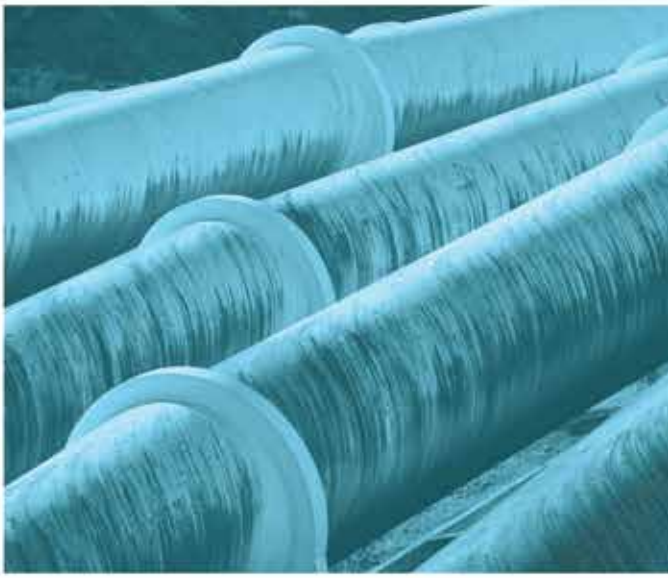
APPENDIX O –
BIODIVERSITY DEVELOPMENT ASSESSMENT REPORT

EMM
creating opportunities


Luddenham Advanced Resource Recovery Centre

Biodiversity Development Assessment Report

Prepared for Coombes Property Group and KLF Holding Pty Ltd
June 2020

EMM
creating opportunities

EMM
creating opportunities

Servicing projects throughout Australia and internationally

SYDNEY
Ground Floor, 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3, 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1, 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

ADELAIDE
Level 1, 70 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Ground Floor, 188 Normanby Road
Southbank VIC 3006
T 03 9993 1905

PERTH
Suite 9.02, Level 9, 109 St Georges Terrace
Perth WA 6000
T 02 9339 3184

CANBERRA
Level 8, 121 Marcus Street
Canberra ACT 2600

Luddenham Advanced Resource Recovery Centre

Biodiversity Development Assessment Report

Report Number

J190749 RP11

Client

Coombes Property Group and KLF Holding Pty Ltd

Date

17 June 2020

Version

v2 Final

Prepared by

Jason Brown
Senior Ecologist
17 June 2020

Approved by

Steven Ward
Associate Ecologist
17 June 2020

Executive Summary

ES1 The project

Coombes Property Group (CPG) in partnership with KLF Holdings Pty Ltd (KLF) propose to construct and operate a new construction and demolition resource recovery centre (the ARRC) at 275 Adams Road, Luddenham NSW (Lot 3, DP 623799) (the subject property).

This Biodiversity Development Assessment Report (BDAR) has been prepared by EMM Consulting Pty Limited (EMM) to address the environmental and planning obligations for the project. The project is classed as a State Significant Development (SSD) under the State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP).

ES2 Landscape

The ARRC will be constructed within the Sydney Basin, Cumberland Interim Biogeographic Regionalisation of Australia region. The subject property is located within the upper reaches of the Hawkesbury River catchment, adjacent the Nepean catchment boundary with Oaky Creek running along the eastern section. The locality is considered highly fragmented with native vegetation often occurring in isolated patches surrounded by a matrix of agricultural land.

There are no areas of outstanding biodiversity value, as defined in Part 3 of the *Biodiversity Conservation Act 2016* (BC Act), within a 1,500 m buffer of the subject property.

ES3 Native vegetation

Survey identified that most of the subject property is dominated by open grasslands of varying condition and quality. Most of these areas have been heavily impacted by pastoral activities, particularly grazing, and are dominated by exotic plant species. The following native plant community types (PCTs) was recorded within the ARRC:

- PCT 849 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain; and
- PCT 1800 – Cumberland Swamp Oak riparian forest.

PCT 849 is located outside of the impact area for the ARRC, and therefore is not assessed as being impacted as part of the ARRC. PCT1800 Cumberland Swamp Oak riparian forest was recorded in a poor and moderate condition, and is associated with the *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions Endangered Ecological Community* listed under the BC Act.

ES4 Threatened species

A number of ecosystem credit species were predicted to be associated with the PCT occurring within the ARRC footprint by the BioBanking Calculator. One candidate species credit species, Southern Myotis (*Myotis macropus*) was recorded within the subject property.

ES5 Impact avoidance, minimisation and mitigation

The project has been designed, where possible, to avoid sensitive biodiversity areas. The ARRC footprint was reduced to avoid potential impacts to the Swamp Oak Floodplain Forest Endangered Ecological Community (EEC) listed under the BC Act (PCT 1800) along the eastern boundary and Cumberland Plain Woodland Critical Endangered Ecological Community (CEEC) listed under the BC Act (PCT 849) that is present between the access road and the western boundary. None of these EECs are consistent with the *Environmental Protection Biodiversity Conservation Act 1999* (EPBC Act) listings.

Key avoidance measures that are to be implemented by the proponent comprise:

- avoidance of direct impacts to Oaky Creek;
- no impacts to PCT 849;
- minimisation of impacts to PCT 1800, by only impacting on small areas of the fragmented habitat;
- minimisation of impacts to PCT 1800, by avoiding impacts to the vegetation on the south-western boundary;
- utilisation of the existing cleared areas wherever feasible; and
- designing a water management system to minimise potential impacts to Oaky Creek.

ES6 Biodiversity impacts and offsets

Following the implementation of avoidance and minimisation measures, the project will remove 0.28 hectares of native vegetation. This is associated with PCT 1800 and species habitat for Southern Myotis.

The project requires seven ecosystem credits for PCT 1800 to compensate for impacts on native PCTs and ecosystem credit species. In addition to ecosystem credits, the project also requires six species credits for Southern Myotis.

Table of Contents

Appendices

Tables

Figures

Abbreviations

ARRC	Advanced Resource Recovery Centre
BAM	Biodiversity Assessment Method
BC Act	NSW *Biodiversity Conservation Act 2016*
BCD	Biodiversity Conservation Division
BDAR	Biodiversity Development Assessment Report
BioNet	NSW BioNet
Biosecurity Act	NSW *Biosecurity Act 2015*
BOS	Biodiversity Offsets Scheme
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
CHM	Canopy Height Model
CPG	Coombes Property Group
DAWE	Commonwealth Department of Agriculture, Water and Environment
DFSI	NSW Department of Finance, Services and Innovation
DPIE	NSW Department of Planning, Industry and Environment
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EMM	EMM Consulting Pty Limited
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
ESCP	Erosion and sediment control plan
FM Act	NSW *Fisheries Management Act 1994*
GDE	Groundwater-dependent ecosystem
GPS	Geographic Positioning System
IBRA	Interim Biogeographic Regionalisation of Australia
KFH	Key Fish Habitats
KLF	KLF Holding Pty Ltd
KTP	Key Threatening Process
LGA	Local Government Area
LiDAR	Light Detection and Ranging
MNES	Matters of National Environmental Significance
NSW	New South Wales
OEH	Office of Environment and Heritage (now BCD)
PCT	NSW Plant Community Type
PMST	Protected Matters Search Tool

RVA	Rapid Vegetation Assessment
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SRD	State and Regional Development
SSD	State Significant Development
TBDC	Threatened Biodiversity Data Collection
TECs	Threatened Ecological Communities
TPZ	Tree Protection Zone
VIS	Vegetation Information System

{¢!D9 M

.ƛ2ŘƛØŜℕăƛűề I·ăăŜăăϒŜyű

1 Introduction

1.1 Overview

CFT No 13 Pty Ltd, a member of Coombes Property Group (CPG), has recently acquired the property at 275 Adams Road, Luddenham NSW (Lot 3 in DP 623799, 'the site') within the Liverpool City Council municipality. The site is host to an existing shale/clay quarry. The site shares its southern and eastern boundaries with the Western Sydney Airport development site (Figure 1.1).

CPG owns, develops, and manages a national portfolio of office, retail, entertainment, land, and other assets. The company's business model is to retain long-term ownership and control of all its assets. CPG has the following staged vision to the long-term development of the site:

- Stage 1 Quarry Reactivation: **Solving a problem**. CPG intends to responsibly avoid the sterilisation of the remaining natural resource by completing the extraction of shale which is important to the local construction industry as raw material used by brick manufacturers in Western Sydney. Following the completion of approved extraction activities, the void will be prepared for rehabilitation.

- Stage 2 Advanced Resource Recovery Centre and Quarry Rehabilitation: **A smart way to fill the void**: CPG in partnership with KLF Holdings Pty Ltd (KLF) and in collaboration between the circular economy industry and the material science research sector, intends to establish a technology-led approach to resource recovery, management, and reuse of Western Sydney's construction waste, and repurposing those materials that cannot be recovered for use to rehabilitate the void. This will provide a sustainable and economically viable method of rehabilitating the void for development.

- Stage 3 High Value Employment Generating Development: **Transform the land to deliver high value agribusiness jobs**. CPG intends to develop the rehabilitated site into a sustainable and high-tech agribusiness hub supporting food production, processing, freight transport, warehousing, and distribution, whilst continuing to invest in the resource recovery research and development (R&D) initiatives. This will deliver the vision of a technology-led agribusiness precinct as part of the Aerotropolis that balances its valuable assets including proximity to the future Western Sydney Airport (WSA) and Outer Sydney Orbital.

This report relates to a new development application relating to the delivery of Stage 2 above.

KLF is an Australian-owned and operated waste management company that operates two strategically located resource recovery and recycling facilities in Sydney; one at Camellia and another at Asquith. KLF has 20 years' experience in the waste recycling and resource recovery industry. KLF facilities are licensed by the NSW Environment Protection Authority (EPA) and have full International Organisation for Standardisation (ISO) accreditation.

1.2 The site

There is an existing clay and shale quarry on the subject property approved under Development Consent DA-315-7-2003, as modified. The quarry is currently inactive. CPG and KLF (the 'applicants') have commenced the application process to modify the quarry's consent to allow quarry operations to recommence, with the primary intention of changing the approved access to the subject property to allow quarry operations (Modification 5, also referred to as MOD 5).

It is proposed to develop an advanced resource recovery centre (AARRC) within the same lot to the north of the existing quarry void. The AARRC site is shown in Figure 1.1.

The project is integral in achieving the intended future commercial/industrial land use for the subject property as the project provides a commercially viable means to infill the quarry void (subject to separate development consent). This will support the Western Sydney Airport and ongoing development of the Western Sydney Aerotropolis.

A new State significant development (SSD) consent under Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) is required to establish the AARRC. On 24 April 2020, the Department of Planning, Industry and Environment (DPIE) issued Secretary's Environmental Assessment Requirements (SEARs) for the environmental impact statement (EIS) for the project. The SSD consent application number is SSD-10446.

This report has been prepared by EMM Consulting Pty Ltd (EMM) on behalf of the applicants.

1.3 Project overview

The key components of the AARRC project are as follows:

- construction and operation of an advanced construction and demolition resource recovery centre;
- accepting and processing up to 600,000 tonnes per annum (tpa) of waste for recycling;
- despatch of approximately 540,000 tpa of recycled product;
- despatch of approximately 60,000–120,000 tpa of unrecyclable material either to an offsite licensed waste facility or to the adjacent quarry void (the later will be subject to separate approval);
- if required, upgrade the access road from the subject property to Adams Road;
- use of the access road from subject property to Adams Road;
- the AARRC will not accept putrescibles, liquid or hazardous waste; and
- the AARRC will operate up to 24 hours a day, 7 days per week.

The AARRC will accept general solid waste comprising building and demolition waste as well as selected commercial and industrial waste. No special, liquid, hazardous, restricted solid water, putrescible solid waste, or odorous waste will be accepted at the AARRC.

The vast majority of materials accepted will be recovered, the remaining minor amount (10–20%) of unrecyclable materials will be disposed of at an offsite licensed landfill or to the quarry void on the site as part of rehabilitating the void.

The proposed project layout is shown in Figure 1.2.

1.4 Purpose of this report

This BDAR has been prepared by EMM on behalf of the applicants, to support the EIS for the project. It documents the terrestrial biodiversity assessment methods and results, the initiatives built into the project design to avoid and minimise impacts to terrestrial biodiversity, and the mitigation and management measures, including offset requirements, proposed to address any unavoidable residual impacts.

The specific objectives of this assessment are to:

- describe the existing biodiversity values and existing environment;
- identify and assess the potential for presence of biodiversity values, including threatened species and communities under relevant legislation including the NSW *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- identify ecological constraints within and impacts arising from the project;
- provide mitigation measures to reduce the impacts from the project on biodiversity wherever possible; and

- where impacts are unavoidable, consider compensatory measures that are appropriate.

1.5 Location

The ARRC site is within 275 Adams Road, Luddenham NSW (described as Lot 3 in DP 623799) in the Liverpool City Council local government area in the Greater Western Sydney region of New South Wales (NSW). The subject property is approximately 19 kilometres (km) north-west of the city of Liverpool, 25 km south-west of the city of Parramatta and approximately 43 km south-west of the city of Sydney. The ARRC site is approximately 3 hectares (ha).

Oaky Creek, runs to along the eastern border of the subject property. The *Draft Western Sydney Aerotropolis Plan* (Western Sydney Planning Partnership 2019) has earmarked a small strip of land along the eastern side of Oaky Creek for Environment and Recreation zoning under the proposed Western Sydney Aerotropolis State Environmental Planning Policy.

1.6 Project area, survey area, disturbance and avoidance footprint definitions

Table 1.1 defines the areas discussed in the BDAR. The ARRC site and subject property boundary is illustrated in Figure 1.2 and covers the development application area for the project.

Table 1.1 Naming of areas referred to in this BDAR

Project elements	Definition
Native vegetation assessment area	Subject property plus 1,500 m buffer
Study area/subject property	Area which was surveyed for ecological values. For this project this was the subject property boundary (Figure 1.2). The term 'subject property' is used within this report instead of study area
Project area/ARRC site	Area subject to proposed direct impacts. The term 'ARRC site' is used in this report instead of project area or project footprint
Indirect impact area	Area subject to anticipated indirect impacts, which was delineated as 20 m buffer from the ARRC site (the project footprint)
Impact area	Combined direct impact and indirect impact areas

1.7 Assessment guidelines and requirements

This BDAR has been prepared in accordance with the *Biodiversity Assessment Method* (BAM; OEH 2017) and the legislative framework outlined in Chapter 2.

This BDAR has also been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) for the project, issued on 24 April 2020 (Ref: SSD-10446) as well as relevant governmental assessment requirements, guidelines and policies.

KEY

- Subject property
- ARRC site
- Western Sydney Airport
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- NPWS reserve (see inset)
- State forest (see inset)

Source: EMM (2020); DFSI (2017); Nearmap (2020)

0 0.5 1 km

GDA 1994 MGA Zone 56

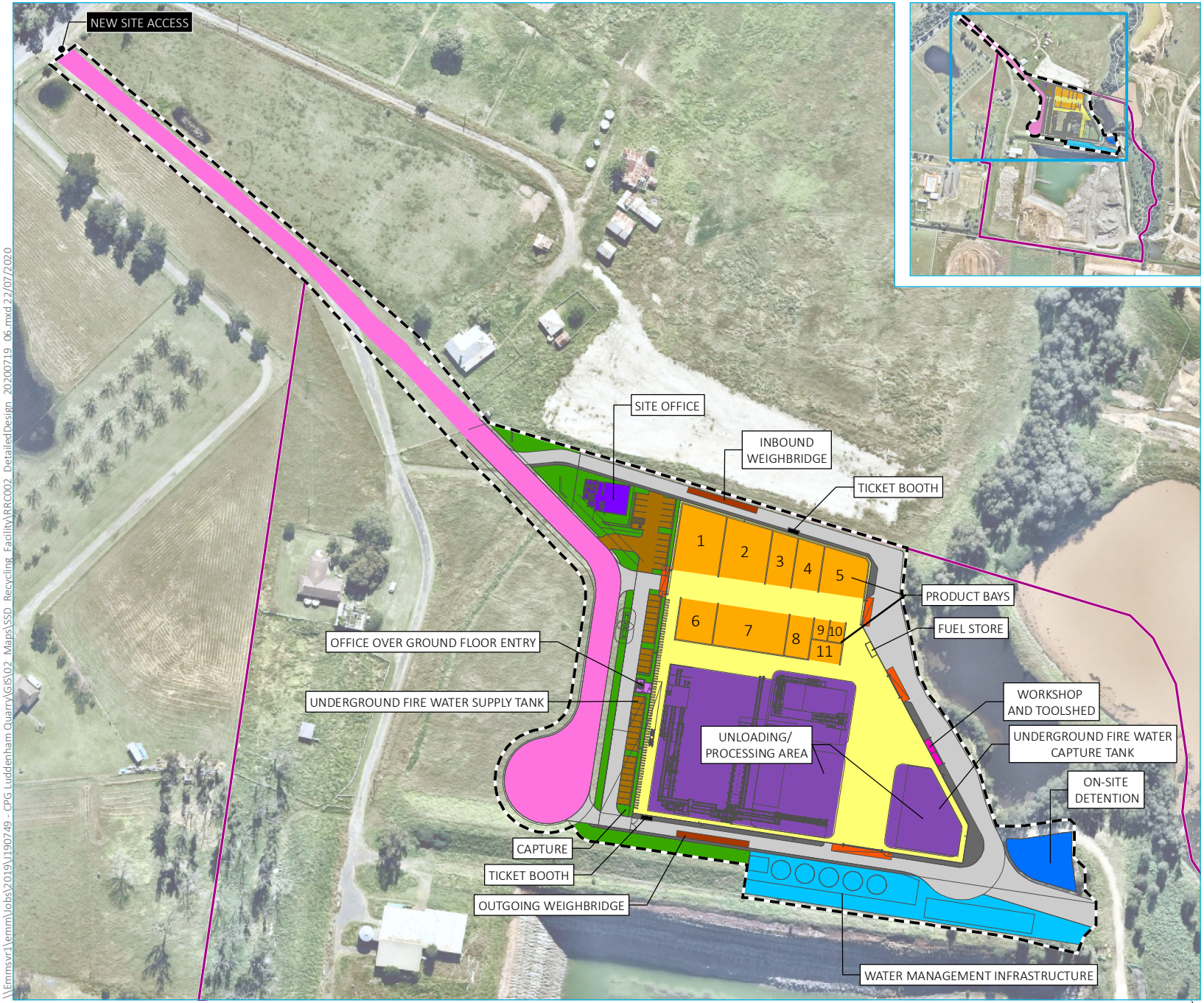
N

\\Emmsvr1\emm\Jobs\2019\190749 - CPG Luddenham Quarry\GIS\02 Maps\SSD Recycling Facility\RRC003 RegionalContext 20200609 02.mxd 16/06/2020

Regional context

Luddenham Advanced Resource Recovery Centre
Biodiversity Development Assessment Report
Figure 1.1

EMM creating opportunities



KEY

- Subject property
- ARRC site
- Indicative detailed layout

Proposed element

- Awning
- Carpark
- Hardstand
- ARRC access road
- Kerb/pedestrian area
- Landscaping
- Office over ground floor
- On-site detention
- ARRC warehouse
- Product bay
- Site office
- Ticketbooth
- Tool shed, workshop
- Unloading/processing
- Water management infrastructure, including treatment plant and storage
- Weighbridge

Product bays

1. Concrete/ rubble masonry
2. Clean timber
3. Rigid plastics
4. Paper/cardboard/film
5. Stumps/asphalt/metal
6. Heavy residual
7. Fines screened
8. Soil audit
9. Ferrous
10. Non-ferrous
11. Non-recyclables

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); Reid Campbell (2020)

0 50 100 m

GDA 1994 MGA Zone 56

N

\\Emmsvr1\emm\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02 Maps\SSD Recycling Facility\RRC002 DetailedDesign 20200719 06.mxd 22/07/2020

Project overview

Luddenham Advanced Resource Recovery Centre
Biodiversity Development Assessment Report
Figure 1.2

EMM creating opportunities

1.8 Information sources

1.8.1 Publications and databases

In order to provide a context for the project, information about flora and fauna within 10 km of the subject property was obtained from relevant public databases. The centre point of the subject property was taken as Latitude -33.87, Longitude 150.72. Records from the following databases were collated and reviewed:

- BioNet Atlas of NSW Wildlife for previous threatened species records;
- Commonwealth Department of the Agriculture, Water and the Environment (DAWE) *Protected Matters Search Tool* (PMST) for Matters of National Environmental Significance (MNES) likely to occur within the subject property (0); and
- the NSW Plant Community Types (PCTs), as held within the BioNet Vegetation Information System database.

The following studies and reports were also reviewed:

- Development Consent, DA No. 315-7-2003, for Badger Mining Company Pty Limited;
- Phillips C 2004, *Assessment report: Proposed clay/shale extraction operation, Lot 3 – 275 Adams Road, Luddenham*, prepared for Badger Mining Company Pty Limited; and
- Douglas Nicolaisen & Associates Pty Ltd 2003, *Environmental Impact Statement – Proposed Clay/ Shale Extraction Operation – Lot 3 - 272 Adams Road Luddenham NSW*, prepared for Badger Mining Company Pty Limited 275 Adams Road Luddenham NSW.
- Department of Infrastructure and Regional Development (DIRB) 2016, *Western Sydney Airport EIS Biodiversity Assessment*, prepared for Western Sydney Unit – Western Sydney Airport EIS, 21/24265.

1.8.2 Spatial data

Mapping has been produced using a Geographic Information System (GIS). The following spatial datasets were utilised during the development of this report:

- site plans supplied by CPG Stage 01 Masterplan Rev. E;
- *Remnant Vegetation of the western Cumberland subregion, 2013 Update. VIS_ID 4207* (OEH 2015);
- *Mitchell Landscapes Version V3.1* (OEH 2016a);
- *Interim Biogeographic Regionalisation of Australia* (IBRA) *Version 7* (DoEE 2017a);
- Directory of important wetlands (DoEE 2018);
- NSW Wetlands (OEH 2010);
- base map data for the subject property was obtained from Department of Finance, Services and Innovation (DFSI) NSW databases, with cadastral data obtained from DFSI digital cadastral database; and
- mapping for stream orders was obtained from the Water Management (General) Regulation 2018 hydroline spatial data 1.0.

1.8.3 Limitations

Vegetation mapping was conducted using a mobile phone running Collector for ArcGIS™ and aerial photo interpretation. The accuracy of this mapping is therefore subject to the accuracy of the GPS units (generally ± 7 metres) and dependent on the limitations of aerial photo rectification and registration.

Surveys were completed during Summer 2020, when field conditions were conducive to detecting many of the flora and fauna species known to occur in the area. Surveys were undertaken in accordance with relevant NSW and Commonwealth survey guidelines for threatened species and the requirements of the *Framework for Biodiversity Assessment* (OEH 2018). Some flora species may be missed in surveys for a variety of reasons, for example: biannual flowering, poor flowering conditions, herbivory, heavy grazing pressures and drought conditions.

During the flora and fauna surveys the following limitation occurred:

- the south-eastern corner was surround by a security fence, so threaten flora and habitat assessments were undertaken from the other side of the fence;
- ephemeral water flooding parts of the vegetation within the ARRC site during the survey, preventing adequate survey of the ground layer (hence plots were moved to dry locations); and
- most of the mapped vegetation occurs outside the ARRC site.

2 Legislative context

This chapter provides a brief outline of the key biodiversity legislation and government policy considered in this assessment.

2.1 Commonwealth

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's key piece of environmental legislation. The EPBC Act applies to developments and associated activities that have the potential to significantly impact on Matters of National Environmental Significance (MNES) protected under the Act.

Nine MNES are identified under the EPBC Act:

- world heritage properties;
- national heritage places;
- wetlands of international importance (also known as 'Ramsar' wetlands);
- nationally threatened species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- the Great Barrier Reef Marine Park;
- nuclear actions (including uranium mining); and
- a water resource, in relation to coal seam gas development and large coal mining development.

Under the EPBC Act, activities that have potential to result in significant impacts on MNES must be referred to the Commonwealth Minister for the Environment for assessment. Assessment of MNES is provided in Chapter 7.

2.1.2 Supplementary environmental assessment requirements

The SEARs and the section which they are addressed are provided in Table 2.1.

Table 2.1 SEARs

Requirement	Section addressed
An assessment of biodiversity impacts in accordance with the BAM and documented in a BDAR.	Provided in 6.1.
Measures to avoid, mitigate or offset all direct, indirect and prescribed impacts in accordance with the BAM	Provided in 6.2.

2.2 State

2.2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) was enacted to encourage the proper consideration and management of impacts of proposed development or land-use changes on the environment (both natural and built) and the community. The EP&A Act is administered by the NSW Department of Planning, Industry and Environment (DPIE).

As described in Chapter 1, the project is State significant development (SSD) pursuant to Schedule 1 of the State Environmental Planning Policy (State and Regional Development) 2011 (State and Regional Development SEPP). Accordingly, approval is required under Part 4, Division 4.1 of the EP&A Act for the project.

i State Environmental Planning Policy (Koala Habitat Protection) 2019

The State Environmental Planning Policy (SEPP) Koala Habitat Protection replaces SEPP 44. This SEPP includes a new definition of 'core koala habitat', with new maps to help protect koalas across NSW, and the most up-to-date tree species data. This SEPP does not apply to SSD projects. Nonetheless, consideration has been given to the potential occurrence and impacts upon the koala within this report.

2.2.2 Biodiversity Conservation Act 2016

The Biodiversity Conservation Act 2016 (BC Act) details mechanisms for the conservation of biodiversity in NSW through the protection of threatened flora and fauna species, populations and ecological communities. The BC Act, together with the NSW Biodiversity Conservation Regulation 2017 (BC Regulation), established the Biodiversity Offsets Scheme (BOS).

The BOS includes establishment of the Biodiversity Assessment Method (BAM, OEH 2017) for use by accredited persons in biodiversity assessment under the scheme. The purpose of the BAM is to assess the impact of actions on threatened species and threatened ecological communities (TECs) and their habitats and determine offset requirements.

The BAM sets out the requirements for a repeatable and transparent assessment of terrestrial biodiversity values in order to:

- identify the biodiversity values on land subject to proposed development area;
- determine the residual impacts of a proposed development following all measures to avoid, minimise and mitigate impacts; and
- quantify and describe the biodiversity credits required to offset the residual impacts of proposed development on biodiversity values.

This biodiversity assessment has been prepared in accordance with the BAM and addresses the requirements of the BC Act.

2.2.3 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) contains provisions for the conservation of fish stocks, key fish habitat, biodiversity, threatened species, populations and ecological communities. It regulates the conservation of fish, vegetation and some aquatic macroinvertebrates and the development and sharing of the fishery resources of NSW for present and future generations. The FM Act lists threatened species, populations and ecological communities, key threatening processes (KTPs) and declared critical habitat. Assessment guidelines to determine whether a significant impact is expected are detailed in section 220ZZ and 220ZZA of the FM Act.

Another objective of the FM Act is to conserve key fish habitats (KFH). These are defined as aquatic habitats that are important to the sustainability of recreational and commercial fishing industries, the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. KFH is defined in sections 3.2.1 and 3.2.2 of the *Policy and Guidelines for Fish Conservation and Management* (DPI 2013).

The subject property is not mapped as a KFH in the Key Fish Habitat map. The project will not impact on any threatened aquatic species, populations, communities, habitats and KFH.

2.2.4 Biosecurity Act 2015

The *Biosecurity Act 2015* (Biosecurity Act) replaced the *Noxious Weeds Act 1993* on 1 July 2017. The Biosecurity Act aims broadly to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, carriers and other activities. The Act is administered by the Department of Primary Industries.

Weeds of National Significance identified and recorded during the flora survey include:

- Alligator Weed (*Alternanthera philoxeroides*);
- African Boxthorn (*Lycium ferocissimum*);
- Blackberry (*Rubus fruticosus*); and
- Bridal Creeper (*Asparagus asparagoides*).

3 Landscape features

The identification of landscape features in the subject property was determined using Section 4 of the BAM (OEH 2017), as summarised within this chapter.

3.1 Landscape features

3.1.1 Bioregions and landscapes

The subject property is confined to the Cumberland Interim Biogeographic Regionalisation of Australia (IBRA) subregion, within the Sydney Basin bioregion (refer to Figure 3.1). The Bionet landscape is entirely Cumberland Plain.

3.1.2 Watercourses and wetlands

One mapped watercourse, Oaky Creek, and two dams intersect the subject property (Figure 3.2). Oaky Creek flows into Cosgroves Creek north of Elizabeth Drive.

3.1.3 Connectivity

The locality is considered highly fragmented with native vegetation often occurring in isolated patches surrounded by a matrix of agricultural land. This is also consistent with the remaining vegetation within and adjoining the subject property.

3.1.4 Areas of geological significance and soil hazard features

The subject property does not contain karsts, caves, crevices, cliffs or other areas of geological significance. Similarly, there are no soil hazard features that occur within the subject property.

3.1.5 Areas of outstanding biodiversity value

There are no areas of outstanding biodiversity value within the subject property, or the 1,500 m buffer.

3.2 Assessment of site context

The site context has been assessed in accordance with Section 4.3 of BAM (OEH 2017) for site-based developments.

3.2.1 Native vegetation cover

Native vegetation cover within the buffer area (including the subject property) was determined as the sum of the areas of native vegetation map units listed above, divided by the entire buffer area (Table 3.1).

Table 3.1 Percentage of native vegetation cover

Native vegetation in buffer area (ha)	Buffer area (ha)	Percentage of native vegetation in buffer area
126.43	1,027.35	12%

4.3 Results

4.3.1 Vegetation description

Most of the subject property is dominated by open grasslands of varying condition and quality. Most of these areas have been heavily impacted by pastoral activities, particularly grazing, and are dominated by exotic plant species. In some areas of grassland, native cover of species such as Kangaroo Grass (*Themeda triandra*), Red-anthered Wallaby Grass (*Joycea pallida*) and Weeping Grass (*Microlaena stipoides*) occurs, but is <10% of the cover, resulting in the areas still being mapped as exotic.

The remaining wooded habitat within the subject property is comprised of a highly degraded woodland in the western section, a narrow riparian corridor dominated by Swamp Oak (*Casuarina glauca*), and scattered Swamp Oak in some areas of the subject property.

Site investigations, including determination of vegetation communities using the methods described in Section 5.2 of the BAM (OEH 2017). The PCTs found including vegetation condition in accordance to Keith (2015), are described within Table 4.2 and shown in Figure 4.1. The PCTs are described in further detail within the following section.

Table 4.2 Vegetation zone identified along with broad condition state

PCT ID	PCT name	Condition	Association with BC Act TEC	Association with EPBC Act TEC	Subject property direct impact area (ha)	Indirect impact area (ha)
1800	Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	Medium	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions ECC	The PCT does not align with the EPBC Act listing	0.21	0.13
		Poor			0.07	0.09
849	Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Poor	Cumberland Plain Woodland in the Sydney Basin Bioregion CEEC	The PCT does not align with the EPBC Act listing	0	0

PCT 849 Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion in poor condition was recorded within the subject property. This PCT is located outside of the impact area for the project and therefore is not assessed as part of the BDAR, but included as part of the results and species assessments.

KEY

- Subject property
- ARRC site
- BDAR 1500m buffer
- Major road
- Watercourse/drainage line

Remnant Vegetation of the Western Cumberland subregion

- PCT 850 - Shale Hills Woodland
- PCT 849 - Shale Plains Woodland
- PCT 835 - Alluvial Woodland

IBRA subregion

- Cumberland interim

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); DOE (2019)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

\\Emmsvr1\emm\Jobs\2019\190749 - CPG Luddenham Quarry\GIS\02 Maps\SSD Recycling Facility\BDAR\SDBDAR003 RegionalLocality 20200616 03.mxd 16/06/2020

Location map

Luddenham Advanced Resource Recovery Centre
Biodiversity Development Assessment Report
Figure 3.1

EMM creating opportunities

KEY

- Subject property
- ARRC site
- BDAR 1500m buffer
- Waterbody
- Major road
- Minor road
- Vehicular track

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order

\\Emmsvr1\emm\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02 Maps\SSD Recycling Facility\BDAR\SDBDAR004 SiteContext 20200615 03.mxd 16/06/2020

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

Site context

Luddenham Advanced Resource Recovery Centre
Biodiversity Development Assessment Report
Figure 3.2

EMM creating opportunities

4 Native vegetation

The extent of native vegetation within the subject property was determined using Section 5 of the BAM (OEH 2017), as summarised within this chapter.

4.1 Background review

A review of regional vegetation mapping was undertaken to inform the survey. OEH (2015) identified the following PCTs within the subject property (Figure 4.1);

- Alluvial Woodland which is equitant to: PCT 835 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion; and
- Shale Plans Woodland which is equivalent to: PCT 849 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion.

DIRD (2016) identified and mapped HN526 *Forest Red Gum – Rough-barked Apple grassy woodland on floodplains, Sydney Basin*, as being present on the eastern side of Oaky Creek. This community corresponds to *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* Endangered Ecological Community (EEC) under the BC Act.

4.2 Methods

The following sections outline the methods employed to map vegetation, and to assess the vegetation integrity of native vegetation within the impact area.

4.2.1 Detailed vegetation mapping and habitat assessment

Native vegetation was assessed in the field by EMM on the following dates:

- 30 January 2020; and
- 24 February 2020.

Field surveys on 30 January stratified the subject property by air photo interpretation and on-ground validation into PCTs. Mapping of vegetation communities was conducted using hand-held tablet computers using the ArcGIS Collector application and aerial photo interpretation.

PCTs were stratified into vegetation zones based on broad condition state. Depending on the condition of these PCTs, they were allocated to a condition class of Medium or Poor was attributed depending on the condition of vegetation.PCTs were stratified into vegetation zones based on broad condition state using the definitions in Table 4.1.

Table 4.1 Definitions used in delineation of vegetation zones

Condition class	Description
Medium	Some elements or stratum missing or immature, but minimal disturbance.
Poor	Tree stratum present, but understorey vegetation degraded due to weeds or other major disturbance.

Where there was some uncertainty about correct PCT alignment, or to justify PCT alignment, a series of rapid vegetation assessments (RVAs) were undertaken, with the three dominant species in the overstorey, midstorey and groundcover recorded. This data was assessed against data held in the Vegetation Information System (VIS) to confirm PCT alignment. Field data was aligned with a canopy height model (CHM) developed using Light Detection and Ranging (LiDAR) data in a GIS.

4.2.2 Vegetation integrity assessment

Following the stratification of vegetation zones within the impact area, native vegetation integrity was assessed using data obtained via a series of plots, as per the methodology outlined in Section 5 of the BAM (OEH 2017). A total of three plots were undertaken within the impact area (Figure 4.1). At each plot location the following was undertaken:

- one 20 x 20 m plot, for assessment of composition and structure; and
- one 20 x 50 m plots for assessment of function, including a series of five 1 x 1 m plots to assess average leaf litter cover.

The assessment of composition and structure, based on a 20 x 20 m plot, recorded species name, stratum, growth form, cover and abundance rating for each species present within the plot. Cover (foliage cover) was estimated for all species rooted in or overhanging the plot, and recorded using decimals (if less than 1%, rounded to whole number (1-5%) or estimated to the nearest 5% (5- 100%). Abundance was counted (up to 20) and estimated above 20, and recorded using the following intervals: 1, 2, 3, 4, 5, 10, 20, 50, 100, 500, 1000, 1500, 2000.

The assessment of function recorded the number of large trees, the presence of tree stem size class, tree regeneration, number of trees with hollows and length of fallen logs, as well as leaf litter cover within the 20 x 50 m plot and five 1 x 1 m subplots (0). The minimum number of plots and transects per vegetation zone was determined using Table 4 of the BAM (OEH 2017). Datasheets are provided in Appendix A, while compiled plot data is provided in Appendix B.

Areas of native vegetation for which a PCT could validly be assigned were identified and delineated in the field, and their condition determined. Identification of PCTs within the subject property was confirmed with reference to the community profile descriptions (and diagnostic species tests) held within the NSW VIS: Classification Version 2.1 (OEH 2014).

Plots were undertaken on 24 February 2020. In order to keep plots inside the impact area, plots were sometimes placed in sub-optimal areas, such as adjacent to access routes. Three plots were located partially outside of their respective mapped PCTs. Constraints to choosing plot locations were:

- parts of the PCTs occur near the edge of the quarry pit where it is unsafe to survey;
- ephemeral water flooding parts of the ARRC site vegetation during the survey, preventing adequate survey of the ground layer (hence plots were moved to dry locations); and
- most of the vegetation mapped occurs outside the ARRC site.

Surveys for flora and vegetation communities were completed under the authority of Scientific License (SL100409). A list of flora species was compiled for each plot and PCT. Records of all flora species will be submitted to Biodiversity Conservation Division (BCD) for incorporation into the Atlas of NSW Wildlife.

3.2.2 Assessment of patch size

For each vegetation zone within the impact area, patch size was assessed using a select process in ArcGIS, using existing vegetation mapping and aerial imagery. All intact native vegetation separated by a distance of less than 100 m (woody vegetation ecosystems) or 30 m (non-woody vegetation ecosystems) was mapped sequentially.

This process showed that all vegetation zones within the subject property are part of a patch of connecting vegetation of a size of >100 ha. A patch size of 101 ha was used in the calculator.

KEY

- Subject property
- ARRC site
- Indirect impact area
- Waterbody
- Cadastral boundary
- Vegetation plot

Plant community type (PCT)

1800 - Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter Valley

- Poor
- Medium

849 - Grey Box Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion

- Poor

Threatened ecological community (TEC)

- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin, South East Corner bioregions
- Cumberland Plain Woodland in the Sydney Basin bioregion

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); DOE (2019)

0 50 100 m

GDA 1994 MGA Zone 56

N

\\Emmsvr1\emm\Jobs\2019\190749 - CPG Luddenham Quarry\GIS\02 Maps\SSD Recycling Facility\BDAR\SDBDAR005 PCTs 20200615 03.mxd 16/06/2020

Plant community types in the project area and plot locations

Luddenham Advanced Resource Recovery Centre
Biodiversity Development Assessment Report
Figure 4.1

EMM
creating opportunities

4.3.2 Plant community type descriptions

Descriptions of the PCTs are provided in Table 4.3. PCTs and vegetation zones are mapped in Figure 4.1.

Table 4.3 PCT 1800 – Cumberland Swamp Oak riparian forest description

PCT 1800 – Cumberland Swamp Oak riparian forest	
PCT ID	1800
Common name	Cumberland Swamp Oak riparian forest
Condition classes	Two vegetation zones were mapped within the subject property: • Medium • Poor
Extent within the subject property	**Total area 2.47 ha** 1.24 ha (medium) 1.23 ha (poor)
Extent within ARRC site	**Total area 0.28 ha** 0.21 ha (medium) 0.07 ha (poor)
Description	The below description relates to vegetation surveyed within the impact area. The adjacent vegetation inside the subject property – but outside the ARRC site – includes a greater variety of canopy and midstorey species, such as Cabbage Gum (*Eucalyptus amplifolia*), Woollybutt (*E. longifolia*) and an unknown Ironbark (*Eucalyptus* sp.). The PCT comprises a canopy of Swamp Oak. The midstorey is sparse, comprising African Boxthorn (*Lycium ferocissimum*) and Moth Vine (*Araujia sericifera*), The groundlayer is dominated by exotic species. Exotic grass and grass-like species are: Kikuyu (*Cenchrus clandestinus*), Paspalum (*Paspalum dilatatum*) and Marsh Bristlegrass (*Setaria parviflora*). Exotic forb species are: Alligator Weed (*Alternanthera philoxeroides*), Black-berry Nightshade (*Solanum nigrum*), Bridal Creeper (*Asparagus asparagoides*) and Paddy's Lucerne (*Sida rhombifolia*). Native grasses and forbs comprise Common Couch (*Cynodon dactylon*), an Oxalis (*Oxalis exilis*), Climbing Saltbush (*Einadia* spp.), Indian Pennywort (*Centella asiatica*), Kidney Weed (*Dichondra repens*), Red Grass (*Bothriochloa macra*), Slender Rat's Tail Grass (*Sporobolus elongatus*), Variable Glycine (*Glycine tabacina*), Weeping Grass (*Microlaena stipoides*) and Wiry Spurge (*Phyllanthus virgatus*).
Survey effort	Three plots/transects within the impact area: • Medium: 2 plots • Poor: 1 plot
Condition description	The community is in medium to poor condition with a high cover of introduced plant species due to past and current grazing activities. Vegetation zones were delineated largely based off whether the canopy was dense or sparse.

Table 4.3 PCT 1800 – Cumberland Swamp Oak riparian forest description

PCT 1800 – Cumberland Swamp Oak riparian forest	
Characteristic species used for identification of PCT	This PCT could align with PCT 1800 or PCT 835. According to the NSW VIS Classification (OEH 2014), PCT 1800 Cumberland Swamp Oak Riparian Forest (*Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter Valley*) is found on the riverflats of the Cumberland Plain in western Sydney and in the Hunter Valley. The distinguishing feature is the prominent stands of Swamp Oak found along or near streams. This community features an open grassy and herbaceous understorey, as is typical of riverflat forests. It may be that this is a pioneering community that is re-establishing following clearing. It is known that many creeklines in western Sydney are slightly saline, particularly during drought (Benson and Howell 1990). The NSW VIS Classification for PCT 835 Cumberland River-flat Forest (*Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion*) is found on broad alluvial flats of the Hawkesbury and Nepean river system. It also forms narrower ribbons alongside streams and creeks that drain the Cumberland Plain. Typically the canopy includes one of either rough-barked apple (*Angophora floribunda*) or broad-leaved apple (*Angophora subvelutina*) and one or both of forest red gum (*Eucalyptus tereticornis*) and cabbage gum (*Eucalyptus amplifolia*). The understorey within this riverflat forest is characterised by an occasional sparse to open small tree stratum of paperbark (*Melaleuca* spp.) and wattles (*Acacia* spp.).
Justification of evidence used to identify the PCT	PCT 1800 is chosen because: • the subject property is on the Cumberland Plain; • a canopy of Swamp Oak is characteristic of this PCT. The description of Cumberland Riverflat Forest in the Sydney Metro veg classification, lists *Casuarina glauca* as an 'Uninformative' (non-diagnostic) species sometimes found (22% frequency) in the community; • the area mapped is regularly inundated, providing swamp conditions; • analysis of plot data against key characteristic species provides: – 20% (Canopy), 7% (Understorey) and 11% (Groundlayer), noting that VIS treats Swamp Oak as both a canopy and understorey species; otherwise the score for understorey would be 0%. The description of PCT 1800 acknowledges that "It may be that this is a pioneering community that is re-establishing following clearing". In conclusion, PCT 1800 has been chosen as the current best fit, based on landform subject to periodic inundation and species currently present, in particular that the vegetation is dominated by Swamp Oak. However, it is noted that the vegetation has likely colonised responding to past clearing; and is probably vegetation in a transitional state between PCT1800 and PCT835.
Status	PCT 1800 Cumberland Swamp Oak riparian forest Bioregion is associated with the *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions Endangered Ecological Community* listed under the BC and EPBC Act. The PCT aligns with the BC Act listing because: • it occurs on the Cumberland plains; • it comprises a dense tree canopy; • it is regularly waterlogged; and • the canopy comprises Swamp Oak. The PCT does not align with the EPBC Act listing because: • the PCT is less than 2 ha with the groundlayer over 50% exotic species.
Estimate of percent cleared value of PCT within NSW	60%

Table 4.3 PCT 1800 – Cumberland Swamp Oak riparian forest description

PCT 1800 – Cumberland Swamp Oak riparian forest

Photograph 4.1 Cumberland Swamp Oak riparian forest within the impact area (Medium condition - plot ID P03).

Table 4.4 PCT 849 - Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion description

PCT 849 - Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	
PCT ID	849
Common name	Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion
Condition classes	Poor
Extent within the subject property	0.35 ha
Extent within footprint	0 ha
Description	The canopy comprises dying Grey Box (*Eucalyptus moluccana*). It is assumed that they are dying from either the drought conditions or from dieback. Due to the absence of fruiting material, adult leaves or a healthy tree form, identification was based on juvenile leaves, bark, and the local species in the area. Trees inspected outside the subject property also lacked identification material. The midstorey is absent. The groundlayer is co-dominated by exotic grass and forb species. Exotic grass and grass-like species are: Kikuyu (*Cenchrus clandestinus*), Rhodes Grass (*Chloris gayana*), Paspalum (*Paspalum dilatatum*) and Marsh Bristlegrass (*Setaria parviflora*). Other exotic species are Moth Vine (*Araujia sericifera*), Turnip Weed (*Rapistrum rugosum*), Paddy's Lucerne (*Sida rhombifolia*), Small-flowered Mallow (*Malva parviflora*), Lamb's Tongues (*Plantago lanceolata*), Apple of Sodom (*Solanum linnaeanum*), Black-berry Nightshade (*Solanum nigrum*) and Shore Verbain (*Verbena caracasana*). The native grasses and grass-like species are Common Couch (*Cynodon dactylon*), Toad Rush (*Juncus bufonius*), Watercrown Grass (*Paspalidium distans*) and Early Spring Grass (*Eriochloa pseudoacrotricha*), which are all commonly associated with exotic grasslands and are often cultivated. The native forbs are Climbing Saltbush (*Einadia* spp.), Kidney Weed (*Dichondra repens*), Fireweed (*Senecio* spp.) and Dock (*Rumex* spp.).
Survey effort	1 plot
Condition description	The community is in poor condition with a high cover of introduced or cultivated plant species, likely due to past grazing activities. Since grazing activities ceased, there is no evidence of mowing or regular grazing, given that the area is littered with rubbish and the large grass tussocks appear to be choking out the smaller species. The overstorey consists of dead and dying trees, where the healthier specimens are covered in large juvenile leaves, but no adult leaves are visible. The trees in the adjacent property are likewise in poor condition. The midstorey (shrub layer) is absent. Surrounding land use (mostly grazing) and associated edge impacts contribute even further to the existing condition of this PCT.
Characteristic species used for identification of PCT	The canopy comprises Grey Box, which is a dominant species of both PCT 849 and 850. The midstorey is absent. The groundlayer includes Kidney Weed (which is characteristic of PCT 849 and 850) and Watercrown (characteristic of PCT 849 only).

Table 4.4 PCT 849 - Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion description

PCT 849 - Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	
Justification of evidence used to identify the PCT	According to the NSW VIS Classification (Version 2.1.9), grassy woodlands in the Cumberland Plains are likely to fit one of two PCTs, which together are known as Cumberland Plain Woodland in the Sydney Basin Bioregion EEC: PCT 849 and 850. These PCTs are very similar. Both comprise a canopy of two to three dominant species, of which Grey Box is one. The elevation is 69 m, which could fit either PCT description. PCT 849 was chosen because: • of the lack of Hickory Wattle (*Acacia implexa*) within the subject property (which the VIS specifically states is a characteristic distinction between the two PCTs); • two present groundlayer species align with PCT 849 (Kidney Weed and Watercrown) but only one species for PCT 850 (Kidney Weed); • analysis of plot data against key characteristic species fits PCT 849 best: – PCT 849: 50% (canopy), 0% (midstorey), 9% (groundlayer); and – PCT 850: 33% (canopy), 0% (midstorey), 7% (groundlayer).
Status	PCT 849 Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion is associated with the *Cumberland Plain Woodland in the Sydney Basin Bioregion Endangered Ecological Community* listed under the BC and EPBC Act. The PCT aligns with the BC Act listing because: • it occurs on the Cumberland plains; • it comprises an open tree canopy; • it comprises a continuous groundcover dominated by grasses and herbs; • the canopy is dominated by Grey Box; and • the PCT does not align with the EPBC Act listing because it is less than 0.5 ha in size.
Estimate of percent cleared value of PCT within NSW	93%

Table 4.4 **PCT 849 - Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion description**

PCT 849 - Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion


Photograph 4.2 **Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion within the subject property (Poor condition - plot ID P01).**

4.3.3 Vegetation integrity score

The vegetation integrity score for each vegetation zone of PCT 1800 within the impact area is presented in Table 4.5.

Table 4.5 Vegetation zones mapped within the impact area

Plant community type	Condition	Vegetation integrity score
PCT 1800 – Cumberland Swamp Oak riparian forest	Medium	48.2
	Poor	45.4

4.4 Groundwater dependent ecosystems

An assessment was completed to identify terrestrial ecosystems which potentially use and/or are reliant on groundwater in the subject property. It included reviewing the Groundwater Dependent Ecosystem (GDE) Atlas (BOM 2020) and groundwater monitoring data.

4.4.1 Identification of potential GDEs

Ecosystems that could rely on either surface or subsurface expression of groundwater within or surrounding the subject property are those associated with:

- creeks where deep groundwater is discharging and provides baseflow;
- shallow (perched) groundwater systems;
- springs; and
- terrestrial vegetation overlaying shallow groundwater (within the vegetation roost zone).

These ecosystems have been classified into three categories according to their dependence on groundwater:

- non-dependent;
- facultative;
- entirely dependent/obligate:
    - opportunistic;
    - proportional; and
    - highly dependent.

Considerations in evaluating PCTs and their potential dependency on groundwater include:

- the physiology of plant species that occur in that community and their likely dependence on water availability;
- the PCTs location in the landscape; and
- if the rooting depth of vegetation would be able to take up groundwater based on likely depth of the aquifer and soil characteristics.

Access to the groundwater is dependent on a number of factors with the core factor being the depth to the water table. As terrestrial vegetation communities are composed of a range of vegetation types with a range of rooting depths and strategies there is a relationship between groundwater depth and the types and composition of the vegetation that is able to access it (Serov P 2012).

4.4.2 Potential GDEs

The GDE Atlas (BOM 2020) does not show any terrestrial GDEs as occurring in the subject property. It is not considered that the ARRC site will have an impact on the water table as no groundwater extraction has been proposed as part of the works.

5 Threatened species

5.1 Fauna habitat assessment

Fauna habitat primarily comprises the riparian corridor running along the eastern boundary of the subject property. The extensive history of use of the subject property for agricultural purposes and quarrying, has resulted in large areas of exotic grassland, a highly degraded woodland, and a narrow riparian corridor. Scattered native trees and some ephemeral dams also provide some habitat. As a result, the subject property provides limited refuge or habitat for fauna.

The exotic grassland comprises dense patches of pasture grasses, particularly Kikuyu. Habitat features, such as bare ground, inter-tussock-space, logs, and perching structures are virtually absent.

PCT 849 is comprised of trees in very poor condition. The area contains minimal areas of fallen timber, with some areas of scattered rubbish providing some habitat in the groundlayer. The canopy of the trees is limited to dense epicormic growth. No adult leaves were seen during the surveys in January and February 2020.

The riparian corridor comprises largely Swamp Oak with occasional juvenile planted native trees growing along Oaky Creek. Due to the young age of these trees, presence of habitat features (such as logs, hollow-bearing trees, etc.) is very limited. During periods of low flow, Oaky creek consists of a series of disconnected pools with a muddy base and little aquatic vegetation.

The scattered trees comprise Swamp Oak, from regenerating trees to mature trees. No hollows were identified. The ephemeral dams and swamps are dominated by exotic species. The groundlayer is either absent or dominated by wetland plants, depending on the frequency and duration of flooding events.

A shed associated with the quarry was located to the south west of the ARRC site, this building is an open large tin shed, with no roof voids with no features considered to support fauna species. A bridge was identified crossing Oaky Creek in the southeast of the subject property and was considered to provide potential microchiropteran habitat.

No threatened flora or fauna were recorded along the eastern side of Oaky Creek within the Western Sydney Airport (DIRD 2016).

5.2 Ecosystem credit species assessment (step 1)

Ecosystem credits species are threatened species that can be reliably predicted to use an area of land based on habitat surrogates. For the purposes of the BAM (OEH 2017), ecosystem credit species are deemed to be offset through the habitat surrogates (PCTs) in which they occur. A list of ecosystem credit species predicted to occur within the impact area, based on the PCTs present and generated by the calculator associated within the BAM (OEH 2017) is provided in Table 5.1. The potential for these species to occur within the impact area was assessed in accordance with Section 6.2 of the BAM (OEH 2017).

Table 5.1 Assessment of ecosystem credit species within the subject property footprint

Common name	Scientific name	Justification for exclusion
Anthochaera phrygia	Regent Honeyeater (Foraging)	Regent Honeyeater inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. The Regent Honeyeater is a generalist forager, although it feeds mainly on the nectar from a relatively small number of eucalypts that produce high volumes of nectar. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany The impact area is dominated by Swamp Oak and lacks suitable numbers of eucalyptus species or abundance of mistletoes for foraging. The surrounding habitat has been cleared for farming and is highly isolated from larger patches of more suitable habitat. This species is excluded.
Artamus cyanopterus	Dusky Woodswallow	Excluded from cleared vegetation zones and condition class Poor.
Callocephalon fimbriatum	Gang-gang Cockatoo (Foraging)	Excluded from cleared vegetation zones (condition class Poor or Derived grassland). Species associated with PCT 849 which is located outside of the impact area.
Chthonicola sagittata	Speckled Warbler	The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. The impact area is dominated by Swamp Oak and lacks native tussock grasses. The surrounding habitat has been cleared for farming and is highly isolated from larger patches of more suitable habitat. This species is excluded.
Circus assimilis	Spotted Harrier	Not excluded. Species associated with PCT 849 which is located outside of the impact area.

Table 5.1 Assessment of ecosystem credit species within the subject property footprint

Common name	Scientific name	Justification for exclusion
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis),* forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; fallen timber is an important habitat component for foraging. Hollows in standing dead or live trees and tree stumps are essential for nesting. The impact area is dominated by Swamp Oak and lacks suitable eucalypts species that this species is known to be associated with. The surrounding habitat has been cleared for farming and is highly isolated from larger patches of more suitable habitat. This species is excluded.
Daphoenositta chrysoptera	Varied Sittella	Excluded from cleared vegetation zones and condition class Poor.
Dasyurus maculatus	Spotted-tailed Quoll	Spotted-tailed Quoll use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites in areas containing rainforest, open forest woodland, coastal heath and inland riparian forest. The impact area lacks suitable den features. The surrounding habitat has been cleared for farming and is highly isolated from larger patches of more suitable habitat. This species is excluded.
Glossopsitta pusilla	Little Lorikeet	Excluded from cleared vegetation zones and condition class Poor.
Grantiella picta	Painted Honeyeater	Excluded from cleared vegetation zones and condition class Poor.
Haliaeetus leucogaster	White-bellied Sea-Eagle (Foraging)	Excluded from cleared vegetation zones and condition class Poor.
Hieraaetus morphnoides	Little Eagle (Foraging)	Excluded from cleared vegetation zones and condition class Poor.
Ixobrychus flavicollis	Black Bittern	Excluded from cleared vegetation zones and condition class Poor.

Table 5.1 Assessment of ecosystem credit species within the subject property footprint

Common name	Scientific name	Justification for exclusion
Lathamus discolor	Swift Parrot (Foraging)	Swift Parrot occur in areas where eucalypts are flowering profusely or where lerp (from sap-sucking bugs) infestations are abundant. Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (C. gummifera), Forest Red Gum (*E. tereticornis*), Mugga Ironbark *(E. sideroxylon*), and White Box (*E. albens*). The impact area is dominated by Swamp Oak and lacks suitable numbers of eucalyptus species for foraging. The surrounding habitat has been cleared for farming and is highly isolated from larger patches of more suitable habitat. This species is excluded.
Lophoictinia isura	Square-tailed Kite	Not excluded.
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	Not excluded.
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	Not excluded.
Micronomus norfolkensis	Eastern Coastal Free-tailed Bat	Not excluded. This species was recorded within the impact area.
Miniopterus australis	Little Bent-winged Bat (foraging)	Not excluded. This species was recorded as having a probable pass during the acoustic detection survey.
Miniopterus orianae oceanensis	Large Bent-winged Bat (foraging)	Not excluded. This species was recorded during the acoustic detection survey.
Neophema pulchella	Turquoise Parrot	Not excluded.
Ninox connivens	Barking Owl (Foraging)	Not excluded.
Ninox strenua	Powerful Owl (Foraging)	Excluded from cleared vegetation zones and condition class Poor.
Pandion cristatus	Eastern Osprey (Foraging)	Excluded from cleared vegetation zones and condition class Poor.
Petroica boodang	Scarlet Robin	Excluded from cleared vegetation zones and condition class Poor.

Table 5.1 Assessment of ecosystem credit species within the subject property footprint

Common name	Scientific name	Justification for exclusion
Petroica phoenicea	Flame Robin	Excluded from cleared vegetation zones and condition class Poor.
Phascolarctos cinereus	Koala (Foraging)	Excluded from cleared vegetation zones and condition class Poor.
Pteropus poliocephalus	Grey-headed Flying-fox (Foraging)	Excluded from cleared vegetation zones and condition class Poor. This species was recorded within the impact area during nocturnal surveys.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Not excluded. The species was heard foraging over the impact area during nocturnal surveys.
Stagonopleura guttata	Diamond Firetail	Not excluded.
Tyto novaehollandiae	Masked Owl (Foraging)	Not excluded.

5.3 Species credit species assessment (step 1)

Species credit species are threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. A list of species credit species predicted to occur within the impact area, based on the PCTs present and generated by the calculator associated within the BAM (OEH 2017) is provided in Table 5.2.

The potential for species credit species to occur within the impact area is assessed in Section 5.3.1 below, in accordance with Section 6.2 of the BAM (OEH 2017).

5.3.1 Habitat constraints assessment (Step 2)

For the purposes of the BAM (OEH 2017), species credit species require detailed assessment and, if present, additional offsets to ecosystem credits. An assessment of habitat constraints for threatened species credit species was undertaken in accordance with Step 2 of Section 6.4 of the BAM (OEH 2017). For those threatened species credit species predicted to occur, for which habitat constraints are listed, an assessment was undertaken of the presence of the habitat features within the subject property.

The species generated by the calculator with habitat constraints, as well as the results of the habitat constraints assessment, are shown in Table 5.2.

Table 5.2 Assessment of geographic and habitat constraint features within the subject property

Scientific name	Common name	Feature	Sensitivity to gain class	Habitat / geographic constraint present in the subject property	Justification
Flora					
Gyrostemon thesioides		• Sandy, alluvial or colluvial soil within 50 m of a water course	High	Yes	The subject property either is within 50 m of a water course.
Maundia triglochinoides		• Ephemerally and semi-permanently wet areas • Wet areas up to 1 m deep • Wet areas can be man-made or natural	High	Yes	The subject property contains semi-permanent and ephemeral wet areas suitable to support this species.
Marsdenia viridiflora subsp. viridiflora - endangered population	Marsdenia viridiflora R. Br. subsp. viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	• Those LGAs named in the population's listing	High	Yes	The subject property is within Liverpool LGA.
Persicaria elatior	Tall Knotweed	• Semi-permanent/ephemeral wet areas; or • within 50 m swamps; or • or within 50 m of waterbodies including Wetlands	High	Yes	The subject property contains semi-permanent and ephemeral wet areas suitable to support this species.
Fauna					
Anthochaera phrygia	Regent Honeyeater (Breeding)	• As per mapped areas	High	No	The subject property is not mapped as containing known breeding habitat for this species.
Burhinus grallarius	Bush Stone-curlew	• Fallen/standing dead timber including logs	High	Yes	The subject property contains minimal features such as fallen and standing dead timer.

Table 5.2 Assessment of geographic and habitat constraint features within the subject property

Scientific name	Common name	Feature	Sensitivity to gain class	Habitat / geographic constraint present in the subject property	Justification
Callocephalon Fimbriatum	Gang-gang Cockatoo (Breeding)	• Eucalypt tree species with hollows greater than 9 cm diameter	High	No	One dead standing tree that contained a small to medium size hollow was observed within the subject property. This hollow was less than 9 cm diameter, and was being used by breeding Red-rumped parrots (*Psephotus haematonotus*).
Chalinolobus dwyeri	Large-eared Pied Bat	• Cliffs within 2 km of rocky areas containing caves, overhangs, escarpments, outcrops, or crevices, or within two kilometres of old mines or tunnels.	Very high	No	The subject property does not contain cliffs, or is within 2 km of rocky areas that could provide features to support this species. This species was recorded during the acoustic detection surveys, having just one pass over the site. It is assumed the riparian corridor may be used as commuting habitat for this species.
Haliaeetus leucogaster	White-bellied Sea-Eagle (Breeding)	• Living or dead mature trees within suitable vegetation within 1 km of a river, lake, large dam or creeks, wetland and coastlines.	High	Yes	The subject property contains living and dead mature trees located 1 km from large dams and wetlands.
Hieraaetus morphnoides	Little Eagle (Breeding)	• Nest Trees – live (occasionally dead) large old trees within vegetation.	Moderate	Yes	The subject property contains live mature trees, however, these trees are not considered to be large old trees.
Lathamus discolour	Swift Parrot	• As per mapped areas	Moderate	No	The subject property is not mapped as containing known breeding habitat for this species.
Litoria aurea	Green and Golden Bell Frog	• Semi-permanent/ephemeral wet areas • Within 1km of wet areas / swamps • Within 1km of swamp / waterbodies • Within 1km of waterbody	High	Yes	The subject property contains semi-permanent and ephemeral wet areas suitable to support this species.

Table 5.2 Assessment of geographic and habitat constraint features within the subject property

Scientific name	Common name	Feature	Sensitivity to gain class	Habitat / geographic constraint present in the subject property	Justification
Lophoictinia isura	Square-tailed Kite (Breeding)	• Nest trees	Moderate	No	No nest trees were observed that are been used by this species.
Miniopterus australis	Little Bent-winged Bat (Breeding)	• Caves, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in BioNet with microhabitat code 'IC – in cave' • Observation type code 'E nest-roost' • With numbers of individuals >500 • Or from the scientific literature	Very High	No	The subject property does not contain caves or out structures that could provide breeding features to support this species.
Miniopterus orianae oceanensis	Large Bent-winged Bat (Breeding)	• Caves, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in BioNet with microhabitat code 'IC – in cave' • Observation type code 'E nest-roost' • With numbers of individuals >500	Very High	No	The subject property does not contain caves or out structures that could provide breeding features to support this species. This species was recorded during the acoustic detection surveys. It is assumed the riparian corridor may be used as commuting habitat for this species.
Myotis macropus	Southern Myotis	• Hollow bearing trees. • Within 200 m of riparian zone. • Bridges, caves or artificial structures within 200 m of riparian zone / waterbodies. • This includes rivers, creeks, billabongs, lagoons, dams and other waterbodies on or within 200 m	High	Yes	The subject property is within 200 m of a riparian zone and contains a number of dams and waterbodies.

Table 5.2 Assessment of geographic and habitat constraint features within the subject property

Scientific name	Common name	Feature	Sensitivity to gain class	Habitat / geographic constraint present in the subject property	Justification
Ninox connivens	Barking Owl (Breeding)	• Hollow bearing trees • Living or dead trees with hollows greater than 20 cm diameter and greater than 4m above the ground	High	No	One dead standing tree that contained a small to medium size hollow was observed within the subject property. This hollow was less than 9 cm diameter, observed to be used by breeding Red-rumped parrots.
Ninox strenua	Powerful Owl (Breeding)	• Living or dead trees with hollow greater than 20 cm diameter	High	No	One dead standing tree that contained a small to medium size hollow was observed within the subject property. This hollow was less than 9 cm diameter, observed to be used by breeding Red-rumped parrots.
Pandion cristatus	Eastern Osprey (Breeding)	• Presence of stick-nest in living and dead trees (>15 m) or artificial structures within 100 m of a floodplain for nesting	Moderate	No	The subject property did not contain any evidence of stick-nest in trees or artificial structures within 100 m of the waterbodies.
Phascolarctos cinereus	Koala (Breeding)	• Areas identified via survey and important habitat	High	Yes	The subject property is mapped as containing land subject to the 'Koala Development Application Map'.
Pommerhelix duralensis	Dural Land Snail	• Leaf litter and shed bark or within 50 m of litter or bark Rocks or within 50 m of rocks	High	Yes	The subject property contains leaf litter and shed bark but lacks any rocky habitat. Species associated with PCT 849 which is located outside of the impact area.
Pteropus poliocephalus	Grey-headed Flying-fox (Breeding)	• Breeding camps	High	No	No breeding camps are located within or adjacent to the subject property.
Tyto novaehollandiae	Masked Owl (Breeding)	• Living or dead trees with hollows greater than 20 cm diameter	High	No	One dead standing tree that contained a small to medium size hollow was observed within the subject property. This hollow was less than 9 cm diameter, observed to be used by breeding Red-rumped parrots.

Using the process outlined in Step 2 of Section 6.4 of the BAM (OEH 2017), the species that were excluded (Table 5.3) do not require further assessment as per section 6.4.1.13 of the BAM (OEH 2017). Species that have not been excluded on the basis of the identified geographic or habitat constraints above are given further consideration in Section 6.3.2.

Table 5.3 Species excluded from further assessment

Scientific name	Common name
Anthochaera phrygia	Regent Honeyeater (Breeding)
Callocephalon Fimbriatum	Gang-gang Cockatoo (Breeding)
Chalinolobus dwyeri	Large-eared Pied Bat
Lathamus discolour	Swift Parrot
Lophoictinia isura	Square-tailed Kite (Breeding)
Miniopterus australis	Little Bent-winged Bat (Breeding)
Miniopterus orianae oceanensis	Large Bent-winged Bat (Breeding)
Ninox connivens	Barking Owl (Breeding)
Ninox strenua	Powerful Owl (Breeding)
Pandion cristatus	Eastern Osprey (Breeding)
Pteropus poliocephalus	Grey-headed Flying-fox (Breeding)
Tyto novaehollandiae	Masked Owl (Breeding)

5.3.2 Identifying candidate species credit species for further assessment (Step 3)

To develop a list of species credit species for further assessment, an assessment was undertaken in accordance with Step 3 of Section 6.4 of the BAM (OEH 2017), as shown in Table 5.4.

Table 5.4 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
Flora			
Acacia bynoeana	Bynoe's Wattle	Yes	Bynoe's Wattle is a semi-prostrate shrub to a metre high. It is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. The species is currently known from about 30 locations, with the size of the populations at most locations being very small (1-5 plants). Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include Red Bloodwood, Scribbly Gum, Parramatta Red Gum, Saw Banksia and Narrow-leaved Apple. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 849, as such this habitat is only considered marginal to support this species within the subject property. Species associated with PCT 849 which is located outside of the impact area.
Acacia pubescens	Downy Wattle	Yes	Downy Wattle occurs in open woodland and forest, in a variety of plant communities. Hybridises with other wattle species (A. *baileyana*, A. *decurrens* and A. *jonesii*). High Sensitivity to loss (ie providing protection above the listing status) based on recent population decline. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 849, as such this habitat is only considered marginal to support this species within the subject property. Species associated with PCT 849 which is located outside of the impact area.
Caladenia tessellata	Thick Lip Spider Orchid	No (degraded habitat)	Found in grassy sclerophyll woodland on clay loam or sandy soils. When not flowering, only a single leaf is visible above ground, and this leaf regrows each year. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 1800, as such this species is not considered to occur within the subject property.

Table 5.4 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
Cynanchum elegans	White-flowered Wax Plant	Yes	The rare species is known in rainforest gullies scrub and scree slopes. Associated vegetation types include littoral rainforest; Coastal Tea-tree *Leptospermum laevigatum* – Coastal Banksia (*Banksia integrifolia subsp. integrifolia*) coastal scrub; Forest Red Gum (*Eucalyptus tereticornis*) aligned open forest and woodland; Spotted Gum (*Corymbia maculata*) aligned open forest and woodland; and Bracelet Honeymyrtle (*Melaleuca armillaris*) scrub to open scrub. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 849, as such this habitat is only considered marginal to support this species within the subject property. Species associated with PCT 849 which is located outside of the impact area.
Deyeuxia appressa		No (degraded habitat)	No records since 1942. Given that this species hasn't been seen in over 60 years, almost nothing is known about its habitat and ecology. The species requires moist conditions to grow. Ecology data is inferred from other species. This species hasn't been seen for over 60 years, the habitat within the subject property has undergone historical clearing and grazing, it may no longer be suitable to support this species. This species has been assumed to be extinct in the wild. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 1800, as such this species is not considered to occur within the subject property.
Dillwynia tenuifolia		Yes	Present in western Sydney, mainly in scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or lateraled clays. Will flower sporadically outside of official survey period in response to rain. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 849, as such this habitat is only considered marginal to support this species within the subject property. Species associated with PCT 849 which is located outside of the impact area.

Table 5.4 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
Eucalyptus benthamii	Camden White Gum	Yes	Occurs from 30 m up to as high as 750 m ASL in the Kedumba population in open forest. Most populations occur between 60 m and 300 m ASL. Requires a combination of deep alluvial sands and a flooding regime that permits seedling establishment (ie. bare silt deposits in rivers and streams). Associated with *Eucalyptus elata*, *E. bauerina*, *E. amplifolia*, *E. deanei* and *Angophora subvelutina*. Understorey species include *Bursaria spinosa*, *Pteridium esculentum*, and a wide variety of agricultural weeds. The species is often associated with floodplains. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 849, as such this habitat is only considered marginal to support this species within the subject property. Species associated with PCT 849 which is located outside of the impact area.
Grevillea juniperina subsp. juniperina	Juniper-leaved Grevillea	Yes	Associated with Cumberland Plain Woodland, amongst other vegetation types common in western Sydney. Grows on reddish clay to sandy soils. Associated canopy species in Cumberland Plain Woodland includes Forest Red Gum (*Eucalyptus tereticornis*), Grey Box, Narrow-leaved Ironbark (*E. crebra*), Red ironbark (*E. fibrosa*) and Thin-leaved Stringybark (*E. eugenioides*). Understorey species include Blackthorn (*Bursaria spinosa*), Siebers Parrot-pea (*Dillwynia sieberi*), Rice Flower (*Ozothamnus diosmifolius*), Gorse Bitter Pea (*Daviesia ulicifolia*), Sickle Wattle (*Acacia falcata*), Parramatta Wattle (*A. parramattensis*), Kangaroo Grass (*Themeda australis*), Purple Wiregrass (*Aristida ramosa*), Barbed-wire Grass (*Cymbopogon refractus*), Browns Lovegrass (*Eragrostis brownii*), Rock Fern (*Cheilanthes sieberi*), Spreading Flax-lily (*Dianella* revoluta) and Ivy Goodenia (*Goodenia hederacea*). The species often colonises mechanically disturbed areas. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 849, as such this habitat is only considered marginal to support this species within the subject property. Species associated with PCT 849 which is located outside of the impact area.

Table 5.4 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
Gyrostemon thesioides	Broom Wheelfruit	No	Grows on hillsides and riverbanks and may be restricted to fine sandy soils. Surveys must occur within three years of fire and thereafter may only be present in the seedbank. Unable to survey due to lack of evidence of fire occurring within the last three years. The subject property is located in a rural landscape with patchy and fragmented native vegetation. PCT 1800 is regularly inundated with areas of standing water surrounded by waterbodies. It is considered rare that this habitat would be affected by fires regular enough to support germination for this species. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 1800, as such this species is not considered to occur within the subject property.
Maundia triglochinoides		Yes	Grows in swamps, lagoons, dams, channels, creeks or shallow freshwater 30–60 cm deep on heavy clay and low nutrients. Fruit are required for identification. Associated with wetland species e.g. *Triglochin procerum*.; spreads vegetatively, with tufts of leaves arising along rhizome. Populations expand following flood events and contract to more permanent wetlands in times of low rainfall. Appears to be somewhat dependent on water quality so a population can go from prolific to nothing and back again over time. It can be absent for many years and then flourish. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 1800, as such this habitat is only considered marginal to support this species within the subject property. Potential to occur in PCT 1800 in areas where water occasionally/regularly reaches up to 1 m depth.
Marsdenia viridiflora subsp. viridiflora - endangered population	-	Yes	The subject property is located within the area mapped for this population. No previous recorded of this species/population are within the subject property. Presence cannot be discounted without survey.
Persicaria elatior	Tall Knotweed	Yes	This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 1800, as such this habitat is only considered marginal to support this species within the subject property. Potential to occur in PCT 1800 in areas either within 50 m of permanent water bodies, or within ephemerally wet areas.

Table 5.4 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
Persoonia bargoensis	Bargo Geebung	Yes	The Bargo Geebung occurs in woodland or dry sclerophyll forest on sandstone and on heavier, well drained, loamy, gravelly soils of the Wianamatta Shale and Hawkesbury Sandstone. It favours interface soil landscapes such as between the Blacktown Soil Landscape and the complex Mittagong Formation soils (Lucas Heights Soil Landscape) with the underlying sandstone (Hawkesbury Soil Landscape and Gymea Soil Landscape). Some of the vegetation the species occurs within would be recognised as the Shale/Sandstone Transition Forest, a listed community. This species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 849, as such this habitat is only considered marginal to support this species within the subject property. Species associated with PCT 849 which is located outside of the impact area.
Pilularia novae-hollandiae	Austral Pillwort	No (degraded habitat)	Austral Pillwort grows in shallow swamps and waterways, often among grasses and sedges. It is most often recorded in drying mud as this is when it is most conspicuous. Most of the records in the Albury-Urana area were from table drains on the sides of roads. The ACT record was from a subalpine grassy plain. This species is probably ephemeral (especially in the drier parts of its range), appearing when soils are moistened by rain. Survey in drying mud after inundation. This species can be associated with highly disturbed areas, found in table drains on roadsides. Most recorded are known to occur within the Albury-Urana area. This species is only predicted to occur within the Cumberland IBRA sub region. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded, as such this habitat is only considered marginal to support this species within the subject property.

Table 5.4 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
Pimelea curviflora var. curviflora		Yes	Restricted to the coastal zone around Sydney occurring on ridge tops and upper slopes in open forest and woodland on sandy soil derived from sandstone on shaley/lateritic soils and shale/sandstone transition soils. It often grows among dense grasses and sedges. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 849, as such this habitat is only considered marginal to support this species within the subject property. Due to the variable flowering and cryptic nature of the species, two surveys are generally required. However, given the highly disturbed nature of the groundlayer in the subject property, no potential habitat is available for the species. Therefore, one survey is considered adequate to assess presence. Species associated with PCT 849 which is located outside of the impact area.
Pimelea spicata	Spiked Rice-flower	No (degraded habitat)	In the Cumberland Plain this species is associated with Grey Box communities (particularly Cumberland Plain Woodland variants and Moist Shale Woodland) on well-structured clay soils. It is associated with Grey Box, Forest red gum (E. *tereticornis*) and narrow-leaved ironbark (*E. crebra*). Blackthorn (*Bursaria spinosa*) is often present at sites (and may be important in protection from grazing) and Kangaroo Grass (*Themeda australis*). Must survey 4 weeks after at least a 30 mm rainfall event. In drier times plants are often not visible above ground unless soil remain moist. Multiple surveys may be required. Survey at least 3 times, each at least a month apart unless found. Is associated with the highly disturbed areas with no or limited native vegetation. Given the density and height of exotic vegetation this species is cryptic. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included waterbody creation of dams. The habitat is highly degraded within PCT 849, as such this species is not considered to occur within the subject property.
Pomaderris brunnea	Brown Pomaderris	Yes	Brown Pomaderris grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines. It is associated with Cabbage Gum (*Eucalyptus amplifolia*) Rough-barked Apple (*Angophora floribunda*), Parramatta Wattle (*Acacia parramattensis*), Blackthorn, and White Kunzea (*Kunzea ambigua*). The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included waterbody creation of dams. The habitat is highly degraded within PCT 1800, as such this habitat is only considered marginal to support this species within the subject property.

Table 5.4 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
Pterostylis saxicola	Sydney Plains Greenhood	No (degraded habitat)	Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where *Pterostylis saxicola* occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils. Habitat requires a native groundcover (ie. over 50% native species). The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included waterbody creation of dams. The habitat is highly degraded within the subject property, as such the subject property does not contain suitable habitat for this species.
Pultenaea pedunculata	Matted Bush-pea	No (degraded habitat)	The Matted Bush-pea occurs in a range of habitats. NSW populations are generally among woodland vegetation but plants have also been found on road batters and coastal cliffs. It is largely confined to loamy soils in dry gullies in populations in the Windellama area. Colonises bare ground very well. In the Cumberland Plain the species favours sites in clay or sandy-clay soils on Wianamatta Shale-derived soils, and (in the Liverpool area) it is usually close to patches of Tertiary Alluvium. In the Liverpool - Fairfield area the majority of occurrences are in lower-lying areas and often close to creek lines. Soils are moderately to poorly drained. Associated species in the Sydney area include Grey Box, Red Ironbark (*E. fibrosa*), Narrow-leaved Ironbark (*E. crebra*), Woollybutt (*E. longifolia*) and White Feather Honeymyrtle (*Melaleuca decora*). Understorey species include Blackthorn, Rice Flower (*Ozothamnus diosmifolius*), Parramatta Wattle, Hickory Wattle (*A. falcata*), Australian Indigo (*Indigofera australis*), Sieber's Parrot-pea (*Dillwynia sieberi*), Sticky Daisy Bush (*Olearia viscidula*), White Kunzea (*Kunzea ambigua*), a Stinkweed (*Opercularia diphylla*), Cranberry Heath (*Astroloma humifusum*), Variable Glycine (*Glycine tabacina*), False Sarsaparilla (*Hardenbergia violacea*), Sprawling Bluebell (*Wahlenbergia gracilis*), Threeawn Speargrass (*Aristida vagans*), Rough Saw-sedge (*Gahnia aspera*), Wattle Mat-rush (*Lomandra filiformis*), Rock Fern (*Cheilanthes sieberi*) and Kangaroo Grass (*Themeda australis*). The subject property has been historically cleared and modified for farming and quarrying works. The habitat is highly degraded within PCT 849, as such this species is not considered to occur within the subject property.

Table 5.4 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
Thesium australe	Austral Toadflax	Yes	Austral Toadflax occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast, often in association with Kangaroo Grass and often in wet areas. This species is a root parasite that takes water and some nutrients from other plants, especially Kangaroo Grass. This species is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands region. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included waterbody creation of dams. The habitat is highly degraded within PCT 849, as such this habitat is only considered marginal to support this species within the subject property. Species associated with PCT 849 which is located outside of the impact area.
Fauna			
Burhinus grallarius	Bush Stone-curlew	Yes	The Bush Stone-curlew inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber. The subject property contains marginal habitat to support this species.
Cercartetus nanus	Eastern Pygmy-possum	No (degraded habitat)	The Eastern Pygmy-possum is found in a broad range of habitats from rainforest through sclerophyll forest and woodland to heath, but in most areas woodlands and heath appear to be preferred. Feeds largely on nectar and pollen collect from banksias, eucalypts and bottlebrushes. Also feeds on insects throughout the year. This feed source may be more important in habitats where flowers are less abundant such as wet forests. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation (eg grass-tree skirts). Nest-building appears to be restricted to breeding females. Tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks. The subject property lacks suitable feed species to support suitable habitat for Eastern Pygmy-possums, the habitat is considered isolated from larger and more suitable habitat that could support this species, and as such is highly degraded.
Haliaeetus leucogaster	White-bellied Sea-Eagle (Breeding)	No (degraded habitat)	Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts'. Nests are large structures built from sticks and lined with leaves or grass. This species was observed 1 km way from the subject property. No nests suitable for the species were observed during the habitat assessment. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the waterbody creation of dams. The habitat is highly degraded, as such breeding habitat unlikely to occur within the subject property.

Table 5.4 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
Hieraaetus morphnoides	Little Eagle (Breeding)	No (degraded habitat)	The Little Eagle occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. The species nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. No nests suitable for the species were observed during the habitat assessment. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded, as such breeding habitat unlikely to occur within the subject property.
Litoria aurea	Green and Golden Bell Frog	Yes	This species inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes waterbodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. This species can occur in highly disturbed areas. The subject property contains suitable habitat to support this species.
Meridolum corneovirens	Cumberland Plain Land Snail	Yes	Primarily inhabits Cumberland Plain Woodland (a critically endangered ecological community). This community is a grassy, open woodland with occasional dense patches of shrubs. It is also known from Shale Gravel Transition Forests, Castlereagh Swamp Woodlands and the margins of River-flat Eucalypt Forest, which are also listed communities. Lives under litter of bark, leaves and logs, or shelters in loose soil around grass clumps. Occasionally shelters under rubbish. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 849, as such this species is not considered to occur within the subject property. Species associated with PCT 849 which is located outside of the impact area.
Myotis macropus	Southern Myotis	Yes	This species roost in groups close to water in caves, mine shafts, hollow-bearing trees, storm water channels, building, under bridges and in dense foliage. The Southern Myotis relies on waterways with pools of 3 m wide or greater for foraging, breeding and roosting. The subject property contains suitable habitat for the species, as defined in OEH (2018a).

Table 5.4 Species credit species and status and habitat suitability assessment

Scientific name	Common name	Candidate species	Justification
Petaurus norfolcensis	Squirrel Glider	No (degraded habitat)	The Squirrel Glider inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. The species prefers mixed species stands with a shrub or Acacia mid-storey. The species relies on large old trees with hollows for breeding and nesting; however, trees need to be less than 50 m apart. No suitable trees with hollows are within the subject property, the habitat is considered isolated from larger and more suitable habitat that could support this species. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded, as such suitable habitat is unlikely to occur within the subject property.
Phascolarctos cinereus	Koala (Breeding)	No (degraded habitat	Koalas live in eucalypt woodlands and forests. Home range size varies according to quality of habitat, ranging from less than two to several hundred hectares. The trees within the study area provide foraging or sheltering resources for Koala. The habitat is considered isolated from larger and more suitable habitat that could support this species. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded, as such suitable habitat is unlikely to occur within the subject property.
Pommerhelix duralensis	Dural Land Snail	Yes	The species has a strong affinity for communities in the interface region between shale-derived and sandstone-derived soils, with forested habitats that have good native cover and woody debris. It favours sheltering under rocks or inside curled-up bark. It does not burrow nor climb. The species has also been observed resting in exposed areas, such as on exposed rock or leaf litter, however it will also shelter beneath leaves, rocks and light woody debris. The project area contains marginal habitat to support this species. Species associated with PCT 849 which is located outside of the impact area.

Table 5.4 identified the following species for further consideration.

Table 5.5 Candidate species

Scientific name	Common name	BC Act	EPBC Act
Flora			
Acacia bynoeana	Bynoe's Wattle	E	V
Acacia pubescens	Downy Wattle	V	V
Cynanchum elegans	White-flowered Wax Plant	E	E
Dillwynia tenuifolia		V	
Eucalyptus benthamii	Camden White Gum	V	V
Grevillea juniperina subsp. *juniperina*	Juniper-leaved Grevillea	V	-
Maundia triglochinoides		V	
Marsdenia viridiflora subsp. *viridiflora* - endangered population		E	
Persicaria elatior	Tall Knotweed	V	V
Persoonia bargoensis	Bargo Geebung	E	V
Pimelea curviflora var. curviflora		V	V
Pomaderris brunnea	Brown Pomaderris	E	V
Thesium australe	Austral Toadflax	V	V
Fauna			
Burhinus grallarius	Bush Stone-curlew	E	-
Litoria aurea	Green and Golden Bell Frog	E	V
Meridolum corneovirens	Cumberland Plain Land Snail	E	-
Myotis macropus	Southern Myotis	V	-
Pommerhelix duralensis	Dural Land Snail	E	E

The presence or absence of these species in the impact area was determined in accordance with Section 6.4 of the BAM (OEH 2017). Survey methods and outcomes are discussed further below.

5.3.3 Targeted survey methods

i Targeted flora surveys

Targeted surveys were completed on 30 January 2020. Surveys were undertaken by walking line transects in accordance with OEH *Guide to surveying threatened plants* (OEH 2016) using transects spaced at 10 m intervals across accessible areas of the subject property (ie. excluding the quarry, which is absent of vegetation). Table 5.6 shows the flora species that were able to be included as part of the flora searches, conducted 30 January 2020.

Table 5.6 Targeted threaten flora searches within the subject property.

Scientific name	Common name	Surveyed in survey guidance period
Acacia bynoeana	Bynoe's Wattle	Yes
Acacia pubescens	Downy Wattle	Yes
Cynanchum elegans	White-flowered Wax Plant	Yes
Dillwynia tenuifolia		Although surveys did not occur during survey season, the shrub form was readily detectable because no native shrub species were present in the ARRC site.
Eucalyptus benthamii	Camden White Gum	Yes
Grevillea juniperina subsp. *juniperina*	Juniper-leaved Grevillea	Yes
Maundia triglochinoides		Yes
Marsdenia viridiflora subsp. *viridiflora* - endangered population		Yes
Persicaria elatior	Tall Knotweed	Yes
Persoonia bargoensis	Bargo Geebung	Yes
Pimelea curviflora var. curviflora		Yes
Pomaderris brunnea	Brown Pomaderris	Although surveys did not occur during survey season, the shrub form was readily detectable because no native shrub species were present in the ARRC site.
Thesium australe	Austral Toadflax	Yes

KEY

- Subject property
- ARRC site
- Waterbody
- Cadastral boundary
- Watercourse
- Flora survey effort

\\Emmsvr1\emm\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02 Maps\SSD Recycling Facility\BDAR\SDBDAR006 FloraSurveyLocations 20200615 03.mxd 16/06/2020

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020)

0 50 100 m

GDA 1994 MGA Zone 56

N

Flora survey locations

Luddenham Advanced Resource Recovery Centre
Biodiversity Development Assessment Report
Figure 5.1

EMM
creating opportunities

ii Targeted fauna surveys

Targeted fauna surveys were conducted for the species listed below. Stratification units, as well as survey methods and effort are outlined for each fauna group below. Fauna survey locations are illustrated in Figure 5.2. Survey effort detailed in Appendix Cand survey weather summary in Appendix D.

a Nocturnal birds

Nocturnal bird surveys were undertaken within the subject property to target Bush Stone-curlew. Stratification units and area of each survey unit in the subject property is shown in Table 5.7. Bird survey methods and survey effort have been development in accordance with DEC (2004) and DSEWPaC (2010) guidelines. Methods and survey effort are outlined in Table 5.8.

Table 5.7 Stratification units and survey area – nocturnal bids

Vegetation class	Area (ha)
PCT 1800 - Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	2.47
PCT 849 - Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	0.35
Total	**2.82**

Table 5.8 Methods and survey effort – nocturnal birds

Method	Survey description	Survey effort
Transect searches	• surveyors walked the length of identified habitat for this species within the subject property; • all calls were investigated; and • birds observed or heard were recorded.	DEC (2004) has not resolved bird survey requirements and does not provide guidance on survey effort. DoEWHA (2010) did not have specific guidance for Bush Stone-curlew. As the habitat is considered marginal to support this species, 4 nights of area searches were undertaken for this species.

b Microchiropteran bats

Microbat surveys were undertaken within the subject property to target Southern Myotis. Stratification units and area of each survey unit in the subject property is shown in Table 5.9. Methods and survey effort have been developed in accordance with DEC (2004) and OEH (2018). Methods and survey effort are outlined in Table 5.10.

Table 5.9 Stratification units and survey area – microchiropteran bats

Vegetation class	Area (ha)
PCT 1800 - Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley	2.47
PCT 849 - Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	0.35
Total	**2.82**

Table 5.10 Methods and survey effort - Microchiropteran bats

Method	Survey description	Survey effort
Roost search (bridges and buildings)	The disused road bridge was searched for the presence of roosting microbats and its suitability to support roosting microbats. The building was not deemed suitable to support roosting microbats. The building is an open large tin shed, with no roof voids or connection to vegetation corridors.	The bridge was searched in its entirety.
Acoustic detection	OEH (2018) permits the use of acoustic devices to record presence of the Southern Myotis. • detectors were set out near bridge and waterbody features; and • detectors were placed out for a minimum of four nights. Calls were analysed by a person experienced in bat call analysis.	OEH (2018) specifies a total effort of 16 nights for each 2.5 km of suitable habitat. An initial habitat assessment indicated that there was approximately 400 m of riparian habitat. As Southern Myotis was already confirmed within the subject property, observed roosting underneath the bridge and were observed foraging on the waterbodies during the frog surveys, only a total effort of 10 was undertaken.

c Amphibians

Amphibian surveys were undertaken within the subject property to target Green and Golden Bell Frog. Stratification units and area of each survey unit in the subject property is shown in Table 5.11. Method and survey effort have been developed in accordance with DoEWHA (2009), DECC (2009) and DSEWPaC (2010) and is outlines in Table 5.12.

Table 5.11 Waterbody areas

Target species	Waterway	ha
Green and Golden Bell Frog	Pond 1 – western	0.04
	Pond 2 – middle	0.24
	Pond 3 - eastern	0.84
	Pond 4 – southern	0.08

Table 5.12 Methods and survey effort - amphibians

Method	Survey description	Survey effort
Habitat assessment	A habitat assessment was undertaken to identify suitable habitat along all the waterbodies within the subject property	All waterbodies were assessed for suitable habitat.
Nocturnal searches	Surveys were undertaken in accordance with the following: • surveyed over a minimum of four nights to increase the detection rate; • between September and March, at the time of peak activity for the species; and • during warm and windless weather conditions following rainfall.	Each pond was surveyed as per the survey descriptions for four nights. Green and Golden Bell Frog confirmed calling at a reference population The minimum survey effort was met.
Egg mass and tadpole sampling surveys	Egg mass and tadpole sampling was undertaken in accordance with the following: • egg mass were detected during the nocturnal searches listed above; and • tadpole sampling was undertaken from visual inspections of banks and ponding water where suitable spawning habitat was present.	DECC (2009) and Commonwealth of Australia do not specify minimum survey requirements for tadpoles. Tadpole searches occurred during each nocturnal search.

d Terrestrial invertebrates

Snail surveys were undertaken for Cumberland Plain Land Snail and Dural Land Snail within the project. Stratification units and area of each survey unit in the subject property are shown in Table 5.13. Snail survey methods and survey effort have been developed in accordance with NSW NPWS (2010) guidance and Clark 2009 habitat requirements, see Table 5.14.

Table 5.13 Stratification units and survey area – terrestrial invertebrates

Stratification unit	Area (ha)
PCT 849 - Grey Box – Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	0.35
Total	**0.35**

Table 5.14 Methods and survey effort – terrestrial invertebrates

Method	Survey description	Survey effort
Area searches	• Searches were performed under logs, debris, leaf and bark accumulation, bases of trees and grass clumps.	All area across the subject property that was accessible (ie excluding the quarry), where vegetation is absent were searched.

KEY

- Subject property
- ARRC site
- Cadastral boundary
- Waterbody
- Watercourse
- Green and Golden Bell Frog and Bush Stone-curlew survey effort
- Cumberland Plain Land Snail and Dural Land Snail survey effort
- Threatened fauna species survey (anabat)
- Hollow bearing tree

\\Emmsvr1\emm\Jobs\2019\190749 - CPG Luddenham Quarry\GIS\02 Maps\SSD Recycling Facility\BDAR\SDBDAR007 FaunaSurveyLocations 20200615 03.mxd 16/06/2020

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020)

0 50 100 m

GDA 1994 MGA Zone 56

N

Fauna survey locations

Luddenham Advanced Resource Recovery Centre
Biodiversity Development Assessment Report
Figure 5.2

EMM
creating opportunities

5.3.4 Targeted survey results

i Threatened flora species results

No threatened flora species were recorded during targeted surveys within the subject property. All candidate threatened flora species are not considered to occur within the subject property following targeted surveys.

ii Threatened fauna survey results

a Microchiropteran bats

Southern Myotis

Southern Myotis was recorded foraging around the main water bodies and two were observed roosting underneath the bridge that crosses Oaky Creek located just out of the subject property, in the south eastern, see Photograph 5.1. For acoustic detection survey results, see Appendix I. This species was recorded using the following PCTs:

- PCT 1800 - Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley.

Southern Myotis forage over streams and pools catching insects and small fish by raking their feet across the water surface. They roost close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage.

The threatened biodiversity data collection specifies that the species polygon should be land within 200 m of a waterbody with pools/stretches 3 m or wider, including rivers and creeks. The species polygon should align with the above PCT. A 200 m buffer was also applied around the confirmed roost site (bridge) for this species.

This data was used to determine species polygons for the species (Figure 5.3).

Photograph 5.1 Roosting Southern Myotis underneath the bridge

Other candidate species were not recorded in the subject property and are considered to be unlikely to occur within the subject property following targeted surveys.

KEY

- Subject property
- ARRC site
- Indirect impact area
- Cadastral boundary
- Waterbody
- Watercourse
- Southern Myotis direct impact species polygon
- Souther Myotis indirect impact species polygon
- Southern Myotis species habitat

Threatened fauna species survey

- Southern Myotis record
- Southern Myotis roost

\\Emmsvr1\emm\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02 Maps\SSD Recycling Facility\BDAR\SDBDAR008 ThreatenedFauna 20200615 03.mxd 16/06/2020

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020)

0 50 100 m

GDA 1994 MGA Zone 56

N

Threatened fauna credit species recorded in the project area

Luddenham Advanced Resource Recovery Centre
Biodiversity Development Assessment Report
Figure 5.3

EMM creating opportunities

5.3.5 Species credit species

A list of candidate species credit species predicted to occur within the subject property, along with an assessment of whether the species will be impacted by the project is provided in Table 5.15.

A summary of the all survey results and credits are provided in Table 5.16.

Based on targeted surveys, Southern Myotis will be impacted (Table 5.15).

Table 5.15 Species impact (ha)

Species	Direct (ha)	Indirect (ha)
Southern Myotis	0.28	0.22

These species will require offsets in accordance with the BAM (OEH 2017). Species polygons across the ARRC site are shown in Figure 5.3.

Table 5.16 Species credit species, habitat suitability and targeted survey results

Scientific name	Common name	Biodiversity risk weighting	Habitat present within the Subject area	Recorded during field surveys	Impacted by development	Justification
Flora						
Acacia bynoeana	Bynoe's Wattle	2.00	Yes	No	No	Not recorded during targeted surveys.
Acacia pubescens	Downy Wattle	2.00	Yes	No	No	Not recorded during targeted surveys.
Cynanchum elegans	White-flowered Wax Plant	2.00	Yes	No	No	Not recorded during targeted surveys.
Dillwynia tenuifolia		2.00	Yes	No	No	Although surveys did not occur during survey season, the shrub form would have been readily detectable because no native shrub species were present in the ARRC site.
Eucalyptus benthamii	Camden White Gum	2.00	Yes	No	No	Not recorded during targeted surveys.
Grevillea juniperina subsp. juniperina	Juniper-leaved Grevillea	1.50	Yes	No	No	Not recorded during targeted surveys.
Maundia triglochinoides		2.00	Yes	No	No	Not recorded during targeted surveys.
Marsdenia viridiflora subsp. viridiflora - endangered population		2.00	Yes	No	No	Not recorded during targeted surveys.
Persicaria elatior	Tall Knotweed	2.00	Yes	No	No	Not recorded during targeted surveys.
Persoonia bargoensis	Bargo Geebung	2.00	Yes	No	No	Not recorded during targeted surveys.
Pimelea curviflora var. curviflora		2.00	Yes	No	No	Not recorded during targeted surveys.
Pomaderris brunnea	Brown Pomaderris	2.00	Yes	No	No	Although surveys did not occur during survey season, the shrub form was readily detectable because no native shrub species were present in the ARRC site.
Thesium australe	Austral Toadflax	1.50	Yes	No	No	Not recorded during targeted surveys.

Table 5.16 Species credit species, habitat suitability and targeted survey results

Scientific name	Common name	Biodiversity risk weighting	Habitat present within the Subject area	Recorded during field surveys	Impacted by development	Justification
Fauna						
Burhinus grallarius	Bush Stone-curlew	2.00	Yes	No	No	Not recorded during targeted surveys.
Litoria aurea	Green and Golden Bell Frog	2.00	Yes	No	No	Not recorded during targeted surveys.
Meridolum corneovirens	Cumberland Plain Land Snail	2.00	Yes	No	No	Not recorded during targeted surveys.
Myotis macropus	Southern Myotis	2.00	Yes	Yes	Yes	Recorded roosting and foraging within the subject property.
Pommerhelix duralensis	Dural Land Snail	2.00	Yes	No	No	Not recorded during targeted surveys.


{¢!D9 H

LYLJI·Ǒű I·ăăŜăăYŜyű




6 Impact assessment (biodiversity values)

6.1 Potential direct, indirect and prescribed impacts

Without any measures to avoid, minimise or mitigate impacts, the project would result in the following impacts on biodiversity.

6.1.1 Direct impacts

The main direct impacts of the project will be associated with impacts arising from the clearing works for construction of the project, they include:

- loss of native vegetation; and
- loss and degradation of native fauna habitats.

In addition to the direct impacts arising from this process, clearing of native vegetation has several indirect impacts.

6.1.2 Indirect impacts

Indirect impacts that could occur as a result of the project include:

- increase in weeds, resulting in degradation of retained native vegetation and habitat;
- stormwater entering the riparian vegetation and Oaky Creek;
- potential inadvertent disturbance of retained habitats; and
- increased movement of vehicles and people into the area has the potential to transport weeds into the subject property. Weeds have the potential to result in degradation of retained vegetation and fauna habitat.

Indirect impacts have been assessed in accordance with the BAM (OEH 2017) and credits have been calculated. The assessment of data collected as a part of the biodiversity monitoring program for Snowy 2.0 Exploratory Works (EMM 2019) showed a substantial difference in weed cover from 10 m to 50 m, but not from 10 m to 20 m or from 20 m to 50 m, and this was used to inform the approach to indirect impacts for the project. The BDAR (EMM 2020b) for Snowy 2.0 Main Works thus assumed that all vegetation within 20 m of the subject land will incur some indirect impacts. Reductions to native groundcover and litter cover scores were applied as a surrogate for increased weed density, as the BAM calculator does not allow scores (including exotic cover scores) to be increased for BDAR assessments. Changes in vegetation integrity score within the 20 m buffer comprise the following:

- the structure (cover) scores for ‘grass’, ‘forbs’, ‘ferns’ and ‘other’ growth forms were reduced by 10%, leaving scores for all other growth forms at the current score; and
- functional score for litter cover was reduced by 5%.

6.1.3 Prescribed impacts

The project also has the potential to result in prescribed impacts on threatened species and communities recorded or assumed to be present within the Table 6.1, as per Section 8.2.1.2 of the BAM (OEH 2017), these are assessed Table 6.2.

Table 6.1 Prescribed biodiversity impacts assessment

The assessment of the impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including subsidence or upsidence resulting from underground mining or other development)	
(a) identify water bodies with potential to be habitat for threatened species or threatened ecological communities that are likely to be impacted by the proposal	The riparian habitat contains areas of dams and standing water associated with Southern Myotis and Swamp Oak Floodplain Forest EEC are likely to be directly and indirectly impacted by the proposal.
(b) identify the threatened species and threatened ecological communities likely to use the habitat	Southern Myotis and Swamp Oak Floodplain Forest EEC
(c) identify hydrological processes that sustain threatened species or threatened ecological communities and the species and communities that are dependent on them	Oaky Creek receives surface and groundwater flows. This creek only flows during times of high rainfall. Swamp Oak Floodplain Forest EEC is dependent on the duration of waterlogging.
(d) describe, with reference to relevant literature and other reliable published sources of information, the importance within the bioregion of the water body or hydrological process to these species or ecological communities	Swamp Oak Floodplain Forest forms part of a complex of forested wetland and treeless wetland communities found throughout the coastal floodplains of NSW.
(e) describe the nature, extent and duration of known short and long-term impacts on water bodies and hydrological processes	Indirect impacts on the hydrological process are likely to be long term from the project, however due to the nature and small scale of these indirect impacts (ie occasional discharges of treated water and wet weather overflows) and the highly degraded and modified nature of the subject property these are unlikely to change the nature of natural drainage into this habitat.
(f) describe the nature, extent and duration of short and long-term impacts on water quality	Water will flow into Oaky Creek from the project will be controlled as part of the project's surface water management system.
(g) predict the consequences of the impacts for the bioregional persistence of the suite of threatened species and communities likely to use these areas as habitat, with reference to relevant literature and other published sources of information	No significant impacts for the bioregional persistence of Southern Myotis and Swamp Oak Floodplain Forest are predicted. The habitat within the impact area is highly degraded with only 0.28 ha been removed as part of the ARRC.
(h) predict the nature, extent and duration of short and long-term impacts on the habitat and life cycle of species using the natural features of any water dependent plant community	No long term impacts are predicted occur as a result of indirect impacts from the project due to the small scale and the highly degraded and modified nature of the subject property these are unlikely to change the nature of natural drainage into this habitat.
(i) justify predictions of impact on any water dependent plant communities, with appropriate modelling and with reference to relevant literature and other published sources of information	It is not considered that the ARRC site will have an impact on the water table as no groundwater extraction has been proposed as part of the works.

Table 6.1 Prescribed biodiversity impacts assessment

The assessment of the impacts of development on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities (including subsidence or upsidence resulting from underground mining or other development)	
(j) predict the cumulative impacts of the project together with existing mining operations mining underneath the same water dependent plant communities	No mining underground is proposed under the Swamp Oak Floodplain Forest EEC as part of the project, the quarry located in the subject property is open cut. Minimal cumulative impacts are expected as the project is not considered to have an impact on the water table.
(k) based on predictions of impacts on water dependant plant communities and the species they support, calculate the maximum predicted offset liability in accordance with the Upland Swamp Policy	It is predicted that the offset liability as per the Addendum to NSW Biodiversity Offsets Policy for Major Projects (OEH 2016e) would be calculated as having a negligible environmental consequence for Southern Myotis and Swamp Oak Floodplain Forest EEC, and as such there is no additional offset liability.
(l) justify any prediction of 'nil' or 'negligible' environmental consequences for any impact on water dependent plant communities and the species they support.	Justification for negligible impacts on Swamp Oak Floodplain Forest is that the project will: have negligible change to the shallow groundwater regime of the EEC. As such he proposed works are considered to only have an indirect impact on the water quality from surface run off, which has been assessed as part of the overall credit calculations; and have negligible change to the composition or distribution of the EEC dependent vegetation communities and threatened species.

Table 6.2 Prescribed biodiversity impacts not related to the project

Prescribed impact	**Justification**
Impacts of development on the habitat of threatened species or ecological communities associated with karst caves, crevices, cliffs and other features of geological significance	None have been identified within the ARRC site.
Habitat of threatened species or ecological communities associated with rocks	None have been identified within the ARRC site.
Impacts of development on the habitat of threatened species or ecological communities associated with human made structures	Both the bridge and the building are located outside of the ARRC site will not be impacted on as part of the project.
Impacts of development on the habitat of threatened species or ecological communities associated with non-native vegetation	None have been identified within the ARRC site.
The assessment of the impacts of development on the connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range must:	The project will not have a direct impact on the connectivity within the area.

Table 6.2 Prescribed biodiversity impacts not related to the project

Prescribed impact	Justification
Impacts of the development on movement of threatened species that maintains their life cycle	No species have been identified where the ARRC site is considered to have impacts on their movement. Southern Myotis is a highly mobile species.
Impacts of wind turbine strikes on protected animals	Not relevant to the project.
Impact of vehicle strikes on threatened species of animals or on animals that are part of a TEC	No species have been identified within the ARRC site that are likely to have an impact from vehicle strikes. Southern Myotis is a highly mobile species and would avoid lit areas at night when they are active.

6.2 Measures to avoid, minimise and mitigate impacts

6.2.1 Avoidance measures

The project has been designed, where possible, to avoid sensitive biodiversity areas.

The ARRC site has been sited to avoid potential impacts to the Swamp Oak Floodplain Forest Endangered Ecological Community (EEC) (PCT 1800) along the eastern boundary of the subject property and Cumberland Plain Woodland CEEC (PCT 849) that is present between the existing internal road and the western boundary.

Iterative project planning, informed by the baseline studies outlined above, has allowed a range of impacts to be avoided and others to be minimised throughout the life of the project. To compensate for unavoidable disturbance, biodiversity offsets will be provided.

Key avoidance measures that are to be implemented by the proponent comprise:

- avoidance of direct impacts to Oaky Creek;
- no impacts to PCT 849;
- minimisation of impacts to PCT 1800, by only impacting on small areas of the fragmented habitat;
- avoiding impacts to PCT 1800, by avoiding impacts to the vegetation on the south-western boundary;
- utilisation of the existing cleared areas wherever feasible; and
- a water management system to minimise potential impacts to Oaky Creek (Section 6.1.2iii).

6.2.2 Mitigation measures

i Retention of vegetation, pre-clearing and clearing works

Site preparation works will require clearing of some native vegetation. These works have the potential to have an impact on fauna species including an indirect impact on the retained vegetation and fauna habitat. To help avoid, this occurring and minimise impacts to vegetation and fauna species the following controls are to be implemented:

- Exclusion zones around all areas of retained vegetation and fauna habitat are to be implemented. These areas will be fenced using appropriate fencing materials and designated and signed as 'No-go Zones' or 'Environmentally Sensitive Areas.
- Where feasible or when required, tree protection zones (TPZs) are to the set up around all trees to be retained within and immediately adjacent to the disturbance footprint. If required, TPZs are to be established in accordance with the Australian Standard AS 4970-2009 Protection of trees on development sites (Standards Australia Committee 2009).

Native vegetation cleared should be mulched and stockpiled for re-use during any rehabilitation works. Large hollow-bearing trees and limbs should be retained as hollows for placement into rehabilitated areas or retained native vegetation.

These measures will be incorporated into a Construction Environmental Management Plan (CEMP).

ii Weed control

Indirect impacts could occur due to the introduction and/or spread of weeds into the subject property.

To prevent this occurring the following controls will be implemented:

- Undertaking of weed control in key areas prior to construction works, to minimize the impacts of weeds during construction and to minimise the requirements for disposal and management of weeds on-site.
- Appropriate management and disposal of weed species during clearing works, in accordance with the biodiversity management plan.
- Active and intensive weed control will be undertaken within the subject property, in areas where significant weeds are known to occur to reduce the cover of weeds adjacent to the construction activities, preventing the spread of weeds into the riparian habitat associated with Oaky Creek.

iii Water Management

The key water management strategy adopted across the ARRC site is containment and management of water that has potentially been in contact with waste material, with reuse where feasible. The key features of the proposed water management system include:

- fully enclosing all waste handling and storage within the ARRC warehouse to prevent rainfall interacting with waste (or recycled products) and to prevent rainfall on hardstand that is used to store waste (or recycled products),
- collection of stormwater within an onsite detention storage,
- capture, treatment and reuse of water recycled from site activities in the warehouse, and
- discharge of excess stormwater from the onsite detention storage to Oaky Creek.

The Surface Water Assessment (EMM 2020a) carried out for the project concluded that the project's water quality controls are expected to function to prevent any material change or degradation of the water quality of Oaky Creek due to discharges.

iv Sediment control

Management of sedimentation will be a key measure to minimise and mitigate impacts. Management measures will be put in place to control sediment. The key period for mobilisation of large amounts of coarse sediment will be during construction. Key management measures to be implemented to manage this risk include:

- sediment controls are to be put in place within the ARRC site, and shall be consistent with relevant standards, including:
    - *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004);
    - *Managing Urban Stormwater: Soils and Construction – Volume 2C – Unsealed Roads* (DECC 2008a); and
    - *Managing Urban Stormwater: Soils and Construction – Volume 2D – Main Road Construction* (DECC 2008b).
- an erosion and sediment control plan (ESCP) are to be prepared for each construction zone;
- where practical, clean water will be diverted around, rather than through, construction areas;
- consider local soil characteristics, topography and environmental constraints and proposed construction methods and identify risks associated with proposed activities;
- apply clean water management controls as per:
    - WM 1.1 for clean water management during surface construction disturbance;
    - WM 2.1 for temporary waterway diversions around temporary surface infrastructure; and
    - WM 3.1 for permanent waterway diversions.
- all temporary drainage and sediment control measures will be designed to have non-erosive hydraulic capacity and be structurally sound for the design events specified in Table 6-1 in *Managing Urban Stormwater: Soils and construction – Volume 2D – Main Road Construction* (DECC 2008b);
- consider all practical erosion control and rehabilitation methods and apply the most appropriate method;
- consider all practical methods to stabilise small temporary stockpiles and apply the most appropriate method. Apply management controls as per WM 2.5 for the management of large temporary stockpiles;
- apply enhanced erosion controls where significant risks are identified;
- include measures to manage the storage and handling of hydrocarbons and other chemicals that have potential to pollute receiving water;
- include measures to manage accidental leaks and spills; and
- be progressively amended as required during construction.

v Noise, vibration and lighting

Impacts from noise and vibration will occur during the construction period, and also during operations from worksite activity. Some impacts to fauna species such as the foraging habitat for the Southern Myotis may result. It is noted that the site will also have experienced previous noise impacts from operation of the quarry, and will also be immediately adjacent to Western Sydney Airport. Thus, there will be some additional noise impacts.

Light spill from night works has the potential to reduce the suitability of retained habitat for some fauna species. To minimise this directional lighting will be used, minimising light spill as much as possible.

6.2.3 Summary of measures to avoid, minimise and mitigate impacts

A summary of impacts arising from the proposed development, and measures outlined above to avoid, minimise and mitigate impacts, is provided in Table 6.3.

Table 6.3 Summary of impacts, and measures to avoid, minimise and mitigate

Impact	Impact avoidance	Impact minimisation	Impact mitigation
Removal and disturbance of native vegetation and threatened species habitat. **Type:** direct and indirect impact. **Frequency:** once, during construction. **Intensity:** removal of 0.28 ha of native vegetation habitat that is listed as a TEC under the BC Act and habitat for threatened species. **Duration:** initial stages of construction. **Consequence:** permanent removal of native vegetation and threatened species habitat.	The ARRC footprint was designed to have minimal impact on the riparian habitat associated along Oaky Creek.	Siting of infrastructure in areas subject to existing disturbance. Use of the existing road network to minimise requirement for removal of native vegetation. Detailed design of the project, resulting in further minimisation of impacts to native vegetation. Minimisation of clearing during construction, wherever possible.	Establishment of exclusion zones around retained vegetation, including fencing and signage. Vegetation clearing undertaken in accordance with the two-stage process. Retention of hollows logs and limbs for placement within retained vegetation and reuse during rehabilitation.
Increase in weeds and pathogens. **Type:** indirect impact. **Frequency:** ongoing during construction and operation. **Intensity:** unknown. **Duration:** ongoing through construction phase. **Consequence:** potential to impact on threatened species habitat, resulting in decline in habitat quality.	Not required.	Weed control prior to construction works being undertaken, where possible. Appropriate disposal and management of weeds during clearing works. Active weed control within the subject property.	Not required.

Table 6.3 Summary of impacts, and measures to avoid, minimise and mitigate

Impact	Impact avoidance	Impact minimisation	Impact mitigation
Light and noise pollution during night works. **Type:** indirect impact. **Frequency:** ongoing during construction and operation. **Intensity:** unknown. **Duration:** ongoing during construction and operation. **Consequence:** potential to result in noise impacts to retained vegetation and light spill into adjacent habitat areas, impacting on occupancy for Southern Myotis.	Design of project to minimise lighting and noise impacts on surrounding landuses and habitat.	Use of directional lighting to retain lighting within works areas as much as possible.	Not required.
Changes to runoff regimes and sediment impacts. **Type:** prescribed impact. **Frequency:** ongoing during construction and operation. **Intensity:** potential to mobilise large amounts of sediment and impact on EEC habitat. **Duration:** initial stages of construction and potential ongoing operational discharges. **Consequence:** impact water quality, erosion and sedimentation in the area and breeding success.	Siting of key infrastructure away from sensitive receiving environments. Design of surface water management system. Fully enclosing all waste handling and storage within the ARRC to prevent rainfall interactions with waste or recycled products. Reuse of recycled water to minimise discharges from the site.	Appropriately designed stormwater sediment basin in accordance with the blue book, which does not directly impact on native vegetation, and which is designed to avoid any scouring impacts from overflow discharge. Stabilisation and rehabilitation of works areas as soon as practicable.	Not required.

6.3 Impact summary

6.3.1 Serious and irreversible impacts (SAII)

No species were identified as candidate species for serious and irreversible impacts (SAII), as per Section 6.5 of the BC Act.

6.3.2 Impacts requiring offsets

This section provides an assessment of the impacts requiring offsetting in accordance with Section 10 of the BAM (OEH 2017).

i Impacts on native vegetation

Impacts to native vegetation requiring offsets include:

- direct impacts on 0.28 ha of PCT 1800 Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley; and
- indirect impacts on 0.22 ha of PCT 1800 Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley.

A summary of ecosystem credits required for all vegetation zones, including changes in vegetation integrity score, are provided in Table 6.4. A credit report is provided in Appendix E.

Table 6.4 Summary of ecosystem credits required for impacts to all vegetation zones for the proposed development

Vegetation zone number	PCT	Vegetation zone name	Impact Type	Area	Vegetation integrity score	Future vegetation integrity score	Change in vegetation integrity score	Credits required
1	1800 Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley.	Poor	Direct	0.07	45.40	0	-45.40	2
			Indirect	0.09		44.50	-0.9	
2	1800 Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley.	Medium	Direct	0.21	48.20	0	-48.2	5
			Indirect	0.13		47.0	-1.2	

ii Impacts on threatened species

A summary of the species credits required for all vegetation zones occupied by the threatened species, including changes in vegetation integrity score, are provided in Table 6.5..

Table 6.5 Species habitat requiring offsets

Species	Vegetation zone name*	Area (ha)	Candidate SAII	Species credits
Southern Myotis	1800 - medium	0.34	No	5
	1800 - poor	0.14		1

* These areas include both direct and indirect impacts areas.

A total of 6 species credits are required to offset the residual impacts of the proposed development. A credit report is provided in Appendix E.

6.3.3 Impacts not requiring offsets

A number of vegetation zones were found to be in degraded condition. In line with the requirements of Section 10.3 of the BAM (OEH 2017) impacts to the vegetation zones and threatened species habitat do not require offsets.

Additional areas not requiring assessment in accordance with Section 10.4 of the BAM (OEH 2017) include:

- existing roads; and
- cleared and highly disturbed land.

STAGE 3: EPBC Act Assessment

7 Impacts to MNES

7.1 Desktop assessment to identify candidate species and communities

A detailed desktop assessment was completed evaluating a range of information sources to gather information on the biodiversity values across the survey area and identify those MNES considered to have potential to occur. Information sources reviewed are summarised below:

- Department of Environment and Energy Protected Matter Search Tool (PMST, 0); and
- BioNet, held and maintained by the NSW Office of Environment and Heritage (OEH), to access the following:
  - Atlas of NSW Wildlife;
  - Threatened Biodiversity Data Collection;
  - Threatened species profiles; and
  - Vegetation Classification System.

7.1.1 Candidate species assessment

A list of species and communities with potential to occur within the impact area was generated following the desktop assessment. No communities were identified as candidates for assessment. Species are listed in Table 7.1 were considered to have potential to occur within the impact area based on the desktop assessment.

Table 7.1 Threatened and migratory species with potential to occur in the subject property based on the desktop assessment

Scientific name	Common name	EPBC Act[1]	BC Act[2]
Flora			
Persicaria elatior	Tall Knotweed	VN	V
Pomaderris brunnea	Brown Pomaderris	VN	V
Fauna			
Chalinolobus dwyeri	Large-eared Pied Bat	VU	V
Pteropus poliocephalus	Grey-headed Flying-fox	VU	V
Migratory species			
Cuculus optatus	Horsfield's Bronze-Cuckoo	Mi	-
Calidris acuminata	Sharp-tailed Sandpiper	Mi	-
Calidris melanotos	Pectoral Sandpiper	Mi	-
Gallinago hardwickii	Latham's Snipe	Mi	-
Tringa nebularia	Common Greenshank	Mi	-

Notes: 1. EPBC Act status: CE- critically endangered, EN – endangered, VU – vulnerable
2. BC Act status: E4B – critically endangered, E3 – endangered, V2 - vulnerable

An assessment of likelihood was completed for listed TECs, Threatened flora and fauna and migratory species predicted to occur in the region by the PMST search (0, Appendix G Table G.2 to Table G.3). This assessment identified the following threatened species and migratory species were considered candidate species requiring further survey or assumed presence in Table 7.2.

Table 7.2 Threatened and migratory species further assessment or presumed presence

Scientific name	Common name	Survey undertaken	Recorded / assumed presence
Fauna			
Chalinolobus dwyeri	Large-eared Pied Bat	Yes	Recorded (one pass assumed to be a movement over the site)
Pteropus poliocephalus	Grey-headed Flying-fox	Incidental sighting	Recorded (foraging)
Migratory species			
Cuculus optatus	Horsfield's Bronze-Cuckoo	No	Assumed presence
Calidris acuminata	Sharp-tailed Sandpiper	No	Assumed presence
Gallinago hardwickii	Latham's Snipe	No	Assumed presence
Tringa nebularia	Common Greenshank	No	Assumed presence

7.2 Significant impact assessments

To support a determination as to whether the project is likely to have a `significant impact' on threatened species the *Matters of National Environmental Significance – Significance Impact Guidelines 1.1* (DoE 2013) have been applied.

A 'significant impact' is defined as "an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends on the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts" (DoE 2013).

Consideration has been given to all communities, threatened and migratory species with potential to occur within the subject property, with reference to DoE (2013). Significant impact assessments have been completed for the species listed in Table 7.2 considered to have potential to be impacted by the project following the process outlined in this assessment report.

Significant impact assessment for the identified communities and species are provided in .Appendix H.

The assessment concluded that no significant impacts are considered in the context of the findings of the project's biodiversity assessment and the area of high-quality habitat in the region.

8 References

Badger Mining Company Pty Limited 2003, *Development Consent, DA No. 315-7-2003, For Badger Mining Company Pty Limited.*

Benson DH, and Howell, J 1990, *Taken for granted: the bushland of Sydney and its suburbs*. Kangaroo Press, Sydney.

BOM 2020, *Groundwater Dependent Ecosystems Atlas*, viewed 29 March 2020, http://www.bom.gov.au/water/groundwater/gde/index.shtml.

Clark, SA 2009. *A review of the land snail genus Meridolum (Gastropoda: Camaenidae) from central New South Wales, Australia*. Molluscan Research 29(2):61-120.

Commonwealth of Australia 2016, *Western Sydney Airport – Airport Plan*. https://www.westernsydneyairport.gov.au/sites/default/files/Western_Sydney_Airport_Plan.pdf

DEC 2004, *Threatened Biodiversity Survey and Assessment: Guidelines for Development and Activities*, Department of the Environment and Conservation, Hurstville.

DECC 2008a, *Managing Urban Stormwater: Soils and Construction – Volume 2C – Unsealed roads.*

DECC 2008b, *Managing Urban Stormwater: Soils and Construction – Volume 2D – Main road construction.*

DECC 2009, *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna Amphibians*, Department of Environment and Climate Change, Sydney.

DoE 2013, *Matters of National Environmental Significance – Significance Impact Guidelines 1.1,* Department of Environment, Canberra.

DoEE 2017a, Interim Biogeographic Regionalisation of Australia (IBRA) Version 7, Department of the Environment and Energy, Canberra.

DoEE 2017, *EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species*, Department of the Environment and Energy, Canberra.

DoEE 2018, Directory of important wetlands, Department of the Environment and Energy, Canberra.

DEWHA 2008, *Threat Abatement Plan for Predation by the European Red Fox*. Department of the Environment, Water, Heritage and the Arts, Canberra.

DIRD 2016, *Western Sydney Airport EIS Biodiversity Assessment*, prepared for Western Sydney Unit – Western Sydney Airport EIS, 21/24265.

DoEWHA 2009, *Significant impact guidelines for the vulnerable green and golden bell frog (Litoria aurea),* Department of Environment, Water, Population and Communities, Canberra.

DoEWHA 2010, *Survey Guidelines for Australia's Threatened Birds, Department of Sustainability*, Department of Environment, Water, Population and Communities, Canberra.

Douglas Nicolaisen & Associates Pty Ltd 2003, *Environmental Impact Statement – Proposed Clay/Shale Extraction Operation – Lot 3 - 272 Adams Road Luddenham NSW*, prepared for Badger Mining Company Pty Limited 275 Adams Road Luddenham NSW.

DPI 2013, *Policy and guidelines for fish habitat conservation and management*, NSW Department of Primary Industries, Sydney.

DSEWPaC 2010, *Survey Guidelines for Australia's Threatened Frogs,* Department of Sustainability, Environment, Water, Population and Communities, Canberra.

EMM 2019, *Exploratory Works Biodiversity Management Plan, Snowy 2.0*. Report prepared for Snowy Hydro Ltd by EMM Consulting Pty Ltd, St Leonards, NSW.

EMM 2020a, *Luddenham Advanced Resource Recovery Centre Surface Water Assessment*, prepared for Coombes Property Group and KLF Holdings Pty Ltd by EMM Consulting Pty Ltd.

EMM 2020b, *Snowy 2.0 Main Works Revised Biodiversity Development Assessment Report*, prepared for Snowy Hydro Limited by EMM Consulting Pty Ltd.

Landcom 2004, *Managing Urban Stormwater: Soils and Construction – Volume 1*.

Keith, DA & Pellow, BJ (2015), *Review of Australia's Major Vegetation classification and descriptions*. Centre for Ecosystem Science, UNSW, Sydney.

NPWS 2010, *Cumberland Plain Large Land Snail, Environmental Impact Assessment Guidelines*, NSW National Parks and Wildlife Service.

NPWS 2016, Sydney Basin, https://www.environment.nsw.gov.au/bioregions/SydneyBasin-Climate.htm accessed 17 February 2020, NSW National Parks and Wildlife Service.

NSW Parliamentary Counsel's Office 2011, *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*.

OEH 2010, NSW Wetlands spatial data, https://datasets.seed.nsw.gov.au/dataset/nsw-wetlands047c7 accessed 16 March 2020.

OEH 2013, *The Native Vegetation of the Sydney Metropolitan Area*, Version 2.0 – VIS_ID 3817, NSW Office of Environment and Heritage, Sydney.

OEH 2014, *NSW VIS: Classification Version 2.1 Public User Manual* NSW Office of Environment and Heritage, Sydney.

OEH 2015, *Remnant Vegetation of the western Cumberland subregion*, 2013 Update. VIS_ID 4207. NSW Office of Environment and Heritage, Sydney.

OEH 2016, *NSW Guide to Surveying Threatened Plants*. NSW Office of Environment and Heritage, Sydney.

OEH 2016a, *Mitchell Landscapes Version V3.1*, NSW Office of Environment and Heritage, Sydney.

OEH 2017, *Biodiversity Assessment Method (BAM*), NSW Office of Environment and Heritage, Sydney.

Phillips C 2004, *Assessment report: Proposed clay/shale extraction operation, Lot 3 – 275 Adams Road, Luddenham*, prepared for Badger Mining Company Pty Limited.

Serov P, Kuginis L, Williams JP 2012, *Risk Assessment Guidelines for Groundwater Dependent Ecosystems*. Department of Primary Industries, Office of Water, NSW Government.

Western Sydney Planning Partnership 2019, *Draft Western Sydney Aerotropolis Plan*.

Appendix A

Vegetation integrity assessment – datasheets

BAM Site – Field Survey Form

Plot ID:	P02	**Date:**	24-02-20	**Project number:**	J190749	**Plot dimensions:**	10x40
Datum:	GDA94	**Easting:**	289,130	**Recorders:**	RP		
Zone:	56	**Northing:**	6,249,503	**IBRA region:**	Sydney Basin (Cumberland)	**Midline bearing:**	86
Plant Community Type:	1800: Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley			**Condition class:**	Poor	**PCT confidence:**	medium
Vegetation Class:	Coastal Floodplain Wetlands			**EEC:**	no	**EEC confidence:**	medium

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	1
	Shrubs:	0
	Grasses etc.:	3
	Forbs:	5
	Ferns:	0
	Other:	0
Sum of Cover of native vascular plants by growth form group	Trees:	30
	Shrubs:	0
	Grasses etc.:	80.1
	Forbs:	0.7
	Ferns:	0
	Other:	0
High Threat Weed cover:		13.6

BAM Attribute (1000 m2 plot) DBH			
DBH	Tree stem count	Length of logs (m) (≥10 cm diameter, >50 cm in length)	0
80 + cm:	0		
50 – 79 cm:	0		
30 – 49 cm:	1		
20 – 29 cm:	0	Tree hollow count	0
10 – 19 cm:	1		
5 – 9 cm:	1		
< 5 cm:	1		

Counts apply when no. of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For multi-stemmed tree, only largest living stem is included in the count. Tree stems must be living.
For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)				
Subplot:	1	2	3	4	5
Subplot score (%):	35	50	1	1	5
Average litter cover (%):	18.4				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography and site features

Positioning plot very difficult. Dam in right, road in left, PCT curves in thin sliver. Steepish slope down to dam, very dense regrowth. Subplots are not representative of the PCT - they reflect the narrowness of the PCT, and the road/dam

Plot Disturbance

Exotic grass. Rubbish paritally visible in tall dense vegetation. No evidence of grazing or mowing.

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Project name:	J190749				
Recorders:	RP	**Plot ID:**	P02	**Date:**	24-02-20

GF Code	Scientific name	Cover	Abundance	Voucher	N, E or HTE
Tree (TG)	*Casuarina glauca (Swamp Oak)*	30	25	no	N
	Paspalum dilatatum (Paspalum)	6	100	no	HTE
Grass & grasslike (GG)	*Cynodon dactylon (Common Couch)*	50	10000	no	N
	Rumex crispus (Curled Dock)	0.1	2	no	E
	Verbena caracasana (Shore Verbain)	0.1	2	no	E
	Verbena bonariensis (Purpletop)	0.1	4	no	E
	Chloris gayana (Rhodes Grass)	1	20	no	HTE
	Alternanthera philoxeroides (Alligator Weed)	0.1	5	no	HTE
	Plantago lanceolata (Lamb's Tongues)	0.1	15	no	E
Forb (FG)	*Phyllanthus virgatus (Wiry Spurge)*	0.1	10	no	N
Forb (FG)	*Einadia spp.*	0.3	5	no	N
Grass & grasslike (GG)	*Typha orientalis (Broad-leaved Cumbungi)*	30	1000	no	N
	Asparagus asparagoides (Bridal Creeper)	0.1	10	no	HTE
	Lycium ferocissimum (African Boxthorn)	0.3	11	no	HTE
	Setaria parviflora	1.5	6	no	E
	Rapistrum rugosum (Turnip Weed)	0.1	15	no	E
Forb (FG)	*Commelina cyanea (Native Wandering Jew)*	0.1	1	no	N
	Dimorphotheca ecklonis (Cape Daisy)	0.2	3	no	E
	Modiola caroliniana (Red-flowered Mallow)	0.1	2	no	E
	Senecio madagascariensis (Fireweed)	0.1	1	no	HTE
Forb (FG)	*Einadia nutans (Climbing Saltbush)*	0.1	5	no	N
	Dipogon lignosus (Dolichos Pea)	0.1	2	no	E
	Cenchrus clandestinus (Kikuyu Grass)	6	50	no	HTE
	Chenopodium album (Fat Hen)	0.1	6	no	E
Forb (FG)	*Portulaca oleracea (Pigweed)*	0.1	1	no	N
	Conyza sumatrensis (Tall fleabane)	0.1	6	no	E
Grass & grasslike (GG)	*Carex spp.*	0.1	1	no	N

BAM Site – Field Survey Form

Plot ID:	P03	**Date:**	24-02-20	**Project number:**	J190749	**Plot dimensions:**	20x20
Datum:	GDA94	**Easting:**	289,086	**Recorders:**	RP		
Zone:	56	**Northing:**	6,249,612	**IBRA region:**	Sydney Basin (Cumberland)	**Midline bearing:**	87
Plant Community Type:	1800: Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley			**Condition class:**	Medium	**PCT confidence:**	medium
Vegetation Class:	Coastal Floodplain Wetlands			**EEC:**	yes	**EEC confidence:**	medium

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	1
	Shrubs:	0
	Grasses etc.:	5
	Forbs:	6
	Ferns:	0
	Other:	1
Sum of Cover of native vascular plants by growth form group	Trees:	50
	Shrubs:	0
	Grasses etc.:	15.7
	Forbs:	1.6
	Ferns:	0
	Other:	0.1
High Threat Weed cover:		101.1

BAM Attribute (1000 m2 plot) DBH			
DBH	Tree stem count	Length of logs (m) (≥10 cm diameter, >50 cm in length)	9
80 + cm:	0		
50 – 79 cm:	1		
30 – 49 cm:	1		
20 – 29 cm:	1	Tree hollow count	0
10 – 19 cm:	1		
5 – 9 cm:	1		
< 5 cm:	1		

Counts apply when no. of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For multi-stemmed tree, only largest living stem is included in the count. Tree stems must be living.
For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)				
Subplot:	1	2	3	4	5
Subplot score (%):	60	25	15	50	1
Average litter cover (%):	30.2				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography and site features

Drainage line running through plot (currently wet). Contains a bees nest

Plot Disturbance

No evidence of grazing or mowing. Scattered rubbish.

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Project name:	J190749				
Recorders:	RP	**Plot ID:**	P03	**Date:**	24-02-20

GF Code	Scientific name	Cover	Abundance	Voucher	N, E or HTE
Tree (TG)	*Casuarina glauca (Swamp Oak)*	50	26	no	N
	Setaria parviflora	2	20	no	E
	Asparagus asparagoides (Bridal Creeper)	1	100	no	HTE
Other (OG)	*Glycine tabacina (Variable Glycine)*	0.1	20	no	N
Grass & grasslike (GG)	*Aristida warburgii*	0.5	10	no	N
Forb (FG)	*Centella asiatica (Indian Pennywort)*	0.1	5	no	N
	Paspalum dilatatum (Paspalum)	30	5000	no	HTE
Grass & grasslike (GG)	*Cynodon dactylon (Common Couch)*	10	3000	no	N
	Araujia sericifera (Moth Vine)	2	200	no	HTE
Forb (FG)	*Galium spp.*	0.1	5	no	N
Forb (FG)	*Phyllanthus virgatus (Wiry Spurge)*	0.1	1	no	N
	Alternanthera philoxeroides (Alligator Weed)	0.1	20	no	HTE
	Cenchrus clandestinus (Kikuyu Grass)	60	10000	no	HTE
	Solanum nigrum (Black-berry Nightshade)	0.1	3	no	E
Forb (FG)	*Einadia nutans (Climbing Saltbush)*	0.2	2	no	N
Grass & grasslike (GG)	*Sporobolus elongatus (Slender Rat's Tail Grass)*	0.1	1	no	N
Forb (FG)	*Oxalis exilis*	0.1	5	no	N
Grass & grasslike (GG)	*Bothriochloa macra (Red Grass)*	0.1	4	no	N
	Lycium ferocissimum (African Boxthorn)	8	20	no	HTE
Grass & grasslike (GG)	*Microlaena stipoides (Weeping Grass)*	5	1000	no	N
	Sida rhombifolia (Paddy's Lucerne)	3	150	no	E
Forb (FG)	*Dichondra repens (Kidney Weed)*	1	50	no	N

BAM Site – Field Survey Form

Plot ID:	P04	**Date:**	24-02-20	**Project number:**	J190749	**Plot dimensions:**	20x20
Datum:	GDA94	**Easting:**	289,191	**Recorders:**	RP		
Zone:	56	**Northing:**	6,249,517	**IBRA region:**	Sydney Basin (Cumberland)	**Midline bearing:**	255
Plant Community Type:	1800: Swamp Oak open forest on riverflats of the Cumberland Plain and Hunter valley			**Condition class:**	Poor	**PCT confidence:**	medium
Vegetation Class:	Coastal Floodplain Wetlands			**EEC:**	yes	**EEC confidence:**	medium

Record easting and northing at 0 m on midline. Dimensions (Shape) of 0.04 ha base plot.

BAM Attribute (400 m2 plot)		Sum values
Count of Native Richness	Trees:	1
	Shrubs:	0
	Grasses etc.:	2
	Forbs:	6
	Ferns:	0
	Other:	0
Sum of Cover of native vascular plants by growth form group	Trees:	50
	Shrubs:	0
	Grasses etc.:	25
	Forbs:	0.7
	Ferns:	0
	Other:	0
High Threat Weed cover:		66

BAM Attribute (1000 m2 plot) DBH			
DBH	Tree stem count	Length of logs (m) (≥10 cm diameter, >50 cm in length)	4
80 + cm:	0		
50 – 79 cm:	0		
30 – 49 cm:	2		
20 – 29 cm:	1	Tree hollow count	0
10 – 19 cm:	1		
5 – 9 cm:	1		
< 5 cm:	1		

Counts apply when no. of tree stems within a size class is ≤ 10. Estimates can be used when > 10 (eg. 10, 20, 30..., 100, 200, 300...). For multi-stemmed tree, only largest living stem is included in the count. Tree stems must be living.
For hollows, count only the presence of a stem containing hollows. For a multi-stemmed tree, only the largest stem is included in the count/estimate. Stems may be dead and may be shrubs.

BAM Attribute (1 x 1 m plots)	Litter cover (%)				
Subplot:	1	2	3	4	5
Subplot score (%):	45	90	10	75	50
Average litter cover (%):	54				

Litter cover is assessed as the average percentage ground cover of litter recorded from five 1 m x 1 m plots centred at 5, 15, 25, 35, 45 m along the plot midline. Litter cover includes leaves, seeds, twigs, branchlets and branches (less than 10 cm in diameter). Assessors may also record the cover of rock, bare ground and cryptogams.

Physiography and site features

Multiple semi-connected swamps in PCT. edge of plot cintains a swamp.

Plot Disturbance

Litttle weediness inside PCT. main weeds in plot are because PCT is too natrow, so includes the road verge weeds too. This is delineated on the floristics data sheet.

GF Code: see Growth Form definitions in Appendix 1; N: native, E: exotic, HTE: high threat exotic; GF – circle code if 'top 3'; Cover: 0.1, 0.2, 0.3, ..., 1, 2, 3, ..., 10, 15, 20, 25, ...100% (foliage cover)
Note: 0.1% cover represents an area of approximately 63 x 63 cm or a circle about 71 cm across, 0.5% cover represents an area of approximately 1.4 x 1.4 m, and 1% = 2.0 x 2.0 m, 5% = 4 x 5 m, 25% = 10 x 10 m
Abundance: 1, 2, 3, ..., 10, 20, 30, ... 100, 200, ..., 1000, ...

Project name:	J190749				
Recorders:	RP	**Plot ID:**	P04	**Date:**	24-02-20

GF Code	Scientific name	Cover	Abundance	Voucher	N, E or HTE
Tree (TG)	*Casuarina glauca (Swamp Oak)*	50	65	no	N
Grass & grasslike (GG)	*Cynodon dactylon (Common Couch)*	15	8000	no	N
	Asparagus asparagoides (Bridal Creeper)	2	30	no	HTE
	Alternanthera philoxeroides (Alligator Weed)	0.1	2	no	HTE
	Juncus acutus	60	500	no	HTE
	Solanum nigrum (Black-berry Nightshade)	0.1	3	no	E
	Araujia sericifera (Moth Vine)	0.1	5	no	HTE
	Chloris gayana (Rhodes Grass)	1	4	no	HTE
Forb (FG)	*Einadia nutans subsp. nutans (Climbing Saltbush)*	0.1	5	no	N
	Plantago lanceolata (Lamb's Tongues)	0.1	10	no	E
	Rapistrum rugosum (Turnip Weed)	0.1	25	no	E
Forb (FG)	*Commelina cyanea (Native Wandering Jew)*	0.1	2	no	N
	Solanum pseudocapsicum (Madeira Winter Cherry)	0.1	1	no	E
Forb (FG)	*Chamaesyce drummondii (Caustic Weed)*	0.1	1	no	N
	Paspalum dilatatum (Paspalum)	0.8	5	no	HTE
	Modiola caroliniana (Red-flowered Mallow)	0.1	25	no	E
	Setaria parviflora	0.4	5	no	E
	Solanum linnaeanum (Apple of Sodom)	0.1	1	no	E
	Verbena caracasana (Shore Verbain)	0.1	2	no	E
	Rumex crispus (Curled Dock)	0.1	2	no	E
Forb (FG)	*Einadia spp.*	0.1	1	no	N
Forb (FG)	*Portulaca oleracea (Pigweed)*	0.2	15	no	N
	Paspalum dilatatum (Paspalum)	2	50	no	HTE
	Chenopodium album (Fat Hen)	0.1	10	no	E
Forb (FG)	*Oxalis exilis*	0.1	5	no	N
Grass & grasslike (GG)	*Microlaena stipoides (Weeping Grass)*	10	3000	no	N

Appendix B

Vegetation integrity assessment – plot data

Table B.1 Vegetation integrity data

plot	pct	Condition class	zone	easting	northing	bearing	comp Tree	comp Shrub	comp Grass	comp Forbs	comp Ferns	comp Other	struc Tree	struc Shrub	struc Grass	struc Forbs	struc Ferns	struc Other	Fun Large Trees	Fun Hollow trees	Fun Litter Cover	Fun Len Fallen Logs	Fun Tree Stem 5 to 9	Fun Tree Stem 10 to 19	Fun Tree Stem 20 to 29	Fun Tree Stem 30 to 49	Fun Tree Stem 50 to 79	Fun Tree Regen	Fun High Threat Exotic
P04	1800	Poor	56	289,191	6,249,517	255	1	0	2	6	0	0	50.0	0.0	25.0	0.7	0.0	0.0	0	0	54.0	4.0	1	1	1	1	0	1	66.0
P03	1800	Med	56	289,086	6,249,612	87	1	0	5	6	0	1	50.0	0.0	15.7	1.6	0.0	0.1	1	0	30.2	9.0	1	1	1	1	1	1	101.1
P02	1800	Poor	56	289,130	6,249,503	86	1	0	3	5	0	0	30.0	0.0	80.1	0.7	0.0	0.0	0	0	18.4	0.0	1	1	0	1	0	1	13.6

Appendix C

Fauna survey effort summary

Table C.1 Fauna survey effort

Surveyor	Survey Type	Start Date	Survey Effort
JB JW	Nocturnal Birds / Green and Golden Frog	27/02/2020	1.5 hr
JB JW	Nocturnal Birds / Green and Golden Frog	02/03/2020	1.5 hr
JB RP	Nocturnal Birds / Green and Golden Frog	03/03/2020	1.5 hr
JB JW	Nocturnal Birds / Green and Golden Frog	04/03/2020	1.5 hr

Appendix D

Targeted survey weather conditions

Table D.1 Weather conditions during fauna surveys

Date	Min Temp (°C)	Max Temp (°C)	Rain (mm)	Max wind direction	Max wind speed (km/hr)
27/02/2020	18	27	0	NNE	35
02/03/2020	16	37	0	SE	52
03/03/2020	19	21	0	S	20
04/30/2020	18	23	11.2	NE	37

Appendix E

Credit Report

BAM Credit Summary Report

Proposal Details

Assessment Id
00019773/BAAS17062/20/00019774

Proposal Name
Luddenham Quarry

BAM data last updated *
04/06/2020

Assessor Name

Report Created
11/06/2020

BAM Data version *
27

Assessor Number

BAM Case Status
Open

Date Finalised
To be finalised

Assessment Revision
0

Assessment Type
Part 4 Developments (General)

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAII	Ecosystem credits
Cumberland Swamp Oak riparian forest								
1	1800_Poor	20.4	0.2	0.25	High Sensitivity to Potential Gain	2.00		2

2	1800_Medium	30.2	0.3	0.25	High Sensitivity to Potential Gain	2.00		5
							Subtotal	**7**
							Total	**7**

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Potential SAII	Species credits
Myotis macropus / Southern Myotis (Fauna)						
1800_Poor	20.4	0.14	0.25	2	False	1
1800_Medium	30.2	0.34	0.25	2	False	5
					Subtotal	**6**

Appendix F

EPBC PMST Report

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 22/01/20 12:38:33

No Image Available

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 1.0Km

No Image Available

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	35
Listed Migratory Species:	15

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	21
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	46
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion	Endangered	Community may occur within area
Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion	Critically Endangered	Community may occur within area
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	Critically Endangered	Community likely to occur within area
Western Sydney Dry Rainforest and Moist Woodland on Shale	Critically Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Fish		
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
[Prototroctes maraena](#) Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area
Frogs		
[Heleioporus australiacus](#) Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat may occur within area
[Litoria aurea](#) Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat may occur within area
Insects		
[Synemon plana](#) Golden Sun Moth [25234]	Critically Endangered	Species or species habitat likely to occur within area
Mammals		
[Chalinolobus dwyeri](#) Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
[Dasyurus maculatus maculatus (SE mainland population)](#) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area
[Petauroides volans](#) Greater Glider [254]	Vulnerable	Species or species habitat likely to occur within area
[Petrogale penicillata](#) Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat may occur within area
[Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)](#) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat likely to occur within area
[Pseudomys novaehollandiae](#) New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
[Pteropus poliocephalus](#) Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Plants		
[Acacia bynoeana](#) Bynoe's Wattle, Tiny Wattle [8575]	Vulnerable	Species or species habitat may occur within area
[Acacia pubescens](#) Downy Wattle, Hairy Stemmed Wattle [18800]	Vulnerable	Species or species habitat may occur within area
[Allocasuarina glareicola](#) [21932]	Endangered	Species or species habitat may occur within area
[Cynanchum elegans](#) White-flowered Wax Plant [12533]	Endangered	Species or species habitat likely to occur within area
[Genoplesium baueri](#) Yellow Gnat-orchid [7528]	Endangered	Species or species habitat may occur within area
[Haloragis exalata subsp. exalata](#) Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Persicaria elatior Knotweed, Tall Knotweed [5831]	Vulnerable	Species or species habitat may occur within area
Persoonia hirsuta Hairy Geebung, Hairy Persoonia [19006]	Endangered	Species or species habitat likely to occur within area
Persoonia nutans Nodding Geebung [18119]	Endangered	Species or species habitat may occur within area
Pimelea spicata Spiked Rice-flower [20834]	Endangered	Species or species habitat likely to occur within area
Pomaderris brunnea Rufous Pomaderris [16845]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis saxicola Sydney Plains Greenhood [64537]	Endangered	Species or species habitat may occur within area
Pultenaea parviflora [19380]	Vulnerable	Species or species habitat known to occur within area
Syzygium paniculatum Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat may occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Migratory Wetlands Species		

Name	Threatened	Type of Presence
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area
[Chrysococcyx osculans](#) Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
[Hirundapus caudacutus](#) White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
[Lathamus discolor](#) Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Monarcha melanopsis](#) Black-faced Monarch [609]		Species or species habitat known to occur within area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area
[Myiagra cyanoleuca](#) Satin Flycatcher [612]		Species or species habitat known to occur within area
[Numenius madagascariensis](#) Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat may occur within area
[Rhipidura rufifrons](#) Rufous Fantail [592]		Species or species habitat likely to occur within area
[Rostratula benghalensis (sensu lato)](#) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
[Tringa nebularia](#) Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		

Name	Status	Type of Presence
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-33.870702 150.715732,-33.870693 150.715721,-33.870577 150.715925,-33.871406 150.71717,-33.871753 150.717588,-33.872109 150.717921,-33.872608 150.719659,-33.872715 150.720657,-33.872537 150.720603,-33.873071 150.720968,-33.873766 150.721011,-33.874301 150.721633,-33.874871 150.721483,-33.875281 150.721655,-33.875548 150.721376,-33.87594 150.72129,-33.876136 150.721032,-33.876474 150.721182,-33.876741 150.72114,-33.876064 150.716397,-33.874319 150.716784,-33.874283 150.716526,-33.871967 150.717191,-33.870702 150.715732

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

Appendix G

EPBC Act protected matters likelihood of occurrence assessment

Table G.1 Likelihood of occurrence assessment – threatened ecological communities

Threatened Ecological Community	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Justification for EPBC Act threatened ecological communities
Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion	E	V	Negligible	This EEC was not recorded within the subject property. It is not associated with PCT 849 or PCT 1800.
Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion	CE	E1	Negligible	This EEC was not recorded within the subject property. It is not associated with PCT 849 or PCT 1800.
Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest	CE	E1	Low	This habitat is associated with PCT 849, however, it does not align with the EPBC Ac listing because it is less than 0.5 ha in size.
Western Sydney Dry Rainforest and Moist Woodland on Shale	CE	E1	Negligible	This EEC was not recorded within the subject property. It is not associated with PCT 849 or PCT 1800.

Notes: 1. EPBC Act status: CE- critically endangered, EN – endangered, VU – vulnerable
2. BC Act status: E4A – critically endangered, E1 – endangered, E2 – endangered population, V - vulnerable

Table G.2 Likelihood of occurrence assessment – threatened flora

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Likelihood of occurrence (following targeted survey)	Justification
Acacia bynoeana	Bynoe's Wattle	VN	E1	Low	Negligible	Bynoe's Wattle is a semi-prostrate shrub to a metre high. It is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. The species is currently known from about 30 locations, with the size of the populations at most locations being very small (1–5 plants). Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include Red Bloodwood, Scribbly Gum, Parramatta Red Gum, Saw Banksia and Narrow-leaved Apple. This species was not recorded during targeted surveys.
Acacia pubescens	Downy Wattle	VN	V	Low	Negligible	Downy Wattle occurs in open woodland and forest, in a variety of plant communities. Hybridises with other wattle species (A. *baileyana*, A. *decurrens* and A. *jonesii*). High Sensitivity to loss (ie providing protection above the listing status) based on recent population decline. Marginal habitat was identified during initial surveys. This species was not recorded during targeted surveys.
Allocasuarina glareicola		EN	E1	Negligible	Negligible	Grows in Castlereagh woodland, which is absent from the subject property. Found in open woodland with Parramatta Gum, Red Ironbark, Narrow-leaved Apple (*Angophora bakeri*), Scribbly Gum (*Eucalyptus sclerophylla*) and White Feather Honeymyrtle (*Melaleuca decora*); none of these species are present within the subject property. Therefore, suitable habitat is considered to be absent.
Caladenia tessellata	Thick Lip Spider Orchid	VN	V	Negligible	Negligible	Found in grassy sclerophyll woodland on clay loam or sandy soils. When not flowering, only a single leaf is visible above ground, and this leaf regrows each year. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 1800, as such this species is not considered to occur within the subject property.

Table G.2 Likelihood of occurrence assessment – threatened flora

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Likelihood of occurrence (following targeted survey)	Justification
Cynanchum elegans	White-flowered Wax Plant	EN	E1	Low	Negligible	The rare species is known in rainforest gullies scrub and scree slopes. Marginal habitat was identified during initial surveys. This species was not recorded during targeted surveys.
Genoplesium baueri	Yellow Gnat-orchid	EN	E1	Negligible	Negligible	Grows in dry sclerophyll forest and moss gardens over sandstone, none of which is present within subject property. Therefore, suitable habitat is considered to be absent from the subject property.
Haloragis exalata subsp. exalata	Square Raspwort,	VN	V	Negligible	Negligible	Predicted to occur in the Cumberland IBRA sub-region, but not recorded there. Not predicted to occur in any of the vegetation types or PCTs recorded within the subject property, except for the vegetation type "Miscellaneous ecosystems - highly disturb ed areas with no or limited native vegetation". Species habitat is considered absent from the subject property.
Persicaria elatior	Tall Knotweed	VN	V	Moderate	Negligible	This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance. Marginal habitat was identified during initial surveys. This species was not recorded during targeted surveys.
Persoonia hirsuta	Hairy Geebung,	EN	E1	Negligible	Negligible	Known to occur in the Cumberland IBRA sub-region. Not predicted to occur in any of the vegetation types or PCTs recorded within the subject property.
Persoonia nutans	Nodding Geebung	EN	E1	Negligible	Negligible	Known to occur in the Cumberland IBRA sub-region. Not predicted to occur in any of the vegetation types or PCTs recorded within the subject property.

Table G.2 Likelihood of occurrence assessment – threatened flora

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Likelihood of occurrence (following targeted survey)	Justification
Pimelea spicata	Spiked Rice-flower	EN	E1	Negligible	Negligible	In the Cumberland Plain this species is associated with Grey Box communities (particularly Cumberland Plain Woodland variants and Moist Shale Woodland) on well-structured clay soils. It is associated with Grey Box, Forest red gum (E. *tereticornis*) and narrow-leaved ironbark (*E. crebra*). Blackthorn (*Bursaria spinosa*) is often present at sites (and may be important in protection from grazing) and Kangaroo Grass (*Themeda australis*). This species was assumed to be present on site as it can only be identified within 3–4 years of a fire. No records of this species occur within 5 km of the subject property. This species has only ever been recorded at three sites near Colo, Georges and Nepean Rivers within Wollemi National Park. The local population is unknown. The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 849, as such this species is not considered to occur within the subject property.
Pomaderris brunnea	Brown Pomaderris	VN	V	Moderate	Negligible	Brown Pomaderris grows in moist woodland or forest on clay and alluvial soils of flood plains and creek lines. It is associated with Cabbage Gum (*Eucalyptus amplifolia*) Rough-barked Apple (*Angophora floribunda*), Parramatta Wattle (*Acacia parramattensis*), Blackthorn, and White Kunzea (*Kunzea ambigua*). Marginal habitat was identified during initial surveys. This species was not recorded during targeted surveys.
Pterostylis saxicola	Sydney Plains Greenhood	EN	E1	Negligible	Negligible	Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where *Pterostylis saxicola* occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils. Habitat requires a native groundcover (ie over 50% native species). Subject property does not contain suitable habitat for this species.
Pultenaea parviflora		VN	E1	Low	Negligible	May be locally abundant, particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. Not predicted to occur in any of the vegetation types or PCTs recorded within the subject property.

Table G.2 Likelihood of occurrence assessment – threatened flora

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Likelihood of occurrence (following targeted survey)	Justification
Syzygium paniculatum	Magenta Lilly Pilly,	VN	E1	Negligible	Negligible	The Magenta Lilly Pilly is found only in NSW, in a narrow, linear coastal strip from Upper Lansdowne to Conjola State Forest. The subject property is outside the known distribution for this species.
Thesium australe	Austral Toadflax	VN	V	Low	Negligible	It occurs in shrubland, grassland or woodland, often on damp sites. Vegetation types include open grassy heath dominated by Swamp Myrtle (*Leptospermum myrtifolium*), Small-fruit Hakea (*Hakea microcarpa*), Alpine Bottlebrush (*Callistemon sieberi*), Woolly Grevillea *(Grevillea lanigera*), Coral Heath (*Epacris microphylla*) and Poa spp. Kangaroo Grass grassland surrounded by Eucalyptus woodland; and grassland dominated by Barbed-wire Grass (*Cymbopogon refractus*). The subject property has been historically cleared and modified for farming and quarrying works. Habitat alterations have included the creation of dams. The habitat is highly degraded within PCT 849, as such this habitat is only considered marginal to support this species within the subject property.

Notes: 1. EPBC Act status: CE- critically endangered, EN – endangered, VU – vulnerable
2. BC Act status: E4A – critically endangered, E1 – endangered, E2 – endangered population, V – vulnerable

Table G.3 Likelihood of occurrence assessment – fauna species

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Justification
Anthochaera phrygia	Regent Honeyeater	CE	E4A	Negligible	The Regent Honeyeater is a striking, predominantly black and yellow bird. Its head and neck are black, with warty pink or yellow skin around the eyes. Endemic to mainland south-eastern Australia, the species has a patchy distribution from south-east Queensland, through NSW and the ACT into central Victoria. Records are widely distributed across this range, but the species is only found regularly at a few localities in NSW and Victoria. Most records of regent honeyeaters come from box-ironbark eucalypt associations, where the species seems to prefer more fertile sites with higher soil water content. Other forest types regularly utilised by the Regent Honeyeater include wet lowland coastal forest dominated by Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum-Ironbark associations and riverine woodlands. The species has not been recorded within 10 km of the subject property. The subject property does not support key habitat or feed tree species.
Botaurus poiciloptilus	Australasian Bittern	EN	E1	Low	The Australasian Bittern's preferred habitat is comprised of wetlands with tall dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. It favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and reeds or cutting grass growing over a muddy or peaty substrate. The subject property contains some marginal habitat that may be suitable to support this species. The species has not been recorded within 10 km of the subject property.
Calidris ferruginea	Curlew Sandpiper	CE	E1	Low	The Curlew Sandpiper is a small, slim sandpiper. Inland, the species mainly occur around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They forage at the edges of shallow pools and drains of intertidal mudflats and sandy. The subject property contains some marginal habitat that may be suitable to support this species. The species has not been recorded within 10 km of the subject property.

Table G.3 Likelihood of occurrence assessment – fauna species

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Justification
Grantiella picta	Painted Honeyeater	VU	V	Low	The Painted Honeyeater has black upperparts, white underparts, black spots on its flanks and yellow edges to the flight and tail feathers. The bill is a deep pink and the eye red. The species is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory, with inland slopes of the Great Dividing Range seeing greatest concentrations and almost all records of breeding. The species has a specialist diet mainly consisting of mistletoe fruits, but also includes nectar. The species inhabits mistletoes in a variety of vegetation types, including eucalypt forests/woodlands, riparian woodlands, box-ironbark-yellow gum woodlands, acacia-dominated woodlands, paperbarks, casuarinas, callitris, and trees on farmland or gardens. The species has not been recorded within 10 km of the subject property.
Hirundapus caudacutus	White-throated Needletail	VU	-	Low	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breeds in Asia. White-throated Needletails almost always forage aerially, at heights up to 'cloud level' The species has not been recorded within 10 km of the subject property.
Lathamus discolour	Swift Parrot	CE	E1	Negligible	The Swift Parrot is a small fast-flying, nectivorous parrot which occurs in eucalypt forests in south eastern Australia. The species breeds in Tasmania and migrate to mainland Australia in autumn. During winter the parrots disperse across a broad landscape, foraging on nectar and lerps in eucalypt forests, particularly inland box-ironbark and grassy woodlands, and Coastal Swamp Mahogany (*E. robusta*) and Spotted Gum (*Corymbia maculata*) woodland when in flower. The subject property is outside of the known breeding habitat area for this species. The subject property does not contain suitable feed tree species for this species. The species has not been recorded within 10 km of the subject property.
Numenius madagascariensis	Eastern Curlew	CE	-	Negligible	The Eastern Curlew is the largest migratory shorebird in the world, migrating to Australia during the northern hemisphere winter. In Australia, the species has a primarily coastal distribution, inhabiting sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. The species has not been recorded within 10 km of the subject property. The subject property does not provide suitable intertidal habitat.

Table G.3 Likelihood of occurrence assessment – fauna species

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Justification
Rostratula australis	Australian Painted Snipe	EN	E1	Low	The Australian Painted Snipe is a stocky wading bird, endemic to Australia and has been recorded at wetlands in all states and territories. The species inhabits shallow ephemeral and permanent freshwater (occasionally brackish) wetlands. The species has not been recorded within 10 km of the subject property.
Chalinolobus dwyeri	Large-eared Pied Bat	VU	V	Recorded	Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years. The subject property doesn't contain suitable maternity roost habitats in the form of sandstone overhangs. This species was recorded once passing over the subject property during the microbat surveys.
Dasyurus maculatus maculatus	Spotted-tail Quoll	EN	V	Negligible	The Spotted-tailed Quoll is one of Australia's largest extant marsupial carnivores and has a distinctive spotted appearance. The species is primarily forest-dependent , and occupies a wide range of habitat types, including rainforest, wet and dry sclerophyll forest, coastal heathland, scrub and dunes, woodland, heathy woodland, swamp forest, mangroves, on beaches and sometimes in grassland or pastoral areas adjacent to forested areas. The species has home ranges of several hundred to several thousand hectares in size and will use multiple dens. moving between den sites every 1–4 days. The species occurs at low densities. The subject property is isolated from areas of suitable habitat for this species. The species has not been recorded within 10 km of the subject property.

Table G.3 Likelihood of occurrence assessment – fauna species

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Justification
Petauroides volans	Greater Glider	VU	-	Negligible	The Greater Glider is the largest gliding possum in Australia. The species is distributed across eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria (Wombat State Forest), with an elevational range from sea level to 1,200 m above sea level. The species is restricted to eucalypt forests and woodlands, typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows. The species distribution may be patchy even in suitable habitat. The subject property does not contain suitable habitat to support this species. The species has not been recorded within 10 km of the subject property.
Petrogale penicillata	Brush-tailed Rock-wallaby	VU	E1	Negligible	The Brush-tailed Rock-wallaby Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night when foraging. Feeds on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. The subject property does not contain suitable habitat to support this species. The species has not been recorded within 10 km of the subject property.
Phascolarctos cinereus	Koala	VU	V	Negligible	The Koala is a tree-dwelling, medium-sized marsupial, distributed from Cairns to South Australia, however, the listed population does not include Victoria or South Australia. Koalas inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus Eucalyptus. The distribution of Koalas is also affected by altitude, with the species limited to below 800 m ASL. The subject property does not contain suitable feed species to support this species. The species has not been recorded within 10 km of the subject property.
Pseudomys novaehollandiae	New Holland Mouse	VU	-	Negligible	The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes. The subject property does not contain suitable habitat to support this species. The species has not been recorded within 10 km of the subject property.

Table G.3 Likelihood of occurrence assessment – fauna species

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Justification
Pteropus poliocephalus	Grey-headed Flying-fox	VU	V	Recorded	The Grey-headed Flying-fox is a large, endemic megachiropteran bat occurring in south-eastern Australia. The species distribution extends from Bundaberg in Queensland to Melbourne in Victoria, and from the coast inland to the western slopes of NNSW. The Grey-headed Flying-fox feeds on nectar and pollen from flowers of canopy trees and fleshy fruits from rainforest trees and vines, with regional preferences shown. The species was recorded foraging within the subject property.
Heleioporus australiacus	Giant Burrowing Frog	VU	V	Negligible	The Giant Burrowing Frog are found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. Spends more than 95% of its time in non-breeding habitat in areas up to 300 m from breeding sites. Whilst in non-breeding habitat it burrows below the soil surface or in the leaf litter. Individual frogs occupy a series of burrow sites, some of which are used repeatedly. The home ranges of both sexes appear to be non-overlapping suggesting exclusivity of non-breeding habitat. Home ranges are approximately 0.04 ha in size. The subject property does not contain suitable habitat to support this species. The species has not been recorded within 10 km of the subject property.
Litoria aurea	Green and Golden Bell Frog	VU	E2	Negligible	This species inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes waterbodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. This species can occur in highly disturbed areas. This species was not recorded during targeted surveys. .

Table G.3 Likelihood of occurrence assessment – fauna species

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Justification
Macquaria australasica	Macquarie Perch	EN	-	Negligible	The Macquarie Perch is found in the Murray-Darling Basin, particularly the upstream reaches of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW. The draft National Recovery Plan for Macquarie Perch identifies four self-sustaining populations; none are within the subject property. Macquarie Perch prefer clear water and deep, rocky holes with extensive cover in the form of aquatic vegetation, large boulders, debris and overhanging banks. They spawn in spring or summer and lay their eggs over stones and gravel in shallow, fast-flowing upland streams or flowing parts of rivers. Macquarie Perch inhabiting impoundments would likely undertake upstream spawning migration in October to mid-January after which adults usually move from the streams to the lake. Migration may not be necessary in stream dwelling fish. The subject property does not contain suitable habitat to support this species. The species has not been recorded within 10 km of the subject property.
Prototroctes maraena	Australian Grayling	VU	-	Negligible	Australian grayling is a primarily freshwater fish found in coastal rivers in south-eastern mainland Australia and Tasmania. The subject property does not contain suitable habitat to support this species. The species has not been recorded within 10 km of the subject property.
Synemon plana	Golden Sun Moth	CE	E1	Negligible	Golden Sun Moth occurs in Natural Temperate Grasslands and grassy Box-Gum Woodlands in which groundlayer is dominated by Spear Grasses (*Austrostipa* spp.) and/or Wallaby grasses (*Rytidosperma* spp.). They are known to spread into adjacent grasslands where Chilean Needle Grass (*Nassella neesiana*) and Serrated Tussock (*Nassella trichotoma*) are present. The subject property does not contain native grasslands. The woodland on site comprises an exotic groundlayer. Chilean Needle Grass and Serrated Tussock were not recorded on site either. Habitat is therefore considered to be absent for this species.

Notes: 1. EPBC Act status: CE- critically endangered, EN – endangered, VU – vulnerable, Mi – migratory
2. BC Act status: E4A – critically endangered, E1 – endangered, E2 – endangered population, V – vulnerable

Table G.4 Likelihood of occurrence assessment – migratory species

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Justification
Migratory Marine Birds					
Apus pacificus	Fork-tailed Swift	Mi		Low	Almost exclusively aerial (foraging). The Fork-tailed Swift breeds in Asia but migrates to Australia from September to April. Individuals or flocks can be observed hawking for insects at varying heights from only a few metres from the ground and up to 300 metres high. The species has not been recorded within 10 km of the subject property.
Migratory Terrestrial Species					
Cuculus optatus	Horsfield's Bronze-Cuckoo	Mi		Moderate	In Australia, Horsfield's Bronze-Cuckoo is found in all regions, including some islands. It is widespread on the eastern side of the Great Dividing Range in Queensland and is found down through New South Wales and Victoria to Tasmania and South Australia. The Horsfield's Bronze-Cuckoo is found in many wooded habitats (such as open and dry woodland and forest) with a range of understoreys from grasses to shrubs or heath. Sometimes found near clearings and in recently logged or burnt forests. Found in farmland with some trees, orchards, vineyards and urban parks and gardens. The subject property contains suitable habitat to support this species. The species has not been recorded within 10 km of the subject property.
Hirundapus caudacutus	White-throated Needletail	VU, Mi		Low	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breeds in Asia. White-throated Needletails almost always forage aerially, at heights up to 'cloud level' The species has not been recorded within 10 km of the subject property.
Monarcha melanopsis	Black-faced Monarch	Mi		Negligible	A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland. The species has not been recorded within 10 km of the subject property. The subject property does not support suitable rainforest habitat.

Table G.4 Likelihood of occurrence assessment – migratory species

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Justification
Motacilla flava	Yellow Wagtail	Mi		Low	Regular spring-summer visitor in north of Australia, rare vagrant or occasional visitor farther south. Found in marshes, damp paddocks, airfields, cultivated fields, lawns and estuaries. The species has not been recorded within 10 km of the subject property. The subject property is outside the known distribution of the species.
Myiagra cyanoleuca	Satin Flycatcher	Mi		Low	The Satin Flycatcher inhabits heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. The species can occur at elevations of up to 1,400 m ASL. The Satin Flycatcher breeds in heavily vegetated gullies. The subject property contains some marginal habitat that may be suitable to support this species. The species has not been recorded within 10 km of the subject property.
Rhipidura rufifrons	Rufous Fantail	Mi		Negligible	Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. The species mainly inhabits wet sclerophyll forests often in gullies dominated by eucalypts such as Tallow-wood (*Eucalyptus microcorys*), Mountain Grey Gum (*E. cypellocarpa*), Narrow-leaved Peppermint (*E. radiata*), Mountain Ash (*E. regnans*), Alpine Ash (*E. delegatensis*), Blackbutt (*E. pilularis*). During migration it can stray into gardens and more open areas. The subject property does not provide suitable habitat for this species. The species has not been recorded within 10 km of the subject property.
Migratory Wetlands Species					
Actitis hypoleucos	Common Sandpiper	Mi		Low	Inhabits a wide range of coastal and inland wetlands, often with muddy or rocky margins. Also known to occur at estuaries, billabongs, dams, pools and lakes, often associated with mangroves. The subject property contains some marginal habitat that may be suitable to support this species. The species has not been recorded within 10 km of the subject property.

Table G.4 Likelihood of occurrence assessment – migratory species

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Justification
Calidris acuminata	Sharp-tailed Sandpiper	Mi		Moderate	The Sharp-tailed Sandpiper forages at the edge of water within wetlands or intertidal mudflats, either on bare wet mud, sand or shallow water. They will also forage among inundated vegetation of saltmarsh, grass or sedges. Roosting occurs at the edges of wetlands, on wet open mud or sand or in sparse vegetation. The subject property contains some marginal habitat that may be suitable to support this species. The species was recorded within 10 km of the subject property.
Calidris ferruginea	Curlew Sandpiper	CE, Mi	E1	Low	The Curlew Sandpiper is a small, slim sandpiper. Inland, the species mainly occur around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They forage at the edges of shallow pools and drains of intertidal mudflats and sandy. The subject property contains some marginal habitat that may be suitable to support this species. The species has not been recorded within 10 km of the subject property.
Calidris melanotos	Pectoral Sandpiper	Mi		Low	Scarce, but regular visitor, usually recorded in summer from November to March. Widespread but scattered records in Australia. Usually found in fresh to saline wetlands, floodplains, swamps, estuaries and lagoons, sometimes with emergent or fringing vegetation such as grass. The subject property contains some marginal habitat that may be suitable to support this species. The species has not been recorded within 10 km of the subject property.
Gallinago hardwickii	Latham's Snipe	Mi		Moderate	Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams. The subject property contains some marginal habitat that may be suitable to support this species. The species was recorded within 10 km of the subject property.
Numenius madagascariensis	Eastern Curlew	CE, Mi		Negligible	The Eastern Curlew is the largest migratory shorebird in the world, migrating to Australia during the northern hemisphere winter. In Australia, the species has a primarily coastal distribution, inhabiting sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. The species has not been recorded within 10 km of the subject property. The subject property does not provide suitable intertidal habitat.

Table G.4 Likelihood of occurrence assessment – migratory species

Scientific name	Common name	EPBC Act[1]	BC Act[2]	Likelihood of occurrence	Justification
Pandion haliaetus	Osprey	Mi		Negligible	The Osprey is cosmopolitan, being found in many coastal and lake areas of the world. In Australia, it is found on the north and east coast from Broome to the south coast of New South Wales. Ospreys are found on the coast and in terrestrial wetlands of tropical and temperate Australia and off-shore islands, occasionally ranging inland along rivers, though mainly in the north of the country. The subject property contains some marginal habitat that may be suitable to support foraging habitat, however, no active or old nesting sites were observed in the subject property for this species. The species has not been recorded within 10 km of the subject property.
Tringa nebularia	Common Greenshank	Mi		Moderate	The Common Greenshank breeds in the Palaearctic regions and is widespread in Africa, Coastal Asia, the Indian subcontinent, the Philippines and southern New Guinea. They are common throughout Australia in the summer. Common Greenshanks are found both on the coast and inland, in estuaries and mudflats, mangrove swamps and lagoons, and in billabongs, swamps, sewage farms and flooded crops. The subject property contains some marginal habitat that may be suitable to support this species. The species was recorded within 10 km of the subject property.

Notes: 1. EPBC Act status: CE- critically endangered, EN – endangered, VU – vulnerable, Mi – migratory
2. BC Act status: E4A – critically endangered, E1 – endangered, E2 – endangered population, V – vulnerable

Appendix H

EPBC Act significant impact criteria assessments

Table H.1 Significant impact criteria assessment – Large-eared Pied Bat

Species profile	**Large-eared Pied Bat** **Status:** Vulnerable (EPBC and BC Act) **Distribution**: The current distribution of this species is poorly known. Records exist from Shoalwater Bay, north of Rockhampton, Queensland, through to the vicinity of Ulladulla, New South Wales in the south. **Biology**: The large-eared pied bat is a small to medium-sized insectivorous bat measuring approximately 100 mm including the head and tail, and weighing between 7–12 g. It has shiny, black fur on the body and there is a white stripe on the ventral side of the torso where it adjoins the wings and tail. The ears are long and prominent and lobes of skin adorn the lower lip and between the corner of the mouth and the bottom of the ear. **Habitat requirements:** Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20–40 females) from November through to January in roof domes in sandstone caves and overhangs. They remain loyal to the same cave over many years. **Threats**: The main identified threats to this species include: • disturbance and damage at primary nursery roosts • long wall mining for coal; • loss of foraging habitat; and • predation by foxes (*Vulpes Vulpes*) and other predators.
Criteria	**Discussions**
Lead to a long-term decrease in the size of an important population	The subject property may be used by this species as a commuting route along Oaky Creek only. There is no known important population present on the subject property, and the vegetation is unlikely to be of key importance or to lead to a long-term decrease in an important population. No individuals were recorded at Western Sydney Airport (DIRD 2016).
Reduce the area of occupancy for an important population	The subject property may be used by this species as a commuting route along Oaky Creek only. No known important population present on the subject property.
Fragment an existing important population into two or more populations	The subject property is considered to be used by this species as a commuting route along Oaky Creek only. The commuting habitat will not be impacted on as part of the ARRC.
Adversely affect habitat critical to the survival of a species	The subject property is considered to be used by this species as a commuting route along Oaky Creek only.
Disrupt the breeding cycle of an important population	The subject property does not contain suitable maternity roost habitats in the form of sandstone overhangs. This species was recorded once passing over the subject property during the microbat surveys. The subject property is considered to be used by this species as a commuting route along Oaky Creek. There is no direct habitat loss as part of the ARRC site that is considered to disrupt the breeding cycle of a population.

Table H.1 Significant impact criteria assessment – Large-eared Pied Bat

Modify, destroy, remove, isolate or decrease the availability habitat to the extent that the species is likely to decline	The subject property does not contain suitable maternity roost habitats in the form of sandstone overhangs. This species was recorded once passing over the subject property during the microbat surveys. The subject property is considered to be used by this species as a commuting route along Oaky Creek. There is no direct habitat loss as part of the ARRC site that is considered to lead to a substantially modify, destroy or isolate an area of important habitat.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The subject property has the potential to be used by foxes as part of their hunting grounds. As no roosting or breeding habitat is presence within the subject property no impacts are expected to occur on important habitat for this species.
Introduce disease that may cause the species to decline	The subject property is considered to be used by this species as a commuting route along Oaky Creek only.
Interfere substantially with the recovery of the species	The subject property is considered to be used by this species as a commuting route along Oaky Creek only.
Conclusion	The ARRC site is unlikely to result in a significant impact as: • no maternity roosts or potential habitat to support maternity roosts will be lost; and • the ARRC site will not disrupt the breeding cycle of this species population.

Table H.2 Significant impact criteria assessment – Grey-headed Flying-fox

Species profile	**Grey-headed Flying-fox** **Status:** **Vulnerable (EPBC and BC Act)** **Distribution:** **Grey-headed Flying-foxes are generally found within 200 km of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia.** **Biology:** **The Grey-headed Flying-fox is the largest Australian bat, with a head and body length of 23–29 cm. It has dark grey fur on the body, lighter grey fur on the head and a russet collar encircling the neck. The wing membranes are black and the wingspan can be up to 1 m.** **Habitat requirements:** **Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.** **Threats:** **Main threats to Grey-headed Flying-fox is disturbance or destruction of roosting camps.**

Criteria	Discussions
Lead to a long-term decrease in the size of an important population	The subject property does not contain roosting camps, this species is highly mobile and would use the site for foraging only. The vegetation is unlikely to be of key importance or to lead to a long-term decrease in an important population.
Reduce the area of occupancy for an important population	The subject property does not contain roosting camps, this species is highly mobile and would use the site for foraging only.
Fragment an existing important population into two or more populations	The subject property does not contain roosting camps, this species is highly mobile and would use the site for foraging only. The ARRC site will not modify destroy or isolate an area of important habitat.
Adversely affect habitat critical to the survival of a species	The subject property does not contain roosting camps, this species is highly mobile and would use the site for foraging only.
Disrupt the breeding cycle of an important population	The subject property does not contain roosting camps. The ARRC site is not considered to disrupt the breeding cycle for the local population of this species.
Modify, destroy, remove, isolate or decrease the availability habitat to the extent that the species is likely to decline	The subject property does not contain roosting camps, this species is highly mobile and would use the site for foraging only.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	As no roosting camps are presence within the subject property, no impacts from invasive species are expected to have an impact on important habitat for this species.

Table H.2 Significant impact criteria assessment – Grey-headed Flying-fox

Species profile	**Grey-headed Flying-fox** **Status:** **Vulnerable (EPBC and BC Act)** **Distribution:** **Grey-headed Flying-foxes are generally found within 200 km of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia.** **Biology:** **The Grey-headed Flying-fox is the largest Australian bat, with a head and body length of 23–29 cm. It has dark grey fur on the body, lighter grey fur on the head and a russet collar encircling the neck. The wing membranes are black and the wingspan can be up to 1 m.** **Habitat requirements:** **Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.** **Threats:** **Main threats to Grey-headed Flying-fox is disturbance or destruction of roosting camps.**
Introduce disease that may cause the species to decline	The subject property does not contain roosting camps, this species is highly mobile and would use the site for foraging only.
Interfere substantially with the recovery of the species	The subject property does not contain roosting camps, this species is highly mobile and would use the site for foraging only.
Conclusion	The ARRC site is unlikely to result in a significant impact as: no roosting camps will be impacted on; and the ARRC site will not disrupt the breeding cycle of this species population.

Table H.3 Significant impact criteria assessment – Horsfield's Bronze-cuckoo

Species profile	**Horsfield's Bronze-cuckoo** **Status:** Migratory (EPBC Act) **Distribution**: In Australia, Horsfield's Bronze-Cuckoo is found in all regions, including some islands. It is widespread on the eastern side of the Great Dividing Range in Queensland and is found down through New South Wales and Victoria to Tasmania and South Australia. **Biology**: Horsfield's Bronze-Cuckoo is an olive-brown above with pale scaling and a bronze to green sheen on the back and upper tail. **Habitat requirements**: The Horsfield's Bronze-Cuckoo is found in many wooded habitats (such as open and dry woodland and forest) with a range of understoreys from grasses to shrubs or heath. Sometimes found near clearings and in recently logged or burnt forests. Found in farmland with some trees, orchards, vineyards and urban parks and gardens.
Criteria	**Discussion**
Substantially modify destroy or isolate an area of important habitat.	The ARRC will remove 0.28 ha of poor and medium condition PCT 1800, this habitat is not considered important for this species. No impacts to Oakey Creek are to occur, which may be used as a habitat corridor for this species. The ARRC is not considered to substantially modify, destroy or isolate areas of important habitat.
Result in an invasive species becoming established in an area of important habitat.	This species uses as variety of habitats. Based on the proposed mitigation measures it is not expected that the ARRC site will result in an increase of invasive species.
Disrupt the breeding cycle of a population.	The ARRC will remove 0.28 ha of poor and medium condition PCT 1800, this habitat is not considered important for this species. The ARRC is unlikely to disrupt the breeding cycle of this species.
Conclusion	The ARRC site is unlikely to result in a significant impact as: • only a small area of poor and medium condition habitat is to be removed; and • the ARRC site will not disrupt the breeding cycle of this species population.

Table H.4 Significant impact criteria assessment – Sharp-tailed Sandpiper

Species profile	**Shape-tailed Sandpiper** **Status:** **Migratory (EPBC Act)** **Distribution:** **The Sharp-tailed Sandpiper spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage.** **Biology:** **The Sharp-tailed Sandpiper is a small-medium wader. The bird has a length of 17–22 cm, a wingspan of 36–43 cm and a weight of 65 g.** **Habitat requirements:** **The Sharp-tailed Sandpiper forages at the edge of water within wetlands or intertidal mudflats, either on bare wet mud, sand or shallow water. They will also forage among inundated vegetation of saltmarsh, grass or sedges. Roosting occurs at the edges of wetlands, on wet open mud or sand or in sparse vegetation.** **Threats:** **The main identified threats to this species include:** **habitat loss;** **reduction in water quality and quantity;** **disturbance;** **global warming; and** **hunting.**
Criteria	**Discussion**
Substantially modify destroy or isolate an area of important habitat.	The ARRC is not considered to support areas of important habitat for the Latham's Snipe as per the guidelines identified in *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (DoEE 2017). The ARRC will not remove any of the waterbodies within the subject property that may contain suitable foraging habitat with wet mud. One ephemeral waterbodies will be lost, however in dry times it is largely dominated by grassland habitat. The ARRC is not considered to substantially modify, destroy or isolate areas of important habitat.
Result in an invasive species becoming established in an area of important habitat.	Based on the proposed mitigation measures it is not expected that the ARRC site will result in an increase of invasive species.
Disrupt the breeding cycle of a population.	The Sharp-tailed Sandpiper breeds in northern Siberia, from the delta of the Lena River, east to Chaun Gulf and east of the Kolyma River delta. No impacts on the breeding cycle of this population is considered to occur.
Conclusion	The ARRC site is unlikely to result in a significant impact as: no suitable foraging habitat will be removed; and the ARRC site will not disrupt the breeding cycle of this species population.

Table H.5 Significant impact criteria assessment – Latham's Snipe

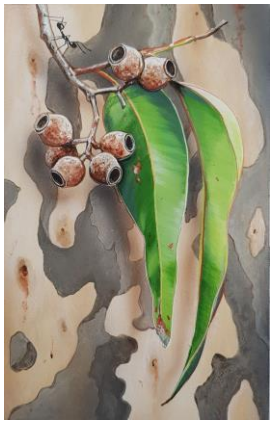
Species profile	**Latham's Snipe** **Status: Migratory (EPBC Act)** **Distribution:** **The Latham's Snipe is a non-breeding migrant to the south east of Australia including Tasmania, passing through the north and New Guinea on passage. The species breeds in Japan and on the east Asian mainland.** **Biology:** **The Latham's Snipe is the largest snipe in Australia; mainly brown plumage, with a long straight bill and short pointed wings. The upper body is boldly patterned with black, brown and white. The sexes are similar in appearance and do not show seasonal variation unlike other migratory waders. Juveniles in fresh plumage differ only slightly from adults.** **Habitat requirements:** **The Latham's Snipe occurs in permanent and ephemeral wetlands up to 2,000 m ASL. The species inhabits open, freshwater wetlands with low, dense vegetation.** **Threats:** **The main threats associated with the Latham's Snipe include the loss of habitat caused by the drainage and modification of wetlands, diversion of water for storage or agriculture, development of land and land management practices such as mowing of habitat. The species was also previously legally hunted.**
Criteria	**Discussion**
Substantially modify destroy or isolate an area of important habitat.	The ARRC is not considered to support areas of important habitat for the Latham's Snipe as per the guidelines identified in *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (DoEE 2017). The ARRC is not considered to substantially modify, destroy or isolate areas of important habitat.
Result in an invasive species becoming established in an area of important habitat.	The *Threat Abatement Plan for predation by the European red fox* (DEWHA 2008) identifies the Latham's Snipe as one of the species likely to be affected by the European red fox. The ARRC will not result in an increase or introduction of the European red fox into an area of important habitat. As discussed above, the project area does not contain important habitat for the species and will not result in invasive species becoming established in an area of important habitat.
Disrupt the breeding cycle of a population.	The Latham's Snipe breeding range is confined to Japan and far eastern Russia, therefore the ARRC site will not impact the species breeding cycle.
Conclusion	The ARRC site is unlikely to result in a significant impact on Latham's Snipe as: no important habitat will be directly impacted on; and the proposed action will not disrupt the breeding cycle of the species.

Table H.6 Significant impact criteria assessment – Common Greenshank

Species profile	**Common Greenshank** **Status: Migratory (EPBC Act)** **Distribution:** **The Common Greenshank is a non-breeding migrant to Australia The species breeds in Eurasia, the northern British Isles, Scandinavia, east Estonia and north-east Belarus, through Russia.** **Biology:** **The Common Greenshank is a heavily built, elegant wader, 30–35 cm in length, with a wingspan of 55–65 cm and weight up to 190 g for both males and females.** **Habitat requirements:** **The Common Greenshank is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. The species uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats. It will also use artificial wetlands, including sewage farms and saltworks dams, inundated rice crops and bores. The edges of the wetlands used are generally of mud or clay, occasionally of sand, and may be bare or with emergent or fringing vegetation, including short sedges and saltmarsh, mangroves, thickets of rushes, and dead or live trees.** **Threats:** **The main identified threats to this species include:** **loss/modification of habitat;** **silt, pollution, weeds or pest invasion;** **disturbance; and** **introduced species.**
Criteria	**Discussion**
Substantially modify destroy or isolate an area of important habitat.	The ARRC is not considered to support areas of important habitat for the Common Greenshank as per the guidelines identified in *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (DoEE 2017). The ARRC is not considered to substantially modify, destroy or isolate areas of important habitat.
Result in an invasive species becoming established in an area of important habitat.	Based on the highly degraded nature and existing weed infestation on the subject property it is not expected that the ARRC site will result in an increase of invasive species
Disrupt the breeding cycle of a population.	**The Latham's Snipe breeding range is confined Eurasia, the northern British Isles, Scandinavia, east Estonia and north-east Belarus, through Russia, therefore the ARRC site will not impact the species breeding cycle.**
Conclusion	The ARRC site is unlikely to result in a significant impact on this species as: no important habitat will be directly impacted on; and the proposed action will not disrupt the breeding cycle of the species.

Appendix I

Acoustic detection survey results



CORYMBIA ECOLOGY

Amy Rowles
415 Parishs Rd, Hilldale, NSW, 2420
Mob: 0418451488
Email: amy@corymbiaecology.com.au
ABN 61854031078

BAT CALL ANALYSIS RESULTS

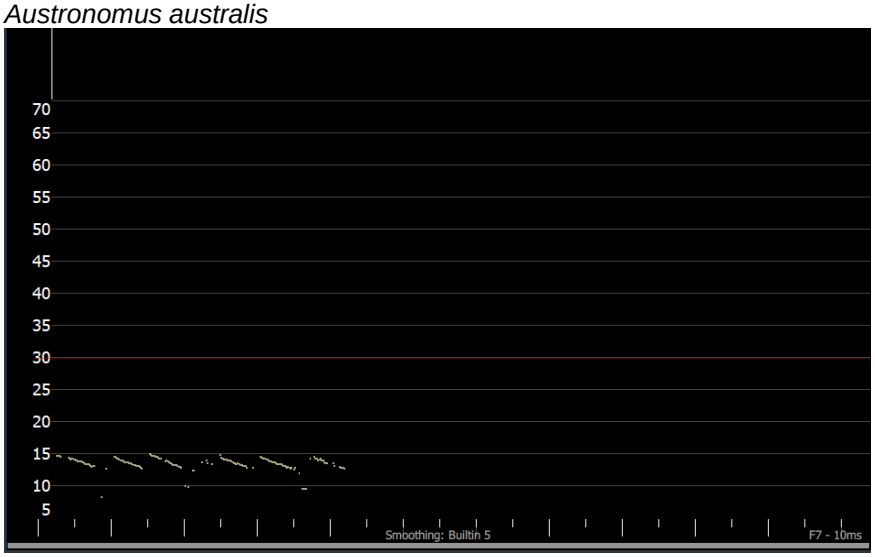
Jason Brown - EMM
J190749 – Adams Rd, Luddenham
27/02/2020 – 02/03/2020

Species	Anabat A	Anabat B	Notes
	SN507269 3892 files 2692 noise	SN507245 2005 files 855 noise	
Austronomus australis	D	D	
Chalinolobus dwyeri	D	D	Only one pass each detector
Chalinolobus gouldii	D	D	
Chalinolobus morio	D	D	
Miniopterus schreibersii oceanensis	D	Pr	
Miniopterus australis	Po	Po	Poor quality calls. Could just be clutter calls from *C. morio*
Myotis macropus		D	Lots of activity at Anabat B
Mormopterus norfolkensis	D	D	Can be difficult to ID calls between these species, unless clear highly characteristic passes
Mormopterus norfolkensis or *Mormopterus(ozimops) ridei*	E	E	
Nyctophilus sp	D	Pr	
Scotorepens orion	Pr	Pr	Calls may be easily confused between *Scotorepens orion, Scoteanax rueppellii* and *F. tasmaniensis.* Less likely to be *F.tasmaniensis* due to marginal habitat for the species.
Scoteanax rueppellii	Pr	Po	
Falsistrellus tasmaniensis	Po		
Vespadelus vulturnus	Pr		Only one pass. Not very clear

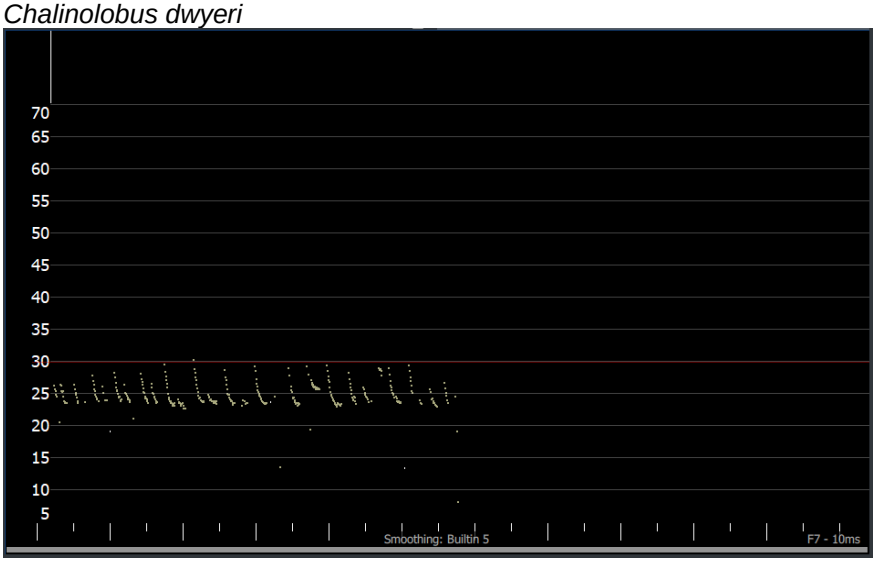
- D – definite; Pr – probable; Po – possible; E-either.
- Calls were analysed using Analook and Anabat Insight.
- Example calls presented below are displayed in this report at F7 or F8 (bottom right corner).
- Analysis was completed on the 15th March 2020
- The following resources were consulted during analysis:
  - Pennay M., Law B., and Reinhold L. (2004) Bat Calls of NSW. DEC of NSW.
  - Corben C. (2009) Anabat Techniques Workshop, Titley Scientific.
  - Anabat Insight Workshop (2019), Titley Scientific and Balance Environmental.
  - Personal experience analysing calls and collection of reference calls in NSW
- **Please note only species with a definite ID should be entered into Bionet.**

Examples of calls for definite identified species

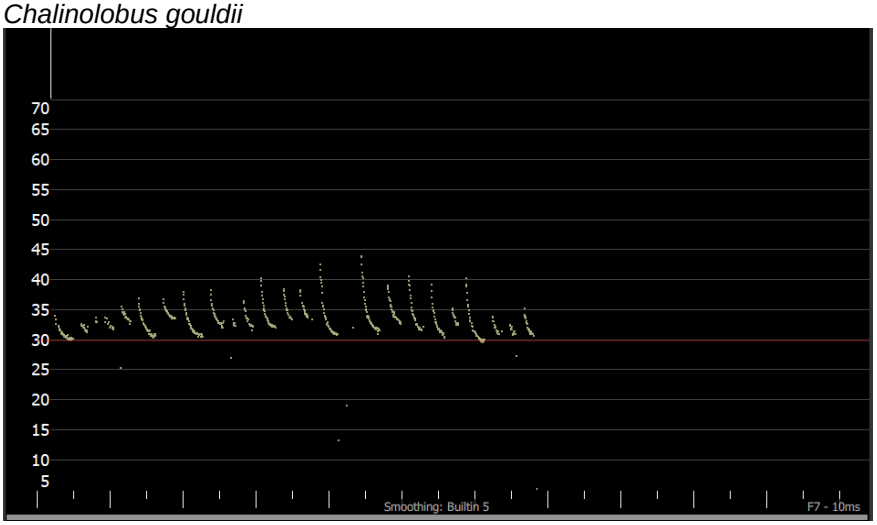
Austronomus australis



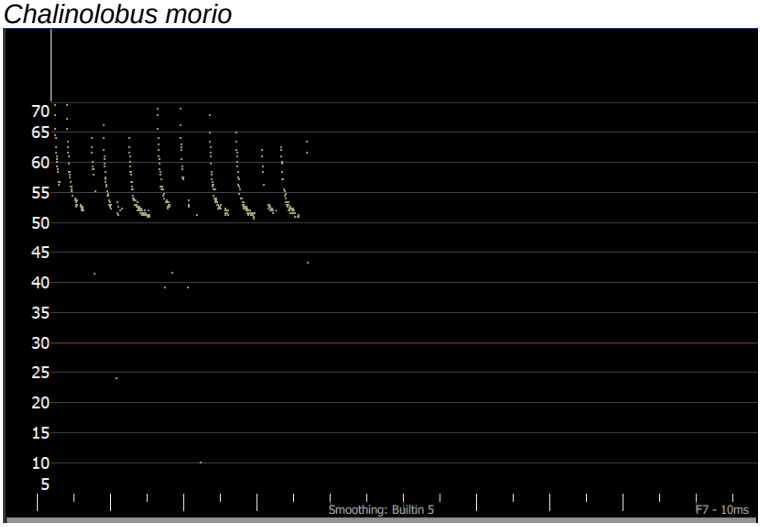
Chalinolobus dwyeri



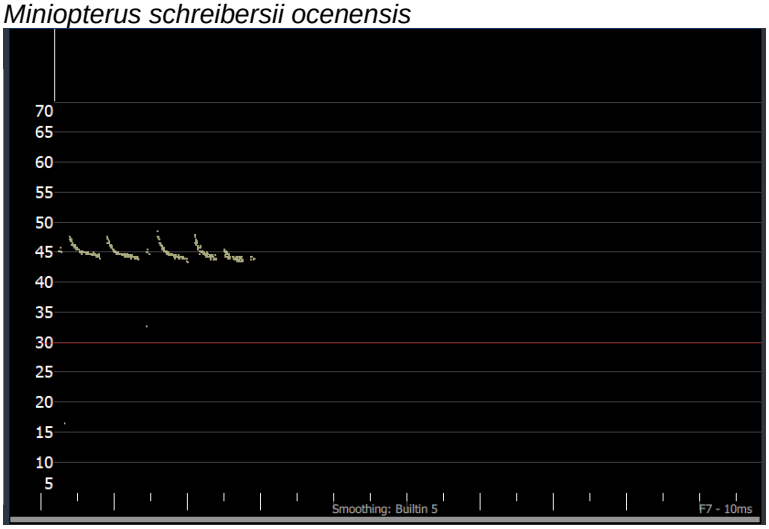
Chalinolobus gouldii



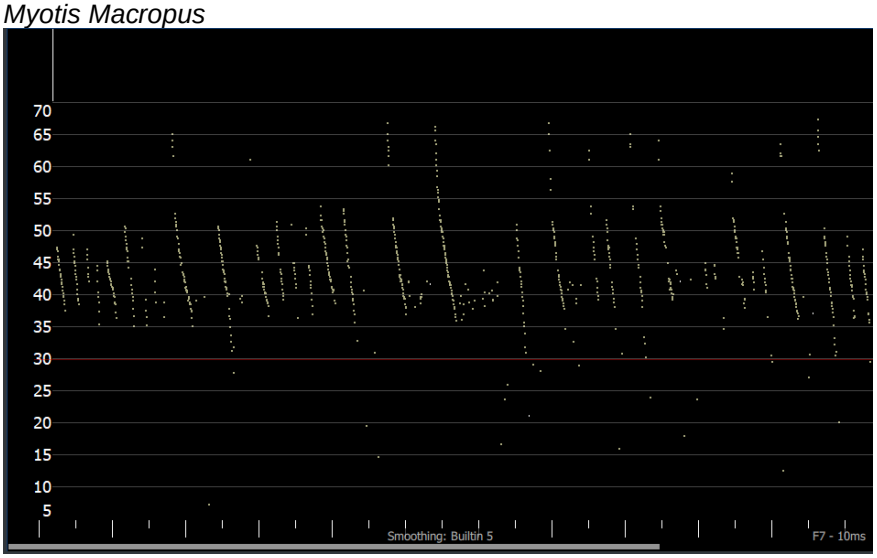
Chalinolobus morio



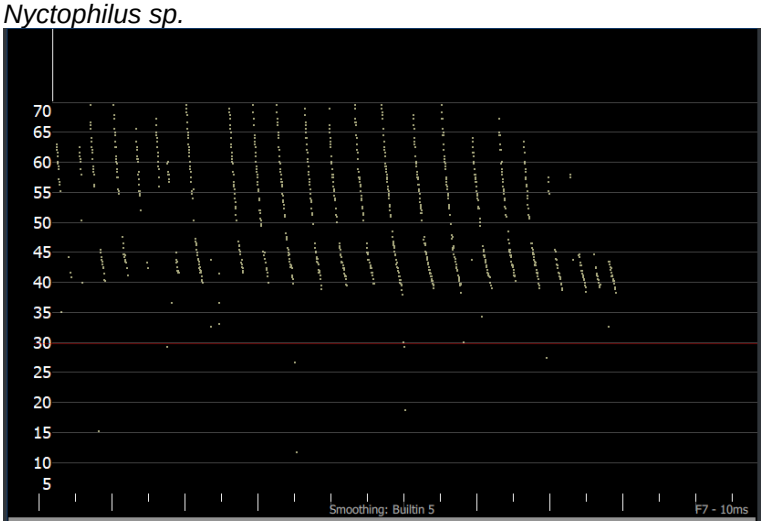
Miniopterus schreibersii ocenensis



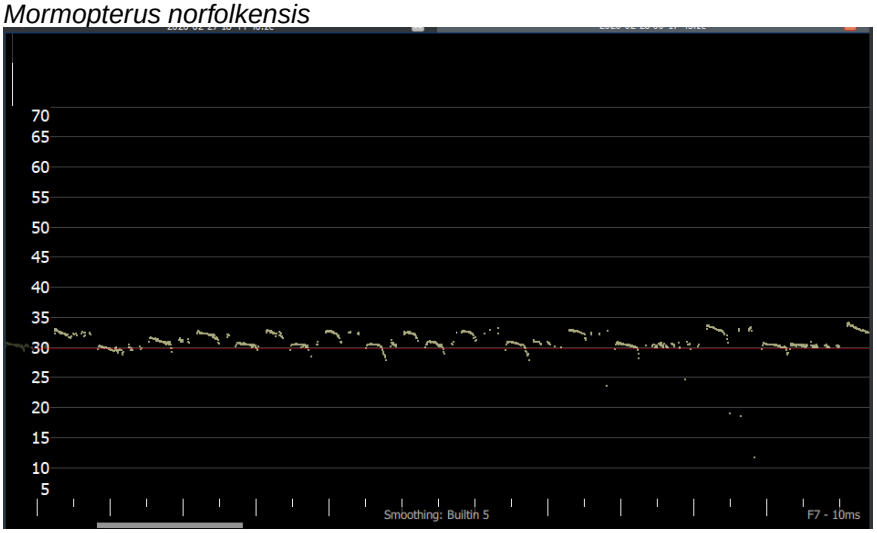
Myotis Macropus



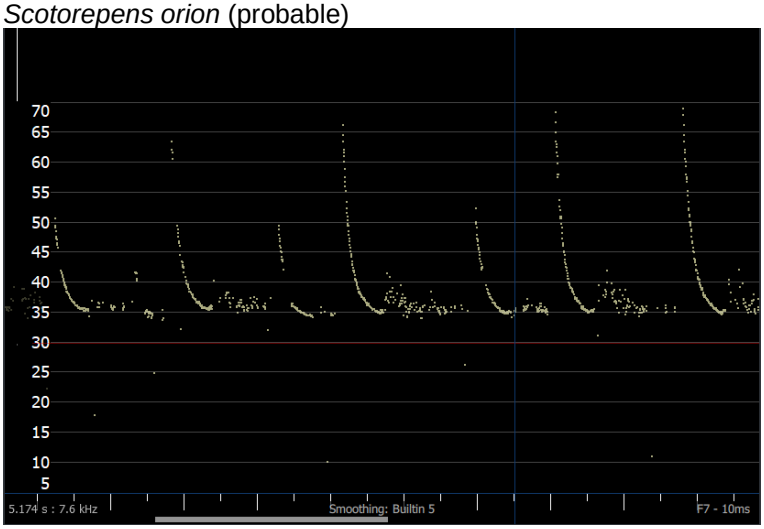
Nyctophilus sp.



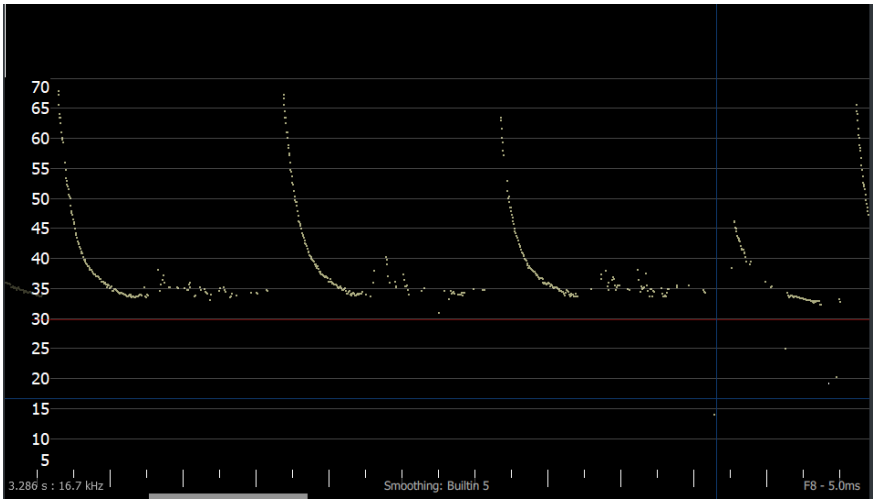
Mormopterus norfolkensis



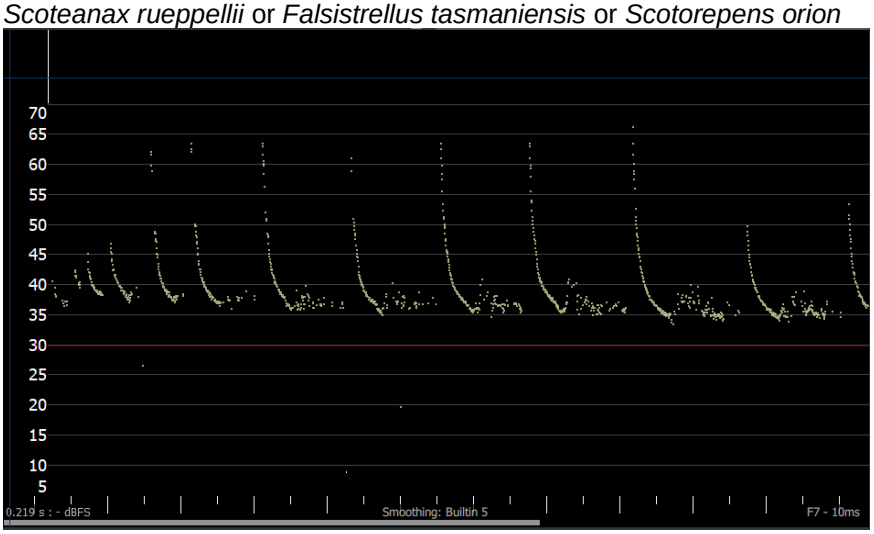
Scotorepens orion (probable)

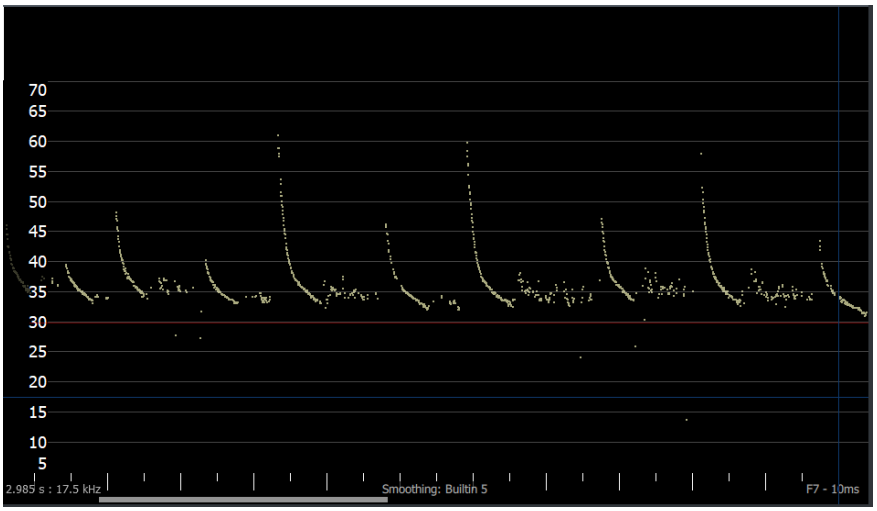


Scoteanax rueppellii (Probable)



Scoteanax rueppellii or *Falsistrellus tasmaniensis* or *Scotorepens orion*





Amy Rowles