Bat calls of NSW: Region based guide to the echolocation calls of microchiropteran bats* (Pennay et al 2004) was used to assist call analysis. Call identification was also assisted by consulting distribution information for possible species (Pennay et al 2011; Churchill 2008; van Dyck and Strahan 2008) and records from the Atlas of NSW Wildlife (OEH 2018a). No reference calls were collected during the survey.

A call (pass) was defined as a sequence of four or more consecutive pulses of similar frequency. Calls with less than four defined pulses were excluded from the analysis. Due to variability in the quality of calls and the difficulty in distinguishing some species, the identification of each call was assigned a confidence rating (see Mills et al 1996 and Duffy et al 2000) as summarised in Table 3-2. Due to the absence of reference calls from the study area, a high level of variability within a bat call and overlap in call characteristics between some species, a conservative approach was taken when analysing calls.

Table 3-2 Confidence ratings applied to bat call analysis

Species Identification	Description
D - Definite	Species identification not in doubt.
P - Probable	Call most likely to represent a particular species, but there exists a low probability of confusion with species of similar call type or call lacks sufficient detail.
Po – Possible (Species Group)	Call made by one of two or more species. Call characteristics overlap making it too difficult to distinguish between species e.g. *Chalinolobus gouldii/Mormopterus* spp. *Nyctophilus* spp. The calls of *Nyctophilus geoffroyi* and *N. gouldi* cannot be distinguished during the analysis process and are therefore lumped together. *Scotorepens orion/Scoteanax rueppellii/Falsistrellus tasmaniensis*.

Hollow-bearing tree assessments

Counts and mapping of hollow-bearing trees were undertaken within the study area. Data collected from hollow-bearing trees comprised:

- Tree species
- Height
- Diameter at Breast Height (DBH)
- No and diameter of trunk and limb hollows
- Evidence of usage.

The locations of hollow-bearing trees were captured with a handheld GPS unit.

Opportunistic observations

Opportunistic and incidental observations of fauna species were recorded at all times during field surveys. Survey effort was concentrated on suitable areas of habitat throughout the course of the survey, for instance fallen timber was scanned and/or turned for reptiles and mature trees and dams were scanned for roosting birds.

3.2.4 Staff qualifications

This report was prepared by Gary Leonard and Brendan Ryan based on field surveys and review of existing information. The assessment was peer reviewed by Dan Williams. Staff qualifications are presented in Table 3-3.

Table 3-3 Staff qualifications

Name	Position/Project Role	Qualifications	Relevant Experience (years)
Gary Leonard	Senior Ecologist/site surveys and reporting	Masters of Science (in progress), Diploma of Education, National Diploma of Horticulture, Horticulture Certificate	40+
Brendan Ryan	Senior Ecologist/site surveys and reporting	Masters of Science, Bachelor of Science	20+
Mal Weerakoon	Ecologist/reporting	Bachelor of Science, Master of Philosophy	5+
Daniel Williams	Associate/technical review	Bachelor of Applied Science, Accredited BAM Assessor	18+ years

3.3 Likelihood of occurrence of threatened and migratory biota

Following collation of database records and species and community profiles, a 'likelihood of occurrence' assessment was prepared with reference to the broad habitats contained within the study area. Identification of potential habitat for threatened and migratory species was based on information provided in the species profiles (DoEE 2018b, OEH 2018b), recovery plans, journal articles, and the field staffs' knowledge of species habitat requirements. The likelihood of occurrence assessment was further refined following field surveys. The likelihood of threatened and migratory biota occurring in the study area was assessed based on presence of records from the locality for the last 20 years, species distribution and habitat preferences, and the suitability of potential habitat present in the study area. The results of this assessment are provided in Appendix A.

Table 3-4 below provides a key to the likelihood of occurrence in the study area of threatened biota known or likely to occur in the locality.

Table 3-4 Key to likelihood of occurrence for threatened species.

Likelihood	Definition
Present	The species or community was observed in the study area during the current survey.
Likely	It is highly likely that a species inhabits the study area and is dependent on identified suitable habitat (i.e. for breeding or important life cycle periods such as winter flowering resources), has been recorded recently in the locality (10 km) and is known or likely to maintain resident populations in the study area. Also includes species known or likely to visit the study area during regular seasonal movements or migration.
Possible	Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on habitat within the study area, or habitat is in a modified or degraded state. Includes cryptic flowering flora species that were not seasonally targeted by surveys and that have not been recorded.
Unlikely	It is unlikely that the species inhabits the study area and has not been recorded recently in the locality (10 km). It may be an occasional visitor, but habitat similar to the study area is widely distributed in the local area, meaning that the species is not dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the study area or the species is a non-cryptic perennial flora species that was specifically targeted by surveys and not recorded.
Nil	Species not previously recorded within a 10 km radius of the study area, suitable habitat not recorded within study area, and/or study area outside species known distribution.

4. Existing environment

4.1 Site context

4.1.1 Location and land uses

The study area comprises the entirety of Lot 1 DP 558196 (the Clover Hill Estate) within Calderwood, NSW. The study area is located approximately 1km from the township of Albion Park and can be directly accessed by Escarpment Drive. The study area is adjacent to residential development to the north and east as part of the Calderwood Valley Project

The study area includes a small area of native vegetation in the north of the site zoned as E3 Environmental Management in the Shellharbour LEP 2013 (1.43 hectares), with all other areas zoned as R1 General Residential (8.69 hectares).

The site is bounded to the:

- West, south and east by existing or proposed residential development and Escarpment Drive
- North west by Johnsons Spur Conservation Area.

The site includes a modified and degraded ephemeral drainage line running south east through the centre of the site. The drainage line is considered a 1st order stream in accordance with the Strahler Stream Order classification system.

4.1.2 Climate

The locality has a relatively temperate climate, typical of the South Coast. Based on data from the Albion Park Wollongong Airport weather station (number 68241), the site has a mean annual rainfall of 925.6 mm, mean monthly maximum temperature of 22.6°C and a mean monthly minimum temperature of 11.6°C.

4.1.3 Hydrology

The drainage line in the study area is a tributary of the Macquarie Rivulet. The Macquarie Rivulet flows downstream into Lake Illawarra, approximately 5 km from the site.

Surface water flows from north to south through the site from a patch of intact vegetation in the north of the site in a poorly defined, channel confined drainage line. This drainage line flows downslope to a series of dams in the south of the study area.

4.1.4 Geomorphology and soils

The site is contained within the Dapto Wollongong Coastal Slopes Mitchell Landscape (DECC, 2008). This landscape consists of a forested hills between rubble slopes and valley floors on Permian sandstone and shale with areas of interbedded basalt. It comprises an open forest dominated by Forest Red Gum (*Eucalyptus tereticornis*), Yellow Stringybark (*Eucalyptus muelleriana*), Gully Gum (*Eucalyptus smithii*) and stringybark with rainforest elements along streamlines. Extensively cleared, former areas of coastal brush may be indicated by remnant Cabbage-tree Palm (*Livistona australis*) and Port Jackson Fig (*Ficus rubiginosa*).

A review of the e-Spade NSW Soil and Land Information online mapping database (OEH 2018b) recorded the Albion Park and Fairy Meadow Soil Landscapes within the study area. The Albion Park Soil landscape is mapped in the north of the site and comprises short steep upper slopes with long gentle footslopes. Local relief is 60-100 m with podzols on crests and midslopes and soloths on footslopes and drainage lines. The soil landscape is poorly drained and seasonal waterlogging is common. Fertility of the soil materials is low.

The Fairy Meadow Soil Landscape occurs in the south of the study area and comprises alluvial plains, valley flats and terraces below the Illawarra Escarpment. Local relief is <10 m with slopes <5%. Alluvial loams, siliceous sands and prairie oils occurs on terraces and drainage plains.

4.2 Vegetation

4.2.1 Vegetation types

Overview

One plant community type (PCT) was recorded in the proposal site, as well as “Shelter plantings and pasture” and “Non-native riparian vegetation and artificial wetlands” (see Table 4-1).

It is likely that most of the original native vegetation was cleared from the site to facilitate agricultural land use, primarily associated with grazing activities. Some mature trees are >100 years old and may have been retained as shade trees during initial clearing. It is likely that the original topsoil and groundcover has been disturbed through clearing and during “pasture improvement”.

The small patch of woodland in the north of the site is subject to grazing and slashing and as a result, native shrubs are mainly restricted to the base of trees.

Data collected from three BAM plots support the condition codes of moderate to high disturbance (regenerating) native vegetation mapped by Ecological Australia (2010) in the study area.

Table 4-1 Vegetation types at the proposal site

Veg Zone ID	Plant Community Type	PCT	Condition	Area (ha)	TSC Act Status	EPBC Act Status
1	Forest Red Gum - Thin-leaved Stringybark grassy woodland on coastal lowlands	838	Moderate	1.87	EEC	CEEC
2	Shelter plantings and pasture	NA	Low	6.57	N/A	N/A
3	Non-native riparian vegetation and artificial wetlands	NA	Low	0.26	N/A	N/A
	Total area			**8.69**		

The structure, species composition and condition of each of the vegetation types within the study area are described below. Plant species recorded within the study area are listed in Appendix B.

Forest Red Gum - Thin-leaved Stringybark grassy woodland on coastal lowlands

Forest Red Gum - Thin-leaved Stringybark grassy woodland on coastal lowlands	
PCT (OEH, 2018c)	Forest Red Gum - Thin-leaved Stringybark grassy woodland on coastal lowlands, southern Sydney Basin Bioregion
PCT ID	838
Equivalent vegetation units	MU23; Coastal Grassy Red Gum Forest (NSW NPWS 2002) Red Gum- Stringybark Forest (Mills 2000) SR 545 Forest Red Gum – Thin-leaved Stringybark grassy woodland on coastal lowlands, southern Sydney Basin
Photo	
Survey effort	Plot/transects 1, 2 and 3
Conservation significance	Components of Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion (EEC) listed under the TSC Act. Components of Illawarra and South Coast Lowland Forest and Woodland CEEC listed under the EPBC Act.
Condition	Moderate
Landscape position	Occurs on low rise at western end of site and extends from northern to southern boundaries. Intergrades to the south-west with patch of MU13 Moist Box-Red Gum Foothills Forest in adjacent property. Part of the patch is zoned for partial protection, while the rest (which includes hollow-bearing trees) is proposed for clearing and residential development.
Structure	Open grassy woodland. Trees to 26 m, FPC 20 to 25%. Shrubs and young trees are absent because of recent mowing, although there is evidence of shrub and eucalypt seedling growth. Some shrubs, apparently missed by the mower, to 1.2 m occur at the base of some trees. Groundcover mainly of grasses, with occasional forbs to 1 m with FPC >50%.
Over storey	Dominated by Forest Red Gum (*Eucalyptus tereticornis*). Other species comprise Rough-barked Apple (*Angophora floribunda*), Thin-leaved Stringybark (*Eucalyptus eugenioides*) and Coast Grey Box (*Eucalyptus bosistoana*).
Mid storey	Sparse due to recent mowing. Hickory (*Acacia implexa*), Maiden's Wattle (*Acacia maidenii*), Muttonwood (*Myrsine variabilis*), Tree Violet (*Melicytus dentatus*), Whalebone Tree (*Streblus brunonianus*), Coffee Bush (*Breynia oblongifolia*).
Groundcover	Diverse and structurally variable. Weeping Grass (*Microlaena stipoides* var. *stipoides*), Brown's Lovegrass (*Eragrostis brownii*), Whiteroot (*Pratia purpurascens*), Hedgehog Grass (*Echinopogon ovatus*), Love Creeper (*Glycine clandestina*), Tick Trefoil (*Desmodium varians*).
Exotic species	African Boxthorn (*Lycium ferocissimum*), Stinkgrass (*Eragrostis cilianensis*), Catsear (*Hypochaeris radicata*), Paddy's Lucerne (*Sida rhombifolia*), Kikuyu Grass (*Pennisetum clandestinum*), Narrow-leafed Carpet Grass (*Axonopus fissifolius*).

Shelter plantings and pasture

Shelter plantings and pasture	
PCT (OEH, 2018c)	N/A
PCT ID	N/A
Equivalent vegetation units	MU56 Disturbed landscapes (NSW NPWS 2002)
Photo	
Survey effort	Rapid assessments
Conservation significance	The most common tree species in the plantings is White-topped Box (*Eucalyptus quadrangulata*), which is indigenous to the LGA. The provenance of the specimens is unknown and it is possible that they are hybrids. No capsules were recorded on any of the sampled specimens. No hollow-bearing specimens were recorded. Most of the planted trees appear to be <20 years old.
Condition	Low
Landscape position	Single lines of trees follow fencelines and farm tracks, extending from the eastern boundary to the headwaters of the creekline.
Structure	Trees to 10m, FPC 5 to 15%. Shrubs and young trees are sparse. Groundcover mostly consists of grazed exotic, with FPC >60%.
Over storey	Dominated *by* White-topped Box. Other canopy species comprise Spotted Gum (*Corymbia maculata*), Swamp Oak (*Casuarina glauca*), Red Cedar (*Toona ciliata*) and Tallowwood (*Eucalyptus microcorys*).
Mid storey	Hickory (*Acacia implexa*), Maiden's Wattle (*Acacia maidenii*), Blackwood (*Acacia melanoxylon*), Pink Tips (*Callistemon salignus*) and Willow-leaved Hakea (*Hakea salicifolia* subsp. *salicifolia*).
Groundcover	Weeping Grass) (*Microlaena stipoides* var. *stipoides*), Brown's Lovegrass (*Eragrostis brownii*), Whiteroot (*Pratia purpurascens*), Hedgehog Grass (*Echinopogon ovatus*) and Love Creeper (*Glycine clandestina*).
Exotic species	*Dominated by* Kikuyu Grass (*Pennisetum clandestinum*), Paspalum (*Paspalum dilatatum)* and *Trifolium* spp in the understorey. Occasional Indian Coral (*Erythrina x sykesii*) present in the mid storey.

Non-native riparian vegetation and artificial wetlands

Non-native riparian vegetation and artificial wetlands	
PCT (OEH, 2018c)	NA
PCT ID	NA
Equivalent vegetation units	NA
Photo	
Survey effort	Rapid assessments
Conservation significance	Drainage line was dry at time of survey, and aquatic species were sparse to absent. Aquatic vegetation around edges of dams was heavily grazed. This vegetation type does not conform to listed TECs.
Condition	Low
Landscape position	The drainage line is narrow and shallow, extending downslope from the woodland patch proposed for partial conservation into a series of dams; the most easterly one located adjacent to the recently formed road along the eastern property boundary.
Structure	Dense groundcover of exotic grasses and forbs, with occasional shrubs.
Over storey	None
Mid storey	Two-veined Hickory (*Acacia binervata)* and Hairy Clerodendrum (*Clerodendrum tomentosum*).
Groundcover	Low in diversity. Dominated by Water Primrose (*Ludwigia peploides* subsp. *montevidensis*), *Carex longebrachiata,* Indian Weed (*Sigesbeckia orientalis* subsp. *orientalis*), Native Raspberry (*Rubus parvifolius*), Spike Sedge (*Eleocharis sphacelata*) and Water Couch (*Paspalum distichum*).
Exotic species	Weeping Willow (*Salix babylonica*) is present in the over storey adjacent to drainage lines and dams in the study area. Exotic mid storey species comprise Small-leaved privet (*Ligustrum sinense)* and Lantana (*Lantana camara*). Exotic grasses such as Kikuyu (*Pennisetum clandestinum*) and Green Pugen Grass (*Setaris viridis*) are also present. Windborne weeds include Crofton Weed (*Ageratina adenophora*) and Wandering Jew (*Tradescantia fluminensis*).

Paper Size A4

0 12.5 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Proposal site
- Study area
- Cadastre
- Watercourse
- E3 land to be restored to full structured vegetation
- E3 land managed vegetation
- Shelter plantings (to be removed)
- Dwelling and access

The Trustee for RBWI Unit Trust
Clover Hill Residential Development
Ecology Assessment

Job Number	21-27415
Revision	2
Date	18 Mar 2019

Vegetation types and survey effort

Figure 3

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Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com.au

Data source: LPI: DTDB / DCDB, 2017; Nearmap: Aerial Imagery Extracted 20190312. Created by: fmackay

4.2.2 Priority weeds

The *Biosecurity Act 2015* provides for the declaration of priority weeds in local government areas. Priority weeds have been identified for the South East region, which includes the Shellharbour LGA. Plant species identified as priority weeds for the South East region and recorded in the study area are listed in Table 4-2.

These species occur in low densities around the edges of the patch of native vegetation in woodland and more broadly throughout the remainder of the site.

Table 4-2 Priority weeds recorded during the field survey

Scientific Name	Common Name	Duty
Lycium ferocissimum	African Boxthorn	Must not be imported into the state or sold
Rubus anglocandicans	Blackberry	Must not be imported into the state or sold
Asparagus aethiopicus	Asparagus	Must not be imported into the state or sold
Senecio madagascariensis	Fireweed	Must not be imported into the state or sold
Lantana camara	Lantana	Must not be imported into the state or sold

4.3 Fauna and habitats

4.3.1 Fauna species

A total of 50 fauna species were recorded within the study area, and comprise 33 species of bird, 11 species of mammals, four species of amphibian, one reptiles and one gastropod. Six of these were exotic species including four mammal species and two bird species.

The fauna species that were recorded, habitat associations and additional species of fauna that may occur based on the habitat resources present are described below.

4.3.2 Fauna habitats

Three broad fauna habitat types were recorded within the study area:

- Native woodland and derived grassland
- Grassland and lightly treed paddocks
- Drainage line and dams.

These broad habitat types are described below.

Fauna habitats of native woodland

Native Woodland		
Description	Native woodland located within the R1 zoned land within the study area provides moderate quality fauna habitats. Habitat resources include: mature canopy trees (i.e. trees between 20 to 80 per cent of their life expectancy) and associated nectar, fruits and leaves as well as foraging substrate; a range of fruiting and flowering small trees and some shrubs, and the head waters of an un-named creek. The woodland remnant is highly fragmented and subject to edge effects and has only partial connectivity with larger remnants to the south and west. This area has and continues to be grazed by livestock. The woodland remnant contains only low quantities of pre-European occupation age trees and associated habitat resources such as tree hollows and stags. These trees include hollows with a range of sizes, orientations and landscape positions and both living and dead trees. *Eucalypt* species provide foraging and shelter resources for a range of birds and mammals. Foraging resources include seasonal nectar resources, seeds and insects. The few winter-flowering acacias provide year-round foraging resources for a range of native birds, bats and mammals, and would also likely be a manna source for local Sugar Gliders recorded during the site surveys. Much of the shrub and ground layer vegetation and habitat features of the woodland and forest has been removed and 'cleaned up' for grazing. As such the remnant has generally low quantities of woody debris and leaf litter, although some patches have higher quantities of these resources. Fallen timber and leaf litter provides shelter habitat for small reptiles, snakes and small mammals.	
Typical fauna species recorded	Relatively few nectarivorous species were recorded, likely due to previous disturbances. Mistletoebird (*Dicaeum hirundinaceum*) were recorded in this remnant along with several species of mistletoe. Similarly, very few insectivorous species were recorded. There was an overabundance of both Noisy Miners (*Manorina melanocephala*) and Crested pigeons (*Ocyphaps lophote*s) across the study area including the woodland remnant. Hollow-bearing trees provide nesting habitat for species such as the Galah (*Eolophus roseicapilla*), Little Corella (*Cacatua sanguinea*), Rainbow Lorikeet (*Trichoglossus moluccanus*) and Sugar Glider (*Petaurus breviceps*). Microbat species recorded included species typical of open woodland and/or agricultural areas, and some species that require large tracts of continuous vegetation. The Gould's Wattled Bat (*Chalinolobus gouldii*) was the most common microchiropteran bat species recorded in native woodland. The Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), which does require larger tracts, was predicted to occur by EcoLogical (2010) as well as a number of other threatened species recoded in the locality.	
Threatened fauna species recorded	Grey-headed Flying-fox (*Pteropus poliocephalus)* EPBC Act/TSC Act	Would forage throughout woodland patch. No breeding habitat present.
	East Coast Freetail Bat (*Mormopterus norfolkensis*) - TSC Act	Probable recording via Anabat detector. Would forage throughout woodland patches. May breed in hollow-bearing trees.
Introduced species recorded	Garden Snail (*Cantareus aspersa*) European Rabbit (*Oryctolagus cuniculus*) Brown Hare (*Lepus europaeus*) Red Fox (*Vulpes vulpes*)	

Native Woodland

Rl lands showing grazed understorey

Fauna habitats of grassland and planted trees

Grassland and planted trees	
Description	The majority of the R1 zoned land contains introduced grassland associated fenced grazing land. These paddocks include by planted eucalypts associated with fence lines, planted some 20 years ago to provide shelter for the grazing stock. Some areas of open lightly treed paddocks at the western portion of the study area include patches of derived grassland (>50% native grasses and forbs), with remnant large Eucalypts and some other mesic species. Many of these large trees were mature and senescent having numerous hollows and evidence of fauna occupation, such as parrot nests and arboreal mammal scent gland marking. These areas would have historically supported native woodland vegetation but have been extensively modified by previous clearing and agriculture. Exotic grassland and cleared land contain few habitat resources of relevance to most threatened species due to low structural and floristic diversity. Exotic grasses and herbs would provide foraging resources for relatively mobile and opportunistic native fauna species. Most of the species recorded in grassland areas would use these areas as an adjunct to the higher quality, more extensive areas of suitable habitat at and adjoining the subject site to the west and south toward the Illawarra escarpment. Some small fauna species such as lizards may rely on grassland habitat for their survival and parrots and arboreal mammals such as Ringtail Possums, Brushtail Possums and Sugar Gliders would rely on the many of the hollows across the site for nesting and roosting.
Typical fauna species recorded	Bird species commonly recorded in this habitat type include the Magpie-lark (*Grallina cyanoleuca*), Australian Magpie (*Cracticus tibicen*), Australian Raven (*Corvus coronoides*), Galah (*Corcorax melanorhamphos*), Rainbow Lorikeet (*Trichoglossus moluccanus*), Little Corella (*Cacatua sanguinea*); Noisy Miner (*Manorina melanocephala*) and Crested Pigeons (*Ocyphaps lophotes*), which were very abundant. Few raptors were recorded and include the Pacific Baza (*Aviceda subcristata*), which is rarely recorded in the Illawarra but has been recorded from the Calderwood area for several years (Illawarra Bird Observers). Both Little Corella and Rainbow Lorikeet were recorded entering and exiting hollows during the site surveys. Grassland and cropped areas provide foraging habitat for herbivorous species, including the Eastern Grey Kangaroo (*Macropus giganteus*) and the introduced Rabbit (*Oryctolagus cuniculus*) and Brown Hare (*Lepus europaeus*). These mammals were recorded only in small numbers. Bats typical of open agricultural land such as the White-striped Freetail Bat

Grassland and planted trees		
	(*Tadarida australis*) and Gould's Wattled Bat (*Chalinolobus gouldii*) were recorded. Grassland areas also provide habitat for a range of reptile species, including snakes and small lizards and frogs. Small grass skinks (*Lampropholis* spp.) were observed, and Verreaux's Tree Frog (*Litoria verreauxii*) were heard calling from small soaks in grassland areas.	
Threatened fauna species recorded	Grey-headed Flying-fox (*Pteropus poliocephalus*)	Forages in flowering myrtaceous trees and other fruiting tree species.
Introduced species recorded	European Rabbit (*Oryctolagus cuniculus*) Brown Hare (*Lepus europaeus*) Red Fox (*Vulpes vulpes*)	

Grassland and planted shelter trees in the north east corner of the proposal site

Derived grassland and mature myrtaceous trees in the south-west corner of the proposal site

Fauna habitats of drainage lines and dams

Drainage line and dams		
Description	There are three small dams in the study area with variety of exotic and native ephemeral species. Dams showed limited habitat value for native fauna, have limited emergent or aquatic vegetation and were impacted by the regular use of these areas by grazing livestock. One drainage was observed on the site but did not contain water at the time of the survey.	
Typical fauna species recorded	A low diversity and abundance of native waterfowl, waders and other wetland birds were observed in these water bodies. Common Ducks; Australian Wood Duck (*Chenonetta jubata*), Pacific Black Duck (*Anas superciliosa*), Straw-necked Ibis (*Threskiornis* spp.), herons (*Ardea* spp. and *Egretta* spp.), and Little Pied cormorants (*Phalacrocorax* spp.) were observed. A Long-finned Eel (*Anguilla reinhardtii*) was recorded in the eastern dam with Eastern Gambusia (*Gambusia holbrooki*) observed in all three dams. A limited range of frog species was recorded during targeted nocturnal surveys. These included Verreaux's Tree Frog (*Litoria verreauxii*), Eastern Dwarf Tree Frog (*Litoria fallax*) and Common Eastern Froglet (*Crinia signifera*). Also heard calling nearby in damp grassy areas were Bibron's Toadlet (*Pseudophryne bibroni*). All dams are unlikely habitat for the threatened Green and Golden Bell Frog (*Litoria aurea*).	
Threatened fauna species recorded	East Coast Freetail Bat (*Mormopterus norfolkensis*) - TSC Act	Probable recording via Anabat detector. Numerous other threatened microbats may also utilise the open water of the three small dams on occasion when drinking. Highly unlikely to rely on these water sources in generally very large home ranges.
Introduced species recorded	Red Fox (*Vulpes vulpes*) Eastern Gambusia (*Gambusia holbrooki*)	

Eastern Dwarf Tree Frog in fringing emergent vegetation of the eastern dam.

Two specific fauna habitats were recorded within the study area and surrounds. These comprise:

- Breeding Pacific Baza habitat (*Aviceda subcristata*)
- Numerous mature senescent hollow-bearing trees across the proposal site

These specific habitat types are described below.

Specific fauna habitat recorded in the study area

Pacific Baza breeding habitat	
Description	A pair of Pacific Baza were recorded displaying to one another over the western portions of the study area during the site surveys and a large raptor nest was recorded in an adjacent property to the west (approximately 60-80 m south west of the property boundary). The study area is likely part of this pairs permanent home range. Pacific Baza are not common south of Sydney and the Calderwood area is a known location for this species, which could be considered regionally significant (Illawarra Bird Observers). This pair has been known to occupy the locality for at least 10 years. While nests were not recorded within the study area, it is possible that this species may breed in the locality due to the continual occupation and presence of fledglings and juvenile birds in the area for at least 10 years. The study area would represent potential foraging habitat within the likely range of this species.
Conservation significance	Pacific Bazas are not listed threatened species or listed on any conservation plans for the region or locality. However, due to the paucity of sightings, particularly from the same location over a number of years, planning of the timing of vegetation removal should be considered, so as not to impact on this pair during the breeding season.
Hollow-bearing trees	
Description	15 hollow-bearing trees were recorded, predominantly across the north western portion of the study area, with some large and well used trees were recorded in the residential portions (Figure 4). A total of 66 hollows were observed in these 15 trees ranging from small 2-3 cm wide opening to large > 40 cm spouts and chimneys (Appendix B). The size and range shapes and forms of hollows were shown to provide roosting and nesting for a range of fauna during the site surveys, including but not limited to Little Corella, Rainbow Lorikeet, Sugar Glider, Ringtail Possum and likely a range of other fauna including microchiropteran bats, owls and nightjars.
Conservation significance	Hollows are the key habitat resource for obligate hollow dwelling native fauna and hollow-bearing trees can be considered a finite resource given the long-time periods involved with the ontogeny of hollow development. The impacts of the removal of hollow-bearing trees from an area may therefore persist for several hundred years (Gibbons & Lindenmayer 2002). Several large hollow-bearing trees with numerous hollows will be removed as part of the current sub-division, but several others will be retained within the E3 zoned lands, habitat enhancement areas and areas of the subdivision where the removal of vegetation will be avoided (Figure 4). As proposed in the Biodiversity Management Vegetation Clearance and Fauna Management Plan (GHD 2017), many of the immediate impacts of the hollows removed will be managed. The maintenance and longevity of those retained in the E3 lands will also be promoted. Consideration should be given to relocating hollows and large hollow trunks and other debris from the mature trees to the nearby Johnsons Spur Conservation area improve woody debris and fauna habitats. Similarly, where possible, mature hollow bearing trees should be retained to provide stepping stones to other remnants and forest, particularly to the south and west as well as to maintain these finite resources.

4.4 Conservation significance

4.4.1 Overview

Based on the desktop assessment the following threatened biota and MNES are known or predicted to occur in the locality:

- 28 threatened ecological communities (TECs)
- 33 threatened flora species
- 55 threatened fauna species, comprising 27 birds, 19 mammals, five frogs, three fish and one reptile
- 7 migratory species.

This list does not include marine threatened and migratory species or shorebirds which were highlighted by the database searches because the locality does not contain any marine or estuarine habitats.

The occurrence and potential occurrence of these threatened biota within the study area is discussed in the following sections.

4.4.2 Threatened biota

Threatened ecological communities

All of the native vegetation within the study area comprise a local occurrence of Illawarra Lowlands Grassy Woodland, which is listed as an Endangered Ecological Community (EEC) under the TSC Act and a Critically Endangered Community (CEEC) under the EPBC Act.

No other threatened ecological communities are present in the study area.

Threatened flora species

No threatened flora were recorded within the study area. There is potential habitat within the study area for 10 threatened flora species (refer to Table 4-3).

One threatened species, Narrow-leaved Peppermint (*Eucalyptus nicholii*) was recorded just outside the southern boundary of the study area and adjacent to Escarpment Drive. This species is listed as a vulnerable species under both the TSC and EPBC Acts. It is normally associated with the New England Tablelands from Nundle to north of Tenterfield. The two individuals recorded adjacent to the study area are planted specimens and are not naturally occurring. As such, this species is not discussed further in this assessment.

Table 4-3 Threatened flora that may occur within the study area

Common Name	Scientific name	TSC Act status	EPBC Act status	Likelihood of occurrence	Likelihood of impact
Thick Lip Spider Orchid	*Caladenia tessellata*	E	V	Possible. Preferred grassy sclerophyll forest is present in Forest Red Gum - Thin-leaved Stringybark grassy woodland. No local records	Low. Would not be visible at the time of this survey

Common Name	Scientific name	TSC Act status	EPBC Act status	Likelihood of occurrence	Likelihood of impact
Chorizema parviflorum Benth. in the Wollongong and Shellharbour Local Government Areas	*Chorizema parviflorum*	EP		Possible. Preferred woodland and forest dominated by Forest Red Gum is present in Forest Red Gum - Thin-leaved Stringybark grassy woodland. High number of records in locality.	Unlikely. Not recorded during this survey, despite targeted searches
Leafless Tongue Orchid	*Cryptostylis hunteriana*	V	V	Possible. Preferred open areas in lowland forest is present in Forest Red Gum - Thin-leaved Stringybark grassy woodland. No local records.	Unlikely. No leaves of associated species including *Cryptostylis erecta* or *Cryptostylis subulata* were recorded during this survey
White-flowered Wax Plant	*Cynanchum elegans*	E	E	Possible. Preferred open woodland is present in Forest Red Gum - Thin-leaved Stringybark grassy woodland. Moderate number of records in locality.	Unlikely. Not recorded during this survey, despite targeted searches
Lespedeza juncea subsp. *sericea* in the Wollongong Local Government Area	*Lespedeza juncea subsp. sericea*	EP		Possible. Preferred open forest dominated by Forest Red Gum is present in Forest Red Gum - Thin-leaved Stringybark grassy woodland. Low number of records in locality.	Unlikely. Not recorded during this survey, despite targeted searches
Spiked Rice-flower	*Pimelea spicata*	E	E	Possible. Preferred coastal woodland with emergent shrubs are present in Forest Red Gum - Thin-leaved Stringybark grassy woodland. Low number of records in locality.	Unlikely. Not recorded during this survey, despite targeted searches

Common Name	Scientific name	TSC Act status	EPBC Act status	Likelihood of occurrence	Likelihood of impact
Illawarra Greenhood	*Pterostylis gibbosa*	E	E	Preferred woodland and forest dominated by Forest Red Gum is present in Forest Red Gum - Thin-leaved Stringybark grassy woodland. High number of records in locality.	Low. Would not be visible at the time of this survey
	Solanum celatum	E		Possible. Sclerophyll forest is present in Forest Red Gum - Thin-leaved Stringybark grassy woodland. High number of records in locality.	Unlikely. Not recorded during this survey, despite targeted searches
Austral Toadflax	*Thesium australe*	V	V	Possible. Preferred habitat occurs in Forest Red Gum - Thin-leaved Stringybark grassy woodland. Not recorded in the locality.	Unlikely. Not recorded during this survey, despite targeted searches
Illawarra Zieria	*Zieria granulata*	E	E	Possible. May occur in Forest Red Gum - Thin-leaved Stringybark grassy woodland. High number of records in locality.	Unlikely. Not recorded during this survey, despite targeted searches

Remaining species identified from desktop searches can be reliably discounted as occurring based on the field survey effort undertaken and their habitat associations.

Threatened fauna species

One threatened fauna species, the Grey-headed Flying Fox (*Pteropus poliocephalus*), was recorded at one location within the study area. Nearest records of this species occur at Albion Park approximately 3 km away (OEH 2018). This species is listed as a vulnerable species under the TSC and also EPBC Acts.

A total of 13 threatened fauna species have been assessed as having the potential to occur within the study area based on the habitats present. These species are listed in Table 4-4 and comprise four threatened bird species, eight threatened bat species and one threatened terrestrial mammal species. Several of these species have been assessed as having the potential to occur within the adjacent Johnsons Spur conservation area based on the high connectivity of vegetation with large areas of high quality habitats in adjacent areas, rather than solely on the basis of the presence of specific habitat features.

Table 4-4 Threatened fauna that may occur within the study area

Scientific name	Common name	TSC Act status	EPBC Act status	Likelihood of occurrence	Likelihood of impact
Birds					
Callocephalon fimbriatum	Gang-gang Cockatoo	V		Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. Limited number of hollows large enough to support breeding habitat for this species; which is more likely to breed up further north in Budderoo. Moderate number of records in locality	Low. Small area of limited potential foraging and marginal breeding habitat would be removed.
Hieraaetus morphnoides	Little Eagle	V		Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. No nests observed during survey. Low number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Lophoictinia isura	Square-tailed Kite	V		Possible. No breeding habitat due to the absence of large watercourses. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. Low number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Tyto novaehollandiae	Masked Owl	V		Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. No breeding habitat is present. Low number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Mammals					
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Possible. Restricted to sandstone escarpment country and adjacent habitats. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. No breeding habitat is present. Low number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. May be attracted by chickens present in the study area. No breeding habitat is present. Moderate number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. Breeding and roosting habitat present in hollow-bearing trees. Low number of local records.	Moderate. Small area of limited potential foraging habitat would be removed. Potential breeding habitat would also be removed.

Scientific name	Common name	TSC Act status	EPBC Act status	Likelihood of occurrence	Likelihood of impact
Miniopterus australis	Little Bentwing-bat	V		Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. No breeding and roosting habitat present. Moderate number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. No breeding and roosting habitat present. Moderate number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Mormopterus norfolkensis	Eastern Freetail-bat	V		Present. From fixed recordings from Anabat at dam and also in treed vegetation in the north of the site. Likely to forage, roost and breed in Forest Red Gum - Thin-leaved Stringybark grassy woodland. Moderate number of local records.	Moderate. Removal of a small area of foraging habitat. Removal of potential breeding and roosting habitat.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Present. Observed foraging adjacent to the study area in the west. Likely to forage in the canopy of Forest Red Gum - Thin-leaved Stringybark grassy woodland. No roost camps observed. Moderate number of local records.	Moderate. Removal of a small area of foraging habitat.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. Breeding and roosting habitat present in hollow-bearing trees. Low number of local records.	Moderate. Small area of limited potential foraging habitat would be removed. Breeding habitat would also be removed.
Scoteanax rueppellii	Greater Broad-nosed Bat	V		Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. Breeding and roosting habitat present in hollow-bearing trees. Low number of local records.	Moderate. Small area of limited potential foraging habitat would be removed. Breeding habitat would also be removed.

Notes: E – Endangered; V – Vulnerable.

The remainder of the threatened fauna species that are known or predicted to occur in the locality have a close association with specific habitat resources that are not present in the site. Notably there are a number of fauna species that are associated with shrubby, sclerophyll vegetation types on sandstone substrates or rocky escarpments that would not occur in the grassy woodlands that characterise the site.

4.4.3 EPBC Act MNES

The database searches identified 14 threatened ecological communities, 27 threatened flora species, 25 threatened fauna species and 7 migratory species listed under the EPBC Act as potentially occurring in the site (see Appendix A). No additional MNES (such as world heritage places), was identified as occurring within the locality.

Threatened ecological communities

Illawarra Lowlands Grassy Woodland, which is listed as an Endangered Ecological Community (EEC) under the TSC Act and a Critically Endangered Community (CEEC) under the EPBC Act is present on the site. This community complies with the Moderate condition class threshold as defined by TSSC 2016 (see Section 3.2.2).

Threatened flora

Seven threatened flora species listed as threatened under the EPBC Act were assessed as having the potential to occur. These species are all also listed under the TSC Act and are addressed in Section 4.4.2.

Threatened fauna

One threatened fauna species listed under the EPBC Act; Grey-headed Flying-fox was recorded foraging to the west of the study area and also recorded flying over it.

Based on the habitats present, a total of three threatened fauna species listed under the EPBC Act may occur in the study area and/or be affected by the proposal. These fauna species are also listed under the TSC Act and are listed in Table 4-4. Relevant habitats for these species are discussed in Section 4.2.2.

Migratory fauna

Seven 'terrestrial' bird species were identified by the database searches as known or having the potential to occur within the locality, comprising:

- Migratory 'terrestrial' species
  - – Oriental Cuckoo (*Cuculus optatus*)
  - – White-throated Needletail (*Hirundapus caudacutus*)
  - – Black-faced Monarch (*Monarcha melanopsis*)
  - – Yellow Wagtail (*Motacilla flava*)
  - – Satin Flycatcher (*Myiagra cyanoleuca*)
  - – Rufous Fantail (*Rhipidura rufifrons*)
  - – Spectacled Monarch (*Symposiachrus trivirgatus*)

Given the habitats present and connectivity of the study area to large areas of high quality habitats on the western side lies adjacent to the Johnsons Spur Conservation Area, each of the predicted species listed above may occur in habitats within the study area on occasion.

Paper Size A4

0 12.5 25 50 75 100

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Proposal site
- Study area
- Cadastre
- Watercourse
- Illawarra Lowlands Grassy Redgum Woodland (listed as an EEC under the BC Act and CEEC under the EPBC Act) (moderate condition class)

The Trustee for RBWI Unit Trust
Clover Hill Residential Development
Ecology Assessment

Job Number 21-27415
Revision 2
Date 12 Mar 2019

Threatened biota and habitat features

Figure 4

N:\AU\Sydney\Projects\21\27415\GIS\Maps\Deliverables\EcologyAssessment\2127415_EA004_ThreatSpecies_2.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com.au

Data source: LPI: DTDB / DCDB, 2017; Nearmap: Aerial Imagery Extracted 20190312. Created by: fmackay

5. Impact assessment

5.1 Proposal description

The proposal involves the subdivision of Lot 1 DP 558196 (the Clover Hill Estate) into 141 conventional residential lots and one homestead lot. The area zoned as E3 Environmental Management in the north-east of the site will form a single residual Lot between subdivisions.

5.2 Direct impacts

5.2.1 Removal of vegetation and habitat

The direct impacts of the proposal would be limited to the areas within the study area shown on Figure 3. The proposal is contained within Lot 1 DP 558196 with impacts limited to the R1 zoned land and a small portion of E3 zoned land only.

Impacts associated with R1 lands

The proposal would result in the removal of predominantly exotic and planted vegetation (as shown in Table 5-1). The proposal would remove 6.40 hectares of Shelter plantings and pasture and 0.26 hectares of non-native riparian vegetation and artificial wetlands. Only a small portion of native vegetation (1.54 hectares) comprising degraded Forest Red Gum- Thin-leaved Stringybark grassy woodlands would also be removed within the proposal site.

It is assumed that construction site compounds, temporary sediment management structures and any other ancillary structures would be entirely contained within the proposal site. Some native trees and some understorey vegetation will be retained and managed within the E3 zoned lands and associated asset protection zones where possible. Consideration will also be given to the potential retention of hollow-bearing trees within the proposed street scape.

Native vegetation within the proposal site has a moderately diverse range of non-threatened native plants, with associated habitat values as discussed in Section 4.3.2. This includes areas of highly modified moderate and low condition vegetation, which have been impacted by current grazing practices and have generally low recovery potential through natural regeneration.

The total area of native vegetation within the proposal site (1.54 ha) is around 0.01 % of the estimated area of native vegetation South Coast Grassy woodlands in the locality (around 1624 ha, based on Southeast NSW Native Vegetation Classification and Mapping - SCIVI. VIS_ID 2230 (OEH 2010) vegetation mapping.

0.33 hectares of moderate condition Forest Red Gum- Thin-leaved Stringybark grassy woodland vegetation would be retained in R1 zoned lands as part of the habitat enhancement areas as shown in Figure 2.

Impacts associated with E3 lands

The E3 lands currently include approximately 1.27 ha of native vegetation comprising degraded Forest Red Gum- Thin-leaved Stringybark grassy woodlands. The following minor impacts are proposed to this vegetation:

- 0.07 ha associated with the proposed dwelling and associated access (the location chosen is already cleared and does not require removal of any canopy trees).

- 0.16 ha in the north east portion of the E3 land adjacent to Lendlease's Stage 2A which is to be cleared and/or managed as part of the bushfire management strategy described in the Bushfire Report (March 2019). Note: Stag tree would be retained within the APZ. Some additional canopy trees may also be retained.
- 0.06 ha to establish an APZ in the south west portion of the E3 lands which is the be cleared and/or managed as part of the bush fire management strategy described in Bushfire Report (March 2019).
- Removal of 0.19 ha of shelter plantings which comprise introduced pine species.

The remaining 0.98 ha of native vegetation, comprising moderate condition Forest Red Gum-Thin-leaved Stringybark grassy woodland and habitat, would be retained and managed for biodiversity values within the E3 Environmental Management zone as shown in Table 5-1. This vegetation would be subject to a Vegetation Management Plan (VMP) and would be restored to full structured vegetation as a condition of consent of approval.

5.2.2 Fauna injury and mortality

As described above, the site provides habitat resources for native fauna species, including threatened fauna. More mobile native fauna such as adult birds, microbats, terrestrial and arboreal mammals are highly unlikely to be affected by construction activities. Construction may result in the injury or mortality of small terrestrial fauna that may be sheltering in vegetation within the proposal site, such, frogs and reptiles described as above. The frog and reptile species that are known or likely to occur within the proposal site are widespread and abundant and so the potential injury or mortality of individuals within a maximum of 8.69 ha of habitat (comprising all vegetation within the proposal site) is highly unlikely to affect an ecologically significant proportion of any local populations. The removal of artificial wetlands as part of the proposal may result in the temporary displacement of wetland birds to the retained riparian corridor network and adjacent properties. Stormwater basins (in accordance with a water cycle concept plan) are likely to develop into wetland habitats through time providing habitat opportunities for species which utilise these environments. Impacts on threatened fauna are discussed in detail in Section 6.

The proposal would increase the extent of developed land in the site and locality to a small degree and may result in a minor increase in the volume of traffic. Recommended mitigation measures to address this issue would include signposting and enforcing safe speed limits (see Section 5.4.2). Considering the scale of the surrounding development associated with the approved Calderwood Urban Development Project, the project would provide relatively low volumes of additional traffic meaning impacts associated with vehicle strike are anticipated to be low. Safe passage for native fauna would be retained around the proposal site as described below.

5.2.3 Habitat fragmentation and isolation

The proposal site is located to the north east of a large patch of Environmentally Significant Lands (Johnsons Spur) and the site also includes a small patch of Environmentally Significant Lands (zoned E3) as identified in the approved Concept Plan for the Calderwood Urban Release Area (see Figure 3).This patch will not be directly impacted by this proposal however the Concept Plan approval means it will be surrounded by urban development and subject to associated impacts through time. Johnsons Spur has been mapped as Environmentally Significant Lands under the approved Concept Plan and zoned E2.

Two small patches of native vegetation within R1 zoned land between Environmentally Significant Lands (zoned E3) and Johnsons Spur will be retained to provide a corridor or ‘link’ with large tracts of contiguous vegetation. These areas (referred to as habitat enhancement areas in Figure 2), will also contain habitat passage ramps and additional habitat resources including nest boxes and a rock cairn.

Table 5-1 Potential extent of vegetation removal within the site

Zone ID	Vegetation zone	TSC Act Status	EPBC Act Status	Vegetation removal within proposal site (hectares)
	R1 Lands			
1	Forest Red Gum - Thin-leaved Stringybark grassy woodland on coastal lowlands	EEC	CEEC	1.54
2	Shelter plantings and introduced pasture	N/A	N/A	6.40
3	Non-native riparian vegetation and artificial wetlands	N/A	N/A	0.26
	E3 Lands			
4	Asset protection zones (Note: some canopy trees retained)	EEC	CEEC	0.22
5	Dwelling and access	EEC	CEEC	0.17
6	Shelter plantings and introduced pasture	N/A	N/A	0.16

5.3 Indirect impacts

5.3.1 Erosion, sedimentation and contamination

There are potential sensitive receptors for indirect impacts on aquatic habitats from the proposal, including Macquarie Rivulet, a large drainage line occurring to the south of the study area. Potential impacts that could result in a decline in aquatic habitat value include:

- Alterations to riparian and floodplain geomorphology
- Alterations to catchment hydrology
- Reduced water quality through hydrocarbon contamination or through increased nutrient or sediment inputs.

The hydrology and water quality of the site has already been substantially modified by clearing, damming and livestock access. The proposal would result in an increase in the proportion of hardstand surfaces within the proposal site and may also modify drainage through culverts and other engineered structures. Given the small extent of full vegetation removal and construction within non-native riparian vegetation and artificial wetlands (up to 0.26 ha) and the modified nature of aquatic habitats at the site, it is anticipated that these potential impacts would be minor and localised.

5.3.2 Weed invasion and edge effects

'Edge effects' refers to changed environmental conditions at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Edge effects would result from clearing of vegetation within the development footprint and then continue to affect vegetation and habitats adjoining development areas for the life of the proposal. Cleared area are present on all sides of the proposal footprint and as such, edge effects are unlikely to affect the habitat value of adjacent areas.

Construction may, in general, increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into areas of native vegetation via wind and water and via worker's shoes, clothing and through construction vehicles. The risk of introduction of weeds would continue during operation of the proposal through wind or water transmission of propagules from gardens, or through recreational use of retained vegetation by property owners or their pets.

5.3.3 Pests and pathogens

Construction activities within the development footprint have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) through vegetation disturbance and increased visitation. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus affects both tadpoles and adult frogs and can eliminate entire populations once introduced into an area.

As a precautionary measure a 'clean on entry, clean on exit' policy should be implemented during construction activities to prevent the introduction or spread of these pathogens.

5.3.4 Light, noise and vibration

The proposal would increase the level of light, noise and vibration disturbance in retained habitats within areas adjacent to the proposal site such as in the land zone E3 Environmental Management. Given the large lot size and low density of the proposed development and the provision of buffer zones between the indicative house pads and retained areas of native vegetation, these impacts would be relatively minor.

5.4 Impact mitigation

5.4.1 Avoidance of impacts

The proposal includes development of the R1 zoned lands in accordance with the approved Concept Plan with these areas already been approved for clearing. The current proposal includes a 'habitat link' from the E3 lands in a south west direction providing connectivity with Johnsons Spur. This link has been incorporated into the subdivision plan in consultation with Council. The link will conserve approximately 10 mature canopy trees and assist fauna movement through the study area.

Approximately 0.98 ha of the E3 zoned lands in the north of the site would be retained. This area would be rehabilitated back to fully structured vegetation. A detailed VMP would be prepared as a condition of approval describing the rehabilitation and management program for this part of the site. The VMP would be prepared in consultation with council and would include a detailed budget and funding proposal for the works. The restoration of 0.98 ha of vegetation within the E3 zone would likely provide improved biodiversity and habitat outcomes when compared to maintaining this area as is with a discontinuous canopy and mown understorey comprising a mix of native and introduced ground cover species.

The cleared and/or managed area in the north east of the E3 zone will include retention of the habitat (stag) tree. Other canopy trees will be retained where possible.

GHD understands the E3 zoned lands includes a dwelling right. GHD has chosen a proposed dwelling location and associated access which does not require any removal of canopy trees (see Figure 3).

5.4.2 Mitigation of impacts

Detailed Design Phase

The proposal site shows the maximum area to be impacted by the development. There is some potential to reduce the impacts of the proposal through retention of native biota and habitats within this footprint.

During the detailed design process, the impact of the proposal on areas with higher biodiversity values should be minimised wherever possible by:

- Minimising the area of native vegetation and especially intact threatened ecological communities to be cleared.
- Retention of native vegetation within residential lots and asset protection zones wherever possible.
- Avoidance of identified hollow-bearing trees wherever possible. Information from the civil design team indicates that 7 of the 15 hollow-bearing trees will need to be removed, as they are located within an area where roadworks are proposed or located within a critical part of a likely building envelope. The remaining 8 hollow-bearing trees are located within a proposed residential lot where a house could substantially be designed to avoid these hollow-bearing trees.

Construction phase

Environmental management and impact mitigation measures would be required for the construction phase of the project. Construction of building platforms, road network and other associated infrastructure would include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures including the procedures outlined below. The proposed measures would include environmental safeguards for protection of downstream properties and waterways in accordance with relevant policy documentation and Government guidelines.

Construction management plans implemented at the site would be required to address the following as a minimum:

- Installation of erosion and sediment control measures prior to construction. Erosion and sediment control sub-plans should be prepared in accordance with Volume 2D of Managing Urban Stormwater: Soils and Construction (DECC 2008d). The erosion and sediment control plans would be updated and managed throughout as relevant to the activities during the construction phase.
- Regular inspection of erosion and sediment control measures, particularly following rainfall events, to ensure their ongoing functionality.
- Vegetation clearing activities completed in accordance with the Vegetation Clearance and Fauna Management Plan (GHD 2017a). This would include the presence of a trained ecologist, staged vegetation clearing and pre-clearance surveys for the removal of local fauna.
- Construction of habitat passage ramps (as shown on Figure 2). Habitat passage ramps will comprise grass covered batters to facilitate fauna passage associated with retaining walls and allow fauna movement between the E3 Environmental Management Zone, habitat enhancement areas and Johnsons Spur to the south west.
- Installation of nest boxes within habitat enhancement areas (shown on Figure 2). Installation of nest boxes should preferable occur on trees without hollows. Recommended nest box types are based on fauna locality likely to occur in the locality, and the dimensions and the minimum numbers of nest boxes required are listed in Appendix D.
- Installation of a rock cairn within the habitat enhancement area and outside the dripline of trees and adjacent to the habitat passage ramp adjacent to Johnsons Spur in the south west (shown on Figure 2). These will comprise a pile of rock of varying sizes.
- Restriction of stockpiles to identified construction compounds, in areas of cleared land and exotic grassland and management of these stockpiles to ensure no offsite impacts through dust generation or sedimentation.
- Separate erosion controls for individual house sites would be established to support the building stage of the development.
- Exposed soil would be stabilised and revegetated as soon as practicable after construction of dwellings to minimise the time that bare earth is exposed to erosion.
- Delineation and protection of exclusion zones around native vegetation to be retained within the E3 zone and habitat enhancement zones.
- Communication with construction personnel of the conservation value of surrounding habitats and their responsibilities with regards to protecting these habitats during construction. This would include an environmental induction for all workers prior to starting work on site.

- Hygiene procedures to prevent the introduction and spread of pathogens such as Phytophthora, Chytrid and Myrtle Rust in areas of native vegetation. These would include exclusion zones around retained areas of native vegetation and/or provision of machine and footwear washdown stations for all equipment and personnel working in areas of native vegetation. Hygiene procedures would be included in a weed and pest species management sub-plan.
- Minimising the clearing of mature trees where possible (i.e. through modification of a house design within a proposed residential lot, re-contouring and providing additional retaining walls to avoid mature trees where practical).

Operational phase

The following recommended mitigation measures are of relevance to the operational phase of the proposed development (i.e. the use of the proposal site as a residential area):

- Appropriate management of bushfire asset protection zones to prevent the spread of weeds or soil into adjacent areas of retained vegetation.
- Enforcement of legal obligations to control priority weeds within residential areas to prevent the spread of propagules into retained areas of native vegetation. Examples would include Lantana and Asparagus fern which are located within and immediately south of the E3 Zone. It is anticipated that council will have management obligations for the E3 and would also be responsible for enforcing the control of priority weeds.

6. Assessments of significance

6.1 Identification of affected threatened biota

The desktop assessment, field surveys and habitat assessments described above have been used to identify the suite of threatened biota that may be affected by the proposal, through either direct or indirect impacts.

This section identifies the threatened biota that are known or likely to occur in the proposal site and may be impacted by the proposal and that are hence considered affected threatened biota for the purposes of this assessment (see Section 0). Affected threatened biota have been grouped in guilds (i.e. species that have similar ecology and/or shared habitat requirements).

Table 6-1 lists the threatened ecological communities and species that are known or likely to be present at the site and are considered affected threatened biota for the proposal. Table 6-1 includes a subset of those threatened flora and fauna species listed in Table 4-3 and Table 4-4, due to the increased likelihood of impacts for these species. Where appropriate, affected threatened species have been grouped in guilds (i.e. species that have similar ecology and/or shared habitat requirements).

Several of the threatened fauna species that may occur at the broader site are not potentially affected threatened biota because they likely occur within the adjacent Johnsons Spur conservation area. This area is contiguous with large areas of high quality habitats providing a broad range of habitats, rather than solely on the basis of the presence of specific habitat features of the proposal site. This may include relatively mobile fauna species that would only occur in the development footprint on a transitory or opportunistic basis.

The proposal would result in direct impacts to known local occurrences of Illawarra Lowlands Grassy Woodland, Grey-headed Flying Fox and Eastern Freetail Bat. Specific assessments of significance for these biota are included in Appendix C and summarised below.

The results of the assessments of significance for threatened ecological communities and for guilds of affected threatened species are described below.

Table 6-1 Potentially affected threatened biota

Scientific name	Common Name	TSC Act status	EPBC Act status	Impact of development
Threatened ecological communities				
Illawarra Lowlands Grassy Woodland		EEC	CEEC	Direct impacts within a local occurrence of the community.
Threatened flora- orchids				
Caladenia tessellata	Thick Lip Spider Orchid	E	V	Removal of potential habitat for possible local populations of these species.
Pterostylis gibbosa	Illawarra Greenhood	E	E	
Threatened fauna- Microbats				
Mormopterus norfolkensis	Eastern Freetail-bat	V		Small area of potential foraging habitat would be removed. Potential breeding habitat would also be removed.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		
Scoteanax rueppellii	Greater Broad-nosed Bat	V		

Scientific name	Common Name	TSC Act status	EPBC Act status	Impact of development
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		
Threatened fauna- Grey-headed Flying Fox				
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Removal of a small area of foraging habitat.

Notes: E – endangered; V – vulnerable; CEEC – critically endangered ecological community; EEC – endangered ecological community.

6.2 Threatened ecological communities

Illawarra Lowlands Grassy Woodland

The proposal site contains a total of 1.54 ha of Illawarra Lowlands Grassy Woodland. The vegetation to be removed or modified is in moderate condition that comprises the moderate condition (C) form of the EPBC Act-listed community. This represents a very small proportion of the local occurrence of this community. At least .098 ha of this community, within E3 zoned land and within 0.33 ha within habitat enhancement areas associated with the R1 zoned lands that also comprises the EPBC Act-listed form of the community, would be retained within the study area. The 0.98 ha would be restored back to full structured vegetation.

A 7-part test for potential impacts on Illawarra Lowlands Grassy Woodland is included in Appendix C. The outcome of this assessment of significance is that the proposal would not result in a significant impact on the local occurrence of the ecological community, given:

- A maximum of 1.54 hectares of native vegetation would be removed within R1 zoned lands and 0.39 ha would be removed and/or modified within the E3 zoned lands.
- The vegetation that would be removed is heavily modified following previous clearing and active grazing.
- The vegetation to be removed comprises only edge vegetation and would only isolate a small patch of community in the study area.
- The areas of vegetation that would be removed are not considered critical for the survival of the community in the locality.
- The proposal would not interfere with the recovery of this community.

Consultation between council and DoEE indicated their preference was to prepare and submit a referral for Illawarra Lowlands Grassy Woodlands regardless of the AoS determination. As such, a referral is now being prepared by the applicant and will be submitted to DoEE accordingly.

6.3 Threatened flora

The proposal would remove potential habitat for threatened orchids Thick Lip Spider Orchid and Illawarra Greenhood, which is listed as an endangered species under the TSC Act (and listed as vulnerable and endangered species under the EPBC Acts respectively).

The Thick Lip Spider Orchid has not been recorded in the locality, however the Illawarra Greenhood has been recorded in high numbers in the locality (OEH 2018a). Both species would not be visible at the time of the survey are both commonly known in association with grassy dry sclerophyll woodlands, such as within the proposal site.

A 7-part test for potential impacts on threatened orchids is included in Appendix C. The outcome of this assessment of significance is that the proposal would not result in a significant impact on the local occurrence of Thick Lip Spider Orchid and Illawarra Greenhood, given:

- A maximum of 1.93 ha of potential habitat would be impacted, comprising substantially modified vegetation through clearing and current grazing practices.
- The small area of potential habitat to be removed is not considered important habitat for these species given an absence of records in the immediate vicinity of the study area or in adjacent intact native vegetation.
- No patches of known habitat would become isolated as a result of the proposal.

6.4 Threatened fauna

Microbats

An assessment of significance of impacts on potential local populations of threatened microbats (Eastern Freetail-bat, Greater Broad-nosed Bat, Eastern False Pipistrelle and Yellow-bellied Sheathtail Bat) has been prepared with reference to Section 5a of the EP&A Act. The outcome of this assessment is that the proposal is not likely to have a significant impact on the local populations of these threatened microbats given:

- Only 1.93 ha of native vegetation that represents potential foraging habitat for these species would be removed within the proposal site.
- 7 out of the 15 trees with hollows providing potential roosting and breeding habitat would be removed.
- A minimum of three microbat - specific nest boxes will be installed in habitat enhancement areas to minimise impacts on microbats in the locality.
- Large areas of habitat containing hollow-bearing trees occur in the locality (e.g. the adjacent Johnsons Spur conservation area and Illawarra escarpment conservation areas in the west).
- No areas of habitat would become isolated for these highly mobile species.
- Indirect impacts would predominantly occur along an already modified and disturbed edge.

Grey-headed Flying-fox

An assessment of significance of impacts on potential local populations of Grey-headed Flying-fox has been prepared with reference to Section 5a of the EP&A Act. The outcome of this assessment is that the proposal is not likely to have a significant impact on the local populations of this species given:

- The vegetation to be removed comprises a negligible proportion of native vegetation present in surrounding areas and the broader locality.
- No roosting habitat or camp sites would be removed or affected.
- The proposed vegetation removal would not isolate areas of habitat or create barriers to movement between camp sites or foraging grounds for this species.

6.5 Migratory fauna

No migratory bird species were recorded during field surveys. As described in Section 4.4.3, other seasonally migratory or nomadic species would be likely to utilise habitats within the site on occasion.

The EPBC Act requires an assessment of the significance of potential impacts of a proposal on migratory species with reference to the criteria specified in the *Matters of National Environmental Significance –Assessment of significance guidelines 1.1* (DotE 2013).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will (DotE 2013):

- Substantially modify, destroy or isolate an area of important habitat for a migratory species.

An area of 'important habitat' for a migratory species is: habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or; habitat that is of critical importance to the species at particular life-cycle stages, and/or; habitat utilised by a migratory species which is at the limit of the species range, and/or; habitat within an area where the species is declining (DotE 2013).

As described in Section 4.4.3 the site would have only moderate value for migratory species and does not comprise 'important habitat'. The 8.69 hectares of terrestrial vegetation (including shelter plantings and pasture) contained in the proposal site would have very minor value for populations of migratory species. Impacts would be restricted to the site and its immediate vicinity and so the proposal would not substantially modify any important habitat.

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

As described above the site does not comprise 'important habitat'. Impacts would be restricted to the development footprint and its immediate vicinity and so the proposal would not result in an invasive species becoming established in important habitat.

- Seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

Given the limited scale of the proposal and quality of habitat for migratory species only a small number of individuals of any migratory species would ever occupy habitat within the area potentially subject to impacts. The risk of injury or mortality of any of these individuals is very slight. The proposal site contains a small proportion of the habitat resources available for migratory species in the study area and the locality. As described in Section 5.2.3, the proposal would not significantly increase the degree of fragmentation or isolation of habitat in the locality. Therefore the proposal would not seriously disrupt the lifecycle of an ecologically significant proportion of the population of any migratory species.

Based on the consideration of the criteria contained in the *Matters of National Environmental Significance –Assessment of significance guidelines* (DotE 2013), the proposal would not be likely to have a significant impact on any migratory species.

6.6 Additional MNES

An assessment of the likely significance of impacts on the Illawarra Lowlands Grassy Woodland CEEC recorded within the study area has been prepared with specific reference to the *Matters of National Environmental Significance – significant impact guidelines* (DotE 2013) and is presented in Appendix C. The outcome of this assessment is that the proposal would not have a significant impact on Illawarra Lowlands Grassy Woodland.

Consultation between council and DoEE indicated their preference was to prepare and submit a referral for Illawarra Lowlands Grassy Woodlands regardless of the AoS determination. As such, a referral is now being prepared by the applicant and will be submitted to DoEE accordingly.

Specific consideration of the *MNES – significant impact guidelines* has not been undertaken for affected threatened species listed under the EPBC Act that may potentially occur on site on occasion for which an assessment of significance in accordance with Section 5A of the EPA Act has been prepared (i.e. the Grey-headed Flying Fox, Thick Lip Spider Orchid and Illawarra Greenhood). The proposal is unlikely to have a significant impact on these species or their habitats as outlined above.

7. Conclusions

This report has been prepared to support a Development Application (DA) for the subdivision of of Lot 1 DP 558196 (the Clover Hill Estate) within Calderwood, NSW. The proposal would involve construction of 141 residential lots, one homestead lot and associated road network and infrastructure within areas approved for residential development under the Part 3A Major Project Concept Plan (MP09 _0082) for the Calderwood Urban Development Project.

The majority of site contains shelter plantings and introduced pasture. Current and historic land uses within the site include grazing, livestock keeping and timber felling and collecting. The site includes areas of modified grassy woodland in the north as well as non-native riparian vegetation and artificial wetlands as a result of the long term management of the property for agricultural purposes.

Based on the targeted surveys and habitat assessments undertaken, the site contains the following threatened biota and their habitats:

- 'Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion' community which is listed as a EEC under the TSC Act and CEEC under the EPBC Acts.
- Potential habitat for a number of flora species including Thick Lip Spider Orchid and Illawarra Greenhood in grassy woodlands.
- Potential habitat for microchiropteran bats that may breed and forage in grassy woodlands including the Eastern Freetail Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat and Yellow-bellied Sheathtail bat.
- Potential foraging habitat for Grey-headed Flying fox.

The proposal would result in the removal or modification of approximately 1.54 hectares of native vegetation within the proposal site. A further 6.40 ha vegetation comprising shelter plantings and pasture and also 0.26 hectares of non-native riparian vegetation and artificial wetlands would also be removed.

Vegetation removal and modification within the R1 zoned lands would include up to 1.54 ha and within the E3 zoned lands would include up to 0.39 ha of Illawarra Lowland Grassy Woodlands in the proposal site. Assessments of significance pursuant to Section 5a of the EPA Act and with reference to the EPBC Act guidelines 1.1 have been performed for impacts on this threatened ecological community as well as other threatened biota that may occur within the proposal site. The outcome of these assessments of significance is that the proposal is not likely to result in a significant impact on any threatened biota or on any other MNES given:

- That potential impacts of the proposal would be restricted to 1.93 hectares of native vegetation and a further 6.40 hectares of shelter plantings, pasture and non-native riparian vegetation which would affect a very small proportion of local populations and their habitat.
- A small proportion of the habitat available to local populations of these biota would be removed, the proposal would not fragment any significant areas of known habitat, and the woodland habitat comprises edge habitat in a modified condition.
- The proposal would not result in a significant increase in the operation of any KTPs nor have any effects that would substantially interfere with the maintenance or recovery of local populations of these biota.

A Species Impact Statement (SIS) is not required for the proposal.

Based on the impact assessments and assessments of significance included in this report, the proposal is not likely to result in a significant impact on any NSW listed threatened biota or MNES. Consultation between council and DoEE indicated their preference was to prepare and submit a referral for Illawarra Lowlands Grassy Woodlands regardless of the AoS determination. As such, a referral is now being prepared by the applicant and will be submitted to DoEE accordingly.

8. Disclaimer

This report: has been prepared by GHD for RBWI Pty Ltd ATF RBWI Unit Trust and may only be used and relied on by RBWI Pty Ltd ATF RBWI Unit Trust for the purpose agreed between GHD and the RBWI Pty Ltd ATF RBWI Unit Trust as set out in Section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than RBWI Pty Ltd ATF RBWI Unit Trust arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by RBWI Pty Ltd ATF RBWI Unit Trust and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

9. References

BOM (2018) Climate Data Online. Accessed by http://www.bom.gov.au/climate/data/?ref=ftr

Churchill, S. (2008). *Australian Bats. Second Edition*. Allen & Unwin, Australia.

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

DECC (2008a) NSW *(Mitchell) Landscapes Version 2*. Department of Environment and Climate Change, Hurstville NSW

DoE (2018a). *EPBC Online Protected Matters Search Tool Database*. Department of the Environment. Accessed at http://www.environment.gov.au/epbc/pmst/

DoE (2018b). *Species Profiles and Threats Database*. Online resource. Accessed at <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl> (viewed June 2018). Department of the Environment.

DoE (2013) *Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth of Australia.

DPI (2016). *Fish communities and threatened species distributions of NSW*. Department of Primary Industries NSW. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/669589/fish-communities-and-threatened-species-distributions-of-nsw.pdf

DPI (2018) NSW *WeedWise Priority weed declarations for Shellharbour LGA*. Accessed at http://weeds.dpi.nsw.gov.au/WeedBiosecurities?AreaId=113

Duffy, AM, Lumsden, LF, Caddle, CR, Chick, RR & Newell, GR 2000. *The efficacy of Anabat ultrasonic detectors and harp traps for surveying microchiropterans in southeastern Australia*, Acta Chiropterologica 2: 127-144.

Eby, P. and Law, B. (2008). *Ranking the feeding habitats of Grey-headed flying foxes for conservation management: a report for The Department of Environment and Climate Change (NSW) & The Department of Environment, Water, Heritage and the Arts*. Available from http://www.environment.nsw.gov.au/resources/threatenedspecies/GHFFmainreport.pdf (accessed 07 July 2010).

Eco Logical Australia (2010) *Calderwood Urban Development Project; Flora and fauna assessment under Part 3A of the Environmental Planning and Assessment Act, 1979 Final Report.*

GHD (2017) Clover Hill Subdivision Biodiversity Management; *Vegetation Clearance and Fauna Management Plan.*

Hoye, G.A. and Richards, G.C. (2008). Greater Broad-nosed Bat *Scoteanax rueppellii*. In S. Van Dyke and R. Strahan (eds), 'The Mammals of Australia' 3rd edition. Reed New Holland, Chatswood.

Mills, DJ, Norton, TW, Parnaby, HE, Cunningham, RB & Nix, HA 1996, *Designing surveys for microchiropteran bats in complex forest landscapes – a pilot study from south-east Australia. Forest Ecology and Management* 85 (1-3):149-161.

Office of Environment and Heritage (OEH) (2018a) *NSW BioNet. The Website for the Atlas of NSW Wildlife*. Accessed at http://www.bionet.nsw.gov.au/

Office of Environment and Heritage (OEH) (2018b) *eSPADE NSW Soil and Land Information database*. Accessed at http://www.environment.nsw.gov.au/eSpade2Webapp

Office of Environment and Heritage (OEH) (2018c) *BioNet Vegetation Classification.* Available from: http://www.environment.nsw.gov.au/research/Visclassification.htm

Pennay, M., Law, B., and Lunney, D. (2011) *Review of the Distribution and status of the bat fauna of NSW and the ACT. Pp. 226-256 in The Biology and Conservation of Australian Bats*, edited by Law., B Eby., P.

Peterson Bushfire (March 2019) *Letter report - Revised subdivision proposal – 269 North Macquarie Road, Calderwood*

Specht R.L. (1970). *Vegetation. In: The Australian environment.* (Ed. G.W. Leeper). pp. 44-67. CSIRO and Melbourne University Press, Melbourne.

The Royal Botanic Gardens and Domain Trust (2011). PlantNET. [Online]. *The Plant Information Network System of The Royal Botanic Gardens and Domain Trust, Sydney, Australia (version 2).* Available from: http://plantnet.rbgsyd.nsw.gov.au.

TSSC (2016) *Approved conservation advice for the Illawarra and south coast lowland forest and woodland ecological community*. Threatened Species Scientific Committee. Accessed at http://www.environment.gov.au/biodiversity/threatened/communities/pubs/144-conservation-advice.pdf

Van Dyke and Strahan (2008) *The Mammals of Australia (Third Edition).*

Appendices

Appendix A – Likelihood of occurrence of threatened and migratory biota

Following collation of database records and threatened species and community profiles, a 'likelihood of occurrence' assessment was prepared for threatened and migratory species and ecological communities with reference to the broad vegetation types and habitats contained within the study area. This was further refined following field surveys and verification of vegetation types and identification and assessment of habitat present within the study area, or the species was recorded in the study area. A likelihood of occurrence ranking was attributed to these biota based on this information.

Likelihood of occurrence of threatened flora species in the study area

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Acacia bynoeana	Bynoe's Wattle	E	V	Species or species' habitat may occur within 10 km (DEE 2018a)	Endemic to central eastern NSW, currently known from only 34 locations, many of only 1-5 plants. Grows mainly in heath/ dry sclerophyll forest on sandy soils, prefers open, sometimes slightly disturbed sites such as trail margins, road edges, and in recently burnt open patches. Flowers September to March, and fruit matures in November.	Unlikely, no suitable habitat in proposal site	Nil
Allocasuarina glareicola		E	E	Species or species' habitat may occur within 10 km (DEE 2018a)	Primarily restricted to small populations in and around Castlereagh NR (NW Cumberland Plain), but with an outlier population at Voyager Point, Liverpool. Also reported from Holsworthy Military Area. Grows on tertiary alluvial gravels, with yellow clayey subsoil and lateritic soil. Occurs in Castlereagh open woodland.	Unlikely, no suitable habitat in proposal site	Nil
Arthropteris palisotii	Lesser Creeping Fern	E		1 record within 10 km, last recorded 2005 (OEH 2018a)	Occurs on the Illawarra Escarpment, North-eastern NSW and also in Queensland. Occurs in rainforest, mainly on tree trunks.	Unlikely, no suitable habitat in proposal site	Nil
Boronia deanei	Deane's Boronia	V	V	3 records within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	This small erect shrub is found in scattered populations between the far south-east of NSW and the Blue Mountains (including the upper Kangaroo River near Carrington Falls, the Endrick River near Nerriga and Nalbaugh Plateau), mainly in conservation reserves. The species grows on the margins of high altitude swamps, in wet heath on sandstone, and in drier open forest.	Unlikely, no suitable habitat in proposal site	Nil
Caladenia tessellata	Thick Lip Spider Orchid	E	V	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Occurs from Central Coast NSW to southern Victoria. Mostly coastal but extends inland to Braidwood in southern NSW. In NSW grows in grassy dry sclerophyll woodland on clay loam or sandy soils, and less commonly in heathland on sandy loam soils (Duncan 2010).	Possible, would not be visible at the time of this survey	Low. Would not be visible at the time of this survey
Chorizema parviflorum	Chorizema parviflorum Benth. in the Wollongong and Shellharbour Local Government Areas	EP		108 records within 10 km (OEH 2018a)	Recorded from between Austinmer and Albion Park in the local government areas of Wollongong and Shellharbour. All known sites occupy woodland or forest dominated by Forest Red Gum and/or Woollybutt. May occur on coastal heathland (OEH 2012).	Possible, but not recorded during this survey, despite targeted searches	Unlikely. Not recorded during this survey, despite targeted searches

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Occurs in coastal areas from East Gippsland to southern Queensland. Habitat preferences not well defined. Grows mostly in coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest. Prefers open areas in the understorey and is often found in association with Large Tongue Orchid and the Bonnet Orchid. Soils include moist sands, moist to dry clay loam and occasionally in accumulated eucalypt leaves. Flowers November-February.	Possible, although no leaves of *Cryptostylis erecta* or *Cryptostylis subulata* were recorded during this survey	Unlikely. No leaves of associated species including *Cryptostylis erecta* or *Cryptostylis subulata* were recorded during this survey.
Cynanchum elegans	White-flowered Wax Plant	E	E	31 records within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Occurs from Gerroa (Illawarra) to Brunswick Heads and west to Merriwa in the upper Hunter. Most common near Kempsey. Usually occurs on the edge of dry rainforest or littoral rainforest, but also occurs in Coastal Banksia Scrub, open forest and woodland, and Melaleuca scrub. Soil and geology types are not limiting.	Possible, but not recorded during this survey, despite targeted searches	Unlikely. Not recorded during this survey, despite targeted searches
Daphnandra johnsonii	Illawarra Socketwood	E	E	91 records within 10 km (OEH 2018a); Species or species' habitat likely to occur within 10 km (DEE 2018a)	Rainforest tree to 20 metres tall. Restricted to the Illawarra region where it has been recorded from the local government areas of Shoalhaven, Kiama, Shellharbour and Wollongong. Occupies the rocky hillsides and gullies of the Illawarra lowlands, occasionally extending onto the upper escarpment slopes.	Unlikely, no suitable habitat in proposal site	Nil
Eucalyptus macarthurii	Camden Woollybutt	E	E	Species or species' habitat may occur within 10 km (DEE 2018a)	Currently known between Moss Vale and Kanangra Boyd National Park. Occurs on grassy woodland on relatively fertile soils on broad cold flats.	Unlikely, no suitable habitat in proposal site	Nil
Genoplesium baueri	Bauer's Midge Orchid	E	E	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Occurs from Ulladulla to Port Stephens, with only 13 known extant populations. Grows in sparse sclerophyll forest and moss gardens over sandstone	Unlikely, no suitable habitat in proposal site	Nil
Gentiana wingecarribiensis	Wingecarribee Gentian	CE	E	Species or species' habitat may occur within 10 km (DEE 2018a)	Known only from Hanging Rock Swamp and Wingecarribee Swamp in the Southern Highlands. Grows in bogs, in Sphagnum Moss humps and in sedge communities.	Unlikely, no suitable habitat in proposal site	Nil

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Gossia acmenoides	Gossia acmenoides population in the Sydney Basin Bioregion south of the Georges River	EP		3 records within 10 km (OEH 2018a)	Known from Shellharbour, Wollongong and Kiama LGAs and encompasses all occurrences south of the Georges River. This population is the southern most 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.	Unlikely, no suitable habitat in proposal site	Nil
Grevillea rivularis	Carrington Falls Grevillea	CE	E	47 records within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Restricted to the Carrington Falls area on the upper Kangaroo River west of Kiama, within Budderoo National Park. Found mainly on moist creek-sides on sandstone in open heath or eucalypt woodland.	Unlikely, no suitable habitat in proposal site	Nil
Haloragis exalata subsp. exalata	Wingless Raspwort	V	V	Species or species' habitat known to occur within 10 km (DEE 2018a)	Occurs in 4 widely scattered localities in eastern NSW, in the central coast, south coast and north-western slopes. Requires protected and shaded damp situations in riparian habitats.	Unlikely, no suitable habitat in proposal site	Nil
Irenepharsus trypherus	Illawarra Irene	E	E	25 records within 10 km (OEH 2018a); Species or species' habitat likely to occur within 10 km (DEE 2018a)	Recorded from 18 sites within the Kiama, Shellharbour, Shoalhaven, Tallaganda, Wingecarribee and Wollongong LGAs. Typically occurs on steep rocky slopes near cliff lines and ridge tops. Associated vegetation includes moist sclerophyll forest, Grey Myrtle thicket and rainforest.	Unlikely, no suitable habitat in proposal site	Nil
Lespedeza juncea subsp. sericea	Lespedeza juncea subsp. sericea in the Wollongong Local Government Area	EP		7 records within 10 km (OEH 2018a)	Population occurs south of Dapto, disjunct from other (non-endangered) populations in Western Sydney, far South Coast and Southern Tablelands. Only known from one roadside population of approximately 200 plants, in open forest dominated by Forest Red Gum, Woollybutt and Melaleuca decora on Broughton Series sandstone.	Possible, but not recorded during this survey, despite targeted searches	Unlikely. Not recorded during this survey, despite targeted searches
Melaleuca biconvexa	Biconvex Paperbark	V	V	Species or species' habitat may occur within 10 km (DEE 2018a)	Scattered, disjunct populations in coastal areas from Jervis Bay to Port Macquarie, with most populations in the Gosford-Wyong areas. Grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects.	Unlikely, no suitable habitat in proposal site	Nil

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Pelargonium sp. Striatellum	Omeo Storksbill	E	E	Species or species' habitat may occur within 10 km (DEE 2018a)	Omeo Storksbill Pelargonium sp. (G.W. Carr 10345), syn. P. striatellum, is a tufted perennial forb known from only 3 locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. 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.	Unlikely, no suitable habitat in proposal site	Nil
Pimelea curviflora var. curviflora		V	V	14 records within 10 km (OEH 2018a)	Confined to area between north Sydney in the south and Maroota in the north-west. Former range extended to Parramatta River including Five Dock, Bellevue Hill and Manly. Grows on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands. Often grows amongst dense grasses and sedges. Flowers October to May.	Unlikely, no suitable habitat in proposal site	Nil
Pimelea spicata	Spiked Rice-flower	E	E	3 records within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Disjunct populations within the Cumberland Plain (from Mount Annan and Narellan Vale to Freemans Reach and Penrith to Georges Hall) and Illawarra (from Mt Warrigal to Gerroa) (DEC 2005). In the Cumberland Plain region, restricted to areas which support or historically supported Cumberland Plain Woodland. Grows on well-structured clay soils derived from Wianamatta Shale. In the Illawarra, grows on variable soils in close proximity to the coast on hills or coastal headlands. Inhabits coastal woodland or grassland with emergent shrubs (DEC 2005).	Possible, but not recorded during this survey, despite targeted searches	Unlikely. Not recorded during this survey, despite targeted searches
Pomaderris walshii	Carrington Falls Pomaderris	CE		51 records within 10 km (OEH 2018a)	Highly restricted distribution, known only from the upper catchment of the Kangaroo River near Robertson, above the Illawarra escarpment. It occurs as two small populations along a roughly 3 km riparian stretch, within habitats varying from shrubland to open grassy forest.	Unlikely, no suitable habitat in proposal site	Nil
Prasophyllum affine	Jervis Bay Leek-orchid	E	E	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Known from three areas south-east of Nowra on South Coast. These are Kinghorne Point, Wowly Gully near the town of Callala Bay, and near the township of Vincentia (OEH 2013). Grows on poorly drained clay soils that support low heathland and sedgeland communities.	Unlikely, no suitable habitat in proposal site	Nil

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Pterostylis gibbosa	Illawarra Greenhood	E	E	117 records within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Known from a small number of populations in the Illawarra, Nowra and Hunter regions. First collected in western Sydney. Only visible above the ground between late summer and spring, and only when soil moisture levels can sustain its growth. Grows in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by Forest Red Gum, Woollybutt and Melaleuca decora. Near Nowra, the species grows in an open forest of Spotted Gum, Forest Red Gum and Grey Ironbark. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark, Forest Red Gum and Black Cypress Pine.	Possible, would not be visible at the time of this survey	Low. Would not be visible at the time of this survey
Pterostylis pulchella	Waterfall Greenhood	V	V	1 record within 10 km (OEH 2018a); Species or species' habitat likely to occur within 10 km (DEE 2018a)	The Waterfall Greenhood is found only at Fitzroy Falls, Belmore Falls, upper Bundanoon Creek (Meryla) and Minnamurra Falls. The Waterfall Greenhood is found on cliff faces close to waterfalls and creek banks and mossy rocks alongside running water.	Unlikely, no suitable habitat in proposal site	Nil
Pterostylis saxicola	Sydney Plains Greenhood	E	E	Species or species' habitat may occur within 10 km (DEE 2018a)	Occurs in western Sydney between Picton and Freemans Reach. Grows in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. Associated vegetation above these rock shelves is sclerophyll forest or woodland on shale or shale/sandstone transition soils.	Unlikely, no suitable habitat in proposal site	Nil
Pultenaea aristata		V	V	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Restricted to the Woronora Plateau, a small area between Helensburgh, south of Sydney, and Mt Kiera above Wollongong (OEH 2012). Occurs in either dry sclerophyll woodland or wet heath on sandstone.	Unlikely, no suitable habitat in proposal site	Nil
Solanum celatum		E		335 records within 10 km (OEH 2018a)	Occurs from Wollongong to Nowra and inland to Bungonia. Grows in rainforest clearings, or in wet sclerophyll forests.	Possible, but not recorded during this survey, despite targeted searches	Unlikely. Not recorded during this survey, despite targeted searches
Syzygium paniculatum	Magenta Lilly Pilly		E	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Occurs in narrow coastal strip from Bulahdelah to Conjola State Forest. Grows in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas, often in remnant littoral or gallery rainforests.	Unlikely, no suitable habitat in proposal site	Nil
Thelymitra sp. Kangaloon	Kangaloon Sun Orchid	CE	CE	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Only known from three locations near Robertson in the Southern Highlands. Grows in seasonally swampy sedgeland on grey silty clay loam at 600–700 m above sea level. Flowers in late October and early November.	Unlikely, no suitable habitat in proposal site	Nil

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Thesium australe	Austral Toadflax	V	V	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Found in small, scattered populations along the east coast, northern and southern tablelands. Occurs in grassland or grassy woodland, and is often found in association with Kangaroo Grass.	Possible, but not recorded during this survey, despite targeted searches	Unlikely. Not recorded during this survey, despite targeted searches
Xerochrysum palustre	Swamp Everlasting		V	Species or species' habitat likely to occur within 10 km (DEE 2018a)	In New South Wales it occurs as far north as the Southern Tablelands and ranges up to about 1300 m altitude. Swamp Everlasting grows in wetlands including sedge-swamps and shallow freshwater marshes, often on heavy black clay soils. Reproduction appears to be largely vegetative via an extensive rhizome system.	Unlikely, no suitable habitat in proposal site	Nil
Zieria granulata	Illawarra Zieria	E	E	153 records within 10 km (OEH 2018a); Species or species' habitat likely to occur within 10 km (DEE 2018a)	A tall bushy shrub that grows to 6 m. Restricted to the Illawarra region where it is recorded from a number of sites. The species primarily occupies the coastal lowlands between Oak Flats and Toolijooa. The typical habitat is dry ridge tops and rocky outcrops on shallow volcanic soils, usually on Bumbo Latite. Less frequently found on the moist slopes of the Illawarra escarpment and in low-lying areas on Quaternary sediments.	Possible, but not recorded during this survey, despite targeted searches	Unlikely. Not recorded during this survey, despite targeted searches

Key: CE – critically endangered; E – endangered; V – vulnerable, X – extinct.

Likelihood of occurrence of threatened fauna species in the study area

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
BIRDS							
Anthochaera phrygia	Regent Honeyeater	CE	E	Species or species' habitat known to occur within 10 km (DEE 2018a)	In NSW confined to two known breeding areas: the Capertee Valley and Bundarra-Barraba region. Non-breeding flocks occasionally seen in coastal areas foraging in flowering Spotted Gum and Swamp Mahogany forests, presumably in response to drought. Inhabits dry open forest and woodlands, particularly Box-Ironbark woodland and riparian forests of River Sheoak, with an abundance of mature trees, high canopy cover and abundance of mistletoes.	Unlikely, no productive foraging forest is present in the proposal site	Very Low
Artamus cyanopterus	Dusky Woodswallow	V		14 records within 10 km (OEH 2018a)	The Dusky Woodswallow is widespread from the coast to inland, including the western slopes of the Great Dividing Range and farther west. It is often recorded in woodlands and dry open sclerophyll forests, and has also been recorded in shrublands, heathlands regenerating forests and very occasionally in moist forests or rainforests. The understorey is typically open with sparse eucalypt saplings, acacias and other shrubs, often with coarse woody debris. It is also recorded in farmland, usually at the edges of forest or woodland or in roadside remnants or wind breaks with dead timber. The nest is an open shallow untidy cup frequently built in an open hollow, crevice or stump. Although Dusky Woodswallows have large home ranges, individuals may spend most of their time in about a 2 ha range and defend an area about 50 m around the nest. Dusky Woodswallows prefer larger remnants over smaller remnants. Competitive exclusion by Noisy Miners (Manorina melanocephala) is a significant threat to this species.	Unlikely, patch size too small for this species	Very Low
Botaurus poiciloptilus	Australasian Bittern	E	E	1 record within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Widespread but uncommon over most NSW except the northwest. Favours permanent freshwater wetlands with tall dense reed beds particularly *Typha* spp. and *Eleocharis* spp., with adjacent shallow, open water for foraging. Roosts during the day amongst dense reeds or rushes and feeds mainly at night on frogs, fish, yabbies, spiders, insects and snails.	Unlikely, no reed like vegetation in wetlands present in the proposal site	Very Low

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Callocephalon fimbriatum	Gang-gang Cockatoo	V		37 records within 10 km (OEH 2018a)	Restricted to the south-eastern coast and highlands, from the lower Hunter and northern Blue Mountains to the South-western Slopes, south to and contiguous with the Victorian population. Inhabits eucalypt open forests and woodlands with an acacia understorey. In summer it lives in moist highland forest types, and in winter it moves to more open types at lower elevations. The Gang-Gang Cockatoo nests in hollows in the trunks, limbs or dead spouts of tall living trees, especially eucalypts, often near water. The Gang-gang Cockatoo feeds on seeds obtained in trees and shrubs, mostly from eucalypts and wattles.	Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. Limited number of hollows large enough to support breeding habitat for this species; which is more likely to breed up further north in Budderoo. Moderate number of records in locality	Low. Small area of limited potential foraging and marginal breeding habitat would be removed.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		1 record within 10 km, last recorded 1999 (OEH 2018a)	Widespread but uncommon from coast to southern tablelands and central western plains. Feeds almost exclusively on the seeds of Allocasuarina species. Prefers woodland and open forests, rarely away from Allocasuarina. Roost in leafy canopy trees, preferably eucalypts, usually <1 km from feeding site. Nests in large (approx. 20 cm) hollows in trees, stumps or limbs, usually in Eucalypts (Higgins 1999).	Unlikely, no stands of Allocasuarina present in proposal site	Very Low
Circus assimilis	Spotted Harrier	V		2 records within 10 km (OEH 2018a)	Occurs throughout Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Inhabits grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods). Most commonly in native grassland, but also in agricultural land, foraging over open habitats including edges of inland wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn).	Unlikely, although broadly suitable habitat is present in proposal site	Very Low
Daphoenositta chrysoptera	Varied Sittella	V		5 records within 10 km (OEH 2018a)	Sedentary, occurs across NSW from the coast to the far west. Inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Sensitive to habitat isolation and loss of structural complexity, and adversely affected by dominance of Noisy Miners. Cleared agricultural land is potentially a barrier to movement. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	Unlikely, no suitable habitat in proposal site	Very Low

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Dasyornis brachypterus	Eastern Bristlebird	E	E	6 records within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Occurs in three disjunct areas of south-eastern Australia: southern Queensland/northern NSW, the Illawarra Region and in the vicinity of the NSW/Victorian border. Illawarra population comprises an estimated 1600 birds, mainly from Barren Grounds Nature Reserve, Budderoo National Park and the Jervis Bay area. Habitat characterised by dense, low vegetation including heath and open woodland with a heathy understorey. The fire history of habitat is important, and the Illawarra and southern populations reach maximum densities in habitat that have not been burnt for over 15 years.	Nil	Nil
Haematopus longirostris	Pied Oystercatcher	E		2 records within 10 km (OEH 2018a)	Scattered along NSW coast. Favours intertidal flats of inlets and bays, open beaches and sandbanks. Forages on exposed sand, mud and rock at low tide. Nests mostly on coastal or estuarine beaches; occasionally saltmarsh or grassy areas.	Nil	Nil
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	C	15 records within 10 km (OEH 2018a)	Primarily coastal but may extend inland over major river systems. Breeds close to water, mainly in tall open forest/woodland but also in dense forest, rainforest, closed scrub or remnant trees. Usually forages over large expanses of open water, but also over open terrestrial habitats (e.g. grasslands).	Nil	Nil
Hieraaetus morphnoides	Little Eagle	V		5 records within 10 km (OEH 2018a)	Occurs throughout NSW except most densely forested parts of the Dividing Range escarpment. Occupies 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.	Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. No nests observed during survey. Low number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Lathamus discolor	Swift Parrot	E	E	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Migratory, travelling to the mainland from March to October. Breeds in Tasmania from September to January. On the mainland, it mostly occurs in the southeast foraging on winter flowering eucalypts and lerps, with records of the species between Adelaide and Brisbane. Principal over-winter habitat is box-ironbark communities on the inland slopes and plains. *Eucalyptus robusta*, *Corymbia maculata* and *C. gummifera* dominated coastal forests are also important habitat.	Unlikely, over-wintering habitat is absent in the proposal site	Very Low

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Lophoictinia isura	Square-tailed Kite	V		2 records within 10 km (OEH 2018a)	Occurs across NSW, resident in North, northeast and along west-flowing rivers. Summer breeding migrant to southeast of state. Inhabits a variety of habitats including woodlands and open forests, with preference for timbered watercourses. Favours productive forests on the coastal plain, box-ironbark-gum woodlands on the inland slopes, and Coolibah/River Red Gum on the inland plains. In Sydney area nests in mature living trees within 100 m of ephemeral/permanent watercourse. Large home range > 100 km^2.	Possible. No breeding habitat due to the absence of large watercourses. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. Low number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Neophema chrysogaster	Orange-bellied Parrot	CE	CE	Species or species' habitat may occur within 10 km (DEE 2018a)	Breeds in Tasmania and migrates in winter to SE South Australia and southern Victoria. There are occasional reports from NSW, including Shellharbour, Maroubra and the Shoalhaven. In winter, usually found within 3 km of the coast in saltmarsh and strandline/foredune vegetation. May also occur on golf courses and other grassy areas, including improved pasture.	Nil	Nil
Neophema pulchella	Turquoise Parrot	V		7 records within 10 km, last recorded 2006 (OEH 2018a)	Occurs from coast to inland slopes. In coastal area, most common between Hunter and Northern Rivers, and further south in S Coast. Inhabits open eucalypt woodlands and forests, typically with a grassy understorey. Favours edges of woodlands adjoining grasslands or timbered creek lines and ridges. Feeds on the seeds of native and introduced grasses and other herbs. Grasslands and open areas provide important foraging habitat for this species while woodlands provide important roosting and breeding habitat. Nests in tree hollows, logs or posts from August to December.	Unlikely, although broadly suitable habitat is present in proposal site	Very Low
Ninox strenua	Powerful Owl	V		6 records within 10 km (OEH 2018a)	Occurs from the coast to the western slopes. Solitary and sedentary species. Inhabits a range of habitats from woodland and open sclerophyll forest to tall open wet forest and rainforest. Prefers large tracts of vegetation. Nests in large tree hollows (> 0.5 m deep), in large eucalypts (dbh 80-240 cm) that are at least 150 years old. Pairs have high fidelity to a small number of hollow-bearing nest trees and defend a large home range of 400 - 1,450 ha. Forages within open and closed woodlands as well as open areas.	Unlikely, breeding habitat is absent and only limited foraging habitat is present	Very Low
Numenius madagascariensis	Eastern Curlew		CE,C,J,K	2 records within 10 km (OEH 2018a)	Within Australia, the species has a primarily coastal distribution. The species is found in all states, particularly the north, east, and south-east regions including Tasmania. Breeds in Russia and north-eastern China. Most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. The birds are often recorded among saltmarsh and on mudflats fringed by mangroves, and sometimes use the mangroves. The birds are also found in saltworks and sewage farms.	Nil	Nil

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Oxyura australis	Blue-billed Duck	V		39 records within 10 km (OEH 2018a)	Partly migratory, travels short distances between breeding swamps and over-wintering lakes. Young birds disperse in April-May from breeding swamps in inland NSW to Murray River system and coastal lakes. Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. Nests in Cumbungi over deep water or in trampled Lignum, sedges or spike-rushes. Completely aquatic, swimming along the edge of dense cover.	Unlikely, no dense aquatic vegetation present in proposal site	Very Low
Pachycephala olivacea	Olive Whistler	V		1 record within 10 km, last recorded 2001 (OEH 2018a)	Occurs along the ranges of the east coast as two disjunct populations; in the beech forests of Barrington Tops and Macpherson Ranges in the north, and from Illawarra to Victoria and inland to the Snowy Mountains and Brindabella Ranges in the south. Inhabits wet forests above 500 m asl, though may migrate to lower altitudes. Nests in the forks of shrubs and forage in trees/shrubs and on the ground for berries and insects.	Unlikely, no wet forest present in the proposal site	Very Low
Pandion cristatus	Eastern Osprey	V		27 records within 10 km (OEH 2018a)	Favours coastal areas, especially the mouths of large rivers, lagoons and lakes. They feed on fish over clear, open water. Breeding takes place from July to September in NSW, with nests being built high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea, though there are a handful of records from inland areas.	Unlikely, no large watercourses present in proposal site	Very Low
Petroica boodang	Scarlet Robin	V		8 records within 10 km (OEH 2018a)	In NSW occurs from coast to inland slopes. Breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within open understorey of shrubs and grasses and sometimes in open areas. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. Abundant logs and coarse woody debris are important habitat components.	Unlikely, logs and woody debris is sparse in proposal site	Very Low
Petroica phoenicea	Flame Robin	V		2 records within 10 km (OEH 2018a)	Breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. Migrates in winter to more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains. Forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris. Fallen logs and coarse woody debris are important habitat components. Open cup nest of plant fibres and cobweb is often built near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank.	Unlikely, logs and woody debris is sparse in proposal site	Very Low
Pezoporus wallicus wallicus	Eastern Ground Parrot	V		4 records within 10 km (OEH 2018a)	Occurs in high rainfall coastal and near coastal low heathlands and sedgelands, generally below one metre in height and very dense (up to 90% projected foliage cover). Ground Parrots can re-colonise burnt habitat after 1-2 years and reach maximum densities after 15-20 years without fire. Home ranges of adult birds is typically 10 ha and overlapping with other birds, while juveniles have a significantly larger home range. Ground Parrots feed mostly on seeds from a large range of plant species, which varies seasonally. eggs are laid in a shallow bowl of fine sticks and grass, well hidden under overhanging tall, coarse grass, sedge or low, heathy shrubs.	Nil	Nil

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Rostratula australis	Australian Painted Snipe	E	E	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Normally found in permanent or ephemeral shallow inland wetlands, either freshwater or brackish. Nests on the ground amongst tall reed-like vegetation near water. Feeds on mudflats and the water's edge taking insects, worm and seeds. Prefers fringes of swamps, dams and nearby marshy areas with cover of grasses, lignum, low scrub or open timber.	Nil	Nil
Stictonetta naevosa	Freckled Duck	V		37 records within 10 km (OEH 2018a)	Breeds in large, ephemeral swamps in the Murray-Darling, particularly along the Paroo and Lachlan Rivers and other Riverina rivers. In drier times moves to more permanent waters. Disperses during extensive inland droughts and may be found in coastal areas during such times. Prefers freshwater swamps/creeks with dense Cumbungi, Lignum or tea-tree. Nests in dense vegetation at or near water level.	Nil	Nil
Tyto novaehollandiae	Masked Owl	V		1 record within 10 km, last recorded 2002 (OEH 2018a)	Occurs across NSW except NW corner. Most common on the coast. Inhabits dry eucalypt woodlands from sea level to 1100 m. Roosts and breeds in large (>40 cm) hollows and sometime caves in moist eucalypt forested gullies. Hunts along the edges of forests and roadsides. Home range between 500 ha and 1000 ha. Prey mostly terrestrial mammals but arboreal species may also be taken.	Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. No breeding habitat is present. Low number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Tyto tenebricosa	Sooty Owl	V		10 records within 10 km (OEH 2018a)	Occurs in the coastal, escarpment and tablelands regions of NSW. More common in the north and absent from the western tablelands and further west. Inhabits tall, moist eucalypt forests and rainforests, and are strongly associated with sheltered gullies, particularly those with tall rainforest understorey. Roosts in tree hollows, amongst dense foliage in gullies or in caves, recesses or ledges of cliffs or banks. Nest in large (>40 cm wide, 100 cm deep) tree hollows in unlogged/unburnt gullies within 100 m of streams or in caves.	Unlikely, no reed like vegetation in wetlands present in the proposal site	Very Low
FISH							
Epinephelus daemelii	Black Rockcod	V (FM Act)	V	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Found in warm temperate/sub-tropical parts of south-western Pacific. Naturally occur along NSW Coast incl. Lord Howe Island. Adults generally found on rocky reefs. Juveniles found in coastal rock pools and around rocky shores in estuaries. (DPI 2013).	Nil	Nil
Macquaria australasica	Macquarie Perch	E (FM Act)	E	Species or species' habitat may occur within 10 km (DEE 2018a)	Occurs in the upper reaches of the Lachlan, Murrumbidgee and Murray Rivers, and in parts of the Hawkesbury and Shoalhaven catchment areas. Inhabits river and lake habitats, especially the upper reaches of rivers and their tributaries. Requires clear water with deep, rocky holes and abundant cover (including aquatic vegetation, woody debris, large boulders and overhanging banks). Spawning occurs in spring and summer in shallow upland streams or flowing sections of river systems.	Nil	Nil

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Prototroctes maraena	Australian Grayling		V	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Occurs in coastal rivers and streams south from the Shoalhaven River. Inhabits estuarine waters and coastal seas as larvae/juveniles, and freshwater rivers and streams as adults. Most of their lives are spent in freshwater rivers and streams in cool, clear waters with a gravel substrate and alternating pool and riffle zones, however can also occur in turbid water. The species can penetrate well inland, being recorded over 100 km inland from the sea. (Backhouse et al 2008).	Nil	Nil
FROGS							
Heleioporus australiacus	Giant Burrowing Frog	V	V	6 records within 10 km, last recorded 2005 (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Occurs along the coast and eastern slopes of the Great Dividing Range south from Wollemi National Park. Appears to exist as two populations with a 100 km gap in records between Jervis Bay and Eden. Northern population occurs on sandy soils supporting heath, woodland or open forest. Breeds in ephemeral to intermittent streams with persistent pools. Only infrequently moves to breeding sites, most commonly found on ridges away from creeks, several hundred metres from water.	Nil	Nil
Litoria aurea	Green and Golden Bell Frog	E	V	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Formerly occurred from Brunswick Heads to Victoria, but >80% populations now extinct. Inhabits marshes, natural and artificial freshwater to brackish wetlands, dams and in stream wetlands. Prefers sites containing cumbungi (*Typha* spp.) or spike rushes (Eleocharis spp.), which are unshaded and have a grassy area and/or rubble as shelter/refuge habitat nearby. *Gambusia holbrooki* is a key threat as they feed on green and Golden Bell Frog eggs and tadpoles.	Unlikely, wetland with emergent aquatic vegetation is absent from the proposal site	Very Low
Litoria littlejohni	Littlejohn's Tree Frog	V	V	1 record within 10 km (OEH 2018a); Species or species' habitat likely to occur within 10 km (DEE 2018a)	Occurs on plateaus and eastern slopes of the Great Dividing Range south from Watagan State Forest. Occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops, hunting either in shrubs or on the ground.	Unlikely, no rocky streams present in the proposal site	Very Low
Mixophyes balbus	Stuttering Frog	E	V	11 records within 10 km (OEH 2018a); Species or species' habitat likely to occur within 10 km (DEE 2018a)	Occurs along the east coast of Australia. Has undergone a massive range reduction particularly in the south of its range: within the Sydney Basin, White (2008a) located only 3 populations south of Sydney (Macquarie Pass and Mt Werong) and Daly et al. (2002, in White 2008a) found only 2 extant populations between Macquarie Pass and Victoria. Inhabits rainforest and wet, tall, open forest. Shelter in deep leaf litter and thick understorey vegetation on the forest floor. Feeds on insects and smaller frogs, breeding in streams during summer after heavy rain. The species does not occur in areas where the riparian vegetation has been disturbed or where there have been significant upstream human impacts (Mahony et al 1997).	Unlikely, no rainforest habitat present on the proposal site	Very Low

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Pseudophryne australis	Red-crowned Toadlet	V		4 records within 10 km (OEH 2018a)	Restricted to Sydney Basin, from Nowra to Pokolbin and west to Mt Victoria. Inhabits heathland and open woodland on Hawkesbury and Narrabeen Sandstones, within 100 m of ridgelines. Breeds in ephemeral feeder creeks or flooded depressions, requiring unpolluted water between 5.5 and 6.5 pH. Shelters under rocks, amongst masses of dense vegetation or leaf litter. Populations restricted to immediate vicinity of breeding areas.	Unlikely, no sandstone habitat present in the proposal site	Very Low
MAMMALS							
Cercartetus nanus	Eastern Pygmy-possum	V		3 records within 10 km (OEH 2018a)	Occurs along the east coast of NSW, and inland to the Pillaga, Dubbo, Parkes and Wagga Wagga. Inhabits range of habitats from coastal heath and woodland though open and closed forests, subalpine heath and rainforest (Tulloch and Dickman 1995). Inhabits rainforest, sclerophyll forests and heath. Banksia spp. and myrtaceous shrubs and trees are favoured food sources and nesting subject sites in drier habitats. Diet mostly pollen and nectar from *Banksia* spp., *Eucalyptus* spp., *Callistemon* spp. and insects (Ward and Turner 2008). Nests in hollows in trees, under the bark of Eucalypts, forks of tea-trees, abandoned bird nests and Xanthorrhoea bases (Ward and Turner 2008, Tulloch and Dickman 2006).	Nil	Nil
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	7 records within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Occurs from the coast to the western slopes of the divide. Largest numbers of records from sandstone escarpment country in the Sydney Basin and Hunter Valley (Hoye and Schulz 2008). Roosts in caves and mines and most commonly recorded from dry sclerophyll forests and woodlands. An insectivorous species that flies over the canopy or along creek beds (Churchill 2008). In southern Sydney appears to be largely restricted to the interface between sandstone escarpments and fertile valleys.	Possible. Restricted to sandstone escarpment country and adjacent habitats. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. No breeding habitat is present. Low number of local records.	Low. Small area of limited potential foraging habitat would be removed.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Dasyurus maculatus	Spotted-tailed Quoll	V	E	18 records within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. Females occupy home ranges of up to 750 ha and males up to 3,500 ha, usually traversed along densely vegetated creek lines.	Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. May be attracted by chickens present in the study area. No breeding habitat is present. Moderate number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		9 records within 10 km (OEH 2018a)	Occurs on southeast coast and ranges. Prefers tall (>20 m) and wet forest with dense understorey. Absent from small remnants, preferring continuous forest but can move through cleared landscapes and may forage in open areas. Roosts in hollow trunks of Eucalypts, underneath bark or in buildings. Forages in gaps and spaces within forest, with large foraging range (12 km foraging movements recorded) (Churchill 2008, Law et al 2008).	Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. Breeding and roosting habitat present in hollow-bearing trees. Low number of local records.	Moderate. Small area of limited potential foraging habitat would be removed. Potential breeding habitat would also be removed.
Isoodon obesulus	Southern Brown Bandicoot (eastern)	E	E	3 records within 10 km, last recorded 1999 (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Occurs mainly in 2 areas: Ku-ring-gai Chase and Garigal National Parks N of Sydney, and far SE NSW including Ben Boyd National Park, East Boyd State Forest, Nadgee Nature Reserve, Nadgee State Forest, South East Forest and Yambulla State Forest but also occurs between these areas. Inhabits scrubby vegetation, including heath, shrubland, and heathy forest and woodland. Often associated with well-drained soils and dry heathland communities, and prefers periodically burnt areas as this increases insect abundance.	Unlikely, dry heathland communities are absent from the proposal site.	Very Low

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Miniopterus australis	Little Bentwing-bat	V		19 records within 10 km (OEH 2018a)	Occurs from Cape York to Sydney. Inhabits rainforests, wet and dry sclerophyll forests, paperbark swamps and vine thickets. Only one maternity cave known in NSW, shared with Eastern Bentwing-bats at Willi Willi, near Kempsey. Outside breeding season roosts in caves, tunnels and mines and has been recorded in a tree hollow on one occasion. Forages for insects beneath the canopy of well-timbered habitats (Churchill 2008, Hoye and Hall 2008).	Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. No breeding and roosting habitat present. Moderate number of local records	Low. Small area of limited potential foraging habitat would be removed.
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		31 records within 10 km (OEH 2018a)	Generally occurs east of the Great Dividing Range along NSW coast (Churchill 2008). Inhabits various habitats from open grasslands to woodlands, wet and dry sclerophyll forests and rainforest. Essentially a cave bat but may also roost in road culverts, stormwater tunnels and other man-made structures. Only 4 known maternity caves in NSW, near Wee Jasper, Bungonia, Kempsey and Texas. Females may travel hundreds of kilometres to the nearest maternal colony (Churchill 2008).	Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. No breeding and roosting habitat present. Moderate number of local records.	Low. Small area of limited potential foraging habitat would be removed.
Mormopterus norfolkensis	Eastern Freetail-bat	V		18 records within 10 km (OEH 2018a)	Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Forages in natural and artificial openings in vegetation, typically within a few kilometres of its roost. Roosts primarily in tree hollows but also recorded from man-made structures or under bark (Churchill 2008).	Present. From fixed recordings from Anabat at dam and also in treed vegetation in the north of the site. Likely to forage, roost and breed in Forest Red Gum - Thin-leaved Stringybark grassy woodland. Moderate number of local records.	Moderate. Removal of a small area of foraging habitat. Removal of potential breeding and roosting habitat.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Myotis macropus	Southern Myotis	V		2 records within 10 km (OEH 2018a)	Mainly coastal but may occur inland along large river systems. Usually associated with permanent waterways at low elevations in flat/undulating country, usually in vegetated areas. Forages over streams and watercourses feeding on fish and insects from the water surface. Roosts in a variety of habitats including caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage, typically in close proximity to water (Campbell 2011). Breeds November or December (Churchill 2008).	Unlikely, broadly suitable foraging habitat in dams	Very Low
Petauroides volans	Greater Glider		V	34 records within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	The greater glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria (Wombat State Forest), with an elevation range from sea level to 1200 m above sea level. It prefers taller montane, moist eucalypt forest with relatively old trees and abundant hollows.	Unlikely , taller montane forest is absent from the proposal site	Very Low
Petaurus norfolcensis	Squirrel Glider	V		1 record within 10 km, last recorded 1999 (OEH 2018a)	Occurs along the drier inland slopes as well as coastal habitats. Inhabits woodland and open forest with a Eucalyptus, Corymbia or Angophora overstorey and a shrubby understorey of Acacia or Banksia. Key habitat components include reliable winter and early-spring flowering Eucalypts, Banksia or other nectar sources, and hollow-bearing trees for roost and nest sites (van der Ree and Suckling 2008, Quin et al 2004), with social groups moving between multiple hollows. Social groups include one or two adult males and females with offspring, and have home ranges of 5-10ha within NSW (van der Ree and Suckling 2008, Kavanagh 2004).	Unlikely, shrubby understorey absent from the proposal site	Very Low
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Occurs from the Shoalhaven north to the Queensland border. Now mostly extinct west of the Great Dividing Range, except in the Warrumbungles and Mt Kaputar. Occurs on rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Diet consists of vegetation in adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.	Nil	Nil
Phascogale tapoatafa	Brush-tailed Phascogale	V		1 record within 10 km (OEH 2018a)	Predominately east of the Great Dividing Range, occasional records to the west. Prefers open forest with sparse groundcover but occurs in habitats ranging from mallees to rainforest. Home ranges span 20-40 ha (females) and >100 ha (males) though may be smaller in optimal habitats. Male ranges overlap with females and other males. May use up to 40 nests/ year in hollow trees, rotted stumps, buildings or bird nests. When breeding females prefer to nest in large tree cavities with small entrances. Forages preferentially in rough barked trees, large logs and dead standing trees (Soderquist and Rhind 2008).	Unlikely, although broadly suitable habitat present in proposal site	Very Low

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Phascolarctos cinereus	Koala	V	V	25 records within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Occurs from coast to inland slopes and plains. Restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from < 2 to several hundred hectares.	Unlikely, although broadly suitable habitat and feed trees present in proposal site	Very Low
Potorous tridactylus	Long-nosed Potoroo	V	V	43 records within 10 km (OEH 2018a); Species or species' habitat known to occur within 10 km (DEE 2018a)	Restricted to east of the Great Dividing Range, with annual rainfall >760 mm. Inhabits coastal heath and dry and wet sclerophyll forests. Requires relatively thick ground cover and appears restricted to areas of light and sandy soil (Johnston 2008). Feeds on fungi, roots, tubers, insects and their larvae, and other soft-bodied animals in the soil.	Nil	Nil
Pseudomys novaehollandiae	New Holland Mouse		V	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Occurs in disjunct, coastal populations from Tasmania to Queensland. In NSW inhabits a variety of coastal habitats including heathland, woodland, dry sclerophyll forest with a dense shrub layer and vegetated sand dunes (Wilson and Bradtke 1999). Populations may recolonise/ increase in size in regenerating native vegetation after wildfire, clearing and sandmining. Presence strongly correlated with understorey vegetation density, and high floristic diversity in regenerating heath (Lock and Wilson 1999).	Nil	Nil
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	17 records within 10 km (OEH 2018a); Foraging, feeding or related behaviour known to occur within 10 km (DEE 2018a)	Roosts in camps within 20 km of a regular food source, typically in gullies, close to water and in vegetation with a dense canopy. Forages in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths, swamps and street trees, particularly in eucalypts, melaleucas and banksias. Highly mobile with movements largely determined by food availability (Eby and Law 2008). Will also forage in urban gardens and cultivated fruit crops.	Present. Observed foraging adjacent to the study area in the west. Likely to forage in the canopy of Forest Red Gum - Thin-leaved Stringybark grassy woodland. No roost camps observed. Moderate number of local records.	Moderate. Removal of a small area of foraging habitat.

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		8 records within 10 km (OEH 2018a)	Migrates from tropics to SE Aus in summer. Forages across a range of habitats including those with and without trees, from wet and dry sclerophyll forest, open woodland, Acacia shrubland, mallee, grasslands and desert. Roosts communally in large tree hollows and buildings (Churchill 2008).	Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. Breeding and roosting habitat present in hollow-bearing trees. Low number of local records.	Moderate. Small area of limited potential foraging habitat would be removed. Breeding habitat would also be removed.
Scoteanax rueppellii	Greater Broad-nosed Bat	V		13 records within 10 km (OEH 2018a)	Occurs on the east coast and Great Dividing Range. Inhabits a variety of habitats from woodland to wet and dry sclerophyll forests and rainforest, also remnant paddock trees and timber-lined creeks, typically below 500 m asl. Forages in relatively uncluttered areas, using natural or man-made openings in denser habitats. Usually roosts in tree hollows or fissures but also under exfoliating bark or in the roofs of old buildings. Females congregate in maternal roosts in suitable hollow trees (Hoye and Richards 2008, Churchill 2008).	Possible. Limited foraging resources present in eucalypts within Forest Red Gum - Thin-leaved Stringybark grassy woodland. Breeding and roosting habitat present in hollow-bearing trees. Low number of local records.	Moderate. Small area of limited potential foraging habitat would be removed. Breeding habitat would also be removed.
REPTILES							
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Species or species' habitat likely to occur within 10 km (DEE 2018a)	Nocturnal, sheltering in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter, and spring, moving to shelters in hollows of large trees within 200 m of escarpments in summer. Feeds mostly on geckos and small skinks, and occasionally on frogs and small mammals.	Nil	Nil

Key: CE – critically endangered; E – endangered; V – vulnerable, X – extinct.

Likelihood of occurrence of migratory fauna species in the study area

Scientific name	Common name	TSC Status	EPBC Status	Source	Habitat association	Likelihood of occurrence	Likelihood of impact
Cuculus optatus	Oriental Cuckoo		C,J,K	Species or species' habitat may occur within 10 km (DEE 2018a)	This species migrates to northern and eastern Australia in the warmer months. Occurs south to the Shoalhaven area. Occurs in a range of habitats, including monsoon forest, rainforest edges, leafy trees in paddocks, river flats, roadsides and mangroves.	Possible	Very low
Hirundapus caudacutus	White-throated Needletail			Species or species' habitat known to occur within 10 km (DEE 2018a)	Recorded along NSW coast to the western slopes and occasionally from the inland plains. Breeds in northern hemisphere. Almost exclusively aerial while in Australia. Occur above most habitat types, but are more frequently recorded above more densely vegetated habitats (rainforest, open forest and heathland) than over woodland or treeless areas.	Possible	Very low
Monarcha melanopsis	Black-faced Monarch			Species or species' habitat known to occur within 10 km (DEE 2018a)	Found along the coast of eastern Australia, becoming less common further south. Found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. Resident in the north of its range, but is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March. It may also migrate to Papua New Guinea in autumn and winter.	Possible	Very low
Motacilla flava	Yellow Wagtail		C,J,K	Species or species' habitat may occur within 10 km (DEE 2018a)	This species breeds in temperate Europe and Asia. They occur within Australia in open country habitat with disturbed ground and some water. Recorded in short grass and bare ground, swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land and town lawns.	Unlikely	Very low
Myiagra cyanoleuca	Satin Flycatcher			Species or species' habitat known to occur within 10 km (DEE 2018a)	In NSW widespread on and east of the Great Divide, sparsely scattered on the western slopes, very occasional records on the western plains. Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, often near wetlands and watercourses. On migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. Generally not in rainforests.	Possible	Very low
Rhipidura rufifrons	Rufous Fantail			Species or species' habitat known to occur within 10 km (DEE 2018a)	Found along NSW coast and ranges. Inhabits rainforest, dense wet forests, swamp woodlands and mangroves. During migration, it may be found in more open habitats or urban areas (Birds Australia 2008).	Possible	Very low
Symposiachrus trivirgatus	Spectacled Monarch			Species or species' habitat known to occur within 10 km (DEE 2018a)	The Spectacled Monarch is found in coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. It is much less common in the south. Prefers thick understorey in rainforest, wet gullies and waterside vegetation as well as mangroves.	Possible	Very low

Key: C- Migratory Bird Agreement between China and Australia, J- Migratory Bird Agreement between Japan and Australia, K- Migratory Bird Agreement between Korea and Australia,

Appendix B – Survey results

Flora species recorded in plot/transects during surveys

Family	Scientific Name	Common Name	Exotic	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance	Plot 3 Cover	Plot 3 Abundance
Acanthaceae	*Brunoniella australis*	Blue Trumpet				0.2	40		
Amaranthaceae	*Nyssanthes diffusa*	Barbwire Weed				5	100		
Apiaceae	*Centella asiatica*	Indian Pennywort		0.3	100			1	40
Apocynaceae	*Araujia sericifera*	Moth Vine	*	0.2	5			0.2	10
Apocynaceae	*Gomphocarpus physocarpus*	Balloon Cotton Bush	*			0.1	10		
Apocynaceae	*Marsdenia rostrata*	Milk Vine				0.2	5		
Apocynaceae	*Tylophora barbata*	Bearded Tylophora				0.3	20		
Asteraceae	*Bidens pilosa*	Cobbler's Pegs		0.2	100				
Asteraceae	*Bidens pilosa*	Cobbler's Pegs	*			0.1	20	0.1	20
Asteraceae	*Cirsium vulgare*	Spear Thistle	*	0.2	30				
Asteraceae	*Conyza sumatrensis*	Tall fleabane	*			0.2	25	0.2	20
Asteraceae	*Euchiton sphaericus*	Star Cudweed		0.1	20				
Asteraceae	*Senecio madagascariensis*	Fireweed	*			0.2	20		
Asteraceae	*Sigesbeckia orientalis subsp. orientalis*	Indian Weed		0.2	20	0.2	20		
Chenopodiaceae	*Einadia hastata*	Berry Saltbush		0.2	20	4	100	0.4	20
Commelinaceae	*Commelina cyanea*	Native Wandering Jew		0.2	20				
Convolvulaceae	*Dichondra repens*	Kidney Weed		2	100	0.4	100		
Cyperaceae	*Carex longebrachiata*			3	50				
Cyperaceae	*Cyperus laevis*			0.1	20	0.1	20	0.2	20
Euphorbiaceae	*Euphorbia peplus*	Petty Spurge	*	0.1	30				
Fabaceae (Faboideae)	*Glycine clandestina*	Twining glycine		0.5	20	0.2	50	1	20
Fabaceae (Faboideae)	*Glycine tabacina*	Variable Glycine		0.2	20			0.4	20
Geraniaceae	*Pelargonium inodorum*			0.1	5				
Juncaceae	*Juncus usitatus*			0.1	20				
Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily		0.1	5	0.2	12		
Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	*	0.5	50	1	30	1	50
Meliaceae	*Melia azedarach*	White Cedar				0.2	1		
Myrtaceae	*Angophora floribunda*	Rough-barked Apple		5	1	8	1		

Family	Scientific Name	Common Name	Exotic	Plot 1 Cover	Plot 1 Abundance	Plot 2 Cover	Plot 2 Abundance	Plot 3 Cover	Plot 3 Abundance
Myrtaceae	*Eucalyptus bosistoana*	Coast Grey Box		8	3	10	1		
Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum		22	10			12	3
Oxalidaceae	*Oxalis perennans*			0.1	10	0.2	100	1	30
Phormiaceae	*Dianella longifolia*	Blueberry Lily		1	6				
Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues	*	1	50	1	200	0.3	30
Plantaginaceae	*Veronica plebeia*	Trailing Speedwell		0.1	10				
Poaceae	*Cenchrus clandestinus*	Kikuyu	*	4	1000				
Poaceae	*Cynodon dactylon*	Common Couch						12	1000
Poaceae	*Echinopogon ovatus*	Forest Hedgehog Grass		0.3	100			2	1000
Poaceae	*Eragrostis brownii*	Brown's Lovegrass						4	500
Poaceae	*Microlaena stipoides*	Weeping Grass		35	2000	5	1000	25	1000
Poaceae	*Oplismenus aemulus*	0				1	1000		
Poaceae	*Paspalum dilatatum*	Paspalum	*	0.2	20	1	500	1	500
Poaceae	*Cenchrus clandestinus*					5	1000	12	500
Poaceae	*Setaria viridis*	Green Pigeon Grass	*					2	1000
Poaceae	*Sporobolus africanus*	Parramatta Grass	*					0.2	200
Poaceae	*Sporobolus elongatus*	Slender Rat's Tail Grass		0.2	50	3	1000	2	500
Rosaceae	*Rubus anglocandicans*	Blackberry	*	0.1	5			1	12
Rosaceae	*Rubus parvifolius*	Native Raspberry				1	30		
Rutaceae	*Melicope micrococca*	Hairy-leaved Doughwood				5	3		
Verbenaceae	*Lantana camara*	Lantana	*	0.4	10	1	10	2	10
Verbenaceae	*Verbena bonariensis*	Purpletop	*					0.5	50
Violaceae	*Melicytus dentatus*	Tree Violet		1	4	0.2	1		
Vitaceae	*Cayratia clematidea*	Native Grape		0.1	5				

Vegetation integrity survey plots

PCT ID	Plot	Tree richness	Shrub richness	Grass and grass-like richness	Forb richness	Fern richness	Other richness	Tree cover	Shrub cover	Grass and grass-like cover	Forb cover	Fern cover	Other cover	Litter cover	Total length of fallen logs	Number of large trees (threshold >50cm dbh)
838	**Benchmark**	**4**	**6**	**11**	**14**	**2**	**5**	**34**	**17**	**61**	**9**	**1**	**4**	**50**	**40**	**3**
	1	1	0	6	3	0	2	12	0	45.2	2.4	0	1.4	50.0	0.0	2
	2	3	3	4	6	0	4	18.2	6.2	9.1	10.0	0.0	0.9	26.0	1.5	3
	3	1	0	6	3	0	2	12.0	0.0	45.2	2.4	0.0	1.4	31.0	0.0	1

Key:

Composition- A count of native plant species richness within each growth form group

Structure- Foliage cover (%) for each growth form group

Fauna species recorded during surveys

Common Name	Scientific Name	TSC Status	EPBC Status	Observation Type
BIRDS				
Australian King-parrot	*Alisterus scapularis*			o
Australian Magpie	*Cracticus tibicen*			o
Australian Raven	*Corvus coronoides*			o
Australian Wood Duck	*Chenonetta jubata*			o
Bell Miner	*Manorina melanophrys*			o
Cattle Egret	*Ardea ibis*			o
Common Bronzewing	*Phaps chalcoptera*			o
Common Myna	*Sturnus tristis*			o
Crested Pigeon	*Ocyphaps lophotes*			o
Crimson Rosella	*Platycercus elegans*			o
Domestic Goose	*Anser sp.*			o
Eastern Rosella	*Platycercus eximius*			o
Galah	*Eolophus roseicapillus*			o
Grey Butcherbird	*Cracticus torquatus*			o
Lewin's Honeyeater	*Meliphaga lewinii*			o
Little Corella	*Cacatua sanguinea*			o

Common Name	Scientific Name	TSC Status	EPBC Status	Observation Type
Little Pied Cormorant	*Microcarbo melanoleucos*			o
Magpie-lark	*Grallina cyanoleuca*			o
Masked Lapwing	*Vanellus miles*			o
Mistletoebird	*Dicaeum hirundinaceum*			o
Noisy Miner	*Manorina melanocephala*			o
Pacific Baza	*Aviceda subcristata*			o
Pacific Black Duck	*Anas superciliosa*			o
Rainbow Lorikeet	*Trichoglossus haematodus*			o
Red-browed Finch	*Neochmia temporalis*			o
Spotted Pardalote	*Pardalotus punctatus*			o
Straw-necked Ibis	*Threskiornis spinicollis*			o
Sulphur-crested Cockatoo	*Cacatua galerita*			o
Welcome swallow	*Hirundo neoxena*			o
White-faced Heron	*Egretta novaehollandiae*			o
White-necked Heron	*Ardea pacifica*			o
Willie wagtail	*Rhipidura leucophrys*			o
Yellow-tailed Black-cockatoo	*Calyptorhynchus funereus*			o
FROGS				
Bibron's Toadlet	*Pseudophryne bibronii*			o
Common Eastern Froglet	*Crinia signifera*			w
Eastern Dwarf Tree Frog	*Litoria fallax*			o
Verreaux's Frog	*Litoria verreauxii*			o
Garden Snail	*Cantareus aspersa*			o
MAMMALS				
Brown Hare	*Lepus capensis*			o
Common Brushtail Possum	*Trichosurus vulpecula*			o
Common Ringtail Possum	*Pseudocheirus peregrinus*			o
Eastern Freetail-bat	*Mormopterus norfolkensis*	V		u (PR)
Eastern Grey Kangaroo	*Macropus giganteus*			p
Fox	*Vulpes vulpes*			o
Gould's Wattled Bat	*Chalinolobus gouldii*			u

Common Name	Scientific Name	TSC Status	EPBC Status	Observation Type
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V	w
Rabbit	*Oryctolagus cuniculus*			p
Sugar Glider	*Petaurus breviceps*			o
Unidentified Deer	*Cervus* sp.			p
REPTILES				
Dark-flecked Garden Sunskink	*Lampropholis delicata*			o

Key: E – endangered, V – vulnerable, O- Observed, W- Heard call, U (Pr)- Ultrasonic recording (Probable call), P- Scat

Hollow-bearing trees recorded within the study area

Species	Height (m)	Diameter Breast Height (DBH)	No trunk hollows average diameter (cm)	No limb hollows average diameter (cm)	Evidence of usage	Crown dieback	Comments	Easting	Northing
White-topped Box (*Eucalyptus quadrangulata*)	15	85	2/10cm	-	yes	yes		293263	6172503
Rough-barked Apple (*Angophora floribunda*)	12	100				yes	flaky bark, fissures and insect holes	293003	6172675
Coast Grey Box (*Eucalyptus bosistoana*)	25	120	4/20cm	3/20cm				293002	6172687
Coast Grey Box (*Eucalyptus bosistoana*)	25	110	3/15cm	4/2@5cm; 2@15cm				292993	6172757
Coast Grey Box (*Eucalyptus bosistoana*)	22	90	-	2/7cm				293010	6172781
Coast Grey Box (*Eucalyptus bosistoana*)	22	120	2/40cm				spout in tree truck	293011	6172801
Coast Grey Box (*Eucalyptus bosistoana*)	30	120	2/20cm	7/15cm	yes	yes	some well used with scent markings – gliders/possums	293071	6172874
Forest Oak (*Allocasuarina torulosa*)	6 m	40	2/10cm	-		yes	chimney – Bats?	293101	6172869
Coast Grey Box (*Eucalyptus bosistoana*)	30	120	-	3/5cm			small stag adjacent with chimney	293132	6172847
Rough-barked Apple (*Angophora floribunda*)	23	100	3/2@15; 1@35	10/10	yes - well used – rainbow lorikeet nest and sugar glider den	yes	Stag watch – emerging Sugar gliders Tree 5 – as tagged	293192	6172799
Coast Grey Box (*Eucalyptus bosistoana*)	23	60	1/15cm	3/10cm		yes		293088	6172800
Coast Grey Box (*Eucalyptus bosistoana*)	25	85	2/30cm	6/15cm		yes		293081	6172807
Forest Red Gum (*Eucalyptus tereticornis*)	15	70	1/8cm	1/5cm	yes	yes		293221	6172788
Forest Oak (*Allocasuarina torulosa*)	6	40	1/20cm	-				293203	6172743
Rough-barked Apple (*Angophora floribunda*)	15	60	-	4/10cm		yes	*Parsonsia* spp. vines all over	292923	6172649

Appendix C – Assessments of Significance

Legislative requirement

The likely significance of impacts on threatened species, populations and ecological communities, or their habitat known or considered likely to occur and be affected by the proposal has been assessed pursuant to Section 5A of the EPA Act (the 7-part test) and/or with reference to the *Matters of National Environmental Significance –Assessment of significance guidelines* (DotE 2013).

The '7 part test' is used to determine whether an activity is 'likely' to impose 'a significant effect' on threatened biota and thus whether a species impact statement (SIS) is required. Should the 7 part test conclude that a significant effect is likely, then an SIS must be prepared.

A 7-part test has been provided for the following threatened ecological communities, populations and biota listed under the TSC Act which have the potential to be impacted by the proposal:

Threatened Ecological Communities

Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion

Threatened flora species

Thick Lip Spider Orchid (*Caladenia tessellata*)

Illawarra Greenhood (*Pterostylis gibbosa*)

Threatened fauna species

Microchiropteran bats: Eastern Freetail Bat (*Mormopterus norfolkensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)

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

Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion

Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion is listed as an endangered ecological community under the BC Act and an CEEC under the EPBC Acts.

The proposal would remove up to 1.54 ha of mapped Illawarra Lowlands Grassy Woodland in the Sydney Basin Bioregion in the proposal site (Figure 4). Much of the vegetation exists in a modified and degraded state through recent clearing and grazing.

Illawarra Lowlands Grassy Woodland
a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.
Not applicable to this TEC.
b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.
Not applicable to this threatened ecological community.
c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
The proposal would require the removal and/or modification of up to 1.93 hectares of degraded Illawarra Lowlands Grassy Woodland (ILGW) within the proposal site, in the north of the site in three discrete patches.

Illawarra Lowlands Grassy Woodland
The ILGW in the proposal site has been substantially modified by the clearing of canopy, slashing of mid storey and ground cover vegetation and current grazing practices. It comprises scattered native canopy trees, a sparse midstorey and a grazed understorey which includes a mix of native and exotic species. Extensive areas of ILGW remain in the locality, particularly to the west in the Johnsons Spur Conservation area, Illawarra Escarpment conservation areas and throughout the environmental zones associated with the Calderwood Urban Release Area. Considering the ILGW occurs as a small patch in a degraded/modified condition, the proposed reduction in extent of the community that would result from the proposal is not likely to place the local occurrence of the community at any further risk of extinction.
(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,
ILGW in the proposal site have been variously disturbed by historical land management practices. Past clearing and recent slashing has substantially modified the species structural and floristic composition. The site is also subjected to grazing from livestock. In this context, the proposal is unlikely to further alter the composition of the community such that the local occurrence of this community would be placed at risk of extinction.
d) In relation to the habitat of a threatened species, population or ecological community:
(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed, and
Up to 1.93 ha of ILGW would be removed and/or modified as a result of the proposal. The vegetation to be removed represents a small proportion of the remaining occurrence of the plant community type that forms this community (less than 0.12%). The proposal is unlikely to affect the long-term survival of the community within the locality given the small area of ILGW proposed to be removed and the already degraded nature of this vegetation within the proposal site.
(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
The patches of ILGW within the proposal site forms the edge of a larger patch of vegetation to the west. Clearing of native vegetation within the proposal site will fragment a small patch of vegetation within the study area. This patch has been Zoned E3 Environmental management zone as part of the Concept Plan approval. Pollination and seed dispersal agents, including birds, insects and wind would continue to operate across the proposal site following construction.
(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,
The patches of ILGW within the proposal site are not likely to be important to the long-term survival of the community in the locality given the small size, existing modified and fragmented condition of the vegetation and the impacts of surrounding urban development.
e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)
There is no recommended or declared critical habitat of relevance to this community.
f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.
There is no recovery plan for ILGW. OEH is currently developing a targeted approach for managing ecological communities. In the interim, a number of management actions have been identified for this community including measures to protect and restore remnant vegetation. The proposal has been designed to avoid impacts on this community where possible. There would be minimal removal of canopy species for the development, and in these cases, the trees in the community mostly represent scattered, isolated individuals, rather than part of patches of complete, continuous canopy.
g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process
The proposal would contribute to the operation of the following KTPs :

Illawarra Lowlands Grassy Woodland
• Clearing of native vegetation – up to 1.93 hectares of this community, comprising modified and degraded patches, would be removed and/or modified at the site as a result of this proposal; • Removal of hollow-bearing trees – the vegetation within the study area contains up to 15 hollow-bearing trees, of which 7 would be removed for the proposal. The proposal has the potential to cause or increase the operation of the following KTPs: • Invasion of plant communities by perennial exotic grasses – the proposal has the potential to increase existing edge effects on the E3 zoned vegetation to be retained and potentially transfer exotic grass propagules. • Invasion and establishment of exotic vines and scramblers, invasion and establishment of *Lantana camara*,– the proposal has the potential to increase the incidence of weeds. • Infection of native plants by *Phytophthora cinnamomi* – the proposal would disturb soil within and adjoining native vegetation and potentially transfer fungi spores, moreover spores could be transferred by infected boots, equipment and machinery during excavation. The proposal would include environmental management measures including specific consideration of potential impacts on soil, water and native vegetation. These measures would mitigate against the operation of these KTPs.
Conclusion of Assessment of Significance
Based on consideration of the above criteria, the proposal is unlikely to have a significant impact on the local occurrence of Illawarra Lowlands Grassy Woodland, pursuant to s.5AA of the EP&A Act, given: • A maximum of 1.93 hectares of vegetation would be removed and/or modified. • The vegetation that would be removed is heavily modified following previous clearing, and the impacts of grazing. • The vegetation to be removed is located at the edge of a larger patch and exists in a degraded state. The proposal would isolate a small patch of community in the study area which has been zoned E3. • The areas of vegetation that would be removed are not considered critical for the survival of the community in the locality. • The proposal would not interfere with the recovery of this community. A species impact statement would not be required for this TEC. The EPBC Act MNES significance impact criteria have been considered for Illawarra Lowlands Grassy Woodland in the light of the above findings and similarly conclude that the proposal is unlikely to have a significant impact on this TEC. A referral would not be required for the proposal with respect to Illawarra Lowlands Grassy Woodland.

Threatened orchids

Up to 1.93 ha of potential habitat for the Thick Lip Spider Orchid (*Caladenia tessellata*) and Illawarra Greenhood (*Pterostylis gibbosa*) comprising Forest Red Gum – Thin-leaved Stringybark Grassy Woodland, would be removed and/or modified at the proposal site. Both threatened orchids are associated with coastal valley grassy woodlands including Forest Red Gum – Thin-leaved Stringybark Grassy Woodland (OEH 2018a).

No individuals of this species were recorded in the proposal site or adjoining areas of potentially suitable habitat, although surveys were undertaken when specimens would be difficult to detect. Consequently, a precautionary approach has been taken regarding the presence of these species and an assessment of the likely significance of impacts pursuant to Section 5A of the EPA Act (7-part test) has been prepared (below).

Threatened orchids: Thick Lip Spider Orchid and Illawarra Greenhood
a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.
The Thick Lip Spider Orchid has not been recorded in the locality, but was predicted likely to occur within 10 km of the study area (DEE 2018a). Thick Lip Spider Orchid regenerates each year from an underground tuber and are thought to be promoted by fires the previous summer. This species is prone to trampling and habitat clearing. The Illawarra Greenhood is a common occurrence within the locality, with 117 records identified within the last 20 years. It has been known to occur within the last 10 km (DEE 2018a). All records within the locality occur with 5km of the study area and occur in 6 discrete patches to the east and to the north east in Albion Park and Yallah respectively. The Illawarra Greenhood breeds through the replacement of tubers from the rosette. No individuals of either species were recorded in the proposal site or adjoining areas of potentially suitable habitat. However, these species are cryptic in nature and unlikely to be recorded unless flowering and surveys were undertaken outside of the key flowering periods. Random meander threatened flora searches conducted by EcoLogical 2010 did not record these species in the wider study area in lands within the approved Concept Plan for the Calderwood Urban Development Project. Potential impacts of the proposed activity on the life cycle of these species would comprise the removal and/or modification of up to 1.93 hectares of potential habitat from the proposal site within Forest Red Gum – Thin-leaved Stringybark Grassy Woodland. This vegetation is in a modified state and is subjected to grazing by livestock. However, considering the small area of potential habitat to be removed, the degraded nature of that habitat and the impacts from grazing, it is unlikely that the proposal would have an adverse impact on the lifecycle of a local population (even if present in the study area) such that a viable local population is likely to be placed at risk of extinction.
b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.
Not applicable to these threatened flora species.
c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
Not applicable to these threatened flora species.
(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,
Not applicable to these threatened flora species.
d) In relation to the habitat of a threatened species, population or ecological community:
(i) The extent to which habitat is likely to be removed or modified as a result of the proposed action and

Threatened orchids: Thick Lip Spider Orchid and Illawarra Greenhood
Up to 1.93 ha of variously modified and degraded potential habitat for the Illawarra Greenhood and Thick Lip Spider Orchid would be removed from the proposal site. This represents a very small area of potential habitat for these species in the locality.
(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
The proposed clearing of habitat would occur in the north of the proposal site within Forest Red Gum – Thin-leaved Stringybark Grassy Woodland. Most of this habitat comprises the edge of cleared land. The proposal would result in some further fragmentation of habitat within the study area but would not isolate patches of known occupied habitat for these species. .
(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,
A maximum of 1.93 hectares of potential habitat would be removed and/or modified for the proposal. Potential habitat within the proposal site is not likely to be important to the long term survival of these species in the locality, given that the species has not been recorded in adjacent grassy woodland vegetation during previous investigations (EcoLogical 2010). The removal and/or modification of 1.93 hectares of largely disturbed and modified potential habitat is unlikely to threaten the persistence of these species in the locality.
e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)
There is no recommended or declared critical habitat of relevance to these species.
f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.
The recovery plan for the Illawarra Greenhood identifies five objectives to help recover this threatened species. These strategies involve the protection and management of known populations on public and private lands, minimising risk of long term population decline through habitat management practices, appropriate management adaptive to research outcomes, and community consultation. The national recovery for the Thick-lip Spider Orchid identifies eight objectives to help recover this threatened species. These strategies include determining habitat requirements, managing threats to known populations, and building community support for conservation. While the removal of habitat is not consistent with these actions, the loss and disturbance of 1.93 hectares of potential habitat is unlikely to interfere with the recovery of both of these species.
e) Whether the proposed development or activity constitutes or is part of a key threatening process or is likely to increase the impact of, a key threatening process
The proposal would directly contribute to the operation of the following KTPs: • Clearing of native vegetation – 1.93 ha of potential, albeit largely degraded and modified habitat for the Illawarra Greenhood and Thick Lip Spider Orchid would be removed by the proposal. The proposal has the potential to cause or increase the operation of the following KTPS: • Invasion of plant communities by perennial exotic grasses. • Invasion and establishment of exotic vines and scramblers, invasion and establishment of *Lantana camara*. The proposal would include environmental management measures, including specific consideration of potential impacts on soil, water and native vegetation. These measures would mitigate against the operation of these KTPs.
Conclusion of Assessment of Significance

Threatened orchids: Thick Lip Spider Orchid and Illawarra Greenhood

Based on consideration of the above criteria, the proposal is unlikely to have a significant impact on a local occurrence of Illawarra Greenhood and Thick Lip Spider Orchid, pursuant to s.5AA of the EP&A Act, given:

- A maximum of 1.93 ha of potential habitat would be impacted, comprising substantially modified vegetation through historical clearing current grazing practices
- The small area of potential habitat to be removed is not considered important habitat for these species given an absence of records in the immediate vicinity of the study area or in adjacent intact native vegetation
- No patches of known habitat would become isolated as a result of the proposal.

Consequently, a species impact statement would not be required for Illawarra Greenhood and Thick Lip Spider Orchid.

The EPBC Act MNES significance impact criteria have been considered for Illawarra Greenhood and Thick Lip Spider Orchid in the light of the above findings and similarly conclude that the proposal is unlikely to have a significant impact on these species.

A referral would not be required for the proposal with respect to Illawarra Greenhood and Thick Lip Spider Orchid.

Microchiropteran Bats

Up to 1.93 hectares of potential foraging habitat for the Eastern Freetail Bat (*Mormopterus norfolkensis*), Greater Broad-nosed Bat (*Scoteanax rueppellii*), Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) and Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) comprising Forest Red Gum – Thin-leaved Stringybark Grassy Woodland, would be removed from the proposal site. The vegetation to be removed may provide roosting habitat these species.

Microchiropteran bats- Eastern Freetail Bat, Greater Broad-nosed Bat and Eastern False Pipistrelle
a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.
The Eastern False Pipistrelle, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat are known from the locality but have not been previously recorded in the study area (OEH 2018a). The Eastern Freetail Bat was detected (probable recording via Anabat detector in a small dam in the south east of the site and also in treed vegetation in the north of the site).These species are likely to forage through the study area and in more extensive patches of contiguous native vegetation in the adjacent Johnsons Spur Conservation Area and Illawarra Escarpment areas. The Eastern False Pipistrelle have been recorded 9 times, Greater Broad-nosed Bat 13 times, Yellow-bellied Sheathtail Bat 8 times and Eastern Freetail Bat 13 times in the locality respectively. Factors likely to affect the lifecycle of these species in general include the removal of foraging and roosting habitat, disturbance of potential breeding sites and habitat fragmentation and isolation. The proposal will remove 1.54 ha of potential foraging habitat for these species from within the proposal site. The small area of potential foraging habitat to be removed would represent a minor proportion of the foraging habitat within the likely home range of these species and is unlikely to be important for local populations given its limited extent and the extent of high quality foraging habitat in the adjoining Johnsons Spur Conservation Area and Illawarra Escarpment areas. The Eastern Freetail Bat, Eastern False Pipistrelle, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat are known to breed and roost in hollow-bearing trees. The proposal site contains a moderate density (up to 10) of hollow-bearing trees, of which 7 may be removed by the proposal (see Appendix B for further details on hollow-bearing trees in the study area). The removal of vegetation from the proposal site will further fragment stands of vegetation in the study area may isolate a stands of native vegetation within the study area in the E3 Environmental Management Zone. This isolation and fragmentation of these small areas of habitat is unlikely to affect these highly mobile species. Given the above considerations, the proposal is unlikely to have an adverse effect on the life cycle of these species such that a viable local population of these species is likely to be placed at risk of extinction.
b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.
Not applicable to these threatened species.
c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
Not applicable to these threatened species.
(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,
Not applicable to these threatened species.
d) In relation to the habitat of a threatened species, population or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed action, and

Microchiropteran bats- Eastern Freetail Bat, Greater Broad-nosed Bat and Eastern False Pipistrelle
Up to 1.93 hectares of potential foraging habitat for the Eastern Freetail Bat, Eastern False Pipistrelle, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat would be removed and/or modified for the proposal. The vegetation to be removed would comprise potential roosting and breeding habitat for the Eastern Freetail Bat, Greater Broad-nosed Bat, Yellow-bellied Sheathtail Bat and Eastern False Pipistrelle.
(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
The proposal would further fragment habitat for these species in the locality, but would not create a 'hostile gap' defined by DECC (2008) or isolate patches of habitat for these highly mobile species. The proposal would not create a barrier to the movements of these highly mobile species through the locality.
(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,
The proposal would remove a small area of potential foraging habitat for the Eastern Freetail Bat, Eastern False Pipistrelle Bat, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat but would not remove habitat of importance for roosting or breeding. More extensive contiguous habitat of higher quality is present in the adjoining Johnsons Spur conservation area and Illawarra escarpment conservation areas in the west. The small patches of largely edge habitat to be removed are not likely to be important to the long term survival of these species in the locality.
d) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),
There is no recommended or declared critical habitat of relevance for these species.
f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.
No recovery plan has been prepared for these species. Priority actions mainly relate to research and habitat management and protection. The proposal would remove potential habitat for these species and is therefore not consistent with the recovery actions. The small area of potential habitat that would be cleared is unlikely to affect critical lifecycle stages of any local population (see factor a) and consequently is unlikely to interfere with the recovery of these species.
g) Whether the proposed development or activity constitutes or is part of a key threatening process or is likely to increase the impact of, a key threatening process
The proposal would directly contribute to the operation of the following KTPs : • Clearing of native vegetation – Up to 1.93 hectares of potential foraging habitat for the Eastern Freetail Bat, Eastern False Pipistrelle, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat; • Removal of hollow-bearing trees – 7 hollow-bearing trees which could provide roosting and breeding habitat for these species would be removed for the proposal. The proposal would include environmental management measures, including specific consideration of potential impacts on soil, water and native vegetation. These measures would mitigate against the operation of these KTPs.
Conclusion of Assessment of Significance
Based on consideration of the above criteria, the proposal is unlikely to have a significant effect on the local occurrence of Eastern Freetail Bat, Eastern False Pipistrelle, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat, pursuant to s.5A of the EP&A Act, given: • 1.93 ha of native vegetation that represents potential foraging habitat for these species would be removed and/or modified within the proposal site • 7 trees with obvious hollows would be removed. • Large areas of habitat containing hollow-bearing trees occur in the locality (e.g. the adjacent Johnsons Spur conservation area and Illawarra escarpment conservation areas in the west) • No areas of habitat would become isolated for these highly mobile species • Indirect impacts would predominantly occur along an already modified and disturbed edge.

Microchiropteran bats- Eastern Freetail Bat, Greater Broad-nosed Bat and Eastern False Pipistrelle
Consequently, a species impact statement would not be required for the Eastern Freetail Bat, Eastern False Pipistrelle, Yellow-bellied Sheathtail Bat or Greater Broad-nosed Bat.

Grey-headed Flying Fox

The Grey-headed Flying-fox was observed foraging adjacent to the study area in the west. It is likely to forage in native vegetation in the locality when trees are flowering or fruiting. Up to 1.93 hectares of potential foraging habitat for the Grey-headed Flying-fox comprising Forest Red Gum – Thin-leaved Stringybark Grassy Woodland and shelter plantings would be removed in the proposal site. The proposal would not remove known roosting habitat for this species or affect any local camps.

Grey-headed Flying-fox
a) In the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.
The Grey-headed Flying-fox was recorded foraging adjacent to the study area and is also known in the locality. The 17 records of the species occurring within the locality are unevenly distributed. The nearest record of this species occurs <3km in Albion Park to the south east of the proposal site (OEH 2018a). This species is a highly mobile species which regularly travel up to 50km in a night to forage, and has been shown to make migratory movements of almost 1,000 km within a year (Churchill 2008, Webb and Tidemann 1996). This species roosts communally in large, established camps which may support several thousand individuals. The proposal site or study area does not contain roost camps for this species with the closest known Grey-headed Flying Fox camp occurring at least ~9 km to the east at Blackbutt Reserve, Shellharbour (DoE 2018c). The nearest nationally important flying fox camp occurs ~35km away at Bomaderry Creek (Nowra) to the south of the proposal site (DoE 2018c). The proposal site contains potential foraging habitat for this species, including a key foraging tree species: Forest Red Gum (*Eucalyptus tereticornis*). Forest Red Gum is recognised as a 'significant species' in the blossom diet of the Grey-headed Flying-fox (Eby and Law 2008) however, it is not a highly productive flowering species. Forest Red Gum scores in the upper quartile of all diet plants for the region for productivity and reliability of flowering (0.67). This species flowers in late winter and spring, partly during the 'food bottleneck'. Rough-barked Apple *(Angophora floribunda*) is also present in the proposal site but does not score highly for productivity and reliability of flowering (0.45). Other myrtaceous trees including Coast Grey Box (*Eucalyptus bosistoana*) are not listed feed trees for the Grey-headed Flying- fox and may only provide limited habitat value within the proposal site. The small area of potential foraging habitat to be removed represents a minor proportion of these highly mobile species' home range and is unlikely to be important for any stage of these species' lifecycle. Large areas of contiguous and higher quality foraging habitat exist in the wider locality, including within intact native vegetation in the Johnsons Spur conservation area and Illawarra escarpment conservation areas to the west. The proposal is unlikely to have an adverse effect on the life cycle of this species such that a viable local population of the species is likely to be placed at risk of extinction.
b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,
Not applicable to these threatened microbats.
c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed: (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
Not applicable to these threatened microbats.
(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,
Not applicable to this threatened species.
d) In relation to the habitat of a threatened species, population or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

Grey-headed Flying-fox
Up to 1.93 hectares of native vegetation, containing foraging trees for the Grey-headed Flying-fox would be removed and/or modified by the proposal. The vegetation to be removed comprises a negligible proportion of native vegetation present in surrounding areas and the broader locality. The proposal would not remove any areas of breeding or roosting habitat for this species. Recommended environmental management measures are likely to mitigate indirect impacts on areas of retained habitat adjoining the proposal site.
(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
The proposal would increase existing gaps in vegetation in the study area. However these impacts would not create a barrier to the movements of this highly mobile species between patches of native vegetation in the study area and surrounds.
(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,
The proposal would remove a small area of potential foraging habitat for the Grey-headed Flying-fox. Better quality foraging habitat is present in similar vegetation within large areas of intact native vegetation to the west of the site in the adjacent Johnsons Spur conservation area and conservation areas of the Illawarra escarpment. The proposal would not remove suitable roosting habitat or affect a known maternity camp of this species. Consequently, the small patches of habitat to be removed are not likely to be important to the long term survival of this species in the locality.
e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)
There is no critical habitat listed for this species.
e) Whether the proposed development or activity constitutes or is part of a key threatening process or is likely to increase the impact of, a key threatening process
The proposal would directly contribute to the operation of the following KTP of relevance to the Grey-headed Flying-fox: • Clearing of native vegetation – Up to 1.93 hectares of potential foraging habitat comprising Forest Red Gum – Thin-leaved Stringybark Grassy Woodland and shelter plantings would be removed in the proposal site; The proposal would include environmental management measures, including specific consideration of potential impacts on soil, water and native vegetation to minimise the potential for adverse indirect impacts on adjoining native vegetation as a result of this KTP.
Conclusion of Assessment of Significance
Based on consideration of the above criteria, the proposal is unlikely to have a significant effect on the local occurrence of Grey-headed Flying-fox, pursuant to s.5A of the EP&A Act, given: • The vegetation to be removed comprises a negligible proportion of native vegetation present in surrounding areas and the broader locality • No roosting habitat or camp sites would be removed or affected • The proposed vegetation removal would not isolate areas of habitat or create barriers to movement between camp sites or foraging grounds for this species. Consequently, a species impact statement would not be required for the Grey-headed Flying-fox as a result of the proposal. The EPBC Act MNES significance impact criteria have been considered for the Grey-headed Flying-fox in the light of the above findings and similarly conclude that the proposal is unlikely to have a significant impact on this species. A referral would not be required for the proposal with respect to the Grey-headed Flying Fox.

Appendix D – Recommended nest box types, dimensions and numbers

Target group	Entrance diameter (mm)	Dimensions (mm)	Depth (mm)	Other requirements	Total number required #
Microbats	10-30	200 x 200	400	Entrance slit at base, heavily grooved	3
Possums	58-100	250 x 300	400		1
Cockatoos	200	300 x 400	1200	Make out of PVC. Layer of sawdust inside.	1
Lorikeets/Rosellas	65	200 x 200	400	Layer of sawdust inside	1
Total					**6**

Based on species in the locality most likely to use nest boxes, small area available and limited number of suitable trees to mount nest boxes. Nest box locations are provided in Figure 2.

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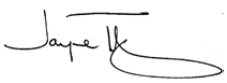
Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	M Weerakoon	D Williams		J Tipping		22/06/2018
1.	M Weerakoon	D Williams		J Tipping		9/01/2019
2.	M Weerakoon	D Williams		J Tipping		14/03/2019

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