



Regrowth – Kurri Kurri – Precinct 1

Biodiversity Development Assessment Report

Loxford Project Management Pty Ltd

2 February 2022

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Your ref:
Our ref: 12527690

17 February 2022

Dear Approver

Regrowth Kurri Kurri Stage 1 – Biodiversity Development Assessment Report
Certification under Section 6.15 of the Biodiversity Conservation Act 2016

I, Arien Quin (BAAS 17098), certify that this Biodiversity Development Assessment Report and the accompanying finalised credit report dated 16/02/2022 has been prepared in accordance with the requirements of (and information provided under) the Biodiversity Assessment Method (2020).

Sincerely

A handwritten signature in black ink, appearing to read "Arien Quin", is placed over a light grey rectangular background.



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			Name	Signature	Name	Signature	Date
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1. Introduction

1.1 Overview

GHD Pty Ltd (GHD) has been engaged by Loxford Project Management Pty Ltd (Loxford Project Management) to prepare this Biodiversity Development Assessment Report (BDAR) to accompany a development application (DA) for a residential subdivision at Cessnock Road, Gillieston Heights ('the proposal', refer Figure 1.1).

The proposal site is located within part of the buffer zone surrounding the former Hydro Aluminium Smelter site and has been recently rezoned by Maitland City Council from RU2 (Rural Landscape) land zoning to R1 zoning (General Residential). Several biodiversity assessments have been prepared across the former Hydro site, of which the proposal site forms a part. Results of these assessments have been reviewed and informed included in this BDAR where relevant.

This BDAR considers the assessment requirements of the NSW *Biodiversity Conservation Act 2016* (BC Act), *Fisheries Management Act 1994* (FM Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This BDAR has been prepared by an accredited assessor in accordance with the Biodiversity Assessment Method (BAM).

1.2 Key features of the proposal

The proposal comprises the development of a residential subdivision that would include the following:

- Clearing of vegetation on all land zoned R1 – General Residential to the standard of an Inner Protection Area (IPA), except for the trees to be retained in the District Park.
- Bulk earthworks and benching over the site with retaining walls.

Full road construction of:

- Road MC01 as a divided carriageway.
- Auburn Street as a primary collector road with 11 m pavement.
- MC05 as a primary collector road with 11 m pavement
- All remaining roads as local streets.
- Footpath construction.
- Residential Torrens Title allotments, varying in size from 450 sqm.
- Signalised interchange on Cessnock Road subject to RMS WAD.
- A District Park proposed to be the subject of a Voluntary Planning Agreement (VPA) with Council.
- Water quality basins that will be dedicated to Council.
- Provision of underground water, wastewater, electrical and telecommunication services.
- Provision of any necessary easements.
- Acoustic wall along Cessnock Road.
- Integrated Development.
- Landscaping.

Other key design features include the following:

- Shared pathways that extend the existing network along Auburn Street and Cessnock Roads.
- Provision of a District Park on the topographic highpoint.
- Arterial Road that will eventually connect to William Tester Drive to provide flood free access to Gillieston Heights.
- Revegetation of land zoned RU2 – Rural Landscape and some land zoned R1 – General Residential, which includes land containing watercourses and mine subsidence features.
- Intersection on Cessnock Road in accordance with the M195 Corridor Strategy.

These proposed works will represent the first stage of the Regrowth -Kurri Kurri Urban Release Area (URA), which is estimated to result in the development of 2,068 lots across both the Maitland and Cessnock Local Government Areas (LGAs). The proposed site layout is shown on Figure 1.2.

1.3 Purpose of this report

The purpose of this report is to assess the potential biodiversity impacts from the construction and operation of the proposal. The report:

- Outlines the methods used in the biodiversity assessment.
- Describes the existing environment of the proposal site, including the results of the desktop assessment and site surveys.
- Assesses the value and conservation significance of native vegetation and habitats at the proposal site and the potential for threatened biota and matters of national environmental significance (MNES) to occur at the proposal site or be affected by the proposal.
- Provides a description of the proposal, including potential impacts on biodiversity values and measures to avoid or mitigate impacts.
- Assesses the significance of impacts on threatened biota and MNES.
- Presents the data used to perform the BAM credit calculations for the proposal.
- Calculates the number and type of biodiversity credits that would be required to offset impacts of the proposal in accordance with the BAM.

1.4 Glossary of terms and acronyms

Table 1.1 Glossary of terms and acronyms

Term	Definition
AOBV	Areas of Outstanding Biodiversity Value
BAM	Biodiversity Assessment Method The rules for biodiversity assessment established under the BC Act that determine credits created, credits required and the circumstances that improve or maintain biodiversity values.
BAM-C	Biodiversity Assessment Method Calculator
BAR	Biodiversity Assessment Report
BC Act	<i>Biodiversity Conservation Act 2016</i>
BC Regulation	<i>Biodiversity Conservation Regulation 2017</i>
BCS	Biodiversity, Conservation and Science Directorate of the Department of Planning, Industry and Environment
BCT	Biodiversity Conservation Trust
BCF	Biodiversity Conservation Fund
BDAR	Biodiversity Development Assessment Report
Biodiversity credit	A unit of biodiversity value to measure specific development impacts or conservation gains in accordance with the BAM. Includes ecosystem credits and species credits.
Biodiversity credit report	Specifies the number and type of biodiversity credits: required to offset the impacts of a development to obtain a Biodiversity Certification Agreement; or that would be generated through conservation and management of a Stewardship site under a Biodiversity Stewardship site agreement.
Biodiversity offsets	Specific measures that are put in place to compensate for impacts on biodiversity values.
Biodiversity values	The composition, structure and function of ecosystems, including threatened species, populations and ecological communities, and their habitats.
BOS	Biodiversity Offset Scheme

Term	Definition
CEEC	Critically endangered ecological community
CEMP	Construction environmental management plan
DBH	Diameter at breast height
DAWE	The Commonwealth Department of Agriculture, Water and Environment
DPI	The NSW Department of Primary Industries
DPIE	The NSW Department of Planning, Industry and Environment
Ecosystem credit	A credit that relates to a vegetation type and the threatened species that are reliably predicted by that vegetation type (as a habitat surrogate).
EEC	Endangered ecological community
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
FFMP	Flora and Fauna Management Plan
HTW	High threat weed
IBRA	Interim Biogeographic Regionalisation for Australia
LEP	Local Environment Plan
LGA	Local Government Area
Locality	The area within a 10 km radius of the proposal site
Migratory species	Species listed under listed under international agreements (i.e Ramsar, JAMBA, CAMBA and ROKAMBA conventions) to which Australia is a party
MNES	Matters of National Environmental Significance
NSW	New South Wales
NPW Act	<i>National Parks and Wildlife Act 1974</i>
OEH	Office of Environment and Heritage
PCT	Plant community type
Proposal site	The area that would be directly impacted by construction and operation of the proposal. Encompasses the solar farm site and the transmission line corridor. Comprises the 'development site' as referenced in the BAM
SAII	Serious and irreversible impact
SAII entity	Species and ecological communities that are at risk of serious and irreversible impacts (SAIIs)
SEPP	State Environment Planning Policy
Species credit	A credit that relates to an individual threatened species that cannot be reliably predicted based on habitat surrogates. Threatened species that require species credits are identified in the Threatened Biodiversity Data Collection
Study area	The area that was subject to a site survey and assessed for direct or indirect impacts arising from construction and operation of the proposal. This included the lots proposed for development as well as land within the adjoining former Hydro Site. Comprises the 'subject land' as referenced in the BAM. A buffer of 1,500 metres has been used in desktop assessments in accordance with the BAM.
TBDC	Threatened Biodiversity Data Collection
TEC	Threatened ecological community
Threatened biota	Threatened species, populations or ecological communities listed under the BC Act, FM Act and/or the EPBC Act.

1.5 Assumptions and limitations

This report has been prepared by GHD for Loxford Project Management Pty Ltd and may only be used and relied on by Loxford Project Management Pty Ltd for the purpose agreed between GHD and Loxford Project Management Pty Ltd as set out in Section 1.3 of this report.

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

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

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

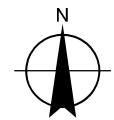
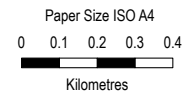
The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD and described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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

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

Investigations undertaken in respect of this report are constrained by the particular site conditions, particular climatic conditions leading up to field surveys. As a result, not all relevant site features and conditions may have been identified in this report. Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

GHD is not responsible for any updates made by the Biodiversity, Conservation and Science Directorate (BCS) to the BAM credit calculator or and additional assessment requirements required due to new or updated survey guidelines or policies being published following issue of this report. If updates to this report are required due to changes made by BCS or other government departments GHD would not be responsible for these changes.



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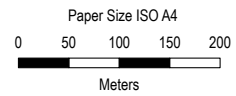
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 Revision No. **0**
 Date **01/02/2022**

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 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 56

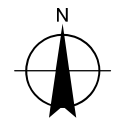
Site map

Figure 1-1

- Legend**
- Proposal site
 - LGA boundary
 - Watercourse
 - Cadastre
 - Proposed site layout



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



Loxford Project Group Pty Ltd
Regrowth Kurri Kurri – Maitland LGA
Biodiversity Development Assessment Report

Project No. **12527690**
 Revision No. **0**
 Date **02/02/2022**

Proposed site layout

Figure 1-2

2. Legislative context

2.1 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) provides legal protection for biota of conservation significance in NSW. The BC Act aims to, amongst other things, 'maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development'. It provides for the listing of threatened species and communities, establishes a framework to avoid, minimise and offset the impacts of proposed development (the Biodiversity Offsets Scheme), and establishes a scientific method for assessing the likely impacts on biodiversity values and calculating measures to offset those impacts (the Biodiversity Assessment Method, BAM 2020). These are discussed further below.

2.1.1 Biodiversity Offset Scheme and Biodiversity Assessment Method

The BC Act, together with the *Biodiversity Conservation Regulations 2017*, provides a mechanism to address impacts on biodiversity from land clearing associated with development. Under this legislation, there are provisions for a Biodiversity Offsets Scheme (BOS), which includes a framework to avoid, minimise and offset impacts of development on biodiversity.

The aim of the BOS is to provide a transparent, consistent and scientifically based approach to biodiversity assessment and offsetting. It also allows for the establishment of biodiversity stewardship agreements, which are in-perpetuity agreements entered into by landholders, to secure offset sites and generate biodiversity credits, which can be used to offset impacts of development. The aim of the BOS is to ensure that the impacts of development, clearing or biodiversity certification will result in no net loss of biodiversity.

The Biodiversity Assessment Method (BAM) was established by OEH as a standard method to implement the aims of the BOS and to address the loss of biodiversity and threatened species. The scheme creates a market framework for the conservation of biodiversity values and the offsetting of development impacts. It also provides the mechanisms to offset impacts of development, clearing or biodiversity certification such that there is no loss of biodiversity values. The BAM replaces and updates the former NSW BioBanking scheme and BioBanking Assessment Methodology (BBAM).

The BAM sets out how biodiversity values will be assessed, prescribes requirements to avoid and minimise impacts, establishes rules for calculating the number and class of credits required for unavoidable impacts, and determines the trading rules that will apply. The methodology includes a software package known as the Biodiversity Assessment Method Calculator (the BAM calculator) which processes site survey and assessment data. The BAM calculator specifies the type and extent of surveys required for a biodiversity assessment and then processes survey data to calculate the number and type of biodiversity credits that are either required at a development site or will be generated at a stewardship site. The BAM must be applied by a person accredited under the BC Act.

The Biodiversity Conservation Fund (BCF) ensures that landowners have the funds needed to carry out the management actions required each year and provides a financial incentive to landowners to carry out those actions. The scheme is administered by DPIE and ensures accountability and compliance through legislation, regular reporting requirements and financial measures. Under certain circumstances a developer may make a payment directly into the BCF to offset the impacts of a proposed development in lieu of purchasing and retiring biodiversity credits. The BCF must then use funds in the BCF to purchase and retire appropriate biodiversity credits.

The BOS and BAM have been addressed through the preparation of this BDAR by an accredited assessor.

2.2 Fisheries Management Act 1994

The objects of the *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. It provides for the listing of threatened species, populations and ecological communities, listing of 'Key Threatening Processes', and the requirements or otherwise for the preparation of a Species Impact Statement (SIS).

One of the objectives of the FM Act is to 'conserve key fish habitats ' which includes aquatic habitats that are important to the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. To assist in the protection of key fish habitats, DPI has produced the Policy and guidelines for fish habitat conservation and management (DPI, 2013). This policy applies to the following developments, works or activities, each of which can impact on key fish habitat:

- Dredging or reclamation
- Impeding fish passage
- Damaging marine vegetation
- De-snagging

The FM Act has been considered in this assessment through:

- Desktop review to determine the threatened biota that are predicted to occur within the locality of the proposal and hence could occur, subject to the habitats present.
- Aquatic habitat assessment.
- Assessment of potential impacts on threatened biota and key fish habitat.
- Identification of suitable impact mitigation and environmental management measures for aquatic habitats, where required.

2.3 Biosecurity Act 2015

The *Biosecurity Act 2015* provides for risk-based management of biosecurity in NSW. It provides a statutory framework to protect the NSW economy, environment and community from the negative impact of pests, diseases and weeds.

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

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

One priority weed for the Hunter region was recorded in the proposal site.

2.4 Environment Protection and Biodiversity Conservation Act 1999

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

The NSW Government and Australian Government finalised amendments to the Assessment Bilateral Agreement after changes to NSW legislation, and the Amending Agreement no. 1 was signed on 24 March 2020. The Australian Government formally endorsed the NSW BOS through the *EPBC Act Condition-setting Policy* (DAWE 2020).

The EPBC Act condition setting policy (DAWE 2020) notes that where a project demonstrates compliance with an endorsed state or territory policy, the proponent will not be required to simultaneously comply with the corresponding Australian Government policy. As such, a proponent is not required to calculate offsets separately using the EPBC Act offsets policy (DSEWPAc 2012) and associated calculator, unless offsets are required for a species not listed under the BC Act.

The EPBC Act has been considered in this assessment through:

- Desktop review to determine the listed biodiversity matters that are predicted to occur within the locality of the proposal and hence could occur, subject to the habitats present.
- Targeted field surveys for listed threatened biota and migratory species.
- Assessment of potential impacts on threatened and migratory biota, including assessments of significance in accordance with the EPBC Act Significant Impact Guidelines 3.1 (DotE 2013).
- Identification of suitable impact mitigation and environmental management measures for threatened and migratory biota, where required.

Based on the assessments of significance of impacts on MNES presented in this BDAR the proposal would not result in a significant impact on any MNES. Therefore, no further assessment or consideration of biodiversity offset requirements under the EPBC Act is required.

2.5 Assessment guidelines and information

This report has been prepared in accordance with the BAM (DPIE 2020a) and with reference to the following guidelines:

- *Surveying threatened plants and their habitats – NSW survey guide for the Biodiversity Assessment Method* (DPIE 2020b).
- *NSW survey guide for threatened frogs – A guide to the survey of threatened frogs and their habitats for the Biodiversity Assessment Method* (DPIE 2020c).
- *Species credit threatened bats and their habitats – NSW survey guide for the Biodiversity Assessment Method* (OEH 2018).

3. Methods

3.1 Desktop review

3.1.1 Data review

A desktop database review was undertaken to identify threatened flora and fauna species, populations and ecological communities (threatened biota) listed under the BC Act and EPBC Act, that could be expected to occur in the locality, based on previous records, known distribution ranges, and habitats present. These were also used to obtain the necessary site data to perform BAM calculations.

A 10 kilometre search radius from the proposal site was used to identify threatened species that were previously recorded in the locality. The threatened biota and migratory species identified in the desktop assessment are presented in Appendix A. Following collation of database records and threatened species and community profiles, a 'likelihood of occurrence' assessment was prepared for threatened biota and migratory species with reference to the broad vegetation types and habitats contained within the study area. This was further refined following field surveys and verification of vegetation types and identification and assessment of habitat present within the proposal site. A likelihood of occurrence ranking was attributed to these biota based on this information.

Information sources used in the preparation of this report include:

- NSW Department of Planning, Industry and Environment (DPIE) BioNet Atlas for records of threatened biota previously recorded in the locality (website for the Atlas of NSW Wildlife) (DPIE 2021a) and *Threatened Biodiversity Data Collection* (TBDC) profiles of threatened species listed under the BC Act (DPIE 2021b).
- DPIE *Threatened biodiversity profile search* online database for threatened ecological communities and species listed under the BC Act (DPIE 2021c).
- NSW *BioNet Vegetation Classification* (OEH 2021d) to identify matching plant community types (PCTs) in the study area.
- EPBC Act Protected Matters Search Tool – for a 10 kilometre radius around the proposal site DAWE (2021a).
- Species profile and threats database, online profiles DAWE (2021b).
- The list of species credit-type species and predicted species identified by the BAM calculator (DPIE 2021b).

3.1.2 Background research

Background research was conducted to identify:

- Landscape-scale features of the study area in accordance with Subsection 3.1.3 of the BAM (DPIE 2020).
- Site context of the study area that includes assessing vegetation cover and patch size as required under Section 3.2 and Subsections 4.3.2 of the BAM (DPIE 2020).
- The likely distribution of native vegetation and threatened ecological communities, based on previous mapping and aerial photograph interpretation, for targeted field verification as required under Section 4 of the BAM (DPIE 2020).
- A list of predicted and candidate threatened species and populations of flora and fauna to assess the habitat suitability and threatened biodiversity data collection as required under Section 5 of the BAM (DPIE 2020).
- Availability of baseline information to determine whether additional surveys, mapping and reporting is required to support project approval.

The background research included analysis of the following information sources:

- Aerial photographic imagery
- NSW (Mitchell) Landscapes mapping and landscape descriptions (DECC 2008b)
- Interim Biogeographic Regionalisation of Australia (IBRA version 7.0) mapping
- Initial BAM calculations
- Available regional-scale vegetation mapping of the site (NPWS 2000, Bell and Driscoll 2007)
- Atlas of Groundwater Dependent Ecosystems (GDE) (BOM 2021a)
- Aerial photographs and satellite imagery, 2 m contour data, and creek line data of the proposal site
- Department of Planning and Environment (DPIE) eSpade V.2 online soil landscape mapping (DPIE 2021d)
- Soil Landscapes of Central and Eastern NSW V2 (DPIE 2020d)
- Australian Wetlands Database (DPIE 2020c)
- Aerial photographs and satellite imagery of the proposal site and buffer area

3.2 Site survey

3.2.1 Previous surveys completed within the proposal site

A number of ecological surveys have been previously completed across the former Hydro site, of which the proposal site forms a part. Results of these surveys have been reviewed and referred to where relevant. Previous surveys completed within the former Hydro site are summarised in Table 3.1.

Table 3.1 Summary of previous ecological surveys completed within and adjacent to the proposal site

Survey	Date/s of survey	Survey techniques/effort
Biodiversity Certification Assessment Report for Hydro Lands (ELA 2016)	December 2014 February 2015 March 2014 March 2016 9 December 2014 24-19 December 2014 27 November 2014 27-29 December 2014 January 17-19 2015 and 23 February 2015	<ul style="list-style-type: none"> – Vegetation mapping – BBAM plot/transects – Threatened flora survey walking parallel transects spaces 5-10 metres apart – Plot based survey for threatened flora, including 80 20 X 50 plots – Arboreal hair tubes (1680 trap nights) – Next box monitoring (70 trap nights) – Camera traps (20 cameras over 10 week period) – Spotlighting – Call playback for forest owls and Koala – Amphibian survey, over six nights – Echolocation call recording – Diurnal bird surveys
Flora assessment – Hydro Aluminium Kurri Kurri (FloraSeach 2004)	29 April – 14 May 2003 8-11 July 2003 23-15 October 2003 22-23 January 2004	<ul style="list-style-type: none"> – Vegetation mapping – Quadrat surveys (thirty 20 X 20 plots) – Spot sampling (77 survey points)
Terrestrial Vertebrate Fauna Assessment (Cenwest Environmental Services 2004)	12-24 May 2003 18-29 November 2003	<ul style="list-style-type: none"> – Elliot A and B trapping on ground (180 trap nights) – Cage traps (72 trap nights) – Elliot A aboreal traps (120 trap nights) – Hair tubes on ground (1200 trap nights) – Aboreal Hair tubes (large and small) (560 trap nights) – Pitfall traps (432 trap nights) – Spotlighting – Systematic herpetological searches for 30 mins over 4 day days – Bird surveys (20 hours) – Call playback (half hour at 10 sites over 4 nights) – Opportunistic observations

3.2.2 Survey overview

Staged surveys of the proposal site were conducted with reference to the appropriate threatened species survey guidelines for targeted species. Surveys were undertaken both within the proposal site and across a much larger 300 hectare study area associated with the wider Hydro site.

Site surveys have included:

- Initial site stratification, preliminary investigation of biodiversity values and vegetation mapping
- Vegetation integrity plots
- Incidental threatened flora surveys
- Opportunistic fauna surveys
- Habitat assessments
- Targeted surveys for threatened flora
- Targeted surveys for threatened fauna

Survey techniques and timing are summarised in Table 3.2.

Table 3.2 Survey techniques and timing

Stage	Date	Survey Technique
Preliminary investigation of biodiversity values and vegetation mapping	26-29 August 2019 8-11 October 2019 18 June 2020	Ground-truthing of previous vegetation mapping. Random meander in accordance with Cropper (1993) to: <ul style="list-style-type: none"> – Document fauna habitats and features within the development area – Assess the general condition of vegetation and habitats present – Confirm vegetation boundaries – Identify potential habitat for threatened biota – Rapid aquatic habitat assessment – Opportunistic fauna observations
Vegetation integrity plot surveys	26-30 August 2019 8-11 October 2019 24 April 2020 18 June 2020 9 November 2021	<ul style="list-style-type: none"> – Vegetation integrity plots – Targeted threatened flora surveys, opportunistic fauna observations – Fauna habitat assessment.
Winter targeted fauna survey	14-29 August 2019	<ul style="list-style-type: none"> – Stag watching – Owl call playback – Spotlighting – Hollow-bearing tree assessments – Large forest owl tree survey – Targeted surveys for breeding habitat for Little Eagle, White-bellied Sea-eagle and Glossy Black-cockatoo
Targeted flora survey	28-31 October 2019 13-15 November 2019 6-8 October 2020 5-6 October 2021 16 November 2021 7 December 2021	Systematic parallel traverses targeting candidate threatened flora species

Stage	Date	Survey Technique
Spring targeted fauna survey	25-29 November 2019	<ul style="list-style-type: none"> – Ultrasonic call recording (Anabat) – Diurnal bird survey – Pitfall trapping – Spotlighting – Call playback for threatened owls – Remote camera traps – Active searches for scats and signs
Summer targeted fauna survey	24 –28 February 2020	<ul style="list-style-type: none"> – Arboreal Elliot traps for small mammals – Spotlighting – Call playback for threatened owls and amphibians – Harp trapping – Ultrasonic call recording (Anabat) – Active searches for scats and signs – Remote camera traps – Habitat assessment
SAll expert assessment	6 October 2021	Site visit to confirm plant community types and assess habitat values for Swift Parrot and Regent Honeyeater
Supplementary Frog Surveys	7-8 November 2021 23-24 November 2021	<ul style="list-style-type: none"> – Spotlighting – Call Playback – Active searches for amphibians

3.2.3 Vegetation mapping

Existing vegetation mapping of the proposal site completed by Bell and Driscoll (2007) and EcoLogical (ELA 2016) was ground-truthed in the field by walking the boundaries of vegetation types. Necessary adjustments were made by hand on aerial photographs of the proposal site with reference to a handheld Global Positioning System (GPS) unit. Other information recorded included observed vegetation structure, soil type, landscape position and condition. The overall condition of vegetation was assessed through general observation and comparison against the PCT condition benchmark data as well as using parameters such as species diversity, history of disturbance, weed invasion and canopy health. This data in combination with plot survey was then used to map the vegetation across the site. PCTs were identified based on vegetation structure, species composition, soil type and landscape position and with reference to the BioNet Vegetation Classification database (DPIE 2021b). The site was subsequently divided into relatively homogenous or discrete zones for assessment (i.e. vegetation zones). Vegetation zones represent a distinct PCT and broad condition state.

3.2.4 Vegetation integrity survey plots (assessment of site condition)

Following the stratification of the proposal site into vegetation zones, plot surveys were conducted in accordance with Section 4.3.3 and Section 4.3.4 the BAM (DPIE 2020a) to obtain vegetation integrity data for the calculation of biodiversity credits.

Plots were located to comply with the minimum number of plots required by Table 3 in the BAM (DPIE 2020a). In total, 13 plots were sampled within the proposal site. Plots were located randomly within each of the vegetation zones by walking a random distance into the vegetation zone and then locating the plot on a randomly generated compass bearing; this was then repeated for subsequent plots within the vegetation zone. Plots were located away from ecotones, tracks and track edges or other disturbed areas where practicable. Plots located in areas of exotic/mixed grassland were assigned to PCT 1600 as scattered trees and remnant native species suggested that this would have been the PCT that originally occurred in these cleared areas.

The location of survey plots are shown on Figure 3.1 and Figure 5.1. The minimum plot survey requirements are summarised in Table 3.3.

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

Attributes assessed within each plot are listed in Table 3.4. All flora species within a 20 metre by 20 metre quadrat nestled within the 50 metre by 20 metre plot were identified according to the nomenclature of the Royal Botanic Gardens and Domain Trust (RBGT 2021). Each species identified was allocated a growth form group¹ and designated as either native, exotic or high threat exotic in accordance with the lists accessed by assessors via the BAM calculator.

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

Table 3.3 Minimum plot survey requirements within the proposal site

Veg Zone	PCT Number	PCT Name	PCT condition	Area (ha)	Minimum number of plots required	Number of plots sampled
1	1600	Spotted Gum – Red Ironbark –narrow-leaved Ironbark – Grey Box shrub – grass open forest of the lower Hunter	Underscrubbed	5.49	3	3
2	1600	Spotted Gum – Red Ironbark –narrow-leaved Ironbark – Grey Box shrub – grass open forest of the lower Hunter	Regrowth	4.49	2	2
3	1591	Grey Gum – Rough-barked Apple shrubby open forest of the lower hunter	Intact	2.74	2	2
4	1736	Water Couch -tall Spike Rush Freshwater Wetland of the Central Coast and Lower Hunter	Disturbed	0.25	1	1
5	1600	Spotted Gum – Red Ironbark –narrow-leaved Ironbark – Grey Box shrub – grass open forest of the lower Hunter	Exotic	43.28	4	4
Nil	N/A	Cleared	Non-native vegetation	1.19	0	0
Nil	Nil	Planted vegetation	Planted	0.96	0	0
Total				58.4	12	12

Table 3.4 Site data collected within each BAM plot

Attribute	Sample area
Composition	
Native plant species richness, total species richness of each growth form group	20 x 20 metre plot
Structure	
Percentage foliage cover for each species, total cover of each growth form group	20 x 20 metre plot
Estimated number of individuals for each species	20 x 20 metre plot
Function	
Number of large trees	20 x 50 metre plot
Tree regeneration (presence/absence)	50 x 20 metre plot
Tree stem size class	50 x 20 metre plot
Total length of fallen logs	50 x 20 metre plot
Litter cover	5 times 1 x 1 metre plot
High threat exotic vegetation cover	20 x 20 metre plot
Hollow bearing trees	50 x 20 metre plot

¹ TG – tree, SG – shrub, GG – grass/grasslike, FG – forb, EG – fern, OG – other (Table 2 of the BAM, DPIE 2020)

3.2.5 Targeted threatened flora surveys

Potential candidate species credit entities for the proposal site were identified and assessed in accordance with Section 5.2 and Section 5.3 of the BAM (DPIE 2020a). All threatened plants are classified under the BAM as species credit entities as their occurrence cannot be reliably predicted based on vegetation type.

The suite of threatened plants with potential to occur in the proposal site was identified based on the desktop assessment results and the species credit entities identified by preliminary BAM Calculations (see Appendix A) Habitat for these species was identified and assessed based on threatened species profiles and the experience and judgement of GHD ecologists. A large area of the proposal site is highly modified and is dominated by exotic species, heavily grazed and can be readily discounted as supporting populations of threatened plant species.

Targeted searches were completed by experienced botanists systematically walking parallel traverses within areas of suitable habitat, with due consideration of the threatened plant survey guidelines (DPIE 2020b). Targeted threatened flora surveys were undertaken in October and November 2019, April 2020, October 2021, November 2021 and December 2021, which according to the BAM, is a suitable time of the year to identify all of the candidate threatened flora species identified as having potential to occur. Surveys focused on areas of suitable habitat for candidate species within the proposal site.

Candidate flora species targeted during surveys are outlined in Table 3.5. The locations of threatened flora traverses are shown on Figure 3.1.

Further detail regarding candidate threatened flora species surveys is provided in Section 5.1.

Table 3.5 Candidate flora species targeted during surveys

Common name	Scientific name	BioNet records in locality	Survey months	Survey completed
Bynoe's Wattle	<i>Acacia bynoeana</i>	183	All year	Oct and Nov
Trailing Woodruff	<i>Asperula asthenes</i>	0	Oct-Dec	Oct and Nov
Netted Bottle Brush	<i>Callistemon linearifolius</i>	1059	Oct-Jan	Oct and Nov
Leafless Tongue Orchid	<i>Cryptostylis hunteriana</i>	0	Nov-Jan	Nov
White-flowered Wax Plant	<i>Cynanchum elegans</i>	0	All year	Oct and Nov
Pine Donkey Orchid	<i>Diuris tricolor</i>	0	Sep -Oct	Oct
Singleton Mallee	<i>Eucalyptus castrensis</i>	0	All year	Oct and Nov
Slaty Red Gum	<i>Eucalyptus glaucina</i>	80	All year	Oct and Nov
Parramatta Red Gum	<i>Eucalyptus parramattensis subsp. decadens</i>	1701	All year	Oct and Nov
Pokolbin Mallee	<i>Eucalyptus pumila</i>	0	All year	Oct and Nov
Small-flower Grevillea	<i>Grevillea parviflora subsp. parviflora</i>	416	Aug-Nov	Oct and Nov
<i>Maundia triglochinosides</i>	<i>Maundia triglochinosides</i>	0	Nov-March	Nov and Dec
Biconvex Paperback	<i>Melaleuca biconvexa</i>	0	All year	Oct and Nov
Large-leafed monotaxis	<i>Monotaxis macrophylla</i>	0	Aug-Feb	Oct and Nov
<i>Ozothamnus tesselatus</i>	<i>Ozothamnus tesselatus</i>	0	Sep-Oct	Oct
Tall Knotweed	<i>Persicaria elatior</i>	0	Dec-May	Dec
Scant Pomaderris	<i>Pomaderris queenslandica</i>	0	All year	Oct and Nov
Singleton Mint Bush	<i>Prostanthera cineolifera</i>	0	Sept-Oct	Oct and Nov
<i>Pterostylis chaetophora</i>	<i>Pterostylis chaetophora</i>	0	Sept-Nov	Oct and Nov
Heath Wrinklewort	<i>Rutidosis heterogama</i>	957	All year	Oct and Nov
Black-eyed Susan	<i>Tetratecha juncea</i>	0	Sept-Oct	Oct
Austral Toadflax	<i>Thesium austral</i>	0	Nov-Feb	Nov
<i>Zannichellia palustris</i>	<i>Zannichellia palustris</i>	0	Oct-Jan	Nov

3.2.6 Terrestrial Fauna Surveys

3.2.6.1 Fauna habitat assessment

Fauna habitat assessments were undertaken throughout the proposal site during all survey periods, including observation of potential shelter, basking, roosting, nesting and/or foraging sites. Specific habitat features and resources such as water bodies, food trees, the density of understorey vegetation, the composition of ground cover, the soil type, presence of hollow-bearing trees, leaf litter and ground debris were noted.

Indicative habitat criteria for targeted threatened species (i.e. those determined as having the potential to occur within the proposal site following the desktop review) were identified prior to fieldwork. Habitat criteria were based on information provided in DPIE and DAWE threatened species profiles, field guides, and the knowledge and experience of GHD field ecologists.

Habitat assessments included searches for resources of potential value to threatened fauna including:

- Hollow bearing trees and number of hollows in ecologically important size-classes (large >20 cm, medium >5-20 cm, small <5 cm).
- Trees with bird nests or other potential fauna roosts.
- Rock outcrops or overhangs providing potential shelter sites for fauna.
- Burrows, dens and warrens.
- Distinctive scats or latrine sites, owl white-wash and regurgitated pellets under roost sites.
- Tracks or animal remains.
- Waterbodies.
- Evidence of activity such as feeding scars, scratches and diggings.
- Specific food trees and evidence of foraging (eg. chewed *Allocasuarina* cones indicative of Glossy Black-cockatoos).

The locations and qualitative descriptions of significant habitat features were captured with a handheld GPS unit.

Opportunistic and incidental observations of fauna species were recorded at all times during field surveys. This included a conscious focus on suitable areas of habitat during flora surveys, for instance fallen timber was scanned and/or turned for reptiles and mature trees and stags were scanned for roosting birds.

Habitat assessments for Swift Parrot (*Lathamus discolor*) and Regent Honeyeater (*Anthochaera phrygia*) were also undertaken by species expert Dr Ross Crates on 6 October 2021. The focus of Dr Crates' assessment was to evaluate the habitat at the site to determine whether the vegetation present within the proposal site would constitute important foraging or breeding habitat for these species (refer to Appendix F).

3.2.6.2 Targeted surveys

Under the BAM, targeted surveys are not required for threatened fauna species that can be reliably predicted to occur at the proposal site based on habitat surrogates (predicted / ecosystem credit species). These species are assumed to be present within certain PCTs, given a certain patch size and condition. Nonetheless these species and their habitats were recorded along with fauna that are not listed as threatened, as a general guide to the condition and biodiversity value of the proposal site.

Targeted, seasonal surveys are required for candidate threatened species entities i.e. species credit species and specific habitat resources such as nesting or roosting habitat for dual credit species. Candidate species credit entities that have a moderate potential to occur at the proposal site (refer to Appendix A) and that were targeted during these surveys are listed in Table 3.6.

Targeted threatened fauna surveys were conducted between:

- 26-31 August 2019
- 25-28 November 2019
- 24-28 February 2020
- 23-24 November 2021
- 7-8 December 2021

Targeted fauna survey techniques and effort conducted in the proposal site are summarised in Table 3.6 and Table 3.7. Further detail regarding candidate fauna species targeted during surveys is provided in section 6.1. Survey effort was stratified across the proposal site and wider Hydro lands, noting that fauna species are mobile and may rely upon habitat resources in the proposal site even if not directly observed at the proposal site. All fauna observations were recorded on pro forma field data sheets.

Table 3.6 Targeted fauna survey effort

Common name	Scientific name	Appropriate survey period	Month/s Surveyed	Survey Method/s
Bush Stone-curlew	<i>Burhinus grallarius</i>	All year	November 2019	Spotlighting
Gang-gang Cockatoo (breeding)	<i>Callocephalon fimbriatum</i>	October - January	November 2019	Diurnal bird surveys Active searches and inspection of candidate nest trees Opportunistic observations
Glossy Black-Cockatoo (breeding)	<i>Calyptorhynchus lathami</i>	April - August	August 2019	Active searches and inspection of candidate nest trees Diurnal bird surveys
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	October-March	November 2019	Elliot Traps Spotlighting
Wallum Froglet	<i>Crinia tinnula</i>	All year	February 2020 and December 2021	Spotlighting Active amphibian searches
Stripped Legless Lizard	<i>Delma impar</i>	September-December	November 2019	Active searches Pitfall trapping
White-bellied Sea-Eagle (breeding)	<i>Haliaeetus leucogaster</i>	July - December	August 2019	Active searches for scats and signs Diurnal bird surveys Active searches and inspection of candidate nest trees
Little Eagle (breeding)	<i>Hieraaetus morphnoides</i>	August-October	August 2019	Diurnal bird surveys Opportunistic observations Active searches for scats and signs Active searches and inspection of candidate nest trees
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	November - March	November 2019, February 2020	Spotlighting
Green and Golden Bell Frog	<i>Litoria aurea</i>	November - March	December 2021	Spotlighting Call playback Active amphibian searches
Green-thighed Frog	<i>Litoria brevipalmata</i>	October - March	December 2021 (note survey was not undertaken after flooding rains however species expert, Frank Lemckert, determined that site does not contain suitable habitat for this species (refer to Appendix G))	Spotlighting Call playback Active amphibian searches
Square-tailed Kite (breeding)	<i>Lophoictinia isura</i>	September-January	November 2019	Active searches for scats and signs Active searches for nests Diurnal bird surveys

Common name	Scientific name	Appropriate survey period	Month/s Surveyed	Survey Method/s
Little Bentwing-bat (breeding)	<i>Miniopterus australis</i>	December to February	February 2020	Anabat detectors Harp trapping Inspection of potential breeding habitat
Large Bent-winged Bat (breeding)	<i>Miniopterus orianae oceanensis</i>	December to February	February 2020	Anabat detectors Harp trapping Inspection of potential breeding habitat
Southern Myotis	<i>Myotis macropus</i>	October -March	February 2020	Anabat detectors Harp trapping Inspection of breeding habitat
Barking Owl (breeding)	<i>Ninox connivens</i>	May – December	August 2019	Stag- watching of potential hollows Call playback Active searches for whitewash and pellets Hollow bearing tree assessment
Powerful Owl (breeding)	<i>Ninox strenua</i>	May – August	August 2019	Stag- watching of potential hollows Call playback Active searches for whitewash and pellets Hollow bearing tree assessment
Greater Glider	<i>Petauroides volans</i>	All year	February 2020	Elliot trapping Spotlighting
Squirrel Glider	<i>Petaurus norfolcensis</i>	All year	February 2020	Elliot trapping Spotlighting Call playback
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	December-June	February 2020	Elliot trapping Spotlighting
Koala (important habitat*)	<i>Phascolarctos cinereus</i>	All year	November 2019 February 2020	Spotlighting Call playback Active searches for scats
Common Planigale	<i>Planigale maculata</i>	All year	November 2020	Pitfall traps (adjacent to proposal site) Spotlighting Camera Traps
Masked Owl (breeding)	<i>Tyto novaehollandiae</i>	May – August	August 2019	Stag- watching of potential hollows Call playback Active searches for whitewash and pellets Hollow bearing tree assessment
Mahony's Toadlet	<i>Uperoleia mahonyi</i>	October-March	February 2021	Spotlighting Active searches for amphibians

*Note that field surveys were completed to assess whether the site would be considered important habitat for Koalas. Results of these surveys assessed determined that the site does not contain "important habitat" for the Koala as there are no recent records within or near to the proposal site and no evidence was found of Koalas utilising the site during targeted surveys completed for this BDAR.

Table 3.7 Targeted fauna survey techniques and effort

Survey technique	Survey effort
Camera trapping	Baited motion activated camera traps were set in vegetation to the south of the proposal site between 25-28 November 2019 and 24-28 February 2020. These surveys targeted Brush-tailed Phascogale, Squirrel Glider, Pygmy Possum and.
Call playback	Owl call playback was conducted for Barking Owl, Powerful Owl and Masked Owl over three consecutive nights between 27 and 29 August 2019. In addition, frog call playback surveys targeting Green and Golden Bell Frog and Green Thighed Frog were conducted on 26 November 2019, between 24 and 28 February 2020 and 24 and 25 February 2021.
Arboreal trapping	Arboreal trapping was conducted between 24 and 28 February 2020. A total of five transects were established (one within proposal site and four adjacent to the site within the wider Hydro lands). Transects consisted of 10 arboreal Elliot B sized traps over 4 day/nights, totalling 200 trap nights. Arboreal traps were used to target Squirrel Glider, Greater Glider Brushed-tailed Phascogale and Eastern-Pygmy Possum
Pitfall trapping	Four pitfall trapping transects were installed on the 25-29 November 2019 within the wider Hydro Lands. Each transect contained 6 traps that were open for 4 nights totalling 96 trap nights. Pitfall traps were used to target Common planigale and Striped legless lizard.
Spotlight survey	Spotlighting surveys were conducted on 26 and 27 November 2019. Additional spotlight surveys were completed between 24 and 27 February 2020, 7-8 December 2021 and on 24-25 November 2021. These spotlight surveys were conducted on two consecutive nights at each location.
Diurnal bird survey	Diurnal bird surveys conducted over three days between 25 -28 November 2019 and three days in February 2020 for a total of six person hours. A list of opportunistic bird sightings was recorded during the November 2019 and February 2020 surveys while undertaking other fieldwork components.
Hollow-bearing tree and nest surveys	Systematic surveys for hollow bearing trees suitable as nest sites for forest owls and glossy black cockatoos were conducted on 14, 15 and 20 August 2019.
Stag watching	Stag watching of candidate nest trees was conducted between 26-29 August 2019.
Ultrasonic recording	Anabat express detectors were placed in flyways and set to record whole nights of data between 25-28 November 2019 and 24-28 February 2020.
Daytime traverses Active reptile/amphibian searches Active searches for scats and other signs	Active searches of woody debris, loose bark and other ground litter were conducted throughout the proposal site targeting threatened frogs and reptiles a total of five person hours was completed undertaking these searches in February 2020 and 22 person hours in November/December 2021.

3.2.7 Aquatic habitat assessment

An assessment of potential habitat for threatened aquatic species was based on the habitat assessments undertaken during the field survey and published habitat preferences of threatened biota. Key fish habitat maps for the area (DPI 2007) were reviewed and key fish habitat was identified according to the following classifications as detailed in (DPI2013):

- Type 1 – highly sensitive fish habitat (includes freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or three metres in length, or native aquatic plants; known or expected protected or threatened fish habitat; and areas of critical habitat).
- Type 2 – moderately sensitive key fish habitat (freshwater habitats other than those defined in Type 1).
- Type 3 – minimally sensitive key fish habitat (ephemeral aquatic habitat not supporting native aquatic or wetland vegetation).
- Not key fish habitat (includes first and second order streams on gaining streams).

3.2.8 Survey conditions

The fauna field surveys were undertaken in August and November 2019, February 2020 and November 2020. The Kurri Kurri region experienced drought conditions during the August and November 2019 surveys which likely impacted on the presence and detection of fauna species at the proposal site. Conditions were otherwise generally good for the detection of the species targeted. The wind conditions during diurnal bird surveys and call playback surveys were low to none and so would not have hampered the detection of bird species.

The Kurri Kurri area received approximately 47 mm of rainfall the week prior to the 24 – 28 February 2020 fauna surveys. In addition, there was a further 9 mm of rain recorded during the February 2020 surveys. Although the site was still considerably dry as a result of long-term drought, these rainfall events resulted in suitable conditions to complete frog surveys within the site. As confirmed by presence of active calling frog species frog.

Supplementary frog surveys were also completed on 24-25 November 2021 and December 7 and 8 2021. These surveys were preceded with 43.4 mm of rainfall in the three prior to the November surveys and 7 mm prior and during the December surveys. Numerous species of frog were calling within the proposal site at the time of these surveys and Green and Golden Bell Frogs were also confirmed to be calling at Kooragang Island (nearest known reference population) during the survey period (pers com Allen Cullen, Newcastle University).

Bureau of Meteorology (BOM) records for the survey periods are outlined in Table 3.8. These records were taken at Maitland Airport weather station (station 061428) located approximately 10 kilometres east of the proposal site (BOM 2021b).

Table 3.8 Daily weather observations during the survey period

Date	Min temp (Deg Celsius)	Max temp (Deg Celsius)	Rainfall (mm)	Onsite weather observations
26-31 August 2019				
26/8/2019	10.7	21.4	0	Light wind
27/8/2019	6.5	21.2	0.2	Clear, cool
28/8/2019	6.9	23.0	0.2	Clear, cool
29/8/2019	5.5	18.9	0	Clear, cool
30/8/2019	10.0	14.9	2.2	Clear, cool
31/8/2019	9.9	16.3	43.8	Moderate rain
25-29 November 2019				
25/11/2019	17.8	35.4	0	Hot, dry
26/11/2019	14.0	37.5	0.2	Hot, dry
27/11/2019	10.0	27.1	0	Hot, dry
28/11/2019	8.8	32.0	0	Hot, dry
24- 28 February 2020				
24/2/2020	18.8	26.4	0	Clear, Warm
25/2/2020	17.9	30.2	8.2	Light rain
26/2/2020	18.6	32.5	0.2	Warm, light wind
27/2/2020	19.3	26.3	0.2	Calm
28/2/2020	16.3	27.8	0.2	Calm
November 2021				
19/11/2021	14.2	25.3	0	Light wind
24/11/2021	16.0	23.5	6.4	Light wind
25/11/2021	17.6	29.8	2.0	Calm
December 2021				
07/12/2021	16.7	29.1	5.2	Warm, light wind
08/12/2021	17.0	25.7	1.2	Warm, light wind

3.3 BAM calculations

The proposal was assessed according to the methodology presented in the BAM (DPIE 2020a), and the Biodiversity Assessment Methods Calculator Users Guide OEH 2018. The BAM calculator is a software application that is used to apply the BAM. Data is entered into the BAM calculator based on information collected in the desktop assessment, site surveys and from using GIS mapping software.

The BAM calculations were performed by Arien Quin (accredited BAM assessor number BAAS 17098), using calculator version 1.3.0.00 (DPIE 2021) and reviewed by Ben Harrington (BAAS 17023). Data entered into the BAM calculator is provided in Appendix C. The biodiversity credit report is included in Appendix H.

3.4 Geographical Information System (GIS) analysis

GIS was used to:

- Plot the proposal site on a high-resolution aerial photo base and to map vegetation zones, survey effort, habitat resources and biodiversity values across the proposal site.
- Plot a 1,500 metre buffer area surrounding proposal site.
- Calculate the extent of native vegetation to be impacted, patch size and cover in the buffer area.
- Confirm the relevant IBRA bioregion, IBRA subregion and Mitchell Landscape for the site.

Native vegetation cover, extent and connectivity were assessed using aerial photography. Aerial photo interpretation was used to identify and record distinct vegetation patches, determine the broad condition state of vegetation types and the location and extent of vegetated habitat corridors.

3.5 Staff qualifications

This BDAR was prepared by Arien Quin in accordance with the BAM 2020. BAM plot data was collected by Arien Quin and Alejandro Barreto (accredited assessor number BAAS 18057). A technical review of the report and credit calculations was undertaken by Ben Harrington.

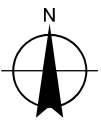
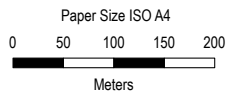
Fauna surveys were completed by Luke O'Brien (GHD) and Brendan Ryan (OMVI Ecological).

Qualifications of all staff involved in the field surveys and preparation of this BDAR are presented in Table 3.9.

Table 3.9 GHD ecology staff and qualifications

Name	Position / Project Role	Qualifications	Relevant Experience
Ben Harrington	Technical Director-Biodiversity Technical review	BSc MSc Accredited BAM Assessor	17+ years
Arien Quin	Senior Ecologist- Certifying accredited assessor and lead author of the BDAR Targeted threatened flora surveys, BAM credit calculations	BA/BSc Accredited BAM Assessor	14+ years
Ben Lewis	Ecologist (Zoologist) Lead Zoologist - Targeted threatened fauna surveys	B. App. Sc	20+ years
Alejandro Barreto	Senior Ecologist Vegetation mapping Vegetation integrity plots Targeted threatened flora surveys Hollow bearing tree assessment Owl surveys	BSc Biotechnology Accredited BAM Assessor	6+ years
Luke O'Brien	Fauna Ecologist Threatened fauna surveys and reporting	BEnvSc BSc (Hons)	5+ years
Craig Grabham	Senior Ecologist Bat call Analysis	B. App. Science (Hons) Anabat system training course (Titley Scientific, December 2012) Wildlife Accoustic's Song Meter/SongScope training (Faunatech, July 2015), Anabat Insight and bat call analysis workshop (Titley Scientific and Balance Environmental June 2019)	22 + years
Fiona MacKay	Senior GIS Technician GIS analysis and mapping	Engineering Drafting Certificate	30+ years
Bianca Seal	Ecologist Data management Targeted threatened flora surveys Field survey assistant	BSc	3+ years

- Legend**
- Proposal site
 - LGA boundary
 - Targeted flora transects - October/November 2019
 - Targeted flora transects - October/November 2020
 - Targeted flora transects - April 2020
 - Targeted flora transects - February 2021
 - Targeted flora transects - October 2021
 - Targeted flora transects - November 2021
 - Targeted flora transects - December 2021
 - Targeted fauna transects - November / December 2021
 - Vegetation integrity plots
- Targeted Fauna Surveys**
- Anabat
 - Call playback
 - ⊠ Camera trap
 - Reptile search
 - ⊠ SAT test
 - Spotlighting
 - + Stagwatch
 - Arboreal trap line
 - Pitfall trap line



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

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Survey effort

Figure 3-1

4. Landscape context

The BAM requires the assessment of landscape features to help describe the biodiversity values of the proposal site and assess the impacts of the proposal. Landscape features relevant to the BAM calculations are shown on Figure 4.1, discussed below and summarised in Table 4.2.

4.1 Location

The proposal site is located off Cessnock Road in the suburb of Gillieston Heights, approximately 30 km northwest of Newcastle Central Business District within the Maitland City Council LGA.

The site occurs within the Hunter Interim Biogeographic Regionalisation for Australia (IBRA) subregion of the Sydney Basin IBRA bioregion. The Sydney Basin IBRA bioregion lies on the central east coast of NSW, and extends north from Batemans Bay to Nelson Bay and west to Mudgee. It includes a significant proportion of the catchments of the Hawkesbury-Nepean, Hunter and Shoalhaven river systems.

The proposal site includes 16 Lots as listed in Table 4.1.

Table 4.1 Property Lots within proposal site

Lot number	Deposited Plan	Whole or part of Lot	Land Tenure
5	DP456946	Part	Freehold
1	DP456946	Whole	Freehold
55	DP975994	Part	Freehold
54	DP975994	Whole	Freehold
71	DP975994	Part	Freehold
69	DP975994	Part	Freehold
2	DP456946	Whole	Freehold
70	DP975994	Part	Freehold
8	DP456946	Part	Freehold
1	DP73597	Part	Freehold
10	DP456946	Part	Freehold
7	DP456946	Part	Freehold
9	DP456946	Part	Freehold
1	DP1206034	Part	Freehold
3	DP456946	Part	Freehold
4	DP456946	Part	Freehold
2	DP601226	Part	Freehold
2	DP302745	Part	Freehold
1	DP302745	Part	Freehold
900	DP1231729	Part	Freehold

4.2 Existing land use

The proposal site includes approximately 58.5 ha of land that was part of the former Hydro Aluminium Smelter buffer zone. This land forms part of an agricultural property called Wangara that has been predominantly cleared and subject to long term cattle grazing. The site contains scattered remnant trees, areas of young regrowth as well as small patches of remnant native vegetation along the southern boundary. There are two small farm dams located either end of the drainage line that runs along the southern boundary of the site as well as a small dam located in the northeast of the site. A coal train line extends along the western boundary of the site.

Approximately 43.23 ha of this land is comprised of mixed grassland (dominated by exotic species), 1.2 ha is cleared land, 0.96 ha comprises planted vegetation and 13.0 ha is native vegetation, of which 10.2 ha is in poor condition and 2.7 ha is in good condition.

4.3 Climate

The site has a warm temperate climate. Based on data from the Maitland Airport weather station (station 061428) located approximately 10 kilometres north of the proposal site, the site has a mean annual rainfall of 720 mm, falling predominantly in late summer to early autumn. The site can reach up to mean monthly maximum temperatures of 30.5 degrees and down to mean monthly minimum temperature of 4 degrees Celsius (BOM 2020a).

4.4 Landscape features

Landscape features within the proposal site are summarised in Table 4.2 and shown in Figure 4.1 as required by Section 3.1 of the BAM.

Table 4.2 Summary of landscape features present within the proposal site

Landscape feature	Proposal site
Method applied for site context components	Site-based
Interim Biogeographic regionalisation of Australia (IBRA) bioregion	Sydney Basin
IBRA subregion	Hunter
Mitchell landscapes	Newcastle Coastal Ramp
Percentage native vegetation extent within buffer area	31 percent (403 ha)
Rivers, streams and estuaries	<p>The proposal site is located within the Wallis Creek catchment. Wallis creek flows into the Hunter River approximately 10 km to the north of the proposal site between East and West Maitland.</p> <p>Low undulating hills to the northwest and south of the proposal site grade into floodplains that surround Wentworth Swamp. This swamp forms a large ephemeral waterbody that is located adjacent to the proposal site.</p> <p>An ephemeral first order drainage line occurs in the southwest of the proposal site and feeds into Wentworth Swamp to the west of the site. This drainage line is not listed as key fish habitat.</p>
Wetlands	<p>There are no natural wetlands within the proposal site.</p> <p>A large ephemeral wetland known as Wentworth Swamp occurs to the north west of the proposal site (refer to Figure 1.2). This large wetland basin occurs on the floodplains of Swamp Creek and is recognised as a regionally significant wetland.</p> <p>The Hunter estuary wetlands that are identified as nationally important wetlands are located approximately 10 km to the south east of the proposal site. These wetlands would not be impacted by the proposal.</p>

Landscape feature	Proposal site
Connectivity features	The proposal site is bordered to the west by the South Maitland Railway and agricultural land. Further west is Wentworth Swamp which adjoins a patch of native vegetation greater than 2,000 ha in area. Connectivity between the proposal site and native vegetation to the west has been impacted by the construction of the South Maitland Railway line and the Hunter Expressway. Cessnock Road and cleared land used for agriculture that has been identified for residential housing is located to the east of the proposal site. North of the site is cleared land and residential development associated with the Gillieston Grove subdivision. South of the proposal site is a patch of remnant native vegetation that is connected by a narrow-vegetated corridor to a larger patch of vegetation that surrounds the Kurri Kurri TAFE.
Areas of geological significance or soil hazard features	Areas of the proposal site have a high probability for containing Acid Sulfate Soils, occurring 2-4 m below ground surface (DPIE 1998; Naylor et al. 1998). There are no karst, caves, crevices, cliffs or other areas of geological significance located within the proposal site.
Areas of outstanding biodiversity value	No areas identified under the BC Act as being of outstanding biodiversity value have been mapped in the development footprint.
Other landscape features	Nil

4.4.1 NSW landscape region (Mitchell Landscapes)

The proposal site is located within the Newcastle Coastal Ramp Mitchell Landscape within the Sydney Basin Bioregion (DECC 2008a) which is described as follows:

“Undulating lowlands and steep hills on complex patterns of faulted and gently folded Carboniferous conglomerate, lithic sandstone, felspathic sandstone and mudstone. General elevation 50-275 m, local relief 40 – 150m. Stony red textured-contrast soils on steep slopes, yellow and brown texture-contrast soils on lower slopes and deep dark clay loams along streams. Woodland of spotted gum (Corymbia maculata), forest red gum (Eucalyptus tereticornis), red ironbark (Eucalyptus sideroxylon), white mahogany (Eucalyptus acmenoides, large-fruited grey gum (Eucalyptus canaliculata), with sub-tropical rainforest elements in sheltered gullies. Similar eucalyptus with forest oak (Allocasuarina torulosa) and grasses on lower slopes, merging to forest of smooth barked apple (Angophora costata), red bloodwood (Corymbia gummifera), blackbutt (Eucalyptus pilularis) with bracken (Pteridium esculentum) and grasses nearer to the coast. (DECC 2008b).

The presence of the soil types, landscape features and vegetation communities associated with the inland form of the Newcastle Coastal Ramp Mitchell Landscape was confirmed at the proposal site through field observations by GHD ecologists.

4.4.2 Soil landscapes

Two soil landscapes have been mapped within the proposal site (DPIE 2020c), Bolwarra Heights (9232bh) and Bolwarra Heights variant a (9232bha).

The Bolwarra Heights soil landscape occurs on rolling low hills on Permian sediments in the East Maitland Hills region. Within the proposal site these soils occur in the northeast on low hills adjacent to the floodplains of Wentworth Swamp. The soil landscape is predominantly associated with the geology of the Branxton Formation of the Maitland Group that is characterised by sandstone, siltstone, conglomerate and erratics. It also includes smaller areas of Muree Sandstone which are characterised by sandstone, conglomerate and siltstone, Greta Coal measures which include lenticular conglomerates, sandstone, shale spitting coal seams and Farley Formation which is associated with sandstone, mudstone, siltstone, shale and erratics (Kovak and Lawrie 1991).

Soils include moderately deep (<150 cm) well drained Yellow Podzolic Soils, Red Podzolic Soils and Brown Podzolic soils with some moderately deep, well drained Lithosols on crests and imperfectly drained yellow Sloths on lower slopes (Kovak and Lawrie 1991).

This variant has similar landscape features, geology and soil characteristics to the Bolwarra Heights soil landscape however soils are shallow (<55 cm) (Kovak and Lawrie 1991).

4.4.3 Soils hazards

The Maitland LEP 2011 indicates a potential Class 5 Acid Sulphate Soils risk affecting the proposal site. Further development associated with the proposal site would require an Acid Sulfate Soil Management Plan.

Part of the proposal site is within a mine subsidence district (MSD) (DFS1 - Spatial Services 2012). This has led to erosion of some areas over time, where water has naturally collected and caused increased surface runoff and subsequent soil erosion. Development within a MSD requires approval from Subsidence Advisory (SA) NSW.

4.5 Site Context

To determine site context as required under Section 3 of the BAM (Section 3.2 and Subsection 4.3.2), an assessment of native vegetation cover and patch size has been undertaken and is outlined below.

4.5.1 Native vegetation cover

Native vegetation cover (woody and non-woody) was assessed on the proposal site and within a 1,500 metre buffer area surrounding the outside edge of the boundary of the site. Aerial photography was examined at scales between 1:2000 and 1:4000. The percent native vegetation cover within 1,500 metre buffer area was assessed to be 31 percent and includes (see Table 4.3):

- Remnant mapped native vegetation types (including wetland vegetation)
- Planted native vegetation types
- Areas mapped as canopy only

Areas that were excluded include:

- Cleared areas
- Non-native vegetation
- Dams, ponds and other waterbodies
- Buildings
- Non-native plantings

The identification of native vegetation in the buffer areas was based on review of the Lower Hunter Vegetation Mapping, 2013. VIS_4513 (DPIE 2017) in combination with aerial photograph interpretation and ground-truthing during field surveys.

Table 4.3 Native vegetation cover

Native vegetation cover unit	1,500 m buffer area
Total assessment area	1317 (nearest whole hectare)
Area of native vegetation cover (woody and non-woody)	403 (nearest whole hectare)
Percentage native vegetation cover	31%
Cover class	30-70%

4.5.2 Patch size

Patch size is defined under the BAM (DPIE 2020a) as an area of native vegetation that:

- Occurs on the development site or biodiversity stewardship site (i.e. proposal site).
- Includes native vegetation that has a gap of less than 100 metres from the next area of native vegetation (or ≤ 30 metres for non-woody ecosystems).

Patch size may extend into adjoining land that is not part of a development site or a biodiversity stewardship site. Patch size area is assigned to each vegetation zone as a class, being < 5 hectares, 5-<25 hectares, 25-<100 hectares or ≥ 100 hectares.

Native vegetation at the proposal site is connected to a much larger patch that extends to the south and west of the site. The total size of this patch within the 1,500 meter buffer is about 250 ha. The overall patch size polygon includes additional areas of connected intact native vegetation, however for the purposes of this assessment, the total patch size has not been calculated outside of the buffer area, given the highest class was already reached within the buffer area. Therefore 101 ha was entered as the patch size for each of the vegetation zones in the BAM calculator.

4.5.3 Connectivity features

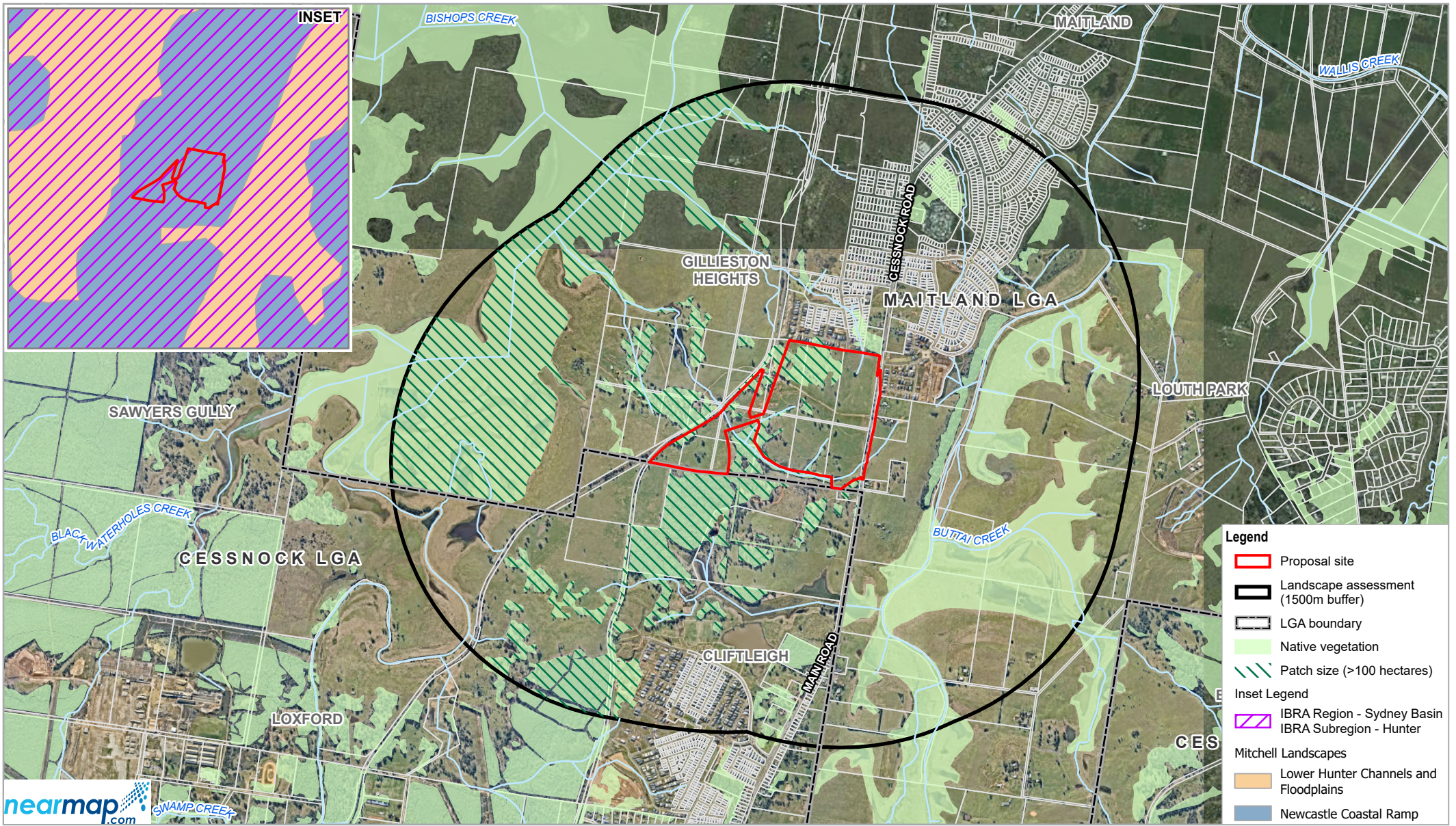
- The proposal site is bordered to the west by the South Maitland Railway and agricultural land. Further west is Wentworth Swamp which adjoins a large patch of native vegetation (>2,000 ha) surrounding Sawyers Gully. Connectivity between the proposal site and remnant native vegetation to the west has been impacted by the construction of the South Maitland Railway.
- Cessnock Road and cleared land used for agriculture that has been identified for residential housing is located to the east of the proposal site. North of the site is cleared land and residential development associated with the Gillieston Grove subdivision. To the south vegetation within the proposal site is connected to a patch of remnant native vegetation that fringes Testers Hollow. This vegetation is then that is connected by a narrow-vegetated corridor to a larger patch of vegetation surrounding the Kurri Kurri TAFE (refer to Figure 4.1).

4.5.4 Areas of significance

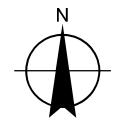
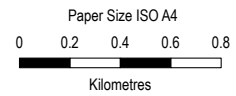
- No areas identified under the BC Act as being of outstanding biodiversity value have been mapped in the proposal site.

There are no karst, caves, crevices, cliffs or other areas of geological significance located within or adjacent to the proposal site.

Vegetation along the southern drainage line has been identified on the Biodiversity Values Map (DPIE 2021f). The biodiversity criteria stated on the map for this patch of vegetation is “threatened species or community at risk of serious and irreversible impacts”.



nearmap.com SWAMP CREEK



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



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Landscape assessment

Figure 4-1

5. Native vegetation

5.1 Flora species

A total of 114 flora species from 34 families were recorded within the proposal site, comprising 76 native and 38 exotic species. The Poaceae (23 species, 12 native, 11 exotic), Myrtaceae (12 species, all native), Asteraceae (11 exotic, 1 native) and Fabaceae (Faboideae) (9 species, 6 native) were the most diverse families recorded. A full list of flora species recorded within the proposal site is provided in Appendix C.

No threatened flora species were identified within the proposal site during field surveys. Threatened flora survey effort was largely limited to areas of native vegetation in the south of the site as the majority of the remainder of the site contains cleared and grazed land that is unlikely to provide suitable habitat for the threatened species with the potential to occur in the locality.

5.1.1 Priority and high threat species

Two flora species listed as priority weeds (*Senecio madagascariensis* (Fireweed) and *Lantana camara* (Lantana) listed in the Hunter region (which includes the Maitland local council area) were recorded within the proposal site during the field surveys.

In addition the following exotic species recorded in the proposal site are classified as high threat weeds for the purposes of the BAM:

- *Bidens pilosa* (Cobbler's Pegs)
- *Cyperus eragrostis* (Umbrella Sedge)
- *Romulea rosea* (Onion Grass)
- *Andropogon virginicus* (Whisky Grass)
- *Ehrharta erecta* (Panic Veldtgrass)
- *Paspalum dilatatum* (Paspalum)
- *Acetosella vulgaris* (Sheep Sorrel)

5.2 Vegetation within proposal site

5.2.1 Native vegetation extent

The majority of the proposal site has been cleared and used for agriculture (cattle grazing) and comprises exotic grassland. Based on its landscape position this grassland is likely to have formerly contained Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest (PCT1600) and so it has been treated as an 'exotic' condition class of this PCT for the purposes of credit calculations. This conservative approach has been adopted to allow the calculation of a vegetation integrity score and to help satisfy an approver that the 43.28 hectares of exotic grassland does not comprise native vegetation or threatened species habitat requiring offset according to the BAM.

There are small patches of Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest (PCT1600) occurring as scattered trees over a highly disturbed, under scrubbed understorey or areas of regrowth. On the southern boundary of the site along there are areas of remnant Grey Gum - Rough-barked Apple shrubby open forest (PCT1591) in the riparian corridor of a drainage line that runs along the boundary of the site.

There is a total extent of 12.98 ha of native vegetation within the proposal site. Of this 2.74 ha is comprised of remnant woodland patches in good condition and 10.24 ha has been substantially modified (see Figure 5.1). There is a further 43.28 ha of exotic grassland that has been treated as a vegetation zone for the purposes of BAM credit calculations as described above but does not comprise native vegetation cover.

5.2.2 Planted native vegetation

- The proposal site also contains a total of 0.96 ha of stands of planted vegetation including:
 - A row of Swamp Mahogany (*Eucalyptus robusta*) along the eastern boundary of the site.
 - Horticultural plantings including *Callistemon citrinus* (Crimson Bottlebrush), *Melaleuca* spp (Paperbark) and *Acacia podalyriifolia* (Queensland Silver-wattle). within private property associated with the proposed intersection upgrade.

An assessment of this planted native vegetation has been completed in accordance with the streamlined assessment module for planted native vegetation outlined in Appendix B of the BAM. This assessment determined that planted vegetation within the proposal site has been planted for functional and aesthetic purposes (landscaping) and as such Chapters 4 and 5 of the BAM are not required to be applied (refer to Appendix D). An assessment of planted native vegetation for threatened species habitat is included in Section 6.1.5 of this BDAR.

5.2.3 Plant community types

Existing vegetation mapping of the proposal site completed by Bell and Driscoll (2007) and EcoLogical (ELA 2016) was reviewed and ground-truthed. The overall condition of vegetation was assessed through general observation and comparison against the PCT condition benchmark data as well as using parameters such as species diversity, history of disturbance, weed invasion and canopy health. Candidate PCTs were identified using the BioNet Vegetation Classification database power query function. Plot survey data along with information collected regarding soil type and landscape position was then analysed and compared to PCT descriptions in the Vegetation Classification Database to confirm PCTs.

Results of field surveys and plot analysis indicate that vegetation within the proposal site corresponds to three native Plant Community Types (PCTs) and one exotic vegetation community. These are:

- PCT 1591, Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter.
- PCT 1600, Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter (under-scrubbed).
- PCT 1736, Water Couch -Tall Spike Rush Freshwater Wetland of the Central Coast and Lower Hunter
- Mixed grassland.

Vegetation types within the proposal site are summarised in Table 5.1 and shown in Figure 5.1. The structure, species composition and condition of PCTs and vegetation zones within the proposal site are described in Table 5.2. to Table 5.7 below. As noted above the site contains 43.28 ha of predominantly exotic grassland that has been treated as a vegetation zone for the purposes of BAM credit calculations as described in Section 5.2.1 but does not comprise native vegetation cover.

Three of the PCTs identified within the proposal site comprise occurrences of threatened ecological communities (TECs) under the BC Act. See Section 6.2.3 for additional description of occurrences of TECs at the proposal site.

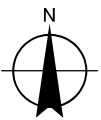
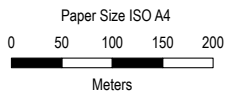
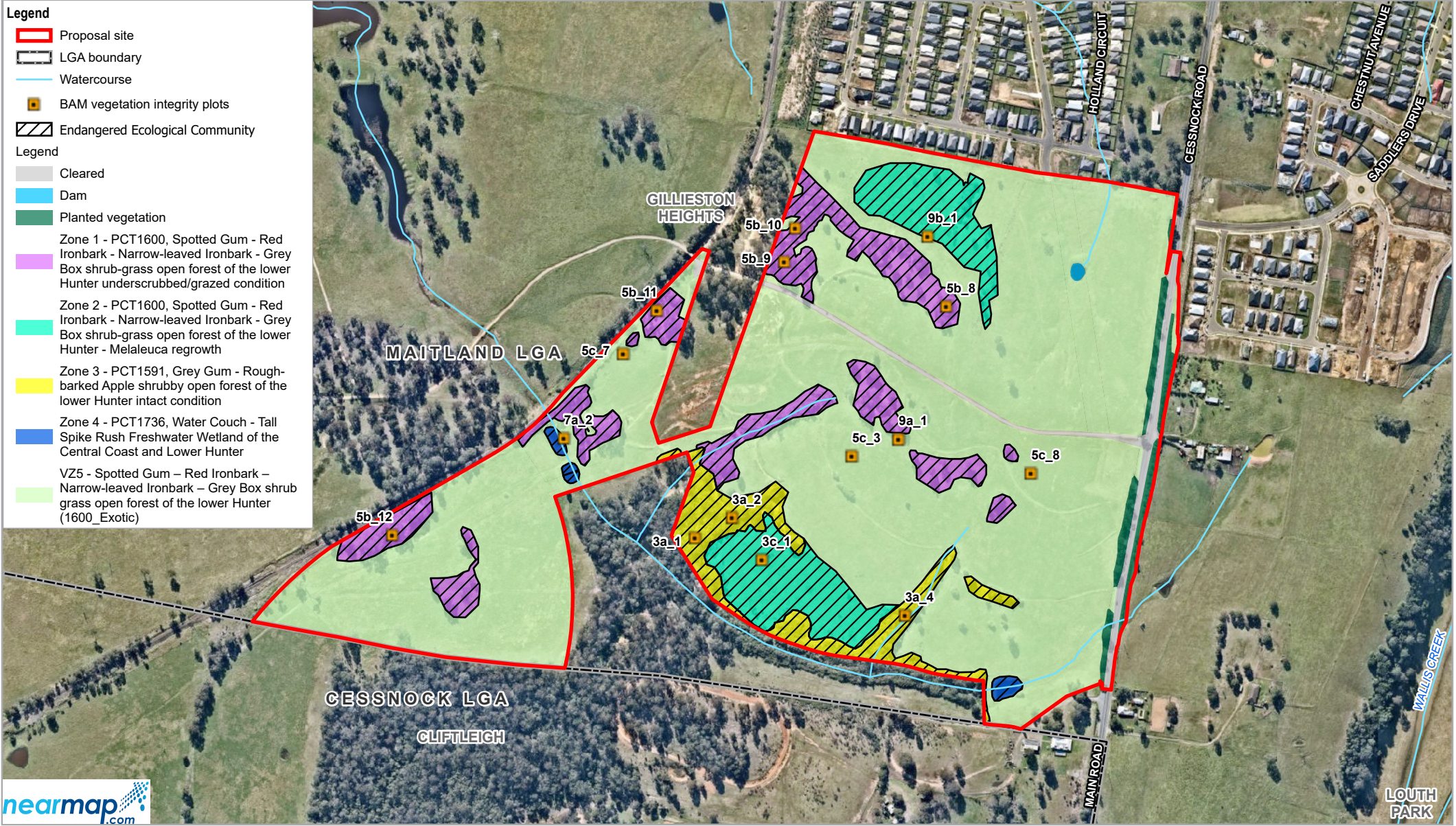
5.2.4 Vegetation zones

- The historical clearing and management for agricultural practices have resulted in areas of PCT 1600 that are in different condition states across the proposal site. Where appropriate, PCTs were split into multiple vegetation zones according to different vegetation condition classes.
- There is a total of four native vegetation zones within the proposal site. Areas of predominantly exotic grassland do not comprise native vegetation but were treated as a fifth vegetation zone to support calculation of a vegetation integrity score and confirmation that biodiversity offsets are not required for this land.
- Planted vegetation has been assessed separately in accordance with Appendix D of the BAM.

Table 5.1 *Vegetation within the proposal site*

Vegetation zone	PCT ID	Condition	Area in proposal site (ha)	Patch size (ha)	Percent cleared	VI score	BC Act Status	EPBC Act Status
1 - Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (1600_underscrubbed)	1600	Under scrubbed	5.49	101	71	49.9	Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC	Not listed
2 - Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (1600_Regrowth)	1600	Regrowth	4.49	101	71	19.2	Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC	Not listed
3 - Grey Gum – Rough-braked Apple shrubby open forest of the lower Hunter (1591_Intact)	1591	Intact	2.74	101	26	61.3	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	Not listed
4- Water Couch - Tall Spike Rush Freshwater Wetland of the Central Coast and Lower Hunter (1736_Disturbed)	1736	Disturbed	0.25	101	80	35.9	Freshwater Wetlands in Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC	Not listed
5 - Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (1600_Exotic)	1600	Exotic	43.28	0	N/A	4.6	Not listed	N/A
Cleared land	N/A	Poor	1.19	N/A	N/A	N/A	Not listed	N/A
Planted vegetation	N/A	Poor	0.96	N/A	N/A	N/A	Not listed	N/A

- Legend**
- Proposal site
 - LGA boundary
 - Watercourse
 - BAM vegetation integrity plots
 - Endangered Ecological Community
- Legend**
- Cleared
 - Dam
 - Planted vegetation
- Zone 1 - PCT1600, Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter underscrubbed/grazed condition
- Zone 2 - PCT1600, Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter - Melaleuca regrowth
- Zone 3 - PCT1591, Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter intact condition
- Zone 4 - PCT1736, Water Couch - Tall Spike Rush Freshwater Wetland of the Central Coast and Lower Hunter
- VZ5 - Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (1600_Exotic)



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


Vegetation zones

Figure 5-1

5.2.5 Vegetation zone profiles


Description profiles of the vegetation zones present in the study area are provided in Table 5.2 to Table 5.7

Table 5.2 *Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed)*

1 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed)	
PCT (DPIE, 2021b)	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter
PCT ID	1600
Equivalent map units	Bell and Driscoll (2007) map unit 17a Lower Hunter Spotted Gum Ironbark Forest
	
Vegetation formation	Dry Sclerophyll Forests (Shrub/grass sub-formation)
Survey effort	Three plots (5b_8, 5b_10, 5b_11)
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests
Conservation significance	Comprises an occurrence of 'Lower Hunter Spotted Gum- Ironbark Forest in the Sydney Basin Bioregion' which is listed as an EEC under the BC Act.
Condition	'Underscrubbed', comprising: <ul style="list-style-type: none"> – Canopy that has been thinned through past clearing. – Understorey that has been cleared and grazed resulting in a largely absent shrub layer and modified ground layer with a high abundance of exotic herbs and perennial grasses.
Evidence used to define PCT	<p>PCTs considered to be possible matches for this vegetation include PCT 1600 and PCT 1593. Although this community has been highly modified PCT 1600 was chosen as the best fit for the following reasons:</p> <ul style="list-style-type: none"> – The site occurs within the PCTs described range, within Maitland LGA, Hunter IBRA sub-region and within the Central Hunter Foothills Mitchell Landscape. – The PCT is described as occurring on an underlying geology comprised of siltstone and conglomerate on hill slopes and low rises. This geology is aligned with the soil landscapes mapped for this vegetation zone (Balwarra Heights). – Dominant canopy species of the site are characteristic of those described by the BioNet Vegetation Classification database. These include <i>Eucalyptus crebra</i> (Narrow-leaved Ironbark) and <i>Eucalyptus fibrosa</i> (Red Ironbark) and <i>Corymbia maculata</i> (Spotted Gum). – Although this vegetation zone has been modified through past clearing and associated ongoing agricultural activities, the species present indicate that the community is more closely aligned to PCT 1600 than PCT 1593. The presence of <i>Corymbia maculata</i> (Spotted Gum) is the primary distinguishing factor along with the more open understorey in PCT 1600. Within this vegetation zone the understorey has been highly altered due to clearing and grazing pressures so the community structure cannot be used as a determining factor for distinguishing between these two communities. The presence of Spotted Gum (as well as other diagnostic species) suggests that this vegetation zone is more closely aligned to PCT 1600 than to 1953. – Regional mapping supports the classification of this community as PCT 1600

1 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed)	
Landscape position	Low slopes and rises.
Occurrence within the proposal site	Patches of this vegetation zone are scattered through the disturbed agricultural paddocks that occur within the proposal site.
Structure	This vegetation zone consists of scattered paddock trees to 20 m with a grassy understorey. The shrub layer has been predominantly removed although occasional low shrubs are present.
Over storey	Remnant canopy species include <i>Eucalyptus fibrosa</i> (Red Ironbark), <i>Eucalyptus moluccana</i> (Grey Box), <i>Corymbia maculata</i> (Spotted Gum), and <i>Eucalyptus crebra</i> (Narrow-leaved Ironbark)
Mid storey	Largely absent with occasional <i>Denhamia silvestris</i> (Narrow-leaved Orangebark) <i>Acacia ulicifolia</i> (Prickly Moses), <i>Melaleuca nodosa</i> , and <i>Leucopogon juniperinus</i> (Prickly Beard-heath).
Groundcover	Comprises a mixture of exotic forbs and grasses and common native species. Characteristic native grass species include <i>Cynodon dactylon</i> (Common Couch), <i>Dichelachne micrantha</i> (Shorthaired Plume Grass) <i>Microlaena stipoides</i> (Weeping Grass). Native forb species include <i>Dianella revoluta</i> (Flax-lily), <i>Glycine clandestinum</i> (Twining Glycine), <i>Oxalis perennans</i> (Oxalis), <i>Pomax umbellata</i> (Pomax), <i>Einadia nutans</i> (Ruby Saltbush), <i>Einadia hastata</i> (Berry Saltbush) and <i>Lomandra confertifolia</i> (Matrush)
Exotic species	This vegetation zone contains a high abundance of weeds, many of which are high threat weeds. Dominant species include <i>Senecio madagascariensis</i> (Fireweed), <i>Lantana camara</i> (Lantana), <i>Andropogon virginicus</i> (Whisky Grass), <i>Lotus subbiflorus</i> (Hairy Birds-foot Trefoil), <i>Facelis retusa</i> (Annual Trampweed), <i>Sida rhombifolia</i> (Paddy's Lucerne), <i>Plantago lanceolata</i> (Lamb's Tongues), <i>Vulpia bromoides</i> (Squirrel Tail Fesque) and <i>Briza minor</i> (Shivery Grass).

Table 5.3 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (melaleuca regrowth)


2 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (regrowth)		
PCT (DPIE 2021b)	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	
PCT ID	1600	
Equivalent map units	Bell and Driscoll (2007) map unit 17a Lower Hunter Spotted Gum Ironbark Forest)	
Survey effort	Two plots (3c_1, 9b_1)	
Vegetation formation	Dry Sclerophyll Forests (Shrub/grass sub-formation)	
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests	
Conservation significance	Comprises an occurrence of 'Lower Hunter Spotted Gum- Ironbark Forest in the Sydney Basin Bioregion' which is listed as an EEC under the BC Act.	

2 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (regrowth)

Condition	<p>'Regrowth' comprising:</p> <ul style="list-style-type: none"> – A tallest native stratum of regenerating shrubs and small trees – No over storey vegetation – Understorey that has been cleared and grazed and features low native species richness
Evidence used to define vegetation unit	<p>This vegetation has been highly modified due to past clearing and ongoing grazing practices. PCT 1600 was chosen as the best fit PCT for this vegetation zone for the following reasons:</p> <ul style="list-style-type: none"> – The site occurs within the PCTs described range, within Cessnock LGA, Hunter IBRA sub-region and within the Newcastle Coastal Ramp Mitchell Landscape. – The PCT is described as occurring on an underlying geology comprised of siltstone and conglomerate on hill slopes and low rises. This geology is aligned with the soil landscapes mapped for this vegetation zone (Balwarra Heights). – Dominant understorey species include species diagnostic of this PCT. – Vegetation zone occurs adjacent to vegetation zones containing canopy species typically found within the PCT (<i>Corymbia maculata</i>, <i>Eucalyptus fibrosa</i> and <i>Eucalyptus crebra</i>).
Landscape position	Low slopes and rises.
Occurrence within the proposal site	This vegetation zone occurs in two small patches in the north and south of the proposal site.
Structure	Consists of young regenerating shrubs to 2 metres over grassy understorey.
Over storey	Absent
Mid storey	Consists of relatively young regenerating <i>Melaleuca nodosa</i> (Prickly-leaved Paperbark), <i>Acacia ulicifolia</i> (Prickly Moses), <i>Pimelea linifolia</i> (Slender Rice-flower), <i>Dillwynia retorta</i> and <i>Leptospermum polygalifolium</i> (Tantoon).
Groundcover	The ground layer retains a relatively diverse mix of native grass, forb and rush species. Characteristic species include <i>Cynodon dactylon</i> (Common Couch) <i>Dichelachne micrantha</i> (Shorthair Plumegrass), <i>Microleana stipoides</i> (Weeping Grass) <i>Aristida vagans</i> (Threeawn Speargrass) and <i>Eragrostis brownii</i> (Brown's Lovegrass). Native herbs include <i>Oxalis perennans</i> , <i>Glycine clandestina</i> , and <i>Cheilanthes sieberi</i> . Native grass-like species include <i>Lomandra multiflora</i> and <i>Juncus usitatus</i>
Exotic species	This vegetation community contains a high abundance of weeds, many of which are high threat weed. Common species include <i>Senecio madagascariensis</i> (Fireweed), <i>Cerastium glomeratum</i> , Mouse Ear Chickweed), <i>Briza major</i> (Quaking Grass), <i>Aira caryophyllea</i> (Silvery Hairgrass), <i>Vulpia bromoides</i> (Squirrel Tail Fescue), <i>Lysimachia arvensis</i> (Scarlet Pimpernel), <i>Andropogon virginicus</i> (Whisky Grass), <i>Hypochoeris radicata</i> (Flat Weed) and <i>Facelis retusa</i> (Annual Trampweed).

Table 5.4 Grey Gum – Rough Barked Apple shrubby open forest of the lower hunter (intact)

3 Grey-Gum – Rough-barked Apple shrubby open forest of the lower hunter (intact)

PCT (DPIE, 2021b)	Grey-Gum- Rough-baked Apple shrubby open forest of the lower hunter	
PCT ID	1591	
Equivalent map units	Bell and Driscoll (2007) map unit 19a (Grey Gum – Red Gum Forest)	

3 Grey-Gum – Rough-barked Apple shrubby open forest of the lower hunter (intact)	
Survey effort	Three plots (3a_1, 3a_2, 3a_4)
Vegetation formation	Dry Sclerophyll Forests (shrub/grass sub-formation)
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests
Conservation significance	Comprises an occurrence of Hunter Lowland Red Gum Forest in the Sydney Basin and NSW North Coast Bioregions which is listed as an EEC under the BC Act.
Condition	The condition of this PCT has been classified as good for the following reasons ‘ <ul style="list-style-type: none"> – Remnant native vegetation with disturbed overstorey, shrub and ground layer – Supports a moderate diversity of native species that is just below benchmark for trees and shrubs – The vegetation zone has a low abundance of exotic species represented in the floral assemblage – Contains a number of hollow-bearing trees and area of fallen timber.
Evidence used to define vegetation unit	PCT 1591 was chosen for the following reasons: <ul style="list-style-type: none"> – The site occurs within the PCTs described range, within Maitland LGA, Hunter IBRA sub-region and within the Central Hunter Foothills Mitchell Landscape. – Within the proposal site the community occurs on flats and low rises. – Dominant canopy species with the community are characteristic of those described by the BioNet Vegetation Classification database (OEH 2020c). Namely <i>Eucalyptus punctata</i> (Grey Gum) and <i>Angophora floribunda</i> (Rough-barked Apple). – The community has a predominantly shrubby mid-storey (plot data recorded a mean species richness for shrubs of 9 and 4.5 for grasses with a cover of 61 % for shrubs and 29 % for grasses). – Other PCTs considered include PCT 1591 Forest Red Gum on Floodplains of the lower Hunter which although floristically similar was largely ruled out due to the absence of <i>Eucalyptus tereticornis</i> (Forest Red Gum) within the vegetation zone, the landscape position which is not on a floodplain and structural elements discussed above (i.e the predominantly shrubby rather than open mid-storey).
Landscape position	Low slopes and rises.
Occurrence within the proposal site	Within the proposal site a this PCT occurs along the southern boundary of the site along and adjacent to the unnamed drainage line.
Structure	An open forest to 20 m with a typically shrubby mid storey and sparse ground layer dominated by grasses, small ferns and forbs.
Over storey	Dominated by sparse <i>Eucalyptus punctata</i> (Grey Gum) and <i>Angophora floribunda</i> (Rough-barked Apple) with occasional <i>Eucalyptus crebra</i> (Narrow-leaved Ironbark) and <i>Eucalyptus agglomerata</i> (Blue-leaved Stringybark)
Mid storey	Diverse shrub layer dominated by <i>Melaleuca nodosa</i> , <i>Leptospermum polygalifolium</i> and <i>Bursaria spinosa</i> (Native Blackthorn). Other shrub species which occur at a smaller percentage cover include <i>Daviesia ulicifolia</i> (Gorse Bitter Pea), <i>Pultenaea spinosa</i> (A Bush Pea), <i>Dillwynia retorta</i> , <i>Acacia ulicifolia</i> (Prickly Moses), <i>Zieria smithii</i> , <i>Hakea sericea</i> (Needlebush), <i>Pittosporum undulatum</i> (Sweet Pittosporum) and <i>Denhamia silvestris</i> (Narrow-leaved Orangebark).
Groundcover	The groundlayer is characterised by native grass species, including <i>Entolasia stricta</i> (Wiry Panic), <i>Cynodon dactylon</i> (Common Couch), <i>Aristida vagans</i> (Threeawn Speargrass) and <i>Eragrostis brownii</i> (Brown's Lovegrass). Additional native ground cover species include <i>Lomandra cylindrica</i> , <i>Hardenbergia violacea</i> (False Sarsaparilla), <i>Pomax umbellata</i> (Pomax), <i>Commelina cyanea</i> (Native Wandering Jew) and <i>Cassytha glabella</i> .
Exotic species	Exotic species recorded within this community include, <i>Ehrharta erecta</i> (Panic Veldtgrass), <i>Senecio madagascariensis</i> (Fireweed), <i>Solanum mauritianum</i> (Tobacco Bush), <i>Lantana camara</i> (Lantana) and <i>Solanum nigrum</i> (Blackberry Nightshade)

Table 5.5 4- Water Couch -Tall Spike Rush Freshwater Wetland of the Central Coast and Lower Hunter (1736_Disturbed)


4- Water Couch -Tall Spike Rush Freshwater Wetland of the Central Coast and Lower Hunter (1736_Disturbed)		
PCT (DPIE, 2021b)	Water Couch -Tall Spike Rush Freshwater Wetland of the Central Coast and Lower Hunter	
PCT ID	1736	
Equivalent map units	Bell and Driscoll (2007) map unit	
Survey effort	One plot 7a_2	
Vegetation formation	Freshwater Wetland	
Vegetation class	Coastal Freshwater Lagoons	
Conservation significance	Comprises an occurrence of Freshwater Wetlands in Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC. which is listed as an EEC under the BC Act.	
Condition	'disturbed' comprising: <ul style="list-style-type: none"> – Occurs within man made dams – Surrounded by exotic vegetation – Now diversity of native aquatic species 	
Evidence used to define vegetation unit	PCT 1736 was chosen for the following reasons: <ul style="list-style-type: none"> – The site occurs within the PCTs described range, within Maitland LGA, Hunter IBRA sub-region and within the Central Hunter Foothills Mitchell Landscape. – Freshwater wetland containing areas of open water (although occurring on man-made dam) – Five of the seven diagnostic species (78 percent) listed in Vegetation Classification Database for this community were present in plot. 	
Landscape position	Flats, open water edges. Community known to occur on poorly drained sites on the coastal lowlands from Paxton to just north of Rayment Terrace. Substates are unconsolidated sediments and elevations ranges from 1- 120m (DPIE 2021e).	
Occurrence within the proposal site	Occurs in south of site, around margins of two man made dams located at either end of drainage line.	
Structure	Community dominated by spike rushes to 1.5 metres tall. Floating aquatic species and grasses also present.	
Over storey	Absent	
Mid storey	Absent	
Groundcover	Common species include <i>Eleocharis spathacelata</i> , <i>Cynodon dactylon</i> (Couch), <i>Juncus usitatus</i> , <i>Cycnogoten procerum</i> (Water Ribbons), <i>Persicaria decipiens</i> (Slender Knotweed), <i>Azolla filiculoides</i> (Azolla), <i>Ludwigia peploides subsp montevidensis</i> (Water Primrose), <i>Lachnagrostis filiformis</i> , <i>Cyperus difformis</i> , <i>Potamogeton sulcatus</i> (Pondweed), <i>Ranunculus inundatus</i> (River Buttercup) and <i>Ottelia ovalifolia subsp ovalifolia</i> (Swamp Lily).	
Exotic species	Edges of dams include a number of exotic herbs and grasses including <i>Paspalum dilatatum</i> (Paspalum), <i>Rumex acetocella</i> (Sheep Sorrel) and <i>Trifolium repens</i> (White Clover)	

Table 5.6 5 - Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (1600_exotic)



Exotic vegetation	
PCT (DPIE, 2021b)	Nil
PCT ID	1600
Equivalent map units	Nil
	
Vegetation formation	N/A
Vegetation class	N/A
Conservation significance	– Non-native vegetation. Treated as a condition class of PCT 1600 to support calculation of a vegetation integrity score and confirmation that biodiversity offsets are not required for this land.
Condition	<p>'Exotic', comprising:</p> <ul style="list-style-type: none"> – No canopy or shrub layer – Tallest vegetation strata is grassland, dominated by exotic groundcover species including high threat weeds – Low native species richness and cover across all plant growth forms – The calculated VI score for this vegetation zone based on benchmarks for the most likely PCT prior to clearing was 4.6
Evidence used to define vegetation unit	<p>A low diversity and abundance of native species within the vegetation community</p> <p>Evidence of historical clearing for grazing and agriculture</p> <p>Ongoing grazing of the site has contributed to a dominance of exotic perennial grasses.</p> <p>PCT 1600 was chosen for this exotic grassland as this PCT occurs in scattered patches throughout this grassland and it is likely that this PCT would have occurred prior to clearing and grazing of the site.</p>
Landscape position	Low slopes and rises.
Occurrence within the proposal site	Occurs within the agricultural paddocks and cleared land throughout the site where evidence of past vegetation clearing occurs. The largest patch of exotic vegetation occurs to the north-east of the site and is currently utilised for agricultural grazing.
Structure	This vegetation community is an exotic grassland, with a dense understorey dominated by exotic species. Sparse remnant trees occur with no mid-storey structure.
Over storey	The canopy structure is relatively absent from this vegetation community apart from very few scattered remnant paddock trees.
Mid storey	No mid-storey within the vegetation community.
Groundcover	The ground layer very occasional native grass, forb and rush species. Characteristic native species include <i>Cynodon dactylon</i> (Common Couch) <i>Dichelachne micrantha</i> (Shorthair Plumegrass), <i>Microleana stipoides</i> (Weeping Grass) <i>Aristida vagans</i> (Threeawn Speargrass) and <i>Eragrostis brownii</i> (Brown's Lovegrass). Native herbs include <i>Oxalis perennans</i> , <i>Glycine clandestina</i> , and <i>Cheilanthes sieberi</i> . Native grass-like species include <i>Lomandra multiflora</i> and <i>Juncus usitatus</i>
Exotic species	This vegetation community contains a high abundance of weeds, many of which are high threat weed. Common species include <i>Senecio madagascariensis</i> (Fireweed), <i>Cerastium glomeratum</i> , Mouse Ear Chickweed), <i>Briza major</i> (Quaking Grass), <i>Aira caryophyllea</i> (Silvery Hairgrass), <i>Vulpia bromoides</i> (Squirrel Tail Fescue), <i>Lysimachia arvensis</i> (Scarlet Pimpernel), <i>Andropogon virginicus</i> (Whisky Grass), <i>Hypochaeris radicata</i> (Flat Weed) and <i>Facelis retusa</i> (Annual Trampweed).

Table 5.7 Planted vegetation

Planted Vegetation	
PCT (DPIE, 2021b)	Nil
PCT ID	N/A
Equivalent map units	N/A
	
Survey effort	Transect
Vegetation formation	N/A
Vegetation class	N/A
Conservation significance	None
Occurrence within the proposal site	Occurs along eastern boundary and on eastern side of Cessnock Road where intersection upgrade proposed.
Structure	Single line of planted trees along eastern boundary of site and scattered planted shrubs to 5 metres along Cessnock Road. Occurs over exotic groundlayer.
Over storey	Native species include planted <i>Eucalyptus robusta</i> (Swamp Mahogany) along eastern boundary of proposal site .
Mid storey	Includes <i>Callistemon citrinus</i> (Crimson Bottlebrush), <i>Melaleuca</i> spp (Paperbark) and <i>Acacia podolyrifolia</i> (Queensland Silver-wattle).
Groundcover	Dominated by exotic grasses and herbs including <i>Paspalum dilatatum</i> (Paspalum), <i>Sida rhombifolia</i> (Paddy's Lucerne), <i>Avena barbata</i> (Bearded Oats), <i>Lolium</i> spp (Ryegrass), <i>Ehrharta erecta</i> (Panic Veldtgrass), and <i>Vulpia bromoides</i> (Squirrel Tail Fescue).
Exotic species	This vegetation community contains a high abundance of weeds, many of which are high threat weed. Common species <i>Cinnamomum camphora</i> (Camphor laurel), <i>Ligustrum sinense</i> (Small Leaved Privet), <i>Senecio madagascariensis</i> (Fireweed), <i>Ehrharta erecta</i> (Panic Veldtgrass), <i>Senecio madagascariensis</i> (Fireweed), <i>Cerastium glomeratum</i> , Mouse Ear Chickweed), <i>Briza major</i> (Quaking Grass), <i>Aira caryophyllea</i> (Silvery Hairgrass), <i>Vulpia bromoides</i> (Squirrel Tail Fescue), <i>Lysimachia arvensis</i> (Scarlet Pimpernel), <i>Andropogon virginicus</i> (Whisky Grass), <i>Hypochoeris radicata</i> (Flat Weed) and <i>Facelis retusa</i> (Annual Trampweed).

5.2.6 Groundwater dependant ecosystems

Groundwater plays an integral role in sustaining a range of aquatic and terrestrial ecosystems including wetland, springs, rivers as well as a number of vegetation types.

The *NSW State Groundwater Dependent Ecosystems Policy* defines groundwater dependent ecosystems (GDEs) as ecosystems which have their species composition, and their natural ecological processes determined by groundwater (DLWC 2002). Ecosystems vary dramatically in the degree of dependency of groundwater, from having no apparent dependence through to being entirely dependent on it (DLWC 2002).

Dependence (or interaction) of the vegetation communities identified within the proposal site on groundwater was determined by searching the Atlas of GDEs (BOM 2020b). This Atlas predicts the occurrence of groundwater dependent ecosystems and ecosystems that potentially use groundwater. It shows ecosystems that interact with the subsurface expression of groundwater (including vegetation ecosystems) or the surface expression of groundwater (such as rivers and wetlands). The Atlas also shows the likelihood that landscapes are accessing water in addition to rainfall, such as soil water, surface water or groundwater. Native vegetation within the proposal site is mapped as vegetation with moderate to high potential for being reliant on the subsurface presence of groundwater.

5.3 Fauna

5.3.1 Fauna species

A total of 131 fauna species (126 native and five exotic) were recorded during surveys that were completed both within the proposal site as well as the wider Hydro site. A full list of fauna species recorded during surveys is provided in Appendix B. The faunal assemblage comprises 87 bird species, ten frog species, 6 reptile species and 28 mammal species.

The majority of these species were recorded in larger patches of remnant vegetation within the wider Hydro site. The fauna species richness at the proposal site is likely to be considerable lower than for the wider Hydro site given the narrower range of habitat types and extent of exotic grassland.

5.3.2 Fauna habitats

5.3.2.1 Overview

The following habitat features, and resources were identified within the proposal site and indicate the potential presence of threatened species that contribute to the credit calculations:

- Mature canopy trees that provide nectar, fruits, leaves and foraging, roosting or nesting substrates, including supporting invertebrate prey diversity for insectivorous fauna.
- A number of small farm dams that would provide foraging and breeding habitat for a range of species including waterbirds, amphibians and some species of microbat. Common frogs recorded during surveys included Spotted Marsh Frog (*Limnodynastes tasmaniensis*), Common Toadlet (*Crinia signifera*), Eastern Dwarf Tree Frog (*Litoria fallax*), Striped Marsh Frog (*Limnodynastes peronii*) and Peron's Tree Frog (*Litoria peronii*).
- Large, hollow-bearing trees, including hollows in a range of size classes from <5 cm up to >20 cm diameter hollows.
- Leaf litter and fallen logs, which provide foraging and shelter substrate for small terrestrial animals.
- Drainage lines surrounded by vegetation.
- Culverts which provide known roost sites for microbats.
- Scattered patches of dense understorey shrubs providing refuge habitat for small terrestrial animals.
- Flowering myrtaceous trees and shrubs which provide foraging habitat for a range of arboreal mammals and birds.
- Approximately three quarters of the site (43 ha) consists of cleared land used for grazing that would provide foraging habitat for macropods, raptors and some species of microbats.

The proposal site or its surrounds does not contain any cliff lines, extensive rock outcrops, caves or disused mines.

The BAM assessment of habitat resources at the proposal site was completed with reference to the above observations. Additional discussion of habitat resources is provided below.

5.3.2.2 Habitat resources

The proposal site is comprised predominantly of cleared land dominated by exotic grasses with scattered paddock trees (photo 1). These areas have been subject to ongoing disturbance from cattle grazing. There are several small patches of disturbed native vegetation that are comprised of either remnant canopy trees or areas of young regrowth that form a mosaic across the site (photo 2). These areas provide very few fauna habitat resources and would be utilised by species common to disturbed and urban environments.



Photo 1 Exotic grassland



Photo 2 PCT 1600 - Melaleuca regrowth



Photo 3 Scattered paddock trees

- Small areas of remnant native vegetation occur along the southern edge of the site (photo 3). These patches of vegetation contain a range of habitat resources, including mature canopy trees, blossom-bearing trees, hollow-bearing trees, leaf litter and small amounts of fallen timber that would provide potential foraging and breeding habitat for a range of fauna, including threatened birds and bats such as *Pomatostomus temporalis* (Grey-crowned Babbler), *Daphoenositta chrysoptera* (Varied Sittella), *Glossopsitta pusilla* (Little Lorikeet), *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat), *Pteropus poliocephalus* (Grey-headed Flying-fox), *Myotis macropus* (Southern Myotis) and *Miniopterus australis* (Little Bent-wing Bat) as well as variety of more common fauna species. Trees within the site may also provide foraging and denning habitat for *Petaurus norfolkensis* (Squirrel Glider) which is known to occur in the area.
- A habitat assessment completed by species expert Dr Ross Crates, determined that the vegetation present within the proposal site does not constitute important habitat for the *Lathamus discolor* (Swift Parrot) or *Anthochaera phrygia* (Regent Honeyeater).
- Three trees with large hollows (> 20 cm in diameter) occur within the proposal site as well as a small number of trees with smaller hollows. Hollow bearing trees within the proposal site would provide potential habitat for several hollow dependant fauna such as possums, gliders, bats and a variety of birds. Two of the larger hollows would also provide potential habitat for forest owls although no evidence of occupation by owls of any of the hollows within the site was observed during surveys within the site. In addition to the hollows within the proposal site there are five hollows near to the site boundary (refer to Figure 6.1).

There is a small ephemeral first order drainage line within the proposal site and a second order creek that run adjacent to the site. These relatively undefined drainage lines contain very few aquatic habitat resources although may provide corridors for the movement of frogs and some smaller aquatic species after large rainfall events. The second order stream has been dammed to the west of Cessnock Road and drains to the west under the rail corridor and into Wentworth Swamp.

Wet grassy depressions and areas with impeded drainage may also provide breeding habitat for range common frogs after rain. There are three farm dams within the proposal site (photo 4). These waterbodies are fringed with aquatic vegetation including *Juncus usitatus* and *Eleocharis sphacelata*. Other aquatic species within these dams include *Azolla finiculoides* and *Cycnogeton procerum* (Water Ribbons) and *Ludwigia peploides* (Water Primrose). Assessment of these waterbodies recorded large populations of the introduced pest species *Gambusia holbrooki* (Mosquito Fish) which may limit its value as habitat for native frogs and other wetland and aquatic species.

These farm dams would provide foraging and sheltering habitat for common frogs, reptiles and waterbird such as the *Limnodynastes peronii* (Striped Marsh Frog), *Limnodynastes tasmaniensis* (Spotted Marsh Frog), *Crinia signifera* (Common Eastern Froglet), *Eulamprus quoyi* (Eastern Water Skink) and *Chelodina longicollis* (Eastern Snake-necked Turtle) which were recorded during assessments.



Photo 4 PCT 1591 – Grey Gum –Rough-braked Apple shrubby open forest



Photo 5 Farm Dam in south-east of site



Photo 6 *Culverts adjacent to proposal site*

6. Conservation significance

6.1 Identification of threatened species under the BAM

6.1.1 Identifying threatened species for assessment

The BAM calculator automatically generates a list of threatened species potential ecosystem or species credits entities (i.e. 'predicted' and 'candidate' threatened species respectively) based on the IBRA subregion, percent native vegetation cover, patch size class and PCT data for the proposal site cross-referenced with the Threatened Biodiversity Database Collection (TBDC).

Additional species not generated by the BAM calculator can be added to the list to be assessed for ecosystem and/or species credits if the species are considered likely to occur within, or to use habitats within the proposal site (based on review of available ecology reports, environmental impact statements, scientific literature or detection on site during survey). For this reason, additional species identified through the desktop assessment (e.g. identified from database searches as occurring within, or having the potential to occur within 10 km of the Proposal site) were also considered for addition to the list of predicted and candidate species (refer to Appendix A). An assessment of the likelihood that additional species not predicted by the BAM calculator was undertaken. This assessment determined that it is unlikely that any additional threatened biota (not already predicted by the calculator) would occur and therefore no additional species were added to the list of species requiring targeted survey within the proposal site.

6.1.2 Refinement of list of threatened species for assessment

Once the list of potential predicted and candidate threatened species have been identified, this list can be further refined by undertaking an additional assessment of the habitat constraints or microhabitats within the proposal site.

Predicted threatened species can be removed from assessment for ecosystem credits if all of the habitat constraints described for the species in the TBDC are absent from the site, otherwise the species must be retained for assessment of ecosystem credits.

Candidate threatened species can be removed from assessment for species credits if:

- All of the habitat constraints described for the species in the TBDC are absent from the site
- Where habitat is determined to be significantly degraded
- Where vegetation is missing key structural elements or other microhabitat features

No targeted survey is required for species that are not confirmed candidate threatened species. For species that are confirmed, targeted seasonal survey is required to determine presence on site in order to assess species credits.

The following sections present the list of predicted and candidate species identified for the assessment of ecosystem and species credits. It also identifies and provides justifications for the exclusion of any threatened species from further assessment where applicable.

6.1.3 Predicted threatened species (ecosystem credit entities)

Based on the bioregional context for the assessment and the PCTs, patch size, vegetation cover and habitat resources present at the proposal site, the BAM calculator generates a list of threatened fauna species that are associated with native vegetation at the proposal site (i.e. potential 'predicted threatened species', or potential 'ecosystem credit entities'). The potential for these predicted threatened species to occur within the site were further refined based on the desktop assessment, habitat resources observed during field surveys and the knowledge and experience of the assessor.

The suite of 'confirmed' predicted threatened species associated with ecosystem credits required for the proposal site, and with relevant habitat resources present on the site, are listed in Table 6.1. For each confirmed predicted threatened species, the vegetation zone association is provided. Targeted surveys are not required under the BAM for these species as they are assumed to be present. It is noted that two of these species were recorded in the proposal site during surveys.

It should be noted that several of these species would only occur in the woodland form of the PCTs present at the proposal site and are only associated with ecosystem credits generated for impacts to woodland vegetation zones. Notably many threatened species of woodland birds would only occur in vegetation with canopy vegetation, as part of relatively extensive patch and/or with habitat resources such as abundant fallen woody debris (Table 6.1 for further detail and justification).

The sensitivity to gain class is based on the species life history characteristics and ecological information. It estimates the ability of a species to respond to improvements in habitat condition at an offset site.

In accordance with Step 2 of Section 5.2 of the BAM (DPIE 2020), the following predicted species that were generated by the BAM calculator are excluded from further assessment for ecosystem credits:

- Curlew Sandpiper (*Calidris ferruginea*) (foraging)
- Great Knot (*Calidris tenuirostris*) (foraging)
- Broad-billed Sandpiper (*Limicola falcinellus*) (foraging)
- Black-tailed Godwit (*Limosa limosa*) (foraging)
- Terek Sandpiper (*Xenus cinereus*)

Reasons for exclusion are provided in Table 6.1.

Additional threatened species that were considered for assessment for ecosystem credits based on known occurrences within the locality (particularly within 1 km of the proposal site) are not considered likely to occur within, or to utilise habitats within the proposal site (see likelihood of occurrence assessment, Appendix A).

Table 6.1 Predicted threatened species (ecosystem credit species)

Common name	Scientific name	Sensitivity class ¹	Associated PCT (s)	Confirmed predicted species	Reason for exclusion from predicted species list and /or additional comments
Magpie Goose	<i>Anseranas semipalmata</i>	Moderate	1736	Yes	-
Regent Honeyeater (foraging) ²	<i>Anthochaera phrygia</i>	High	1600	Yes	-
Australian Bittern	<i>Botaurus poiciloptilus</i>	Moderate	1736	Yes	-
Curlew Sandpiper (foraging)	<i>Calidris ferruginea</i>	High	1736	No	Not within an area mapped as important habitat by OEH
Great Knot (foraging)	<i>Calidris tenuirostris</i>	High	1736	No	Not within an area mapped as important habitat by OEH
Gang-gang Cockatoo (foraging) ²	<i>Callocephalon fimbriatum</i>	Moderate	1591,1600	Yes	-
Glossy Black-Cockatoo (foraging) ²	<i>Calyptorhynchus lathami</i>	High	1600	Yes	-
Speckled Warbler	<i>Chthonicola sagittata</i>	High	1591, 1600	Yes	-
Spotted Harrier	<i>Circus assimilis</i>	Moderate	1736	Yes	-

Common name	Scientific name	Sensitivity class ¹	Associated PCT (s)	Confirmed predicted species	Reason for exclusion from predicted species list and /or additional comments
Brown Treecreeper (eastern subspecies)	<i>Climacteris picumnus victoriae</i>	High	1591, 1600	Yes	-
Varied Sittella	<i>Daphoenositta chrysoptera</i>	Moderate	1591, 1600	Yes	Recorded in the proposal site
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	High	1591, 1600	Yes	-
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	Moderate	1736	Yes	-
White-fronted Chat	<i>Epthianura albifrons</i>	Moderate	1736	Yes	-
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	High	1600	Yes	-
Little Lorikeet	<i>Glossopsitta pusilla</i>	High	1591, 1600	Yes	Recorded in the proposal site
Painted Honeyeater	<i>Grantiella picta</i>	Moderate	1600	Yes	-
White-bellied Sea-Eagle (foraging) ²	<i>Haliaeetus leucogaster</i>	High	1736, 1600	Yes	Recorded in the proposal site
Little Eagle (foraging) ²	<i>Hieraetus morphnoides</i>	Moderate	1591, 1736, 1600	Yes	-
Comb-crested Jacana	<i>Irediparra gallinacea</i>	Moderate	1736	Yes	
Black Bittern	<i>Ixobrychus flavicollis</i>	Moderate	1736	Yes	-
Swift Parrot (foraging) ²	<i>Lathamus discolor</i>	Moderate	1600	Yes	-
Broad-billed Sandpiper (foraging)	<i>Limicola falcinellus</i>	High	1736	No	Not within an area mapped as important habitat by OEH
Black-tailed Godwit (foraging)	<i>Limosa limosa</i>	High	1736	No	Not within an area mapped as important habitat by OEH
Square-tailed Kite (foraging) ²	<i>Lophoictinia isura</i>	Moderate	1600	Yes	-
Hooded Robin (south eastern form)	<i>Melanodryas cucullata cuculla</i>	Moderate	1591, 1600	Yes	-
Black-chinned Honeyeater (eastern subspecies)	<i>Melithreptus gularis gularis</i>	Moderate	1600	Yes	-
Eastern Coastal Free-tailed Bat	<i>Micronomus norfolkensis</i>	High	1600	Yes	Recorded in the proposal site
Little Bentwing-bat (foraging) ²	<i>Miniopterus australis</i>	High	1600	Yes	Recorded in the proposal site
Large Bent-winged Bat (foraging) ^{2,3}	<i>Miniopterus orianae oceanensis</i>	High	1600	Yes	Recorded in the proposal site
Turquoise Parrot	<i>Neophema pulchella</i>	High	1591, 1600	Yes	-

Common name	Scientific name	Sensitivity class ¹	Associated PCT (s)	Confirmed predicted species	Reason for exclusion from predicted species list and /or additional comments
Barking Owl (foraging) ²	<i>Ninox connivens</i>	High	1591, 1600	Yes	-
Powerful Owl (foraging) ²	<i>Ninox strenua</i>	High	1600	Yes	-
Blue-billed Duck	<i>Oxyura australis</i>	Moderate	1736	No	-
Eastern Osprey (foraging) ²	<i>Pandion cristatus</i>	Moderate	1736	Yes	-
Yellow-bellied Glider	<i>Petaurus australis</i>	High	1600	Yes	-
Scarlet Robin	<i>Petroica boodang</i>	Moderate	1591, 1600	Yes	-
Koala (foraging) ²	<i>Phascolarctos cinereus</i>	High	1600	Yes	-
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	Moderate	1600	Yes	Recorded in the proposal site
Grey-headed Flying-fox (foraging) ²	<i>Pteropus poliocephalus</i>	High	1600	Yes	Recorded in the proposal site
Australasian Painted Snipe	<i>Rostratula australis</i>	Moderate	1736	Yes	-
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	High	1600	Yes	-
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	High	1600	Yes	-
Diamond Firetail	<i>Stagonopleura guttata</i>	Moderate	1600	Yes	-
Freckled Duck	<i>Stictonetta naevosa</i>	Moderate	1736	Yes	-
Eastern Grass Owl (foraging)	<i>Tyto longimembris</i>	Moderate	1736	Yes	-
Masked Owl (foraging) ²	<i>Tyto novaehollandiae</i>	High	1600	Yes	-
Terek Sandpiper (foraging)	<i>Xenus cinereus</i>	High	1736	No	Not within an area mapped as important habitat by OEH

¹ Sensitivity to gain class – High = high sensitivity to potential gain, Moderate = moderate sensitivity to potential gain.

² These species are dual credits species (i.e. predicted ecosystem credit species based on the presence of foraging habitat as well as species credit species when breeding habitat occurs).

6.1.4 Candidate threatened species (species credit entities)

Threatened species that cannot be reliably predicted to occur at a site based on vegetation surrogates or landscape feature are identified by the TBDC as 'species credit species'. In some circumstances, the particular habitat components of species assessed for ecosystem credit species, such as the breeding habitat of a cave roosting bat or forest owls, are also assessed for species credits.

Searches of threatened species databases and review of previous ecological reports pertaining to the site were completed to determine in addition species to those generated by the BAM credit calculator that are known or predicted to occur in the locality (refer to likelihood of occurrence table in Appendix A). The likelihood of occurrence of these additional potential candidate threatened species were reviewed, giving consideration to the habitats available in the study area.

The full list of species credit species considered is presented in the threatened species assessment table in Section 3. A number of species could be reliably discounted as occurring within the proposal site area based on the habitat types present and/or the known distribution of the species. These species are not 'confirmed candidate species' for this assessment. Detailed justification for the conclusion is provided in Table 6.2 and/or the 'habitat/constraints' fields in the credit calculator.

Potential candidate threatened species that could occur in the study area based on the habitat resources observed during field surveys were confirmed as candidate threatened species. 'Confirmed' candidate threatened species require targeted survey in accordance with Section 5.3 of the BAM (DPIE 2020). The list of confirmed candidate threatened species is presented in Table 6.2; these species were subjected to targeted survey. Surveys were conducted in the appropriate season for all confirmed candidate threatened species and so the targeted survey results can be considered a reliable indicator of their presence or absence at the proposal site.

6.1.5 Threatened species associated with planted vegetation

An assessment of planted native vegetation was completed to determine the potential value of this vegetation as habitat for threatened fauna. This assessment included walking the length of the planted vegetation and searching for nests, hollows, scats and/or other signs of threatened species utilising the vegetation. The habitat assessment did not record any threatened species or find any evidence that any of the planted vegetation within the proposal site is being utilised by threatened species. It is possible that when in flower this vegetation may be providing a small amount of foraging habitat for Swift Parrot, Regent Honeyeater, Squirrel Glider and Grey Headed Flying-fox as well as other blossom feeding threatened bats and birds known or predicted to occur within the locality. The value of these habitat resources would be limited by its landscape context, as a narrow, isolated strip of vegetation adjacent to a road. Relative to the large amounts of alternative potential foraging habitat associated with remnant native vegetation in the locality it is highly unlikely that this small number of planted trees would provide important foraging habitat for any of these species.

No hollows, nests or other habitat features were observed within planted vegetation and given the location of this vegetation adjacent to a busy road there is a low probability that this vegetation would be used as breeding habitat for any threatened species.

Table 6.2 Confirmed candidate species credit species

Common name	Scientific name	Biodiversity risk rating	BioNet records in locality	Survey months	Survey completed	Recorded within or adjacent to proposal site
Bynoe's Wattle	<i>Acacia bynoeana</i>	High (2)	183	All year	Oct and Nov	No
Trailing Woodruff	<i>Asperula asthenes</i>	High (2)	0	Oct-Dec	Oct and Nov	No
Bush Stone Curlew	<i>Burhinus grallarius</i>	High (2)	0	All year	Nov	No
Netted Bottle Brush	<i>Callistemon linearifolius</i>	Moderate (1.5)	1059	Oct-Jan	Oct and Nov	No
Gang-gang Cockatoo (breeding)	<i>Callocephalon fimbriatum</i>	High (2)	0	Oct-Jan	Nov	No
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	High (2)	19	Apr- Aug	Aug	No
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	High (2)	0	Oct-Mar	Nov	No
Wallum Froglet	<i>Crinia tinnula</i>	Moderate (1.5)	0	All year	Feb and Nov	No
Leafless Tongue Orchid	<i>Cryptostylis hunteriana</i>	Moderate (1.5)	0	Nov-Jan	Nov	No
White-flowered Wax Plant	<i>Cynanchum elegans</i>	High (2)	0	All year	Oct and Nov	No
Pine Donkey Orchid	<i>Diuris tricolor</i>	Moderate (1.5)	0	Sep -Oct	Oct	No
Singleton Mallee	<i>Eucalyptus castrensis</i>	Very High (3)	0	All year	Oct and Nov	No
Slaty Red Gum	<i>Eucalyptus glaucina</i>	High (2)	80	All year	Oct and Nov	No
Parramatta Red Gum	<i>Eucalyptus parramattensis</i> subsp. <i>decadens</i>	High (2)	1701	All year	Oct and Nov	Yes
Pokolbin Mallee	<i>Eucalyptus pumila</i>	Very High (3)	0	All year	Oct and Nov	No
Small-flower Grevillea	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	High (2)	416	Aug-Nov	Oct and Nov	Yes
White-bellied Sea-Eagle (breeding)	<i>Haliaeetus leucogaster</i>	High (2)	25	Jul-Dec	Aug	No
Little Eagle (breeding)	<i>Haliaeetus morphnoides</i>	Moderate (1.5)	0	Aug-Oct	Aug	No
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	High (2)	0	Nov-Mar	Feb and Nov	No
Green and Golden Bell Frog	<i>Litoria aurea</i>	High (2)	852	Nov-Mar	Feb and Nov	No
Green-thighed Frog	<i>Litoria brevipalmata</i>	Moderate (1.5)	4385	Oct-Mar	Feb	No
Square-tailed Kite (Breeding)	<i>Lophoictinia isura</i>	Moderate (1.5)	6	Sept-Jan	Nov	No

Common name	Scientific name	Biodiversity risk rating	BioNet records in locality	Survey months	Survey completed	Recorded within or adjacent to proposal site
<i>Maundia triglochinos</i>	<i>Maundia triglochinos</i>	High (2)	0	Nov-March	Nov	No
Biconvex Paperback	<i>Melaleuca biconvexa</i>	Moderate (1.5)	0	All year	Oct and Nov	No
Little Bent-wing Bat (Breeding)	<i>Miniopterus australis</i>	Very High (3)	0	Dec-Feb	Feb	No
Large Bent-wing Bat (Breeding)	<i>Miniopterus orianae oceanensis</i>	Very High (3)	0	Dec-Feb	Feb	No
Large-leafed monotaxis	<i>Monotaxis macrophylla</i>	High (2)	0	Aug-Feb	Oct and Nov	N
Southern Myotis	<i>Myotis macropus</i>	High (2)	44	Oct-Mar	Nov and Feb	Yes
Barking Owl (breeding)	<i>Ninox connivens</i>	High (2)	42	May-Dec	Aug	No
Powerful Owl (breeding)	<i>Ninox strenua</i>	High (2)	36	May-Aug	Aug	No
<i>Ozothamnus tessalatus</i>	<i>Ozothamnus tessalatus</i>	Moderate (1.5)	0	Sep-Oct	Oct	No
Tall Knotweed	<i>Persicaria elatior</i>	High (2)	0	Dec-May	Dec	No
Greater Glider	<i>Petauroides volans</i>	High (2)	0	All year	Feb	No
Squirrel Glider	<i>Petaurus norfolcensis</i>	High (2)	74	All year	Feb	Yes ¹
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	High (2)	7	Dec-Jun	Feb	No
Common Planigale	<i>Planigale maculata</i>	High (2)	0	All year	Nov	No
Scant Pomaderris	<i>Pomaderris queenslandica</i>	High (2)	0	All year	Oct and Nov	No
Singleton Mint Bush	<i>Prostanthera cinolifera</i>	High (2)	0	Sept-Oct	Oct and Nov	No
Pterostylis chaetophora	<i>Pterostylis chaetophora</i>	High (2)	0	Sept-Nov	Oct and Nov	No
Heath Wrinklewort	<i>Rutidosia heterogama</i>	High (2)	957	All year	Oct and Nov	No
Black-eyed Susan	<i>Tetratea juncea</i>	High (2)	0	Sept-Oct	Oct	No
Austral Toadflax	<i>Thesium australe</i>	Moderate (1.5)	0	Nov-Feb	Nov	No
Masked Owl (breeding)	<i>Tyto novaehollandiae</i>	High (2)	21	May-Aug	Aug	No
Mahony's Toadlet	<i>Uperoleia mahonyi</i>	High (2)	0	Oct-Mar	Feb and Nov	No
<i>Zannichellia palustris</i>	<i>Zannichellia palustris</i>	High (2)	0	Oct-Jan	Nov	No

¹ Recorded during previous surveys completed adjacent to the proposal site (ELA 2015).

A number of species could be reliably discounted as occurring within the study area based on the habitat types present and/or the known distribution of the species. A number of dual credit fauna species have foraging habitat present but either no potential breeding habitat was identified during the field surveys, or the species does not breed in the area. These species are not 'confirmed candidate threatened species' for the purposes of this assessment and do not require further assessment. Detailed justification for the conclusion is provided in Table 6.3 and/or the 'habitat/constraints' fields in the credit calculator.

Table 6.3 Potential candidate species not requiring survey

Common name	Scientific name	Justification
Regent Honeyeater (Breeding)	<i>Anthochaera phrygia</i>	Proposal site within an area of important habitat as mapped by BCS therefore species is assumed present
Pink-tailed Legless Lizard	<i>Aprasia parapulchella</i>	Proposal site does not contain rocky areas and/or within 50 m of rocky areas
Curlew Sandpiper (Breeding)	<i>Calidris ferruginea</i>	Proposal site not within an area of important habitat as mapped by BCS
Great Knot	<i>Calidris tenuirostris</i>	Proposal site not within 5 km of the coast and tidal influenced water bodies (geographic restrictions)
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	Not within two kilometres of rocky areas containing caves, overhands, escarpments, outcrops or crevices or within two kilometers of old mines or tunnels
Rough Doubletail	<i>Diuris praecox</i>	Not within the Newcastle LGA (geographic limitation)
Swift Parrot (Breeding)	<i>Lathamus discolor</i>	Proposal site not within an area of important habitat as mapped by BCS
Broad-billed Sandpiper (Breeding)	<i>Limicola falcinellus</i>	Proposal site not within an area of important habitat as mapped by BCS
Black-tailed Godwit (Breeding)	<i>Limosa limosa</i>	Proposal site not within an area of important habitat as mapped by BCS
North Rothbury Persoonia	<i>Persoonia pauciflora</i>	Proposal site not within 10 km of North Rothbury (geographic limitation)
Koala (Breeding)	<i>Phascolarctos cinereus</i>	No areas identified via survey as important habitat
Terek Sandpiper (Breeding)	<i>Xenus cinereus</i>	Proposal site not within an area of important habitat as mapped by BCS

6.2 Threatened species survey results

6.2.1 Threatened flora

No threatened species were recorded during targeted survey completed within the proposal site that were undertaken in October and November 2019, April 2020, October 2021, November 2021 and December 2021, which according to the BAM, is a suitable time of the year to identify all of the candidate threatened flora species identified by the BAM-C as having potential to occur.

Although the proposal site contains a small amount of potential habitat for several flora species, based on the survey effort as well as the types and condition of habitats present within the proposal site it is unlikely that any threatened flora species would occur.

6.2.2 Threatened fauna

6.2.2.1 Ecosystem credit species

Five threatened fauna species classified as ecosystem credit species were recorded within the proposal site. These are:

- Grey-crowned Babbler (*Pomatostomus temporalis*) (nest recorded in the proposal site)
- Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*)
- Little Bent-wing Bat (*Miniopterus australis*)
- Large Bent-wing Bat (probable) (*Miniopterus orianae oceanensis*)

All these species are listed as vulnerable under the BC Act. The Grey-headed Flying-fox is also listed as a vulnerable species under the EPBC Act.

- There is potential foraging habitat for each of these species within the 112.97 ha of native vegetation that occurs within the subject area. A Grey-crowned Babbler nest was recorded in the proposal site and there are potential roosts for the Eastern Coastal Free-tailed Bat at the proposal site.

6.2.2.2 Dual credit species

The Grey-headed Flying-fox (*Pteropus poliocephalus*), the Little Bent-wing Bat (*Miniopterus australis*) and the Large Bent-wing Bat (*Miniopterus orianae oceanensis*) are listed in the TBDC as dual credit species meaning that they require offsets through ecosystem credit species for impacts to foraging habitat and through species credits where breeding habitat is impacted. For the purposes of this assessment all three of these species are considered to be ecosystem credit entities only as:

- There are no Grey-headed Flying-fox roost camps present within the proposal site. Occupied roost camps with breeding individuals are conspicuous features and would have been readily detected if present.
- Ultrasonic recordings of bat calls taken during targeted surveys completed in November 2019 and February 2020 identified 58 definite calls of the Little Bent-wing Bat and nine 'probable' calls of the Large Bent-wing Bat. There is potential roosting habitat for these species within a large culvert that runs under the train line located in the south-western edge of the site. This culvert was inspected for roosting bats in November 2019 and November 2021 and although several Southern Myotis were recorded within the structure Large Bent-wing Bat or Little Bent-wing Bats were not observed utilising the culvert. Little Bent-wing and Large Bent-wing bats are known to breed in a small number of large limestone maternity caves of which there are none within 5 km of the proposal site. As such breeding habitat for these species would not be impacted and neither require offsetting through species credits.

6.2.2.3 Species credit species

One species credit type threatened fauna species as identified within the proposal site during field surveys. Approximately ten Southern Myotis individuals were observed roosting within a culvert that runs under an active train track adjacent to the site. This culvert is located next to a large dam in the north east of the proposal site (refer Figure 6.1).

In addition to the Southern Myotis, Squirrel Gliders (*Petaurus norfolkensis*) have been previously recorded within and adjacent to the proposal site (DPIE 2020b, ELA 2016). Although this species was not recorded during targeted surveys completed for this BDAR that were undertaken in February 2020, based on the known previous records and presence of suitable habitat it is assumed that this species may utilise the proposal site.

There is broadly suitable habitat for the remaining candidate threatened fauna species listed in Table 6.2 within the proposal site. However as none were recorded during multiple targeted field surveys undertaken at a suitable time of year to detect these species (including spotlighting, call play back, Anabat detector, camera trap, pit fall traps, harp traps and Elliott trap surveys completed within and adjacent to the proposal site as well as previous comprehensive surveys within the wider Hydro site (ELA 2016, Cenwest 2004), these candidate threatened fauna species can be reliably discounted as occurring at the proposal site. As such no species credits are required to be calculated for the remaining candidate threatened fauna species which were not detected at the proposal site.

Species polygons have been mapped for all species credit species recorded within the proposal site. The method for calculating species polygons is outlined in Section 9.1.1.2.

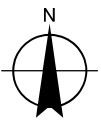
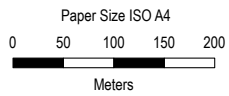
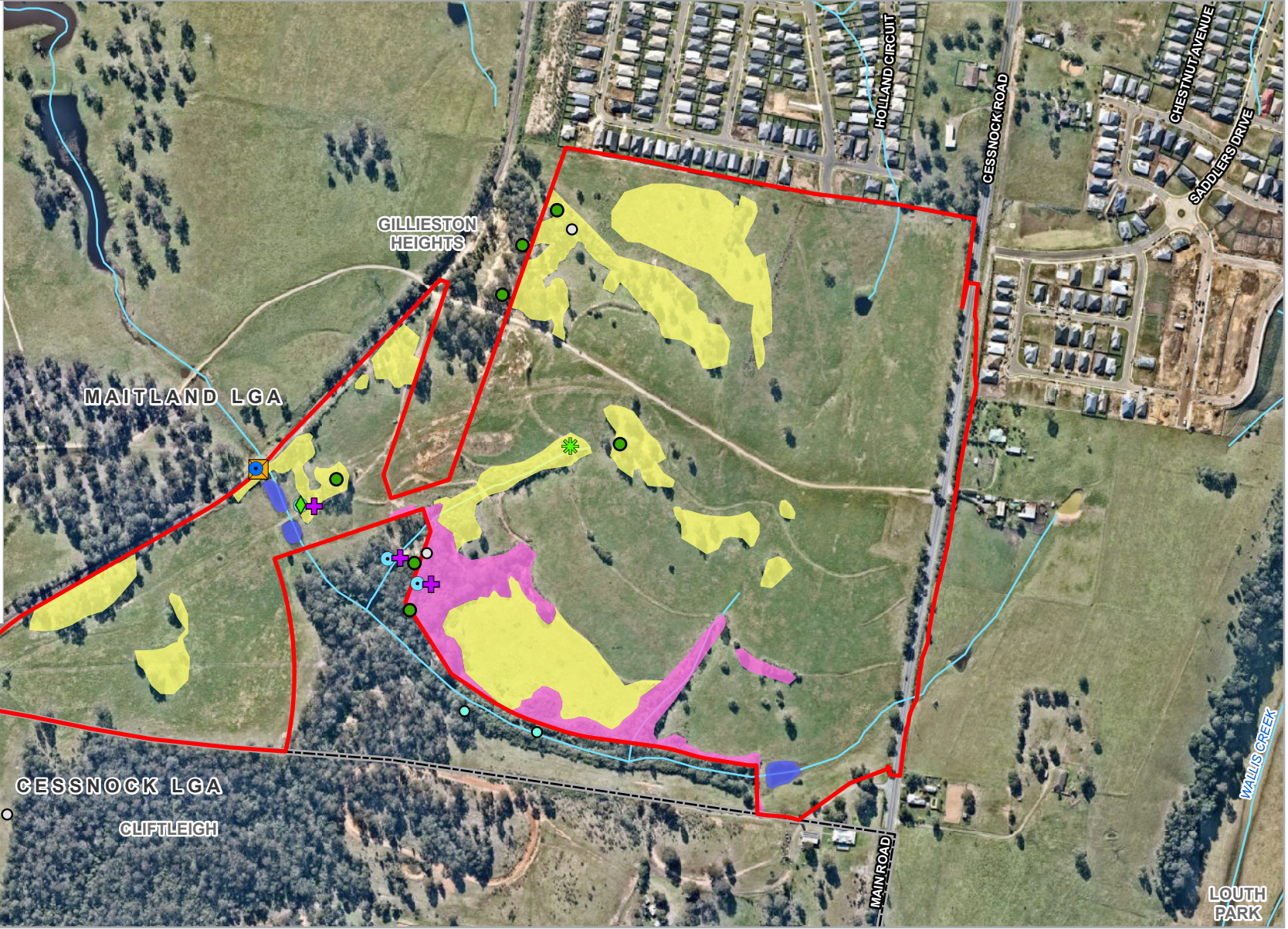
6.2.3 Threatened ecological communities

Three endangered ecological communities (EECs) listed under the BC Act occur within the proposal site (refer to Figure 6.1):

- Vegetation mapped within the site as PCT 1591 comprises part of an occurrence of Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC.
- Vegetation mapped within the site as PCT 1600 in 'underscrubbed' or 'regrowth' condition comprises part of an occurrence of Lower Hunter Spotted Gum –Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC.

Vegetation mapped within the site as PCT 1736 comprises part of an occurrence of Freshwater Wetlands in Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC. As described in Section 5.2 above, exotic grassland at the proposal site has been assessed as PCT 1600 in 'exotic' condition to allow the calculation of a vegetation integrity score. However, this area does not comprise native vegetation and is not part of the local occurrence of the Lower Hunter Spotted Gum –Ironbark Forest EEC.

- Legend**
- Proposal site
 - LGA boundary
 - Watercourse
- Threatened Fauna Recorded**
- + Eastern coastal free-tailed bat (*Micronomus norfolkensis*)
 - Grey crowned babbler (*Pomatostomus temporalis*)
 - Grey-headed flying fox (*Pteropus poliocephalus*)
 - ◆ Large Bent-winged Bat (*Miniopterus orianae oceanensis*)
 - Little bent-wing bat (*Miniopterus australis*)
 - Southern myotis (*Myotis macropus*)
 - ✱ Grey crowned babbler nest
- Endangered Ecological Community**
- Freshwater Wetland on coastal floodplains
 - Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC
 - Lower Hunter Spotted Gum –Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC
- Fauna habitat**
- Culvert
- Hollow Bearing Trees**
- >20 cm



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



Loxford Project Group Pty Ltd
 Regrowth Kurri Kurri – Maitland LGA
 Biodiversity Development Assessment Report

Project No. 12527690
 Revision No. 0
 Date 01/02/2022

**Threatened biota and
 habitat resources**

Figure 6-1

7. Measures to avoid and minimise impacts

The proposed development site rezoning masterplan footprint has undergone a number of revisions through the proposal planning and design process that have looked at how impacts to areas of higher conservation value could be avoided as far as is practical. Various iterations of the masterplan footprint have been developed and amended in response to detailed understanding of the site's biodiversity values and offsets requirements. The intention through the sites rezoning process and development of the preliminary masterplan has been to avoid and minimise impacts on high biodiversity values within the site.

7.1 Avoidance measures

7.1.1 Master planning

The proposal site assessed in this BDAR forms part of the former Hydro land parcel. Approximately 300 ha of this has been proposed for development (approximately 57 ha included in this BDAR and 243 ha located within the Cessnock LGA that is proposed for biocertification). A large portion of the remaining Hydro land (770 ha) will be conserved as a stewardship site that will be used to generate credits to offset the impacts of the proposed development on the site with the remaining area land set aside for continued agricultural use.

In 2014, an initial assessment was completed that assessed and evaluated a range of identifiable constraints within the entire 2000 ha Hydro land parcel. This assessment process produced a preliminary masterplan for the site. The intention of the preliminary masterplan was to be able to identify broad characteristics and potential land uses, which was then subject to more detailed study and refinement. In general, the characteristics that were considered when developing the preliminary masterplan for the site were developable land, conservation land and flood prone/rural land. Regarding the native vegetation on site, the assessment considered and put forward the conservation of areas of highest biodiversity value, which are located to the north-west of the site and focused areas for development predominantly in previously disturbed areas and isolated patches of low and/or poor condition vegetation or at the edges of larger patches of existing vegetation.

Following the design of the preliminary masterplan, a Biodiversity Certification Assessment (BCA) of the site was prepared in accordance with the provisions in the now repealed *Threatened Species Conservation Act 1995* (ELA 2016). As part of this assessment an initial desktop assessment using the BioBanking Assessment Methodology (BBAM) calculator was undertaken to determine if the quantum and type of offsets proposed would satisfy the credits required by the development footprint. It became clear that at this early stage that the proposed credits generated in the conservation area was not sufficient to offset the development footprint identified in the Preliminary Masterplan. The results of this assessment indicated there would be a considerable 'shortfall' in the credits required to offset the development impacts from the proposed onsite conservation area. Based on recommendations in the BCA (ELA 2016), Further amendments were then made to the masterplan to further avoid impacts on biodiversity values, with the footprint of the development lands reduced from 1229 ha to 657 ha, resulting in the avoidance of impacts to 570 ha of EEC. Initial calculations completed as part of the BCA indicated at that time the credit balance between development and conservation land was in positive, with surplus ecosystem credits likely to be generated.

Further refinement and update of the rezoning masterplan was undertaken in 2019 in order to further reduce impacts to areas of high biodiversity value. This resulted in the area of development land being further reduced to 301 ha. These amendments resulted in the further avoidance of approximately 45 ha of Kurri Kurri Sand Swamp Woodland EEC located around the proposed containment cell and areas to the north-east of the smelter site.

Within the area assessed for this BDAR the design process has sort to avoid impacts to the highest quality vegetation along the drainage line to the south and restrict impacts to areas of lower quality vegetation (areas with lowest integrity scores) that have been previously disturbed.

In 2021 an additional area was added to the proposal site in response to requirements to upgrade the intersection between the site and Cessnock Road. Clearing of vegetation in this area will be unavoidable due to the need to widen Cessnock Road.

7.1.2 Biodiversity Stewardship Site

Approximately 770 ha of the Hydro Lands will be secured within a biodiversity stewardship site (BSS). Credits generated within the BSS would be retired to enable the development to commence. The proposed BSS will be protected and managed through the establishment of a Biodiversity Stewardship Agreement (BSA) under the BC Act. The biodiversity credits generated by the BSS would be used to meet the credit requirements for development of the proposal site as far as possible. Additional credits may be needed to meet the credit requirements of the development in accordance with the BAM. Any shortfall in credits would be sourced from either alternative BSS site/s, purchased through the “open market” or via a payment into the BCF in accordance with the trading rules associated with the BOS and the requirements for offsetting impacts to MNES under the Amending Agreement, as applicable.

The proposed BSS broadly occurs on the large parcels of Hydro land that occur to the north and west of the proposal site, but also includes parts of the vegetated riparian corridors along Swamp Creek. PCTs within the BSS are broadly reflective of the vegetation community's that occur in the proposal site.

The proposed BSS contains areas of high biodiversity values, including a large population of Parramatta Red Gum as well as Small Flowered Grevillia and Netted Bottlebrush. The site also provides known habitat for the Squirrel Glider, Southern Myotis as well as a range of other threatened fauna. The BSS also contains areas of mapped important habitat for the Reagent Honeyeater and Swift Parrot.

The proposed stewardship site would be assessed in accordance with the BAM and a separate Biodiversity Stewardship Site Assessment Report (BSSAR) is currently being prepared that would describe the ecosystem and species credits generated at the site. A Site Management Plan (SMP) is also being drafted that describes the restoration and management actions required to be undertaken at the site to improve biodiversity values. The SMP would be accompanied by a Total Fund Deposit (TFD) amount which would determine the funds that would be required to implement the restoration and management program in perpetuity. Once these documents are finalised an application for a BSA would then be lodged with the Biodiversity Conservation Trust (BCT).

7.2 Mitigation measures

7.2.1 Construction phase

7.2.1.1 Construction Environmental Management Plan

A construction environmental management plan (CEMP) would be required for the construction phase of the proposal. In the event of staged construction, CEMPs would be prepared prior to the issue of construction certificates for each stage.

The CEMPs would specify environmental safeguards for the protection of biodiversity values on neighbouring properties and waterways in accordance with relevant Government policy and guidelines and development conditions. Mitigation measures will typically include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific mitigation measures and procedures for the management of flora and fauna.

The mitigation and management measures outlined in Table 7.1 would be expected to be implemented as part of the CEMPs for future development at the proposal site in order to minimise the potential impacts of the proposal on biodiversity values.

Table 7.1 Mitigation measures (construction)

Impact	Mitigation	Timing	Responsibility
General	All workers are to be provided with an environmental induction prior to starting work on site. This will include information on the ecological values of the site, protection measures to be implemented to protect biodiversity and penalties for breaches.	Prior to clearing/construction works.	Construction contractor
	A flora and fauna management sub-plan will be prepared as part of the CEMP, incorporating recommendations below, and expanding on specific details where necessary.	Prior to clearing/construction works.	Construction contractor
	A vegetation management plan will be prepared to mitigate potential indirect impacts on adjoining vegetation located along the drainage line to the south of the site. This plan would be submitted to Council for assessment and approval.	Prior to clearing/construction works	DA applicant
	Measures to suppress dust will be implemented during clearing and construction.	Throughout clearing and construction phases	Construction contractor
	Disturbance of vegetation will be limited to the minimum necessary to undertake the proposal.	Prior to works commencing	Construction contractor
	Any lighting used during construction should be appropriately positioned to direct light away from adjoining bushland areas and to limit the impacts of light spill on native fauna habitats	Prior to works commencing	Construction contractor
Vegetation clearing	Prior to the commencement of any work in or adjoining areas of native vegetation (including planted vegetation), a survey would be carried out to mark the construction impact boundary. The perimeter of this area will be fenced using high visibility fencing and clearly marked as the limits of clearing. All vegetation outside this fence line will be clearly delineated as an exclusion zone to avoid unnecessary vegetation and habitat removal. Fencing and signage must be maintained for the duration of the construction period. Fencing should be designed to allow fauna to exit the site during clearing activities.	Prior to clearing / Daily inspections of exclusion zones during works in area.	Construction contractor and qualified ecologist
	For individual trees being retained fencing will protect the entire Tree Protection Zone (i.e. 10 times the diameter of the trunk at breast height).	Prior to clearing/ construction works	Construction contractor
	Stockpiles of fill or vegetation will be placed within existing cleared areas (and not within areas of adjoining native vegetation).	Prior to clearing/ construction works	Construction contractor
	Sediment fences will be installed to prevent transfer of sediments into adjacent vegetation and waterways.	Prior to clearing/ construction works	Construction contractor
Introduction of Weeds and Pathogens	A weed and pest species management sub-plan will be developed and implemented as part of project CEMP to manage weeds and pathogens during the construction and operational phase of the proposal. This sub-plan would include but not be limited to the following:	Prior to clearing/ construction works	Construction contractor

Impact	Mitigation	Timing	Responsibility
	Provisions for identify the location and extent of any priority and/or high threat environmental weeds within the site	Prior to clearing/ construction works	Construction contractor and qualified ecologist (or experienced bush regenerator)
	Protocols for the management of noxious and environmental weeds	Prior to clearing/ construction works	Construction contractor and qualified ecologist (or experienced bush regenerator)
	Protocols to prevent the introduction and/or spread of pathogens and weeds	Prior to any plant or machinery being brought onto the site	Construction contractor and qualified ecologist (or experienced bush regenerator)
	Protocols to limit the spread of weed propagules downstream of proposal site.	Prior to clearing/ throughout construction works	Construction contractor and qualified ecologist (or experienced bush regenerator)
Removal of fauna habitat	<p>The flora and fauna management sub-plan will be developed and implemented to minimise impacts to fauna during clearing works. This plan will include but not be limited to:</p> <ul style="list-style-type: none"> – Provisions for pre-clearing surveys to identify significant habitat features such as hollow bearing trees, logs and nests – Protocols for the removal of hollow bearing trees and other identified significant habitat features – Protocols to prevent introduction or spread of chytrid fungus in accordance with Office of Environment and Heritage Hygiene protocol for the control of disease in frogs (DECCW 2008c) – Protocols for the salvage and relocation of fallen logs and hollows (where appropriate) – Provisions to have suitably qualified ecologist present during vegetation clearing – Protocols for the appropriate handling, capture and release of fauna – Provisions for stages vegetation removal to increase the opportunity for fauna to vacate the site and disperse into areas of adjoining habitat to evade injury – Protocols for post clearing reporting 	Prior to clearing	Qualified Ecologist / Construction contractor
Indirect impacts to Southern Myotis roost	Mitigation measures will be incorporated into the flora and fauna management sub-plan to minimise disturbance to known Southern Myotis roost, within culvert located in south-west of the site. This should include appropriate to mitigate potential impacts associated with construction noise, vibration and lighting.	Prior to construction commencing	Construction contractor

Impact	Mitigation	Timing	Responsibility
Water Quality and aquatic habitats	Erosion and sediment control plans will be prepared in accordance with Volume 2D of Managing Urban Stormwater: Soils and Construction (DECC, 2008d). The erosion and sediment control plans would be established prior to the commencement of construction and be updated and managed throughout as relevant to the activities during the construction phase.	Prior to construction commencing	Construction contractor
	Erosion and sediment control controls will be regularly inspected, particularly following rainfall events, to ensure their ongoing functionality.	Weekly during construction phase or after any significant rainfall event	Construction contractor
	Stabilised surfaces will be reinstated as quickly as practicable after construction.	Immediately following clearing	Construction contractor
	Appropriate speed limits will be enforced to limit dust generation and minimise chances of fauna mortality through vehicle strike.	During construction	Construction contractor
	All stockpiled material will be stored in bunded areas and kept away from waterways to avoid sediment or contaminants entering the waterway.	During construction	Construction contractor
	Spill kits will be made available and carried in construction vehicles. A management protocol for accidental spills would be put in place.	During construction	Construction contractor

7.2.2 Operational phase

The occupation of the proposal site and operation of residential land uses has the potential for indirect impacts on biodiversity values in adjoining retained vegetation along the drainage line located in the south of the site and. There will be a need to explore different mechanisms to appropriately manage potential impacts across the interface between the proposal site and retained habitat, including plans for ongoing vegetation management within areas of retained vegetation.

Environmental Management Plans (EMPs) including a Vegetation Management Plan (VMP) and a Wildlife Management Plan (WMP) would be required for the operational life of the proposal and would be prepared prior to the issue of the subdivision certificates. Future plans would include, as a minimum, measures to appropriately manage matters such as stormwater infrastructure, open space and APZs as well as industry-standard measures for the management of soil, surface water, weeds and pollutants. The proposed mitigation measures would include environmental safeguards for protection of the retained areas, neighbouring properties and waterways in accordance with relevant policy documentation and Government guidelines.

In order to appropriately address the potential impacts of the proposal on biodiversity as discussed in Section 8, the mitigation and management measures outlined in Table 7.2 would be implemented as part of the EMP for the site. Table 7.2 has been prepared with reference to Section 7.13 of the BAM and includes an assessment of the risk of these mitigation measures not succeeding and adaptive management responses to address any consequences.

Further detail regarding environmental management and mitigation measures and details of monitoring required to help identify any shortfalls in the implementation of the proposed mitigation measures and appropriate management responses would be further developed once the subdivision layout and specific uses throughout the proposal site have been confirmed.

Table 7.2 Environmental management measures (operation)

Impact	Mitigation	Timing	Responsibility	Risk	Adaptive management response
Proposal site management	All property owners / tenants are to be provided with an environmental induction prior to occupying site. This would include information on the biodiversity values of the site and surrounding area, protection measures to be implemented to protect biodiversity and any penalties for breaches. In particular, site occupiers would be made aware of the biodiversity value along adjoining drainage line	Prior to occupying the site.	Contractor	Nil	N/A
Proposal site management	Animal and speed limit signposting to raise resident, visitor and driver awareness and enforce appropriate speed limits along the proposed access road to reduce the likelihood of vehicle strike and mortality of native fauna.	In perpetuity	Land owner	Failure to comply with speed limits resulting in fauna mortality	Construction of speed humps or other physical speed deterrents
Edge effects	APZs will be managed to act as a buffer to minimise edge effects potentially including weed, light and erosion impacts on adjacent areas of retained vegetation.	In perpetuity	Land owners	Increased extent or cover of exotic plants in APZs threatening adjoining areas of native vegetation.	Periodic monitoring and adaption and/or intensification of bush regeneration activities to reduce weed cover, restore native vegetation cover etc as required.
	Control of priority weeds within the proposal site to prevent the spread of propagules into adjacent areas of native vegetation.	In perpetuity	Land owner/s	Increased extent or cover of priority weeds	Periodic monitoring and adaption and/or intensification of weed control activities
	Street lighting and security lighting to be designed to direct light away from adjoining bushland areas and to limit the impacts of light spill on native fauna habitats. Lighting design must identify and adopt technologies that are least likely to adversely affect fauna use of habitat through impacts such as disruption of microbat foraging. This should consider light colour and intensity, provision of light shields and other measures as appropriate to the position of lighting relative to off site habitats.	In perpetuity	Land owner	Disturbance of fauna habitat adjacent to proposal site	Redesign lighting to minimise impacts to adjacent habitat

Impact	Mitigation	Timing	Responsibility	Risk	Adaptive management response
Water Quality and aquatic habitat	Water Sensitive Urban Design infrastructure, perimeter roads and setbacks would be included in APZ. Water Sensitive Urban Design infrastructure should be appropriately maintained. This includes Gross Water Pollution Traps, ponds and bioretention basins.	In perpetuity	Landowner/Council	Poorly maintained infrastructure may result in downstream impacts to Swamp Creek	Water Sensitive Urban Design infrastructure to be repaired or upgraded
	Erosion and sediment control would be regularly inspected, particularly following rainfall events, to ensure their ongoing functionality.	After any significant rainfall event	Landowner/Council	Failure of erosion and sediment controls may result in downstream impacts to ephemeral drainage line and Wentworth swamp	Erosion and sediment controls showing signs of deterioration to be repaired or replaced as required.

8. Impact assessment

8.1 Direct impacts

8.1.1 Removal or modification of vegetation

The proposal would result in the clearing of 12.98 ha of native vegetation and a further 45.43 ha of predominantly exotic grassland, planted vegetation and/or cleared land as summarised in Table 8.1. Native vegetation that would be impacted includes 10.23 ha of poor condition vegetation (underscrubbed tree, disturbed wetland vegetation or regrowth to 1 metre tall) and 2.74 ha of intact native vegetation.

Table 8.1 Extent of vegetation removal in the proposal site

Vegetation zone	PCT ID	Condition	Area in proposal site (ha)	Indirect impacts (ha within 10m buffer of proposal site)	BC Act Status	EPBC Act Status
1 Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (1600_underscrubbed)	1600	Underscrubbed	5.49	0.21	Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC	Not listed
2 Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (1600_Regrowth)	1600	Regrowth	4.49	0	Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC	Not listed
3 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (1591_Intact)	1591	Intact	2.74	0.74	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	Not listed
4- Water Couch -Tall Spike Rush Freshwater Wetland of the Central Coast and Lower Hunter (1736_Disturbed)	1736	Disturbed	0.25	0	Freshwater Wetlands in Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC	Not listed
5 - Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (1600_Exotic)	1600	Exotic	43.28	N/A	Not listed	N/A
Cleared land	N/A	Poor	1.19	N/A	Not listed	N/A
Planted vegetation	N/A	Poor	0.96	N/A	Not listed	N/A

8.1.2 Removal of habitat and habitat resources

The proposal would involve the clearing of approximately 2.74 ha of woodland, 4.49 ha of regrowth and 5.50 ha of scattered paddock trees over a highly modified understory. Approximately 0.96 ha of planted trees and shrubs would also be removed.

Clearing of the site would include the removal of mature trees and hollow-bearing trees. Mature trees have value for fauna populations as sources of foraging resources such as leaves, nectar, sap or seed and substrate for invertebrate prey.

The proposal would remove three hollow bearing trees. Hollows are a limited resource, relied on by many native fauna for shelter and breeding. Galahs and Eastern Rosellas were observed during surveys at hollows in the wider study area. The removal of these hollows would reduce the extent of potential breeding habitat for native species in the area and could potentially remove breeding habitat for threatened species such as the Little Lorikeet, which is known to occur nearby and has the potential to breed in the locality.

Three existing farm dams would also be impacted by the proposal. Two small dams located in the east of the site would be drained and filled and a larger dam in the south west of the site would be upgraded and utilised as a stormwater retention basin. These waterbodies are fringed by a small amount of native vegetation and would provide habitat for a range of common frogs and waterbirds.

The proposal would also remove exotic grassland which would provide some habitat for some generalist fauna species typical of disturbed grassland environments such as Kangaroos, common birds and reptile species, including the Australian Magpie, Little Raven, Indian Myna and Grass Skink.

In the context of the areas of remaining native woodland and wetland vegetation surrounding the proposal site, particularly in the large area proposed to be retained within the Loxford stewardship site, the proposal would remove a very small proportion of available habitat resources for local populations of native fauna. It is unlikely that the proposal would substantially impact on the available habitat resources for local fauna in the locality.

8.1.3 Fauna injury and mortality

As described above, the proposal site provides a variety of habitat resources for native fauna species, including foraging, roosting and shelter resources for threatened species as well as common native fauna. Groundcover vegetation, leaf litter and woody debris would provide shelter and foraging substrate for reptiles, frogs and invertebrates. Construction may result in the injury or mortality of some individuals of these less mobile fauna species and other small terrestrial fauna that may be sheltering in vegetation within the proposal site during clearing activities. There is a potential risk of injury or mortality to any species which may be using hollows, such as microbats, arboreal mammals or hollow-nesting birds. The potential for impacts on fauna utilising hollows would be reduced through pre-clearance surveys of habitat trees and protocols for less-impact felling of habitat trees (see Table 7.1). More mobile native fauna such as native birds, bats, terrestrial and arboreal mammals that may be sheltering in vegetation in the proposal site are likely to evade injury during construction activities.

Recommendations have been made in Section 7.2 above to minimise the risk of vegetation clearing activities resulting in the injury or mortality of resident fauna.

8.1.4 Fragmentation and isolation of habitat

Habitat fragmentation through the clearing of vegetation can increase the isolation of remnant vegetation patches, increase edge effects and create barriers to the movements of small and sedentary fauna such as ground dwelling mammals, reptiles and amphibians. Furthermore, habitat fragmentation can create barriers to the movement of pollinator vectors, such as insects, and consequently affect the life cycle of both common and threatened flora.

The proposal site is mostly located in already cleared land, the majority of which has been grazed and is dominated and exotic grassland and that already comprises a gap in habitat for less mobile or shelter dependent native fauna.

A small patch of remnant native vegetation consisting of PCTs 1600 and 1591 occurs along the outer edge of a larger patch of vegetation that extends south from the proposal site and borders the Heddon Greta and Cliftleigh residential housing estates. The vegetation proposed to be removed occurs along the edge of this larger patch of vegetation. The proposal would reduce the size of this patch but would not result in the isolation of any areas of habitat and would make a minor contribution to the degree of habitat fragmentation in the locality.

8.2 Indirect impacts

Indirect impacts that may occur as a result of the proposal are described in Table 8.2. Mitigation measures proposed to minimise the risk of these impacts are detailed in Section 7.2.

Given the minor area and intensity of potential indirect impacts, proposed mitigation measures and substantially modified character of the receiving environment, indirect impacts are not likely to result in substantial negative impacts on native vegetation or other threatened species habitat. Regardless offsets have been calculated for indirect offsets by applying a 10 metre buffer to areas where the development adjoins native vegetation and assuming a total loss of this vegetation (noting that indirect impacts would not result in a total loss of function of this vegetation however the offset would account for any additional indirect impacts that may occur beyond the 10 metre buffer). The estimated extent of indirect impacts is summarised in Table 8.1 and a qualitative assessment of these impacts is provided below.

Table 8.2 Indirect impacts

Impact	Description
Weed invasion and edge effects	<p>Weed species are effective competitors for food and habitat resources and have the potential to exclude native species and modify the composition and structure of vegetation communities.</p> <p>'Edge effects' can include increased noise and light or erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Edge effects would result from construction activities and then continue to affect vegetation and habitats adjoining the proposal site. This may include dumping of garden refuse and other rubbish as has occurred along the boundary and access tracks of the proposal site.</p> <p>Altered environmental conditions along new edges can allow invasion by pest animals specialising in edge habitats and/or change the behaviour of resident animals. Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators.</p> <p>The majority of the native vegetation proposed for removal is currently subjected to grazing and is made up of small isolated patches, or patches with large edge to area ratios, and are already subject to edge effects in their current state.</p> <p>The proposal would result in an increase in the length of interface of existing vegetation adjoining urban development. Vegetation adjoining the site contains mostly intact vegetation in relatively good condition. There is therefore a risk that construction activities may increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into areas of retained native vegetation via erosion (wind and water) and associated with construction activities. The risk of introduction of weeds would continue during the operation of the proposal as members of the public may enter adjoining vegetation.</p> <p>The creation of new edges within areas of native vegetation also has the potential to introduce impacts associated with noise and light into areas of adjacent vegetation. This may result in disruptions to fauna utilising vegetation adjacent to the site (as described below).</p> <p>There is a risk that weed invasion and the influence of edge effects would have an ongoing negative impact on the adjoining areas of intact native vegetation. Mitigation measures including the development of a weed management sub-plan as part of the project CEMP would be implemented to mitigate these potential impacts (refer to Section 7.2.1).</p> <p>Other relevant mitigation measures to reduce the impacts of edge effects include the establishment and maintenance of APZ's which, when managed appropriately, could act as a buffer from the development lands, lighting design to minimise light spill as well as dust suppression and erosion and sediment measures during construction.</p>

Impact	Description
Pests and pathogens	<p>Disturbance associated with vegetation clearing, vehicle traffic and general day to day operations of the proposal during construction increase the potential for the spread, introduction and establishment of pest species, diseases and pathogens.</p> <p>Construction activities within the proposal site may, in general, have the potential to introduce or spread pathogens such as Phytophthora (<i>Phytophthora cinnamomi</i>), Myrtle Rust (<i>Uredo rangelii</i>) and Chytrid fungus (<i>Batrachochytrium dendrobatidis</i>) into adjacent habitat through vegetation disturbance and increased visitation. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus may harm frog populations once introduced into an area.</p> <p>The potential for impacts associated with these pathogens is moderate considering large areas within the development footprint are subject to grazing with large areas consisting of predominantly introduced pasture.</p> <p>Diseases and pathogens can be introduced or spread to site via dirt or organic material attached to machinery, vehicles, equipment and employees as well as soil imported to fill areas of the site. The potential for significant or new impacts associated with these pathogens is relatively low, given the suburban context of the proposal site. To help mitigate the risk of pathogens being brought onto and/or spread through the site all machinery brought to site will be washed down and inspected to be free of soils, seeds and other organic material in accordance with Section 7.2.1.</p>
Noise, light and vibration	<p>Construction activities would increase noise levels and vibration in the vicinity of the proposal site during construction, through plant and machinery operation. Native fauna may temporarily or permanently vacate or avoid areas disturbed by construction activities. This includes Southern Myotis individuals that were recorded roosting in a culvert in the south-west of the proposal site.</p> <p>The majority of the proposed construction works would be undertaken during standard, daytime construction hours. Exemptions and approval for works outside of the above standard construction hours may be required during certain circumstances and would require approval from consent authorities.</p> <p>As such, construction noise would be temporary and generally confined to daylight hours. There would be an increase above existing background noise and vibration levels. Once the development is completed there may also be some indirect impacts from noise and light around the immediate periphery of the proposal site. To help mitigate these impacts lighting within the development will be designed to limit the light spill into retained vegetation adjoining the site.</p>
Sedimentation and erosion	<p>The proposed development has the potential to result in sedimentation and erosion within the proposal site and adjoining areas through soil disturbance and construction activities. Sediment laden runoff to waterways can alter water quality and adversely affect aquatic life. Erosion may also impact native vegetation by undermining vegetation resulting in tree instability and potential for uprooting, especially vegetation associated with drainage lines. Impacts to the adjacent drainage line would be mitigated through the development and implementation an erosion and sediment control plan, including the CEMP for the project.</p>
Aquatic disturbance and pollution	<p>Construction of the proposal has the potential to result in the mobilisation of contaminated sediments into waterways, or chemical spills from vehicles or plant. The introduction of pollutants from the proposal into the surrounding environment, if uncontrolled, could potentially impact on water quality further downstream. Management measures to prevent potential impacts on waterways including development and implementation of a stormwater management plan would mitigate impacts to the adjacent drainage line and downstream waterways.</p>

8.3 Assessment of serious and irreversible impacts

Under the BC Act, a determination of whether an impact is serious and irreversible must be made in accordance with the principles set out in Section 6.7 of the BC Regulation.

The principles are aimed at capturing impacts which are likely to contribute significantly to the risk of extinction of a threatened species or ecological community in New South Wales. These impacts will:

- Cause a further decline of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline, or
- Further reduce the population size of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very small population size, or
- Impact on the habitat of a species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very limited geographic distribution, or
- Impact on a species or ecological community that is unlikely to respond to measures to improve habitat and vegetation integrity and is therefore irreplaceable

The decision-maker must determine whether or not an impact on biodiversity values is likely to be a serious and irreversible impact (SAII). The framework allows for decision-makers to take into account the scale of an impact and the potential for avoidance and mitigation. These factors are weighed against the status and vulnerabilities of the potential SAIL entity to ultimately determine if a proposal would result in a SAIL (DPIE 2019). If there is a SAIL for a State Significant Development, the development may be approved but the approval authority must take those impacts into consideration and determine whether there are any additional and appropriate measures that would minimise those impacts if approval is granted.

The proposal site does not contain any threatened ecological communities or species that are listed as an SAIL entity. The proposal would not result in any impacts to listed SAIL entities or their habitat. Therefore, no further consideration of potential SAILS has been included in this BDAR.

8.4 Impacts on aquatic habitats

Two small farm dams would be removed by the proposal, a third would be modified to act as a storm water detention basin for the development. None of the aquatic habitats in the proposal site or study area are classified as Key Fish Habitat and these dams would not provide potential habitat for threatened fish. Aquatic habitats may provide limited breeding and shelter resources for common frog, reptile species and waterbirds.

No habitat for threatened biota listed under the FM Act would be directly impacted. There is potential that indirect impacts such as sediment and erosion during the construction phase of the project (discussed above) any impact on water quality within the ephemeral drainage line located to the south of the site. Given the ephemeral nature of this drainage line and limited habitat resources for aquatic biota, the risk of indirect impacts is low. There would be no blockage of fish passage or removal of snags as a result of the proposal.

8.5 Prescribed impacts

The BAM requires the assessment of potential impacts on threatened species and their habitats beyond those associated with the removal of vegetation ('prescribed impacts'). Prescribed impacts include potential impacts to significant geological features, hydrological features, connectivity features and man-made structures that may provide habitat to threatened biota.

The potential for prescribed impacts associated with the proposal is considered below. Given the scale and context of the proposal there are unlikely to be any substantial impacts on threatened species and their habitats beyond those associated with the removal of vegetation and habitat in the proposal site.

8.5.1 Karst, caves crevices, cliffs, rocks and other geological features of significance

No areas of geological significance are present within or adjacent to the proposal site nor are any caves, karsts, crevices, cliffs or rocky outcroppings present.

8.5.2 Human made structures and non-native vegetation

The study area contains a number of man-made structures, including two large culverts that runs under the train line located to the northwest of the proposal site. One of these culverts is known to provide roosting habitat for a small group of Southern Myotis (*Myotis macropus*) and may also provide potential roosting habitat for other bat species (refer Figure 6.1 to for location of culvert where Southern Myotis recorded). These culverts would not be directly impacted by the proposal however they may experience some indirect impacts due to vibration and light. Mitigation measures have been included in Section 7.2 to minimise any potential impact to this habitat. Impacts to the Southern Myotis have been assessed and offsets calculated in Section 9.1.1 of this report.

The proposed development would include the removal of 43.28 ha of non-native vegetation associated with grazed paddocks. Non-native vegetation does not comprise habitat for any threatened flora species and provides minimal habitat resources for threatened fauna species. This exotic vegetation may provide some habitat for highly mobile fauna species, commonly found in open country. Raptors including the Little Eagle may hunt over non-native grassland on occasion. Similarly, microchiropteran bats may forage above the non-native grassland. Bird species that forage in woodland areas may also forage in the adjacent non-native grassland on occasion. It is highly unlikely that any threatened fauna species would rely on habitat resources in these areas for their survival in the locality, although some individuals may use these areas on occasion as part of a much larger home range.

8.5.3 Habitat connectivity

- Habitat fragmentation resulting from clearing of vegetation can increase the isolation of remnant vegetation and create barriers to the movements of small and sedentary fauna such as ground dwelling mammals, reptiles and amphibians. Furthermore, habitat fragmentation can create barriers to the movement of pollinator vectors, such as insects, or seed vectors, such as birds, and consequently affect the life cycle of both common and threatened flora.
- The proposal site is bordered to the west by the South Maitland Railway and agricultural land. Further west is Wentworth Swamp which adjoins a patch of native vegetation greater than 2,000 ha in area. Connectivity between the proposal site and native vegetation to the west has been impacted by the construction of the South Maitland Railway line and the Hunter Expressway. Cessnock Road and cleared land used for agriculture that has been identified for residential housing is located to the east of the proposal site. North of the site is cleared land and residential development associated with the Gillieston Grove subdivision. South of the proposal site is a patch of remnant native vegetation that is connected by a narrow-vegetated corridor to a larger patch of vegetation that surrounds the Kurri Kurri TAFE.

A small patch of remnant native vegetation consisting of PCTs 1600 and 1591 occurs along the outer edge of a larger patch of vegetation that extends south from the proposal site and borders the Heddon Greta and Cliftleigh residential housing estates. A small area of native vegetation is proposed to be removed along the edge of this larger patch. The native vegetation to be removed in the proposal site does not form part of an important connecting link. Clearing of this vegetation would result in a widening of the existing gaps between patches however would not substantially impact habitat connectivity.

Scattered trees and small patches of woodland present within the proposal site would provide 'stepping stones' of habitat between larger areas of vegetation for mobile species such as bats and birds. Removal of these patches and trees would reduce the availability of these stepping stones to a minor degree. Species that require larger tracts of connected vegetation would not occur in these small, already fragmented patches.

8.5.4 Water bodies, water quality and hydrological processes

Two farm dams would be removed by the proposal and a third in the south west of the site would be modified to act as a storm water retention basin. Removal of these dams would reduce the number of watering points in the wider study area to a minor degree, however there is a substantial area of waterbodies adjacent to the site (including Wentworth swamp to the west) that would remain undisturbed. Targeted surveys were completed at these ponds for candidate species, including the Green and Golden Bell Frog (*Litoria aurea*), Green Thighed Frog (*Litoria brevipalmata*), Wallum Froglet (*Crinia tinnula*), Mahoney's Toadlet (*Uperoleia mahonyi*) and the threatened flora species *Maundia triglochoides* and Tall Knot Weed (*Persicaria elatior*). None of these species were recorded during targeted surveys it is therefore considered unlikely that the removal of these ponds would result in adverse impacts to threatened biota.

More mobile threatened species that may use these habitats (such as the Grey-crowned Babbler and microchiropteran bats) would likely use a number of similar watering points throughout their home range and are not likely to be impacted by the removal of these waterbodies.

There is potential for the introduction of pollutants from the proposal into the surrounding aquatic environment through the ephemeral drainage lines that flow through and adjacent to the site. If uncontrolled, this could potentially impact on water quality further downstream. Potential water quality impacts would be managed through the implementation of mitigation measures, including the provision of sedimentation basins, silt fences and other structures to intercept runoff. Details would be included in a Stormwater Management Plan.

No endangered aquatic communities, aquatic fauna or marine vegetation listed under the FM Act or EPBC Act occur in or adjacent to the footprint and no significant impacts on riparian vegetation or habitats downstream of the development footprint are anticipated as a result of the proposal.

8.5.5 Vehicle strike

The proposal site currently has low levels of vehicle activity typically associated with low density agricultural land uses. Occasional movements of cars, utility vehicles, trucks and farming equipment would occur throughout the proposal site.

The proposal would result in an increase in cars and other vehicles during construction and operation. Exclusion fencing would be installed between the boundary of the site and the adjoining native vegetation to prevent movement of ground-dwelling fauna into the site. There is however still a risk that increased vehicle activity may result in native fauna being struck and killed. The potential risk of vehicle strike is most relevant to common species such as kangaroos which often graze along roadsides. Vehicle strike poses a higher risk for owls and ground feeding birds as they are known to utilise urban areas where they can take advantage of an abundance of prey such as mice, rats and possums that often thrive in urban environments. Furthermore, owls will often pick up prey from the sides of roads making them more vulnerable to being struck.

Mitigation measures would include signposting and enforcement of appropriate speed limits along proposed access roads to reduce the likelihood of vehicle strike and mortality of native fauna. Appropriate fencing would also be maintained between the proposal site and areas of adjoining native vegetation.

8.6 Removal of planted native vegetation

The proposal would remove 0.96 ha of planted native vegetation. An assessment of threatened species habitat did not find any evidence of this vegetation being used by threatened biota. The removal of this vegetation would slightly reduce the available potential foraging habitat for several threatened fauna species including the Regent Honeyeater, Swift Parrot, Grey-headed Flying fox as well as other blossom feeding bats and birds that are known or predicted to occur in the locality. Given the limited extent and context of this vegetation and extensive areas of alternative foraging habitat within the local area it is highly unlikely that the removal of this planted vegetation would result in any substantial impacts to any threatened fauna species.

8.7 Consideration of Matters of Environmental Significance (MNES)

The proposal would remove a small amount of potential foraging habitat for the Swift Parrot and Regent Honeyeater, both of which are listed as critically endangered species under the EPBC Act and the Grey Headed Flying-fox, which is listed as a vulnerable species under the EPBC Act. While these species may forage opportunistically on occasion when trees within the site are in flower, the site does not provide breeding habitat or any mapped important habitat for the Swift Parrot or Regent and no Grey-headed Flying-fox roosts occur.

Assessments of significance have been prepared for these three species in accordance with the '*Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999*' (DotE, 2013). These assessments are provided in Appendix E).

Given that only a small area of potential foraging habitat for these species would be impacted and that there are large areas of much higher quality habitat surrounding the proposal site and within locality, the proposal is unlikely to constitute a significant impact on any of these species, and no further assessment or approval of the proposal under the EPBC Act is likely to be required.

This conclusion is supported by the results of a site assessment completed Dr Ross Crates (recognised species expert for the Swift Parrot and Regent Honeyeater) who determined that the site would only provide marginal habitat for Swift Parrot and Regent Honeyeater and it is unlikely that the removal of vegetation within the site would result in a significant impact to either of these species (refer to Appendix F).

9. Offsetting

9.1 BC Act offset requirements

Impacts associated with the proposal that require offsetting include the removal of 12.98 hectares of native vegetation, and associated habitat for threatened biota. Impacts within the proposal site that require biodiversity offsets are shown on Figure 9.1.

9.1.1 Impacts requiring offsetting

9.1.1.1 Ecosystem credits

The data from the fieldwork and mapping was entered into version 1.4.0.00 of the BAM calculator as a 'Development Assessment' to determine the number and type of biodiversity credits that would be required to offset impacts of the proposal (Case 00029358/BAAS17098/21/00029359).

The biodiversity credit reports are included in Appendix H and are summarised below.

There are 12.98 hectares of native vegetation and associated threatened species habitat that would be directly impacted within the proposal site. It has been assumed that all vegetation and habitat resources in the proposal site would be removed so the 'future vegetation integrity score' for this vegetation zone was entered as 0.

Additional ecosystem credits have also been included to account for any potential indirect impacts that may occur as a result of the development (this offset has been calculated by applying a 10 metre buffer to adjacent areas of native vegetation and adding a total 0.95 ha additional area to vegetation zones).

Ecosystem credits that would be required to offset the impacts of the proposal are shown in Table 9.1.

Table 9.1 Ecosystem credits required to offset direct and indirect impacts of the proposal

Vegetation zone / PCT	Area (ha) (direct impacts)	Area (ha) (indirect impacts)	Current VI score	Future VI score	Change in VI score	BC Act status	Ecosystem credits required
1 Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (PCT 1600_underscrubbed)	5.7	0.21	49.9	0	-49.9	EEC	142
2 Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (PCT 1600_regrowth)	4.5	0	19.2	0	-19.2	EEC	43
3 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (PCT 1591_intact)	3.5	0.74	61.3	0	-61.3	EEC	107
4- Water Couch -Tall Spike Rush Freshwater Wetland of the Central Coast and Lower Hunter (PCT 1736_moderate)	0.25	0	35.9	0	-35.9	EEC	4
Total	13.95	0.95					296

9.1.1.2 Species credits

Species credits would be required to offset impacts to Southern Myotis (*Myotis macropus*) and Squirrel Glider (*Petaurus norfolcensis*) habitat.

Approximately ten Southern Myotis individuals were recorded roosting within a culvert that runs beneath the train line on the western edge of the site. The species polygon for this species was calculated in accordance with the requirements specified in Table 1 of the “*species credit threatened bats and their habitats: NSW survey guide for the BAM* (OEH 2018). Aerial imagery was used to map waterbodies with pools/stretches 3 m or wider or within 200 m of the subject land. All habitat within 200 m of mapped waterbodies was then mapped as the species polygon, with habitat defined as any PCTs on the proposal site with which this species is associated (as listed in the TBDC) (refer to Figure 9.2).

There is 6.5 ha of potential habitat for the Southern Myotis within the species polygon.

PCT 1591 and parts of PCT 1600 within the proposal site contain suitable foraging and nesting habitat for the Squirrel Glider. Although this species as not recorded during targeted surveys completed for this BDAR, Squirrel Gliders are known to occur in the locality including within vegetation connected to the site (ELA 2016). As such the species has been assumed to be present. The species polygon for the Squirrel Glider was mapped to include all areas of intact PCTs (containing mature canopy trees) within the proposal site which are associated with this species (as listed in the TBDC). The polygon also includes underscrubbed vegetation that adjoins areas of higher quality of habitat containing mature trees and that is separated by a distance of less than 50 m (refer to Figure 9.2).

There is 4.5 ha of potential habitat for the Squirrel Glider mapped within the species polygon.

The species credits required to offset future impacts associated with development within proposal site are provided in Table 9.2.

Table 9.2 Species credits required to offset impacts of the proposal in the proposal site

Species Name	Common Name	Area of habitat (ha)	Species credits required
<i>Myotis macropus</i>	Southern Myotis	6.5	175
<i>Petaurus norfolcensis</i>	Squirrel Glider	4.5	128

9.1.2 Impacts not requiring offsetting

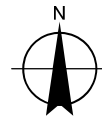
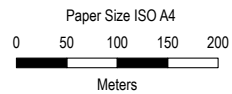
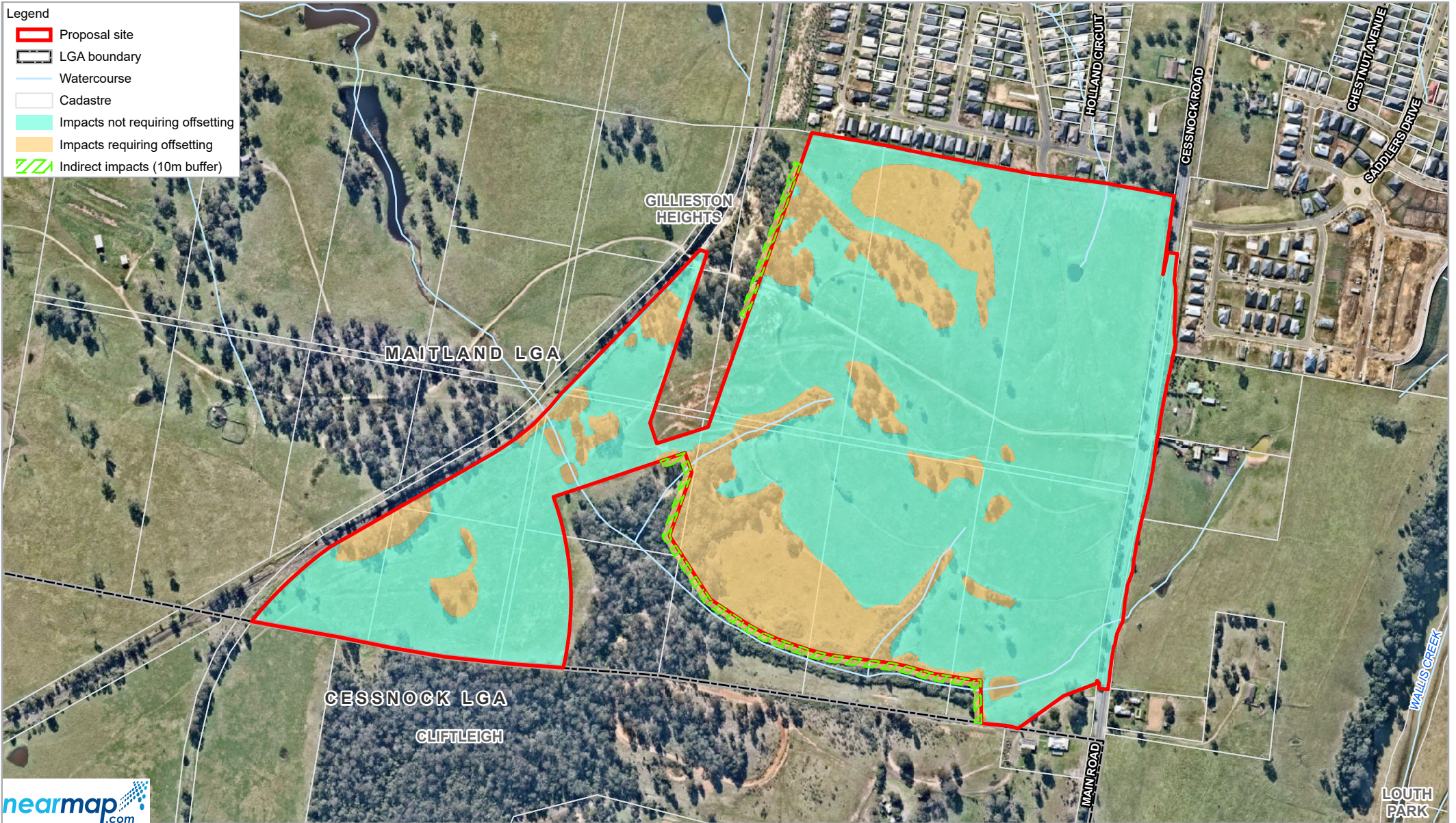
Areas of exotic grassland (43.25 ha), cleared land (1.19 ha) and planted vegetation (0.96) occur within the proposal site (refer to Figure 5.1 and Table 9.3). There is a total of four native vegetation zones within the proposal site. Areas of predominantly exotic grassland do not comprise native vegetation but were treated as a fifth vegetation zone to support calculation of a vegetation integrity score and confirmation that biodiversity offsets are not required for this land. BAM plots were sampled in exotic grassland areas. Results of these plots determined that these areas have an integrity score of 4.6, which according to the BAM is less than the minimum VI score of 15 that would require calculation of an offset.

Assessment of planted vegetation within the proposal site in accordance with decision making key provided in Appendix D of the BAM (streamlined assessment module – planted native vegetation) determined that removal of this vegetation does not require offsetting (refer to Appendix E for results of assessment).

Table 9.3 Impacts not requiring offsetting

Vegetation type	Area (ha) (direct impacts)	Area (ha) (indirect impacts)	Current VI score	Future VI score	Change in VI score	BC Act status	Ecosystem credits required
Mixed Grassland (Zone 5 - Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (1600_Exotic)	43.28	0	4.6	0	4.6	Non-native	0
Cleared land	1.19	0	n/a	n/a	n/a	Non-native	0
Planted vegetation	0.96	0	n/a	n/a	n/a	Planted	0

- Legend**
- ▭ Proposal site
 - LGA boundary
 - Watercourse
 - Cadastre
 - Impacts not requiring offsetting
 - Impacts requiring offsetting
 - Indirect impacts (10m buffer)



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

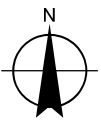
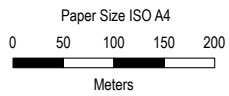
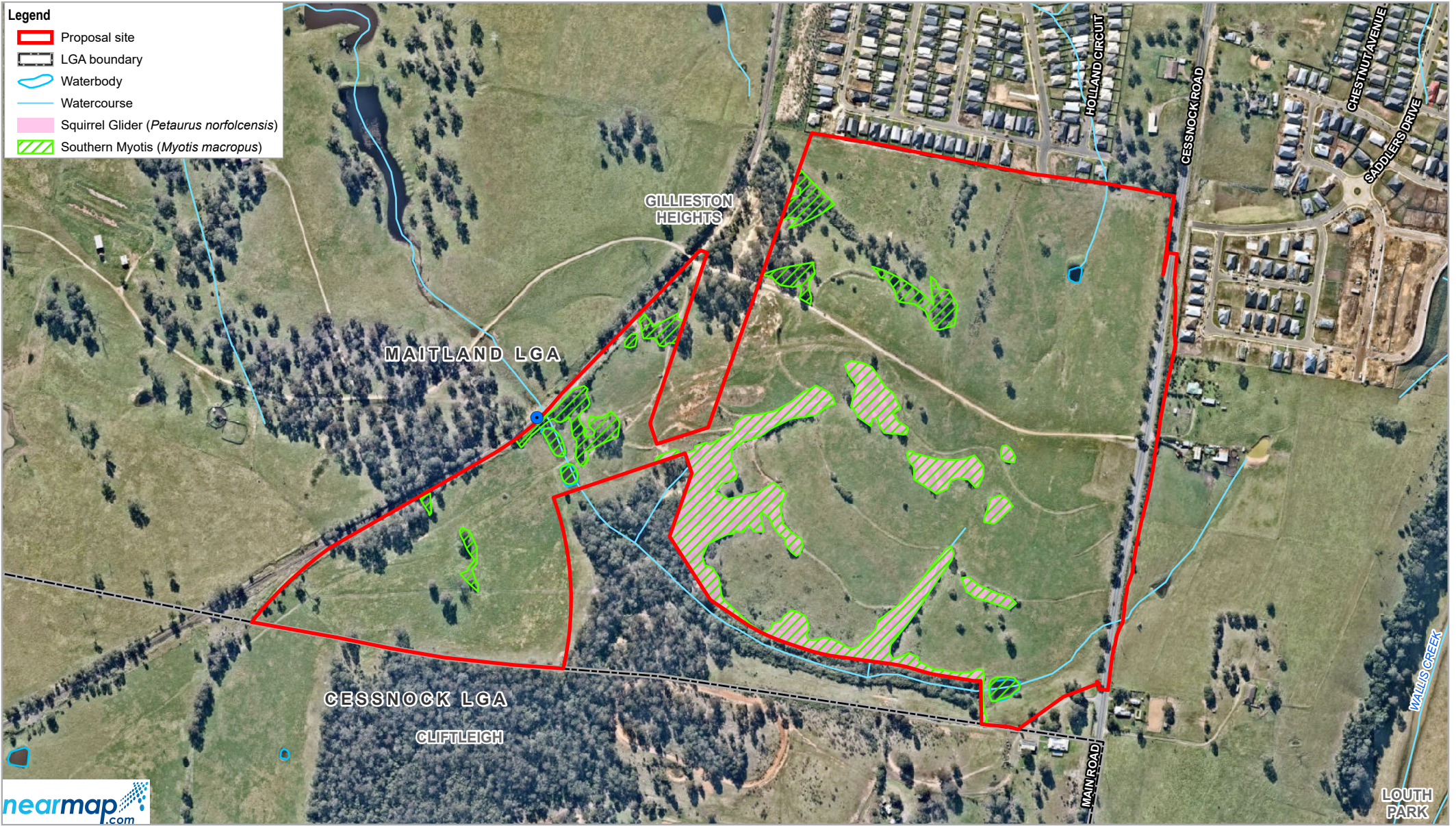


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Areas requiring offsetting

Figure 9-1



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

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 Biodiversity Development Assessment Report

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**Threatened fauna species polygons
 Southern Myotis & Squirrel Glider**

Figure 9-2

9.1.3 Options to meet offset obligations/approach to delivering offsets

In accordance with the offset rules established by the *Biodiversity Conservation Regulation 2017* there are various means by which offset obligations described in Section 9.1 can be met. These include:

- Retiring the appropriate credits from an established stewardship site.
- Monetary payment directly into the Biodiversity Conservation Trust Fund,.
- Funding an approved biodiversity action. Funding a biodiversity action may be available as a last resort, subject to consultation with approval authorities, if all other options are determined to be unsuitable.

9.1.4 Preferred offset approach

9.1.4.1 Onsite stewardship site establishment

Loxford Project Management's preferred approach to offset the residual impacts of the proposed development is to secure and retire appropriate credits from a proposed 770 ha Biodiversity Stewardship Site (BSS), located adjacent to the development footprint (known as the Loxford Stewardship Site). The assessment of the proposed stewardship site has commenced and vegetation mapping at the site has determined that the proposed stewardship site contains each of the PCTs that would be impacted by the proposal. The required species credits for the Squirrel Glider and Southern Myotis would also be generated from the proposed BSS.

The proposed stewardship site would be assessed in accordance with the BAM and a separate Biodiversity Stewardship Site Assessment Report (BSSAR) would be prepared that would describe the ecosystem and species credits generated at the site. A Site Management Plan (SMP) would be prepared to describe the restoration and management actions required to be undertaken at the site to improve biodiversity values. The SMP would be accompanied by a Total Fund Deposit (TFD) amount which would determine the funds that would be required to implement the restoration and management program in perpetuity. An application for a Biodiversity Stewardship Agreement (BSA) would then be lodged with the Biodiversity Conservation Trust (BCT).

Vegetation types at the proposed stewardship site are similar to those within the proposal site and it is anticipated that the stewardship site would provide suitable habitat for a similar suite of threatened species and contain the appropriate credits to substantially meet offset obligations for the proposal. Once the stewardship site has been established appropriate like for like credits would be retired from the stewardship site accordingly.

9.1.4.2 Biodiversity credit market

If the BSA has not been finalised by the time development is proposed to commence within the proposal site, like for like biodiversity credits and/or those that comply with the trading rules of the BOS would be secured through the open market.

'Like for like' trading rules for the ecosystem credits required for the proposal are shown in Table 9.4 and Table 9.5 and Appendix H. The 'like for like rules' for species credits require matching credits for each individual species, though these credits could be generated anywhere in NSW. An application to apply the 'variation to trading rules' is not preferred and would only be considered after all reasonable steps to seek like-for-like credits were undertaken (in accordance with the BAM) and suitable credits still could not be sourced.

Table 9.4 'Like for like' ecosystem credits required to offset impacts

Name of Plant Community Type/ID	Class	Trading groups	Hollow-bearing trees	Credits	IBRA subregions
PCT 1591 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter	Hunter Lowland Redgum Forest and NSW North Coast Bioregions This includes PCT's: 1591, 1598, 1603, 1605, 1691, 1692, 1749	-	No	107	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo Any IBRA subregion that is within 100kilometres of the outer edge of the impacted site.
PCT 1600 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast BioregionsThis includes PCTs 1590, 1592, 1593, 1600, 1602	-	Yes	142	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo Any IBRA subregion that is within 100kilometres of the outer edge of the impacted site.
PCT 1600 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast BioregionsThis includes PCTs 1590, 1592, 1593, 1600, 1602	-	No	43	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo Any IBRA subregion that is within 100kilometres of the outer edge of the impacted site.
PCT 1736 Water Couch- Tall Spike Rush freshwater wetland of the Central Coast and Lower Hunter	Freshwater Wetlands on Coastal Floodplains of the NSW north Coast Sydney Basin and South East Corner Bioregions This includes PCTs 780, 781, 782, 828, 1071, 1735,1736, 1737, 1740, 1741, 1742, 1911	-	No	4	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo Any IBRA subregion that is within 100kilometres of the outer edge of the impacted site.

Table 9.5 'Like for like' species credits required to offset impacts of the project

Species	PCT	Like-for-like retirement options species	Like-for-like retirement options IBRA region
Southern Myotis (<i>Myotis macropus</i>)	1591_intact 1600_underscrubbed 1736	Southern Myotis (<i>Myotis macropus</i>)	Any in NSW
Squirrel Glider (<i>Petaurus norfolcensis</i>)	1591_intact 1600_underscrubbed	Squirrel Glider (<i>Petaurus norfolcensis</i>)	Any in NSW

9.1.4.3 Biodiversity Conservation Fund Payment

Alternatively, a payment to the Biodiversity Conservation Fund would be considered to meet any residual credit requirements if the above two options are not available at the time credits need to be retired.

It should be noted that biodiversity offset payments are subject to change and that credit payment prices are reviewed by the BCT quarterly. The payment amounts presented within this report were calculated and valid as of 1 December 2021 and are included in Table 9.6.

Table 9.6 Estimated biodiversity offset credit payment price

Credit class	Price per credit	Number of credits required	Final credit price
Ecosystem Credits			
PCT 1591 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter	\$2,997.08	107	\$320,687.28
PCT 1600 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	\$3,033.34	185	\$561,167.20
PCT 1736 Water Couch- Tall Spike Rush freshwater wetland of the Central Coast and Lower Hunter	\$9,248.98	4	\$36,995.94
Total ecosystem credits (excl. GST)		296	\$918,850.42
Species Credits			
Southern Myotis (<i>Myotis macropus</i>)	\$80.00	175	\$170,570.23
Squirrel Glider (<i>Petaurus norfolcensis</i>)	\$80.00	128	\$86,746.26
Total species credits (excl. GST)		303	\$257,316.49
TOTAL (incl GST)			\$1,293,783.60

10. Conclusion

Loxford Project Management Pty Ltd proposes to develop a residential subdivision at Cessnock Road, Gillieston Heights, approximately 8 km southwest of Maitland.

The proposal site includes approximately 59 ha of land that was part of the former Hydro Aluminium Smelter buffer zone. This site forms part of an agricultural property called Wangara that has been predominantly cleared and subject to long term cattle grazing. Areas of native vegetation within the site include small patches of remnant trees with disturbed native understorey, areas of young regrowth as well as areas of remnant native vegetation adjoining larger tracks of vegetation along the southern boundary. There are two small farm dams located either end of the drainage line that runs along the southern boundary of the site as well as a small dam located in the northeast of the site. A coal train line extends along the western boundary of the site.

Approximately 12.98 ha of the proposal site is comprised of native vegetation, 43.28 ha is mixed grassland (dominated by exotic species), 1.19 ha is cleared land and 0.96 ha is planted vegetation. Assessment of the native vegetation within the site determined that 10.24 ha is in poor condition and 2.74 ha is in good condition.

There are three PCTs present within the proposal site, all of which comprise local occurrences of endangered ecological communities listed under the BC Act.

Five threatened fauna species classified as ecosystem credit species were recorded within the proposal site. These are:

- Grey-crowned Babbler (*Pomatostomus temporalis*) (nest recorded in the proposal site)
- Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*)
- Little Bent-wing Bat (*Miniopterus australis*)
- Large Bent-wing Bat (*Miniopterus orianae oceanensis*) (probable call recorded)

All these species are listed as vulnerable under the BC Act. The Grey-headed Flying-fox is also listed as a vulnerable species under the EPBC Act.

One species credit fauna species (Southern Myotis (*Myotis macropus*)) was also recorded utilising a culvert located immediately adjacent to the site while a second species credit species (Squirrel Glider (*Petaurus norfolcensis*)) has been assumed present based on the presence of previous records and the presence of suitable habitat within and adjacent to the proposal site (DPIE 2020b and ELA 2016).

The location and layout of the proposal has been designed and modified to avoid impacts to areas adjacent to the site that have the best quality vegetation and highest biodiversity values. A range of mitigation measures are also proposed to minimise impacts of the development, including development and implementation of a Vegetation Management Plan (VMP) and Construction Environment Management Plan (CEMP) that would include comprehensive measures to maintain and improve vegetation adjacent to the site, manage habitat clearance, and prevent impacts associated with erosion and sedimentation, weeds, pest, noise light and vibration. These documents would also outline measures for the protection of vegetation to be retained on and adjacent to the site.

Credits to offset direct impacts within the site as well as potential indirect impacts adjacent to the site (applying a 10 metre buffer to areas of adjacent native vegetation) were calculated using version 1.4.0.00 of the BAM-C.

The following ecosystem and species credits would be required to offset the residual direct and indirect impacts of the proposal:

- 142 ecosystem credits to offset direct impacts to 5.50 ha of PCT 1600, Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (underscrubbed) and indirect impacts to 0.21 ha of this PCT.
- 43 ecosystem credits to offset impacts to 4.49 ha of PCT 1600, Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (melaleuca regrowth).
- 107 ecosystem credits to offset impacts to 2.74 ha of PCT 1591, Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (intact) and 0.74 ha of indirect impacts to this PCT.
- 4 ecosystem credits to offset impacts to 0.25 ha of PCT 1736, Water Couch -Tall Spike Rush Freshwater Wetland of the Central Coast and Lower Hunter (moderate).
- 175 species credits to offset impacts to 6.5 ha of Southern Myotis habitat
- 128 species credits to offset impacts to 4.5 ha of Squirrel Glider habitat

No ecosystem credits are required to offset removal of mixed (predominantly exotic) grassland as this vegetation has a VI score of < 14 and therefore does not require offsetting according to the BAM.

The proposal site also contains a total of 0.96 ha of planted vegetation. Assessment in accordance with the streamlined assessment module for planted native vegetation outlined in Appendix B of the BAM determined that this vegetation has been planted for functional and aesthetic purposes (landscaping) and as such Chapters 4 and 5 of the BAM are not required to be applied (refer to Appendix D). This planted native vegetation has little value as threatened species habitat.

There would be impacts on potential foraging habitat for three species (Grey-headed Flying-fox, Regent Honeyeater and Swift Parrot) listed under the EPBC Act. Given the proposal would not impact on breeding habitat for any of these species and the relatively small area of foraging habitat that would be impacted in the context of the large area of known and potential habitat in the surrounding locality, the proposal is unlikely to constitute a significant impact to any of these EPBC listed species. No further assessment or approval or provision of biodiversity offsets is likely to be required under the EPBC Act.

Aquatic habitat is limited to farm dams and first order ephemeral drainage lines. These do not constitute key fish habitat and would not provide potential habitat for threatened fish listed under the FM Act.

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Appendices

Appendix A

**Likelihood of occurrence of threatened
and migratory biota**

Likelihood of occurrence evaluation

An evaluation of the likelihood and extent of impact to threatened and migratory fauna recorded from within the Forbes LGA (BC Act threatened species and EPBC Act threatened and migratory species). Records are from a search of the NSW BioNet Atlas, and the EPBC Protected Matters Search Tool available from the Department of the Agriculture, Water and the Environment (DAWE) website. Ecology information has been obtained from the Threatened Species Profiles on the NSW Environment, Energy and Science website (<http://www.environment.nsw.gov.au/threatenedspecies/>) and from the Species Profiles and Threats Database on the Commonwealth DAWE website (<http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>).

Status:

- National - Environment Protection and Biodiversity Conservation Act 1999.
- NSW - Biodiversity Conservation Act 2016 and Fisheries Management Act 1994.
- E - Endangered
- CE -Critically Endangered
- V - Vulnerable
- Mi - Migratory

Likelihood of occurrence in proposal site:

- Recorded – The species was observed in or adjacent to the proposal site during the current survey
- High – It is highly likely that a species inhabits the study area and is dependent on identified suitable habitat (i.e. for breeding or important life cycle periods such as winter flowering resources), has been recorded recently and is known or likely to maintain resident populations in the study area. Also includes species known or likely to visit the proposal site during regular seasonal movements or migration.
- Moderate – Potential habitat is present in the study area. Species unlikely to maintain sedentary populations, however, may seasonally use resources within the study area opportunistically or during migration. The species is unlikely to be dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on habitat within the proposal site, or habitat is in a modified or degraded state.
- Low – It is unlikely that the species inhabits the study area and has not been recorded recently in the LGA. It may be an occasional visitor, but habitat similar to the study area is widely distributed in the local area, meaning that the species is not dependent (i.e. for breeding or important life cycle periods such as winter flowering resources) on available habitat. Specific habitat is not present in the study area or the species is a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded. A category of 'Low' is also assigned for biota known or likely to be present in the proposal site but unlikely to be impacted by the project.
- None – Suitable habitat is absent from the proposal site

Scientific Name	Common Name	Taxonomy	BC Act statu	EPBC Act s	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
<i>Acacia bynoeana</i>	Bynoe's Wattle	-	E	V	Habitat known to occur within area	Y	-	183	0	Found in central eastern NSW, from the Hunter to the Southern Highlands to west of the Blue Mountains. Occurs in dry sclerophyll forest or heathlands on sandy soils. Associated with Red Bloodwood <i>Corymbia gummifera</i> , Scribbly Gum <i>Eucalyptus haemastoma</i> and Parramatta Red Gum <i>Eucalyptus parramattensis</i> .	Low	Species known to occur in wider Hydro site however was not recorded during targeted surveys of the proposal site
<i>Angophora inopina</i>	Charmhaven Apple	-	V	V	Habitat may occur within area	-	-	-	-	Endemic to the Central Coast of NSW. The known northern limit is near Karuah where a disjunct population occurs; to the south populations extend from Toronto to Charmhaven and Morisset. Occurs in four main vegetation communities: <i>Eucalyptus haemastoma</i> - <i>Corymbia gummifera</i> - <i>Angophora inopina</i> woodland/forest; <i>Hakea teretifolia</i> - <i>Banksia oblongifolia</i> wet heath; <i>Eucalyptus resinifera</i> - <i>Melaleuca sieberi</i> - <i>Angophora inopina</i> sedge woodland; and <i>Eucalyptus capitelata</i> - <i>Corymbia gummifera</i> - <i>Angophora inopina</i> woodland/forest.	Low	No previous records within the proposal site. Vegetation communities within the proposal site do not correspond with known habitat for this species. Conspicuous species not recorded during targeted surveys.
<i>Asperula asthenes</i>	Trailing Woodruff	-	V	V	-	Y	-	-	-	This herb occurs in scattered locations from Buladelah to Kempsey. Some records from Port Stephens/Wallis Lakes area. Occurs in damp sites, often along riverbanks (OEH 2012).	Low	No records within locality, some marginal habitat along ephemeral drainage line. Not recorded during targeted surveys
<i>Caladenia tessellata</i>	Thick-lipped Spider-orchid	-	E	V	Habitat may occur within area	-	-	-	-	Known to exist within the Sydney and Central Coast area of NSW. It is found in grassy sclerophyll woodland. Found on clay loam or sandy soils. Flowers from September to November (this is reduced from late September to early October for southern populations).	Low	The proposal site is located north of the Central Coast. Most of the sclerophyll woodland within the proposal site is shrubby. Not previously recorded in locality or known to occur within any of the PCTs that occur within the proposal site
<i>Callistemon linearifolius</i>	Netted Bottle Brush	-	V	-	-	Y	-	1598	160	Recorded from the Georges to Hawkesbury Rivers in Sydney, and north to Nelson Bay. There is also a recent record from the northern Illawarra. Grows in dry sclerophyll forest on the coast and adjacent ranges.	Low	The species was found within wider Hydro site during targeted surveys. Not recorded during targeted surveys completed within the proposal site.
<i>Cryptostylis hunteriana</i>	Leafless Tongue-orchid	-	V	V	Habitat likely to occur within area	Y	-	-	-	Occurs in coastal areas from East Gippsland to southern Queensland. Habitat preferences not well defined. Grows mostly in coastal heathlands, margins of coastal swamps and sedgeland, coastal forest, dry woodland, and lowland forest. Prefers open areas in the understorey and is often found in association with Large Tongue Orchid and the Bonnet Orchid. Soils include moist sands, moist to dry clay loam and occasionally in accumulated eucalypt leaves. Flowers November-February.	Low	Suitable marginal habitat within the proposal site. Not found during targeted surveys and no previous records within or nearby to the proposal site. No other <i>Cryptostylis</i> species recorded during surveys.
<i>Cymbidium canaliculatum</i>	Cymbidium canaliculatum population in the Hunter Catchment	-	EP	-	-	-	-	5	1913	The endangered population of this species occurs in the Hunter region, centred in the Upper Hunter north of Singleton but extending south to Weston and Pokolbin. Grows in hollows and forks of eucalypts and acacias, in dry sclerophyll forest or woodland. In the Hunter catchment most commonly found in White Box dominated communities.	Low	Suitable habitat present, although no White Box occurs within the proposal site. Not recorded during surveys
<i>Cynanchum elegans</i>	White-flowered Wax Plant	-	E	E	Habitat likely to occur within area	Y	-	-	-	Occurs from Gerroa (Illawarra) to Brunswick Heads and west to Merriwa in the upper Hunter. Most common near Kempsey. Usually occurs on the edge of dry rainforest or littoral rainforest, but also occurs in Coastal Banksia Scrub, open forest and woodland, and Melaleuca scrub. Soil and geology types are not limiting.	Low	No rainforest vegetation, banksia scrub or Melaleuca scrub within the proposal site. This species was not found during targeted surveys and no previous records of the species occur within the locality
<i>Dichanthium setosum</i>	Bluegrass	-	V	V	Habitat likely to occur within area	-	-	-	-	Occurs on the New England Tablelands, North-west Slopes and Plains and the Central-west Slopes. Associated with heavy basaltic black soils and red-brown loams with clay subsoil. Often found in moderately disturbed areas, and appears to have wide environmental tolerances.	None	No suitable habitat within the subject site due to the underlying soils predominantly sandstone influence.

Scientific Name	Common Name	Taxonomy	BC Act statu	EPBC Act s	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
<i>Diuris pedunculata</i>	Small Snake Orchid	-	E	E	-	-	-	1	1913	Originally found scattered from Tenterfield south to the Hawkesbury River, but is now mainly found on the New England Tablelands, around Armidale, Uralla, Guyra and Ebor. Grows on grassy slopes or flats, preferring moist areas between 50-900 m asl. Soils well-structured red-brown clay loams and stony loams, or occasionally on peaty soils, from shale and fine granite.	Low	Only one previous record within the locality, not suitable habitat present. Soil landscape within the proposal site unlikely to provide for suitable habitat.
<i>Eucalyptus camaldulensis</i>	Eucalyptus camaldulensis population in the Hunter catchment	-	EP	-	-	-	-	6	8458	Population occurs on the major floodplains of the Hunter and Goulburn Rivers. Grows in forested wetlands and grassy woodlands, especially in areas where water impoundment occurs after flood. Associated species include Forest Red Gum, Yellow Box, River Oak and Rough-barked Apple.	Low	Nearest record is approximately 8.5 km from the proposal site. Suitable wetland and woodland habitat occurs within the proposal site. This species would be highly visible during site surveys.
<i>Eucalyptus glaucina</i>	Slaty Red Gum	-	V	V	Habitat known to occur within area	Y	-	24	80	Distributed along the North coast of NSW. Occurs in grassy woodland and dry eucalypt forest. Prefers deep, moderately fertile and well-watered soils. Flowers from August to December.	Low	The species has an occurrence within the locality. Suitable habitat occurs within the proposal site however not detected during targeted surveys. The sandy soils may indicate lack of optimal fertile soils.
<i>Eucalyptus parramattensis subsp. decadens</i>	Earp's Gum	-	V	V	Habitat known to occur within area	Y	-	1701	0	Endemic to the Hunter Region of NSW. Occurs in low-lying, swampy areas. Found with Narrow-leaved Scribbly Gum <i>Eucalyptus racemosa</i> , Narrow-leaved Apple <i>Angophora bakeri</i> and White Stringybark <i>Eucalyptus globoidea</i> . Prefers deep low-nutrient sands.	Low	The species recorded adjacent to the proposal site during surveys. Species forms dominant canopy within PCT 1633. Conspicuous species that would likely have been detected if present within the proposal land.
<i>Eucalyptus pumila</i>	Pokolbin Mallee	-	V	V	-	Y	-	-	-	Currently known only from a single population west of Pokolbin in the Hunter Valley. Historical records also exist for Wyong and Sandy Hollow, however, has not been recorded recently in these areas. The single known population occupies north-west-facing slopes derived from sandstone. Present as a mid-canopy species to a height of 6 m within dry sclerophyll woodland which has a canopy comprising <i>Eucalyptus fibrosa</i> , <i>Callitris endlicheri</i> and, to a lesser extent, <i>Corymbia maculata</i> . Very little is known about the biology or ecology of this species.	Low	proposal site is located east of Pokolbin and does not occur near the known current population. Marginal habitat occurs within the proposal site. The species was not found during targeted surveys and no previous records of this species occur within the locality.
<i>Euphrasia arguta</i>	-	-	CE	CE	Habitat may occur within area	-	-	-	-	Recently rediscovered near Nundle on the north-western slopes and tablelands, once known from scattered locations between Sydney, Bathurst and Walcha. Known populations occur in eucalypt forest with a mixed grass/shrub understorey, while previous records are described as occurring in open forest, grassy country and river meadows. Annual and dies back over winter. Dense stands observed in cleared firebreak areas, suggesting it may respond well to disturbance.	Low	Suitable Eucalypt habitat with a grassy/shrubby understorey occurs within the proposal site. Previous fire disturbance has also occurred within the proposal site however, this has resulted in dense thickets of <i>Acacia</i> spp. and is unlikely to provide preferred growing conditions. The species has not been previously recorded within the locality.
<i>Grevillea parviflora subsp. parviflora</i>	Small-flower Grevillea	-	V	V	Habitat known to occur within area	Y	-	416	0	Occurs between Moss Vale/Bargo and lower Hunter Valley, with most occurrences in Appin, Wedderburn, Picton and Bargo. Broad habitat range including heath, shrubby woodland and open forest on light clay or sandy soils, and often in disturbed areas such as on the fringes of tracks	Low	Species recorded during targeted surveys adjacent to the proposal land. Conspicuous species that would likely have been detected if present within the proposal site
<i>Maundia triglochinoidea</i>	-	-	V	-	-	Y	-	-	-	Coastal NSW: current southern limit at Wyong, former populations near Sydney now extinct. Grows on heavy clay, low nutrient soil in swamps, lagoons, dams, channels, creeks or shallow freshwater 30-60 cm depth.	Low	Marginal habitat present within Typha wetlands present within proposal site. Not recorded during targeted surveys
<i>Melaleuca biconvexa</i>	Biconvex Paperbark	-	V	V	Habitat may occur within area	Y	-	-	-	Scattered, disjunct populations in coastal areas from Jervis Bay to Port Macquarie, with most populations in the Gosford-Wyong areas. Grows in damp places, often near streams or low-lying areas on alluvial soils over shale of low slopes or sheltered aspects	Low	Despite damp habitat occurring within the proposal site The proposal site is not characteristically derived from shale soils, rather sandstone. No previous records within the locality.
<i>Ozothamnus tessellatus</i>	-	-	V	V	-	Y	-	-	-	Restricted to a few locations in an east-west zone south of Bunnan and between west Bylong and east Ravensworth. Grows in eucalypt woodland.	Low	Suitable habitat within the proposal. however the species was not found during targeted surveys. No previous records within the locality.
<i>Persicaria elatior</i>	Knotweed	-	V	V	Habitat likely to occur within area	Y	-	-	-	Tall Knotweed has been recorded in south-eastern NSW (Mt Dromedary (an old record), Moruya State Forest near Turlinjah, the Upper Avon River catchment north of Robertson, Bermagui, and Picton Lakes. In northern NSW it is known from Raymond Terrace (near Newcastle) and the Grafton area (Cherry Tree and Gibberagee State Forests). This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	Low	Some marginal habitat present within constructed waterbodies present surrounding smelter site however likelihood of occurrence is low as these ponds are not connected to any natural waterways or lakes. Species not previously recorded in locality or during targeted surveys within the site.

Scientific Name	Common Name	Taxonomy	BC Act statu	EPBC Act s	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
<i>Persoonia hirsuta</i>	Hairy Geebung	-	E	E	Habitat may occur within area	-	-	-	-	Occurs within the Blue Mountains, Southern Highlands and Sydney coastal regions from Hilltop to Glen Davis and Royal NP to Gosford. Population within the Hills Shire particularly important due to high density of plants. Grows on sandy soils in dry sclerophyll open forest, woodland and heath on sandstone up to 600 m above sea level.	Low	Suitable habitat within the proposal site. The site is not located within the species known range. No previous records within the locality.
<i>Persoonia pauciflora</i>	North Rothbury Persoonia	-	CE	CE	Habitat may occur within area	-	-	1	9043	Extremely restricted distribution; all but one of the plants which make up the only known population occur within a 2.5 km radius of the original specimen at North Rothbury in the Cessnock local government area. Within this range, there are three main sub-populations which comprise approximately 90% of the total population. The other 10% of the population occurs as scattered individuals in what is a relatively disturbed landscape. It is found in dry open forest or woodland dominated by Spotted Gum (<i>Corymbia maculata</i>), Broad-leaved Ironbark (<i>Eucalyptus fibrosa</i>) and/or Narrow-leaved Ironbark (<i>E. crebra</i>) and supporting a moderate to sparse shrub layer and grassy groundcover. The majority of the population is known to occur on silty sandstone soils derived from the Farley Formation. Flowers from January through to May. Its breeding system is unknown, but it is likely that native bees are required for pollination. Seedlings are present in most sub-populations which indicates that the population is capable of reproducing under favourable conditions.	Low	Nearest record is approximately 8.5 km from the proposal site. Soil landscape is not derived from the Farley Formation. Its highly restricted distribution indicates likelihood of occurrence is unlikely.
<i>Pomaderris queenslandica</i>	Scant Pomaderris	-	E	-	-	Y	-	-	-	Widely scattered but not common in north-east NSW and in Queensland. It is known from several locations on the NSW north coast and a few locations on the New England Tablelands and North West Slopes, including near Torrington and Coolata. Found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	Low	Marginal habitat within the proposal. Species not found during targeted surveys. There have also been no previous records within the locality.
<i>Prasophyllum sp. Wybong</i>	a leek-orchid	-	-	CE	Habitat may occur within area	-	-	-	-	Endemic to NSW, known from seven populations within the Border Rivers, Central Rivers and Central West NRM regions. Known to occur in open eucalypt woodland and grassland.	Low	Despite suitable habitat occurring within the proposal site, it is located within predicted habitat only. No previous records within the locality.
<i>Prostanthera cineolifera</i>	Singleton Mint Bush	-	V	V	Habitat may occur within area	-	-	-	-	Inhabits sclerophyll forests and open woodlands on exposed sandstone ridges, usually on shallow or skeletal sands. Restricted to few areas near Walcha, Scone and St Albans.	Low	No suitable exposed sandstone ridges within proposal site. There have also been no previous records within the locality.
<i>Pterostylis chaetophora</i>	<i>Pterostylis chaetophora</i>	-	V	-	-	Y	-	-	-	Recorded in Queensland and NSW. In NSW it is currently known from 18 scattered locations in a relatively small area between Taree and Kurri Kurri, extending to the south-east towards Tea Gardens and west into the Upper Hunter, with additional records near Denman and Wingen. There are also isolated records from the Sydney region. The species occurs in two conservation reserves, Columby National Park and Wingen Maid Nature Reserve. The preferred habitat is seasonally moist, dry sclerophyll forest with a grass and shrub understorey. Flowers from September to November. Vegetative reproduction is not common in this group of Greenhoods, but some species may form more than one dropper annually. Fails to flower in dry seasons.	Low	Suitable habitat within the proposal, however the species was not found during targeted surveys. There have also been no previous records within the locality.
<i>Pterostylis gibbosa</i>	Illawarra Greenhood	-	E	E	Habitat may occur within area	-	-	2	1913	Known from a small number of populations in the Illawarra, Nowra and Hunter regions. First collected in western Sydney. Only visible above the ground between late summer and spring, and only when soil moisture levels can sustain its growth. Grows in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by Forest Red Gum, Woollybutt and Melaleuca decora. Near Nowra, the species grows in an open forest of Spotted Gum, Forest Red Gum and Grey Ironbark. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark, Forest Red Gum and Black Cypress Pine.	Low	No cypress pine present within proposal site. Not associated with any of the PCTs present.

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<i>Rhizanthella slateri</i>	Eastern Underground Orchid	-	V	E	Habitat may occur within area	-	-	-	-	The species grows in eucalypt forest but no informative assessment of the likely preferred habitat for the species is available (DECC 2005b; c). Currently known only from 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. Flowers during October and November (Harden 1993).	Low	No previous records within the locality, species not known to occur in Hunter Valley area.
<i>Rhodamnia rubescens</i>	Scrub Turpentine	-	CE	-	-	-	-	3	8776	Occurs in coastal districts north from Batemans Bay in New South Wales, approximately 280 km south of Sydney, to areas inland of Bundaberg in Queensland. Populations of <i>R. rubescens</i> typically occur in coastal regions and occasionally extend inland onto escarpments up to 600 m a.s.l. in areas with rainfall of 1,000-1,600 mm. Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.	None	No suitable habitat present within the subject site
<i>Rhodomyrtus psidioides</i>	Native Guava	-	CE	-	-	-	-	4	6948	Occurs from Broken Bay, approximately 90 km north of Sydney, New South Wales, to Maryborough in Queensland. Populations are typically restricted to coastal and sub-coastal areas of low elevation however the species does occur up to c. 120 km inland in the Hunter and Clarence River catchments and along the Border Ranges in NSW. Pioneer species found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest often near creeks and drainage lines.	None	No suitable habitat present within the subject site
<i>Rutidosia heterogama</i>	Heath Wrinklewort	-	V	V	Habitat known to occur within area	Y	-	957	1892	This species has been recorded in several patches from near Cessnock to Kurri Kurri with an outlying occurrence at Howes Valley. On the Central Coast it is located north from Wyong to Newcastle. There are north coast populations between Woolli and Evans Head in Yuraygir and Bundjalung National Parks. It also occurs on the New England Tablelands from Torrington and Ashford south to Wandsworth south-west of Glen Innes. Grows in heath on sandy soils and moist areas in open forest. Has also been recorded along disturbed roadsides.	Low	A high number of previous records within the locality. The nearest record occurs approximately 2 km from the proposal site. The species was not found during targeted surveys.
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	-	E	V	Habitat known to occur within area	-	-	3	5275	Occurs in narrow coastal strip from Bulahdelah to Conjola State Forest. Grows in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas, often in remnant littoral or gallery rainforests.	None	No suitable habitat present within the subject site
<i>Tetradlea juncea</i>	Black-eyed Susan	-	V	V	Habitat known to occur within area	Y	-	57	6701	Regarded as extinct within the Sydney area, current range from Wyong north to Bulahdelah and inland 50 km to edge of Sugarloaf Range. Occurs predominately in areas of over 1000 mm annual rainfall, within dry sclerophyll forest, and sometimes heath and moist forest, with a preference for Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland.	Low	The proposal site receives lower than 1000 mm annual rainfall. Despite potential habitat for the species to occur, the preferred vegetation types are not present within the site. A large number of previous records occur within the locality, however these are located approximately 7 km from the proposal site. Species not associated with any of the PCTs that occur within proposal site.
<i>Thesium australe</i>	Austral Toadflax	-	V	V	Habitat may occur within area	-	-	-	-	Found in small, scattered populations along the east coast, northern and southern tablelands. Occurs in grassland or grassy woodland, and is often found in association with Kangaroo Grass.	Low	No suitable habitat present. Historical grazing of grassland vegetation within the proposal site indicates that this species is unlikely to occur. Themeda not recorded within proposal site.
<i>Zannichellia palustris</i>	-	-	E	-	-	Y	-	-	-	Known from the Lower Hunter and Sydney Olympic Park. A submerged aquatic plant that grows in fresh or slightly saline water.	Low	Marginal habitat present within man made dams. Not previously recorded in locality
<i>Anseranas semipalmata</i>	Magpie Goose	Bird	V	-	-	-	Y	1	4092	Occurs in the tropics, increasing numbers in central and northern NSW and vagrants to south-east NSW. Inhabits shallow wetlands containing dense rushes or sedges, and nearby dry land used for grazing. It feeds on grasses, bulbs and rhizomes and roosts in tall vegetation within wetland areas. Breeding is occurs predominately in monsoonal areas and is unlikely in SE NSW. Nests are formed in trees over deep water.	Low	Breeding very unlikely within the proposal site due to its location. Marginal foraging wetland habitat occurs within the proposal site. The species is more likely to utilise the wetland habitat adjacent to the proposal site. Only one previous record within the locality approximately 4 km from the proposal site.

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<i>Anthochaera phrygia</i>	Regent Honeyeater	Bird	CE	CE	Habitat known to occur within area	Y (parts of the site mapped as important habitat)	Y	92	1202	In NSW confined to two known breeding areas: the Capertee Valley and Bundarra-Barraba region. Non-breeding flocks occasionally seen in coastal areas foraging in flowering Spotted Gum and Swamp Mahogany forests, presumably in response to drought. Inhabits dry open forest and woodlands, particularly Box-Ironbark woodland and riparian forests of River Sheoak, with an abundance of mature trees, high canopy cover and abundance of mistletoes.	Moderate	Potential foraging habitat present. Expert report indicates site does not contain suitable breeding habitat for this species. Mistletoe abundance is low.
<i>Arenaria interpres</i>	Ruddy Turnstone	Bird	-	Mi	Habitat known to occur within area	-	-	-	-	Breeds in northern Hemisphere. In non-breeding season, widespread in most coastal regions of Australia with occasional inland records. Strongly prefers rocky shores or beaches with large seaweed deposits.	None	No suitable habitat within the subject site.
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow	Bird	V	-	-	-	-	29	2143	The Dusky Woodswallow is widespread from the coast to inland, including the western slopes of the Great Dividing Range and farther west. It is often recorded in woodlands and dry open sclerophyll forests, and has also been recorded in shrublands, heathlands regenerating forests and very occasionally in moist forests or rainforests. The understorey is typically open with sparse eucalypt saplings, acacias and other shrubs, often with coarse woody debris. It is also recorded in farmland, usually at the edges of forest or woodland or in roadside remnants or wind breaks with dead timber. The nest is an open shallow untidy cup frequently built in an open hollow, crevice or stump. Although Dusky Woodswallows have large home ranges, individuals may spend most of their time in about a 2 ha range and defend an area about 50 m around the nest. Dusky Woodswallows prefer larger remnants over smaller remnants. Competitive exclusion by Noisy Miners (<i>Manorina melanocephala</i>) is a significant threat to this species.	Moderate	The species has a high number of records within the locality. Suitable dry sclerophyll forests occur within the proposal site for both foraging and breeding.
<i>Botaurus poiciloptilus</i>	Australasian Bittern	Bird	E	E	Habitat known to occur within area	-	Y	-	-	Widespread but uncommon over most NSW except the northwest. Favours permanent freshwater wetlands with tall dense reedbeds particularly <i>Typha</i> spp. and <i>Eleocharis</i> spp., with adjacent shallow, open water for foraging. Roosts during the day amongst dense reeds or rushes and feeds mainly at night on frogs, fish, yabbies, spiders, insects and snails.	Low	Marginal wetland habitat with retention basins. No previous records within the locality of the proposal site.
<i>Burhinus grallarius</i>	Bush Stone-curlew	Bird	E	-	-	Y	-	-	-	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Nest on the ground in a scrape or small bare patch.	Low	Suitable habitat occurs within the proposal site, however due to not found during targeted surveys and no previous records within the locality, the species is unlikely to occur.
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	Bird	V	-	-	Y (Breeding)	Y	15	2815	Restricted to the south-eastern coast and highlands, from the lower Hunter and northern Blue Mountains to the Southwestern Slopes, south to and contiguous with the Victorian population. Inhabits eucalypt open forests and woodlands with an acacia understorey. In summer it lives in moist highland forest types, and in winter it moves to more open types at lower elevations. The Gang-Gang Cockatoo nests in hollows in the trunks, limbs or dead spouts of tall living trees, especially eucalypts, often near water. The Gang-gang Cockatoo feeds on seeds obtained in trees and shrubs, mostly from eucalypts and wattles.	Low	No suitable breeding habitat present within the site. The species was not found during targeted surveys
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	Bird	V	-	-	Y (Breeding)	Y	16	2544	Widespread but uncommon from coast to southern tablelands and central western plains. Feeds almost exclusively on the seeds of <i>Allocasuarina</i> species. Prefers woodland and open forests, rarely away from <i>Allocasuarina</i> . Roost in leafy canopy trees, preferably eucalypts, usually <1 km from feeding site. Nests in large (approx. 20 cm) hollows in trees, stumps or limbs, usually in Eucalypts (Higgins 1999).	Low	Potential foraging <i>Casuarina</i> sp. Vegetation within the proposal site. A moderate number of records have previously been recorded within close proximity to the proposal site. Despite this, the species was not found during targeted surveys

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<i>Chlidonias leucopterus</i>	White-winged Black Tern	Bird	-	Mi	-	-	-	1	9909	Breeds in northern hemisphere, and one breeding record in New Zealand. In NSW, widespread east of the Great Divide, mainly north from Wollongong but with scattered records further south. Mostly inhabits a wide range of fresh, brackish or saline wetlands, which may be open or with floating emergent or marginal vegetation. Rarely occur on inland wetlands. Mainly forages aerially over water or muddy/ sandy wetland edges and adjacent habitats.	Low	proposal site occurs approximately 30 km from the coast. Only one previous record approximately 10 km away from the proposal site.
<i>Chthonicola sagittata</i>	Speckled Warbler	Bird	V	-	-	-	Y	19	107	Within NSW most frequently reported from the hills and tablelands of the Great Dividing Range, rarely from the coast. Inhabits a wide range of Eucalyptus-dominated communities with a grassy understorey, a sparse shrub layer, often on rocky ridges or in gullies. Sedentary and requires large, relatively undisturbed remnants to persist in an area. Forages on the ground for seeds and insects, and nests in a slight hollow in the ground or at the base of a low dense plant.	Moderate	Suitable nesting and foraging habitat occurs within the proposal site despite not occurring on rocky ridges and gullies. Eucalypt spp. communities with grassy understoreys allow for the species potential persistence within the site. A high number of records in close proximity to the proposal site indicates that this species is likely to occur.
<i>Circus assimilis</i>	Spotted Harrier	Bird	V	-	-	-	Y	2	4130	Occurs throughout Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Inhabits grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods). Most commonly in native grassland, but also in agricultural land, foraging over open habitats including edges of inland wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn).	Moderate	A low number of previous records within the locality. Potential foraging and breeding habitat within the proposal site. Known presence of other raptor species may discourage the Spotted Harrier from inhabiting the proposal site.
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	Bird	V	-	-	-	Y	60	3026	Occurs from Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell to the east coast, in areas such as the Snowy River Valley, Cumberland Plain, Hunter Valley and parts of the Richmond and Clarence Valleys. Most common on the inland slopes and plains. Inhabits eucalypt woodlands and dry open forest, usually dominated by stringybarks or rough-barked species with open grassy understorey. Fallen timber is important foraging habitat. Nests in hollows in standing trees or stumps.	High	The proposal site has suitable foraging and breeding habitat, which is characteristic of Eucalypt woodlands and dry open forest. A high number of hollows also occur within the proposal site. The species has also been previously recorded in high numbers within 3 km of the proposal site.
<i>Cuculus optatus</i>	Oriental Cuckoo	Bird	-	Mi	Habitat may occur within area	-	-	-	-	This species migrates to northern and eastern Australia in the warmer months. Occurs south to the Shoalhaven area. Occurs in a range of habitats, including monsoon forest, rainforest edges, leafy trees in paddocks, river flats, roadsides and mangroves. It will forage from the ground, but requires shrubs or trees from which it sallies and returns to consume prey items.	Low	Marginal habitat occurs on site including remnant trees in paddocks and floodplain vegetation. No previous records within the locality of the proposal site.
<i>Daphoenositta chrysoptera</i>	Varied Sittella	Bird	V	-	-	-	Y	30	0	Sedentary, occurs across NSW from the coast to the far west. Inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Sensitive to habitat isolation and loss of structural complexity, and adversely affected by dominance of Noisy Miners. Cleared agricultural land is potentially a barrier to movement. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in	High	Observed adjacent to the proposal land (Cessnock LGA) during targeted surveys. A high number of previous records within close proximity to the proposal site. Potential breeding and foraging habitat occurs within the proposal site.
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	Bird	E	E	Habitat likely to occur within area	-	-	-	-	Occurs in three disjunct areas of south-eastern Australia: southern Queensland/northern NSW, the Illawarra Region and in the vicinity of the NSW/Victorian border. Illawarra population comprises an estimated 1600 birds, mainly from Barron Grounds Nature Reserve, Budderoo National Park and the Jarvis Bay area. Habitat characterised by dense, low vegetation including heath and open woodland with a heathy understorey. The fire history of habitat is important, and the Illawarra and southern populations reach maximum densities in habitat that have not been burnt for over 15 years.	Low	The proposal site is not located within the three disjunct areas of known populations. No previous records within the locality. Recent fire within some areas of the proposal site may discourage the species from inhabiting the site.

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<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	Bird	E	-	-	-	Y	14	639	In NSW, becomes increasingly uncommon south of the Northern Rivers region, and rarely occurs south of Sydney. Breeding recorded as far south as Bulahdelah, though most breeding in NSW occurs in the north-east. Primarily inhabits permanent freshwater wetlands and surrounding vegetation including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters. Will also forage in intertidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water. Breeds during summer, nesting in or near a freshwater swamp.	Low	Marginal foraging wetland habitat occurs within the proposal site. The species is more likely to utilise the wetland habitat adjacent to the proposal site.
<i>Ephianura albifrons</i>	White-fronted Chat	Bird	V	-	-	-	Y	1	8060	This species occurs from southern Queensland to Western Australia and down to Tasmania, mostly in temperate to arid climates and very rarely in sub-tropical areas. It is found in damp open habitats, particularly wetlands containing saltmarsh areas that are bordered by open grasslands. Along the coast they are found in estuarine and marshy habitats with vegetation <1 m tall, and in open grasslands and areas bordering wetlands. Inland, they are often observed in grassy plains, saltlakes and salt pans along waterway margins.	Low	No suitable habitat within proposal site. Only one previous record within the locality within approximately 8 km of the proposal site.
<i>Erythrotriorchis radiatus</i>	Red Goshawk	Bird	CE	V	Habitat likely to occur within area	-	-	-	-	Very rare in NSW, generally confined to the Northern Rivers bioregion with most records in the Clarence River catchment with few around the lower Richmond and The Black Falcon is widely, but sparsely, distributed in New South Wales, mostly occurring in inland regions. Some reports of 'Black Falcons' on the tablelands and	Low	Suitable open woodland occurs on site with <i>Melaleuca</i> spp and <i>Eucalypt</i> spp occurring on site. These are marginally riparian with some areas being ephemeral. Permanent water occurs within and adjacent to the site within the locality
<i>Falco subniger</i>	Black Falcon	Bird	V	-	-	-	-	1	4622	Some reports of 'Black Falcons' on the tablelands and	Moderate	Potential foraging and breeding habitat within the proposal site. Known presence of other raptor species may discourage the Black Falcon from inhabiting the proposal site.
<i>Gallinago hardwickii</i>	Latham's Snipe	Bird	-	Mi	Habitat known to occur within area	-	-	7	3658	Occurs along the coast and west of the Great Dividing Range. Non breeding visitor to Australia. Inhabit permanent and ephemeral wetlands up to 2000 m asl. Typically in open, freshwater wetlands with low, dense vegetation (incl. swamps, flooded grasslands and heathlands). Can also occur in saline/brackish habitats and in modified or artificial habitats close to human activity.	Low	No suitable wetland habitat within proposal site.
<i>Glossopsitta pusilla</i>	Little Lorikeet	Bird	V	-	-	-	Y	109	0	Occurs from coast to western slopes of the Great Dividing Range. Inhabits dry, open eucalypt forests and woodlands. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Feed primarily on profusely-flowering eucalypts and a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands <i>Eucalyptus albens</i> and <i>E. melliodora</i> are particularly important food sources for pollen and nectar respectively. Mostly nests in small (opening approx. 3 cm) hollows in living, smooth-barked eucalypts, especially <i>Eucalyptus viminalis</i> , <i>E. blakelyi</i> and <i>E. dealbata</i> . Most breeding records are from the western slopes.	High	Observed adjacent to the proposal land (Cessnock LGA) during targeted surveys. May utilise flower eucalypts within the site for foraging.
<i>Grantiella picta</i>	Painted Honeyeater	Bird	V	V	Habitat likely to occur within area	-	Y	-	-	Nomadic, occurring in low densities across most of NSW. Highest concentrations and almost all breeding occur on inland slopes of the Great Dividing Range. Inhabits Boree, Brigalow and Box Gum woodlands and Box-Ironbark forests. Specialist forager on the fruits of mistletoes, preferably of the <i>Amyema</i> genus. Nests in outer tree canopy.	Low	No breeding habitat within the proposal site, as it is not located on the inland sloped of the Great Dividing Range. Despite Box Gum woodlands and Box-Ironbark woodlands being present, mistletoe's are rare throughout the site. No previous records within the locality.
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	Bird	V	Ma	-	Y (Breeding)	Y (foraging)	25 to 28	0	Primarily coastal but may extend inland over major river systems. Breeds close to water, mainly in tall open forest/woodland but also in dense forest, rainforest, closed scrub or remnant trees. Usually forages over large expanses of open water, but also over open terrestrial habitats (e.g. grasslands).	High	Observed foraging adjacent to the site during site surveys (Cessnock LGA). A high number of previous records within the locality within very close proximity. Suitable foraging habitat within the site. No active nests were observed on site.

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<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	Bird	V	-	-	-	-	3	4084	Sparsely distributed in areas of less than 500 mm rainfall, north from north-western NSW. Inhabits a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. Also hunts over grasslands and sparsely timbered woodlands. Breeds from August to October near water in a tall tree.	Low	Some foraging and breeding habitat within the proposal site. Known presence of other raptor species may discourage the Black-breasted Buzzard from inhabiting the proposal site.
<i>Hieraaetus morphnoides</i>	Little Eagle	Bird	V	-	-	Y (Breeding)	Y (foraging)	4	3026	Occurs throughout NSW except most densely forested parts of the Dividing Range escarpment. Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring.	Moderate	Potential foraging and breeding habitat within the proposal site. Known presence of other raptor species may discourage the Little Eagle from inhabiting the proposal site.
<i>Hirundapus caudacutus</i>	White-throated Needletail	Bird	-	V, Mi	Habitat known to occur within area	-	-	10	5114	Recorded along NSW coast to the western slopes and occasionally from the inland plains. Breeds in northern hemisphere. Almost exclusively aerial while in Australia. Occur above most habitat types, but are more frequently recorded above more densely vegetated habitats (rainforest, open forest and heathland) than over woodland or treeless areas.	Moderate	Species likely to utilise the project area for fly-overs only. The open woodland and grassland areas within the proposal site provide lesser preferred habitat than densely vegetated habitats.
<i>Irediparra gallinacea</i>	Comb-crested Jacana	Bird	V	-	-	-	Y	15	3899	Occurs on freshwater wetlands in northern and eastern Australia, mainly in coastal and subcoastal regions, from the north-eastern Kimberley Division of Western Australia to Cape York Peninsula then south along the east coast to the Hunter region of NSW – some recorded in south-eastern NSW potentially in response to unfavourable conditions (OEH 2012). Inhabit permanent freshwater wetlands, either still or slow-flowing, with a good surface cover of floating vegetation, especially water-lilies, or fringing and aquatic vegetation.	Low	No suitable wetland habitat within proposal site.
<i>Ixobrychus flavicollis</i>	Black Bittern	Bird	V	-	-	-	Y	2	668	Occurs from southern NSW to Cape York and the Kimberley, and southwest WA. Inhabits terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. May occur in flooded grassland, forest, woodland, rainforest and mangroves as long as there is permanent water. Roosts by day in trees or within reeds on the ground. Nests in branches overhanging water and breeds from December to March.	Low	No suitable wetland habitat within proposal site.
<i>Lathamus discolor</i>	Swift Parrot	Bird	E	CE	Habitat known to occur within area	Y (Breeding)	Y (foraging)	73	619	Migratory, travelling to the mainland from March to October. Breeds in Tasmania from September to January. On the mainland, it mostly occurs in the southeast foraging on winter flowering eucalypts and lerps, with records of the species between Adelaide and Brisbane. Principal over-winter habitat is box-ironbark communities on the inland slopes and plains. Eucalyptus robusta, Corymbia maculata and C. gummifera dominated coastal forests are also important habitat.	Low	The species has a high number of previous records within close proximity to the proposal site. Marginal suitable foraging habitat present.
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	Bird	V	Mi	Habitat known to occur within area	-	-	-	-	Breeds in the northern hemisphere. In the non-breeding season most common in north and north west of Australia, but is a regular visitor in small numbers to the NSW coast from Ballina to Shoalhaven Heads. Occurs on sheltered parts of the coast, favouring estuarine mudflats but also occasionally in saltmarshes, freshwater lagoons, saltworks and sewerage farms. Forage on exposed mudflats or wet sand.	None	No suitable habitat within the subject site.
<i>Limosa lapponica baueri</i>	Bar-tailed Godwit	Bird	-	V, Mi	Habitat known to occur within area	-	-	-	-	Has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria, including the offshore islands. Breeds in the north of Scandinavia, Russia and north-west Alaska. Found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays.	None	No suitable habitat within the subject site.

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<i>Limosa lapponica menzibieri</i>	Northern Siberian Bar-tailed Godwit	Bird	-	CE	Habitat may occur within area	-	-	-	-	The Northern Siberian Bar-tailed Godwit is a large Migratory shorebird which breeds in northern Siberia, Russia between the Khatanga River and the delta of the Kolyma River. During the non-breeding period, the distribution of <i>L. l. menzibieri</i> is predominantly in the north and north-west of Western Australia and in south-eastern Asia.	None	No suitable habitat within the subject site.
<i>Limosa limosa</i>	Black-tailed Godwit	Bird	V	Mi	Habitat known to occur within area	-	-	-	-	The Black-tailed Godwit is a migratory wading bird that breeds in Mongolia and Eastern Siberia and flies to Australia for the southern summer, arriving in August and leaving in March. In NSW, it is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the north and south coast, and inland. Records in western NSW indicate that a regular inland passage is used by the species, as it may occur around any of the large lakes in the western areas during summer, when the muddy shores are exposed. It is usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. It has also been found around muddy lakes and swamps, wet fields and sewerage treatment works.	None	No previous records within the locality of the subject site. No muddy wetland flats or lakes occur within the subject site. May utilise adjacent wetland habitat which would provide better suited habitat for the species.
<i>Lophoictinia isura</i>	Square-tailed Kite	Bird	V	-	-	-	Y	6	3026	Occurs across NSW, resident in North, northeast and along west-flowing rivers. Summer breeding migrant to southeast of state. Inhabits a variety of habitats including woodlands and open forests, with preference for timbered watercourses. Favours productive forests on the coastal plain, box-ironbark-gum woodlands on the inland slopes, and Coolibah/River Red Gum on the inland plains. In Sydney area nests in mature living trees within 100 m of ephemeral/permanent watercourse. Large home range > 100 km ² .	Low	Potential foraging and breeding habitat within the proposal site. Known presence of other raptor species may discourage the Square-tailed Kite from inhabiting the proposal site. The species was not found during targeted surveys
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	Bird	V	-	-	-	Y	1	5535	Considered a sedentary species, but local seasonal movements are possible. Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Nests on low, live or dead forks or branches of trees or stumps, or occasionally on fallen trees or limbs.	Moderate	Suitable open woodland habitat within the proposal site adjacent to clearings and open areas. Only one previous record within the locality. Potential breeding habitat within the proposal site.
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	Bird	V	-	-	-	-	88	2696	Widespread in NSW, but rarely recorded east of Great Dividing Range except in Richmond and Clarence River areas and scattered sites in the Hunter, Central Coast and Illawarra regions. Mostly in upper levels of drier open forests /woodlands dominated by box and ironbark eucalypts, or less commonly smooth-barked gums, stringybarks and tea-trees. Forage over home range of >5 ha. Tend to occur within largest woodland patches in the landscape. They forage for insects, nectar and honeydew. The nest is hidden by foliage high in the crown of a tree.	High	Suitable box-ironbark vegetation within the proposal site for foraging and nesting. The species has previously been recorded in high number within the locality and has been recorded within approximately 2.5 km from the proposal site.
<i>Monarcha melanopsis</i>	Black-faced Monarch	Bird	-	Mi	Habitat known to occur within area	-	-	-	-	Found along the coast of eastern Australia, becoming less common further south. Found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. Resident in the north of its range, but is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March. It may also migrate to Papua New Guinea in autumn and winter.	Moderate	No rainforest habitat within the proposal site. May utilise the open woodland within the proposal site for foraging or roosting, however it does not occur within a damp gully. Despite being characteristic of floodplain vegetation, these areas may still remain predominantly dry throughout the year. No previous records within the locality.
<i>Motacilla flava</i>	Yellow Wagtail	Bird	-	Mi	Habitat likely to occur within area	-	-	-	-	This species breeds in temperate Europe and Asia. They occur within Australia in open country habitat with disturbed ground and some water. Recorded in short grass and bare ground, swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land and town lawns.	Low	Rare migrant to Australia, records in NSW concentrated in the Hunter Estuary. Unlikely to occur.

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<i>Myiagra cyanoleuca</i>	Satin Flycatcher	Bird	-	Mi	Habitat known to occur within area	-	-	-	-	In NSW widespread on and east of the Great Divide, sparsely scattered on the western slopes, very occasional records on the western plains. Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, often near wetlands and watercourses. On migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. Generally not in rainforests.	Low	Suitable eucalypt dominated habitat within the proposal site in close proximity to adjacent wetland habitat. The proposal site is not however located within a heavily vegetated gully, nor would be considered a taller woodland, with many of the vegetation communities characteristic of young trees. No previous records within the locality.
<i>Neophema pulchella</i>	Turquoise Parrot	Bird	V	-	-	-	Y	10	2634	Occurs from coast to inland slopes. In coastal area, most common between Hunter and Northern Rivers, and further south in S Coast. Inhabits open eucalypt woodlands and forests, typically with a grassy understorey. Favours edges of woodlands adjoining grasslands or timbered creek lines and ridges. Feeds on the seeds of native and introduced grasses and other herbs. Grasslands and open areas provide important foraging habitat for this species while woodlands provide important roosting and breeding habitat. Nests in tree hollows, logs or posts from August to December.	Moderate	Suitable breeding and foraging habitat available within the proposal site.
<i>Ninox connivens</i>	Barking Owl	Bird	V	-	-	Y (Breeding)	Y (foraging)	4	4	Occurs from coast to inland slopes and plains, though is rare in dense, wet forests east of the Great Dividing Range and sparse in higher parts of the tablelands and in the arid zone. Inhabits eucalypt woodlands, open forest, swamp woodlands, and, especially in inland areas, timber along watercourses. Roosts along creek lines in dense, tall understorey foliage (e.g. in Acacia and Casuarina), or dense eucalypt canopy. Nests in hollows of large, old eucalypts including <i>Eucalyptus camaldulensis</i> , <i>Eucalyptus albens</i> , <i>Eucalyptus polyanthemos</i> and <i>Eucalyptus blakelyi</i> . Birds and mammals important prey during breeding. Territories range from 30 to 200 ha.	Low	The proposal site doesn't contain suitable hollow-bearing trees to support breeding for this species. Lack of suitable vegetated habitat suggests species is unlikely to occur.
<i>Ninox strenua</i>	Powerful Owl	Bird	V	-	-	Y (Breeding)	Y (foraging)	39	0	Occurs from the coast to the western slopes. Solitary and sedentary species. Inhabits a range of habitats from woodland and open sclerophyll forest to tall open wet forest and rainforest. Prefers large tracts of vegetation. Nests in large tree hollows (> 0.5 m deep), in large eucalypts (dbh 80-240 cm) that are at least 150 years old. Pairs have high fidelity to a small number of hollow-bearing nest trees and defend a large home range of 400 - 1,450 ha. Forages within open and closed woodlands as well as open areas.	Low	Lack of suitable hollows within the proposal site to support breeding. May forage in forested areas of the site associated with the riparian corridor. Previously been recorded adjacent to the site.
<i>Numenius minutus</i>	Little Curlew	Bird	-	Mi	-	-	-	2	1120	Generally spend the non-breeding season in northern Australia. In NSW, most records are scattered east of the Great Dividing Range, from Casino, south to Greenwell Point with a few scattered records west of the Great Dividing Range. Recorded breeding in Siberia. Most often found feeding in short, dry grassland and sedgeland, including dry floodplains and blacksoil plains, which have scattered, shallow freshwater pools or areas seasonally inundated. Open woodlands with a grassy or burnt understorey, dry saltmarshes, coastal swamps, mudflats or sandflats of estuaries or beaches on sheltered coasts, mown lawns, gardens, recreational areas, ovals, racecourses and verges of roads and airstrips are also used.	Low	No suitable habitat within the proposal site.
<i>Oxyura australis</i>	Blue-billed Duck	Bird	V	-	-	-	Y	6	6147	Partly migratory, travels short distances between breeding swamps and over-wintering lakes. Young birds disperse in April-May from breeding swamps in inland NSW to Murray River system and coastal lakes. Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. Nests in Cumbungi over deep water or in trampled Lignum, sedges or spike-rushes. Completely aquatic, swimming along the edge of dense cover.	Low	No suitable habitat within the proposal site.

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<i>Pandion cristatus</i>	Eastern Osprey	Bird	V	-	-	Y (Breeding)	Y (foraging)	2	6156	Favours coastal areas, especially the mouths of large rivers, lagoons and lakes. They feed on fish over clear, open water. Breeding takes place from July to September in NSW, with nests being built high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea, though there are a handful of records from inland areas.	Low	Only one previous record within the locality approximately 9 km from the proposal site. Whilst foraging habitat occurs within the proposal site, the proposal site is located approximately 30 km from the coast.
<i>Pandion haliaetus</i>	Osprey	Bird	V	Mi	Habitat known to occur within area	-	-	-	-	The Osprey is found around the Australian coast line, except for Victoria and Tasmania. They favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Ospreys feed on fish over clear, open water and breed from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.	Low	The proposal site is located within approximately 30 km of the coast. Whilst permanent stands of water occur within the proposal site, this does not meet the open water criteria for foraging habitat. Breeding and foraging behaviour unlikely to occur within the proposal site. No previous records within the locality.
<i>Petroica boodang</i>	Scarlet Robin	Bird	V	-	-	-	Y	8	714	In NSW occurs from coast to inland slopes. Breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within open understorey of shrubs and grasses and sometimes in open areas. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. Abundant logs and coarse woody debris are important habitat components.	Moderate	Suitable habitat within the proposal site. A low number of previous records within the locality with the nearest record being approximately 700 m from the proposal site.
<i>Petroica phoenicea</i>	Flame Robin	Bird	V	-	-	-	-	2	1251	Breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. Migrates in winter to more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains. Forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris. Fallen logs and coarse woody debris are important habitat components. Open cup nest of plant fibres and cobweb is often built near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank.	Moderate	The proposal site is located on the lowland habitats from which grasslands and open woodlands within the proposal site provide Winter foraging habitat. Two previous records within the locality with the nearest record occurring approximately 1.2 km from the proposal site indicate that this species may utilise the habitat to forage.
<i>Philomachus pugnax</i>	Ruff	Bird	-	Mi	Habitat known to occur within area	-	-	-	-	In NSW the species has been recorded at Kurnell, Tomiki, Casino, Ballina, Kooragang Island, Broadwater Lagoon and Little Cattai Creek. The species has also found around the Riverina, including Windouran Swamp, Wanganella, Fivebough Swamo abd the Tullakool Saltworks. Most NSW records come from the Sydney region. In Australia the Ruff is found on generally fresh, brackish of saline wetlands with exposed mudflats at the edges. It is found in terrestrial wetlands including lakes, swamps, pools, lagoons, tidal rivers, swampy fields and floodlands. They are occasionally seen on sheltered coasts, in harbours, estuaries, seashores and are known to visit sewage farms and saltworks. They are sometimes found on wetlands surrounded by dense vegetation including grass, sedges, saltmarsh and reeds.	Low	Despite wetland habitat present within the proposal site, it is not sizeable enough for the species to occur. The species is more likely to inhabit the wetland areas adjacent to the proposal site. The wetland habitat within the proposal site does not provide exposed mudflats or saltmarsh. No previous records within the locality.
<i>Pluvialis fulva</i>	Pacific Golden Plover	Bird	-	Mi	Habitat known to occur within area	-	-	-	-	Widespread in coastal regions, though there are also a number of inland records (in all states), sometimes far inland and usually along major river systems, especially the Murray and Darling Rivers and their tributaries. Most Pacific Golden Plovers occur along the east coast, and are especially widespread along the Queensland and NSW coastlines. Breeds mostly in northern Siberia as well as in western Alaska. In Australia this species usually inhabits coastal habitats, though it occasionally occurs around inland wetlands.	Low	No previous records within the locality of the proposal site. proposal site is located approximately 30 km from the coast.
<i>Pluvialis squatarola</i>	Grey Plover	Bird	-	Mi	Habitat known to occur within area	-	-	1	5971	Breed in the northern Hemisphere. Widespread on Australian coast in the non-breeding season. Occur almost entirely in coastal areas, usually in sheltered embayments with mud or sandflats and occasionally on rocky coasts or near-coastal lakes and swamps. Very occasionally recorded further inland. Forage on exposed mudflats and beaches.	None	No suitable habitat within the subject site.

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<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	Bird	V	-	-	-	Y	127	0	Occurs on western slopes and plains, as well as in the Hunter Valley and several locations on the north coast. Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Family groups have territories between 1-50 (generally around 10) ha. Nests typically built in shrubs or sapling eucalypts.	Recorded	Suitable Box-Gum woodlands and alluvial plains occur within the proposal site. This species was observed on site during site surveys. A high number of previous records also occur within the locality.
<i>Rhipidura rufifrons</i>	Rufous Fantail	Bird	-	Mi	Habitat known to occur within area	-	-	-	-	Occurs in coastal and near coastal districts of northern and eastern Australia. Has breeding populations in NSW. Two subspecies intergrade in a zone between the Queensland-NSW border ranges and the Clarence-Orara rivers in NSW. The species mainly inhabits wet sclerophyll forests, often in gullies dominated by <i>Eucalyptus microcorys</i> , <i>E. cytellocarpa</i> , <i>E. radiata</i> , <i>E. regnans</i> , <i>E. delegatensis</i> , <i>E. pilularis</i> or <i>E. resinifera</i> ; usually with a dense shrubby understorey, often including ferns. They also occur in subtropical and temperate rainforests. They occasionally occur in secondary regrowth, following logging or disturbance in forests or rainforests. When on passage, they are sometimes recorded in drier sclerophyll forests and woodlands, including <i>Eucalyptus maculata</i> , <i>E. melliodora</i> , ironbarks or stringybarks, often with a shrubby or heath understorey.	Low	No previous records within the locality. Marginal potential habitat occurs within the proposal site. .
<i>Rostratula australis</i>	Australian Painted Snipe	Bird	E	E	Habitat known to occur within area	-	Y	1	693	Normally found in permanent or ephemeral shallow inland wetlands, either freshwater or brackish. Nests on the ground amongst tall reed-like vegetation near water. Feeds on mudflats and the water's edge taking insects, worm and seeds. Prefers fringes of swamps, dams and nearby marshy areas with cover of grasses, lignum, low scrub or open timber.	Low	No suitable wetland habitat within proposal site.
<i>Sterna albifrons</i>	Little Tern	Bird	E	Mi	-	-	-	1	1120	In eastern Australia, many breeding colonies lie within conservation reserves, or within Ramsar-listed wetlands, or both. Little Terns occur in two Ramsar listed sites in NSW, Towra Point Nature Reserve and Hunter Estuary Wetlands (including Kooragang Nature Reserve). Inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets, especially those with exposed sandbanks or sand-spits, and also on exposed ocean beaches.	Low	No suitable wetland habitat within proposal site.
<i>Stictonetta naevosa</i>	Freckled Duck	Bird	V	-	-	-	Y	4	9925	Breeds in large, ephemeral swamps in the Murray-Darling, particularly along the Paroo and Lachlan Rivers and other Riverina rivers. In drier times moves to more permanent waters. Disperses during extensive inland droughts and may be found in coastal areas during such times. Prefers freshwater swamps/creeks with dense Cumbungi, Lignum or tea-tree. Nests in dense vegetation at or near water level.	Low	Suitable habitat occurs within the proposal site, however closest previous record occurred approximately 10 km from the proposal site with only four records within the locality. The proposal appears to be located on the edge of the species range.
<i>Tringa glareola</i>	Wood Sandpiper	Bird	-	Mi	-	-	-	2	9925	Breeds in N Hemisphere. Occurs in largest numbers in NW Australia, with all sites of national importance within WA. In NSW there are records east of the Divide north from Nowra, and inland from the upper and lower Western regions. Uses well-vegetated, shallow, freshwater wetlands and are typically associated with wetlands supporting emergent aquatic plants or grass and taller fringing vegetation such as dense reeds/rushes, shrubs or trees. Also frequent flooded grasslands and irrigated crops. Rarely in brackish wetlands or saltmarsh. Known from artificial wetlands.	Low	No suitable wetland habitat within proposal site.
<i>Tringa stagnatilis</i>	Marsh Sandpiper	Bird	-	Mi	Habitat known to occur within area	-	-	2	693	Breeds in N Hemisphere. Occurs in coastal and inland wetlands, including freshwater and estuarine habitats, throughout Australia. All regions of NSW but particularly central and south coasts and western slopes and plains. Sites of national importance in NSW include Parkes wetlands, Macquarie Marshes and Tullakool Evaporation Ponds.	Low	No suitable wetland habitat within proposal site.

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<i>Tyto longimembris</i>	Eastern Grass Owl	Bird	V	-	-	-	Y	-	-	Most common in N and NE Australia, but recorded in all mainland states. In NSW most likely to be resident in the NE. Inhabit areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. Nests on the ground in trodden grass, and are often accessed by tunnels through vegetation.	Low	No suitable habitat within proposal site
<i>Tyto novaehollandiae</i>	Masked Owl	Bird	V	-	-	Y (Breeding)	Y (foraging)	21	3026	Occurs across NSW except NW corner. Most common on the coast. Inhabits dry eucalypt woodlands from sea level to 1100 m. Roosts and breeds in large (>40 cm) hollows and sometime caves in moist eucalypt forested gullies. Hunts along the edges of forests and roadsides. Home range between 500 ha and 1000 ha. Prey mostly terrestrial mammals but arboreal species may also be taken.	Low	Not observed during targeted surveys for owls with similar habitat requirements despite suitable conditions. No previous records within the locality. No suitable breeding habitat present.
<i>Tyto tenebricosa</i>	Sooty Owl	Bird	V	-	-	-	-	5	1961	Occurs in the coastal, escarpment and tablelands regions of NSW. More common in the north and absent from the western tablelands and further west. Inhabits tall, moist eucalypt forests and rainforests, and are strongly associated with sheltered gullies, particularly those with tall rainforest understorey. Roosts in tree hollows, amongst dense foliage in gullies or in caves, recesses or ledges of cliffs or banks. Nest in large (>40 cm wide, 100 cm deep) tree hollows in unlogged/unburnt gullies within 100 m of streams or in caves.	Low	Species prefers moist eucalypt forest and rainforest within sheltered gullies
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	Frog	V	V	Habitat may occur within area	-	-	-	-	Occurs along the coast and eastern slopes of the Great Dividing Range south from Wollemi National Park. Appears to exist as 2 populations with a 100 km gap in records between Jervis Bay and Eden. Northern population occurs on sandy soils supporting heath, woodland or open forest. Breeds in ephemeral to intermittent streams with persistent pools. Only infrequently moves to breeding sites, most commonly found on ridges away from creeks, several hundred metres from water.	None	Small section of intermittent creekline occurs on site however subject site is located north east of Wollemi National Park and therefore outside of this species known range. No ridges occur within the subject site. No previous records of the species have been recorded.
<i>Litoria aurea</i>	Green and Golden Bell Frog	Frog	E	V	Habitat known to occur within area	Y	-	8	852	Formerly occurred from Brunswick Heads to Victoria, but >80% populations now extinct. Inhabits marshes, natural and artificial freshwater to brackish wetlands, dams and in stream wetlands. Prefers sites containing cumbungi (<i>Typha</i> spp.) or spike rushes (<i>Eleocharis</i> spp.), which are unshaded and have a grassy area and/or rubble as shelter/refuge habitat nearby. <i>Gambusia holbrooki</i> is a key threat as they feed on green and Golden Bell Frog eggs and tadpoles.	Low	Despite suitable habitat on site, species not found during targeted surveys. The nearest previous record within the locality is approximately 800 m from the proposal site. Species expert (Frank Lemckert) concluded that there is a low likelihood of the species occurring within proposal site (refer to Appendix H)
<i>Litoria brevipalmata</i>	Green-thighed Frog	Frog	V	-	-	Y	-	2	4385	Occurs north from Gosford to Qld. Breeding occurs in flooded semi-permanent or ephemeral pools, usually in grassy areas and within 100 m of significant stands of native vegetation (Ehman 1997, Lemckert et al 2006). Can tolerate some disturbance but not found in >50% cleared grazing land or entirely urban areas (Ehmann 1997, Lemckert et al 2006). Usually associated with moist forest (swamp forest, wet sclerophyll or rainforest) but often recorded from dry sclerophyll forests in the northern part of its range (Lemckert et al 2006).	Low	Suitable ephemeral habitat within the proposal site, particularly the floodplain woodlands and forests. The proposal site has historically been disturbed in most areas, particularly in areas which may have suited the Green-thighed Frog. Species expert (Frank Lemckert) determined site is unlikely to provide habitat for this species (refer to Appendix H)
<i>Uperoleia mahonyi</i>	Mahoney's toadlet	Frog	E	-	-	Y	-	-	-	Mahony's Toadlet is endemic to the mid-north coast of New South Wales (NSW) between Kangy Angy and Seal Rocks. Mahony's Toadlet inhabits ephemeral and semi-permanent swamps and swales on the coastal fringe of its range occurring in heath or wallum habitats almost exclusively associated with leached (highly nutrient impoverished) white sand. Commonly associated with acid paperbark swamps wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney red gum woodland. Records are associated with shallow ephemeral/semi-permanent water bodies with limited flow of water. Aquatic vegetation at breeding sites includes sedges (<i>Shoenoplectus</i> spp., <i>Baumea</i> spp. and <i>Lepironia articulata</i>) and Broadleaf Cumbungi (<i>Typha orientalis</i>).	Low	No suitable habitat within proposal site

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<i>Synemon plana</i>	Golden Sun Moth	Invertebrate	E	CE	Habitat may occur within area	-	-	-	-	In NSW, this species is now found between Queanbeyan, Gunning, Young and Tumut. It occurs in Natural Temperate Grasslands and grassy Box-Gum Woodlands in which groundlayer is dominated by wallaby grasses <i>Austrodanthonia</i> spp.	Low	Extensive grassland areas occur within the proposal site however these are exotic. Box-Gum woodland also occurs however no <i>Austrodanthonia</i> has been recorded during site surveys.
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	Mammal	V	-	-	Y	-	-	-	The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast to the western slopes of the divide. Largest numbers of records from sandstone escarpment country in the Sydney Basin and Hunter Valley (Hoye and Schulz 2008). Roosts in caves and mines and most commonly recorded from dry sclerophyll forests and woodlands. An insectivorous species that flies over the canopy or along creek beds (Churchill 2008). In southern Sydney appears to be largely restricted to the interface between sandstone escarpments and fertile valleys.	Low	Despite suitable Box-Ironbark habitat occurring within the proposal site, this species was not found during targeted surveys. No previous records within the locality. Suitable breeding habitat (hollows) and foraging (<i>Banksia</i> , <i>Fucalvat</i> and <i>Callistemon</i> spp.) occur
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	Mammal	V	V	Habitat known to occur within area	Y	-	14	0	Inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. Females occupy home ranges of up to 750 ha and males up to 3,500 ha, usually traversed along densely vegetated creek lines.	High	The species is likely to utilise the wetland areas within and adjacent to the proposal site for foraging. Recorded adjacent to site during targeted surveys. No breeding or roosting habitat present within or adjacent (within 2 km) of the proposal site
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	Mammal	V	E	Habitat known to occur within area	-	Y	5	5412	Occurs on southeast coast and ranges. Prefers tall (>20 m) and wet forest with dense understorey. Absent from small remnants, preferring continuous forest but can move through cleared landscapes and may forage in open areas. Roosts in hollow trunks of Eucalypts, underneath bark or in buildings. Forages in gaps and spaces within forest, with large foraging range (12 km foraging movements recorded) (Churchill 2008, Law et al 2008).	Low	No breeding habitat within the proposal site, as it lacks small caves, rock crevices, boulder fields and rocky-cliff faces. Foraging habitat may occur, however is marginal and has been proposal to previous disturbance. A low number of records occur with the nearest record occurring approximately 5.5 km from the proposal site.
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	Mammal	V	-	-	-	Y	45	3915	Occurs from Cape York to Sydney. Inhabits rainforests, wet and dry sclerophyll forests, paperbark swamps and vine thickets. Only one maternity cave known in NSW, shared with Eastern Bentwing-bats at Willi Willi, near Kempsey. Outside breeding season roosts in caves, tunnels and mines and has been recorded in a tree hollow on one occasion. Forages for insects beneath the canopy of well-timbered habitats (Churchill 2008, Hoye and Hall 2008).	Moderate	Suitable foraging and some roosting habitat present within site. Not recorded during surveys.
<i>Miniopterus australis</i>	Little Bent-winged Bat	Mammal	V	-	-	Y (Breeding)	Y (foraging)	164	0	Generally occurs east of the Great Dividing Range along NSW coast (Churchill 2008). Inhabits various habitats from open grasslands to woodlands, wet and dry sclerophyll forests and rainforest. Essentially a cave bat but may also roost in road culverts, stormwater tunnels and other man-made structures. Only 4 known maternity caves in NSW, near Wee Jasper, Bungonia, Kempsey and Texas. Females may travel hundreds of kilometres to the nearest maternal colony (Churchill 2008).	Recorded	Suitable foraging and some roosting habitat present within site. Also likely to utilise the waterbodies within and adjacent to the proposal site for foraging. Recorded during targeted surveys
<i>Miniopterus orianae oceanensis</i>	Large Bent-winged Bat	Mammal	V	-	-	Y (Breeding)	Y (foraging)	80	0	Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Forages in natural and artificial openings in vegetation, typically within a few kilometres of its roost. Roosts primarily in tree hollows but also recorded from man-made structures or under bark (Churchill 2008).	Recorded	Suitable foraging and some roosting habitat present within site. Also likely to utilise the waterbodies within and adjacent to the proposal site for foraging. Recorded during targeted surveys
<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed Bat	Mammal	V	-	-	Y (Breeding)	Y	82	0	Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Forages in natural and artificial openings in vegetation, typically within a few kilometres of its roost. Roosts primarily in tree hollows but also recorded from man-made structures or under bark (Churchill 2008).	Recorded	Foraging and roosting habitat present. Recorded during targeted surveys.
<i>Myotis macropus</i>	Southern Myotis	Mammal	V	-	-	Y	-	47	35	Mainly coastal but may occur inland along large river systems. Usually associated with permanent waterways at low elevations in flat/undulating country, usually in vegetated areas. Forages over streams and watercourses feeding on fish and insects from the water surface. Roosts in a variety of habitats including caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage, typically in close proximity to water (Campbell 2011). Breeds November or December (Churchill 2008).	Recorded	The Southern Myotis was recorded within a culvert on the site. Species is likely to utilise the waterbodies within and adjacent to the proposal site for foraging.

Scientific Name	Common Name	Taxonomy	BC Act statu	EPBC Act s	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
<i>Petaurus norfolcensis</i>	Squirrel Glider	Mammal	V	-	-	Y	-	74	0	Occurs along the drier inland slopes as well as coastal habitats. Inhabits woodland and open forest with a Eucalyptus, Corymbia or Angophora overstorey and a shrubby understorey of Acacia or Banksia. Key habitat components include reliable winter and early-spring flowering Eucalypts, Banksia or other nectar sources, and hollow-bearing trees for roost and nest sites (van der Ree and Suckling 2008, Quin et al 2004), with social groups moving between multiple hollows. Social groups include one or two adult males and females with offspring, and have home ranges of 5-10 ha within NSW (van der Ree and Suckling 2008, Kavanagh 2004).	High	Despite not found during targeted surveys by GHD, species has been previously recorded within the proposal site. Suitable open forests with shrubby Acacia and Banksia understoreys are present within the proposal site.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	Mammal	E	V	Habitat likely to occur within area	-	-	-	-	Occurs from the Shoalhaven north to the Queensland border. Now mostly extinct west of the Great Dividing Range, except in the Warrumbungles and Mt Kaputar. Occurs on rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Diet consists of vegetation in adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.	None	No suitable rocky habitat within the subject site including escarpments, outcrops and cliffs. Not found during targeted surveys
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	Mammal	V	-	-	Y	-	7	6197	Predominately east of the Great Dividing Range, occasional records to the west. Prefers open forest with sparse groundcover but occurs in habitats ranging from mallees to rainforest. Home ranges span 20-40 ha (females) and >100 ha (males) though may be smaller in optimal habitats. Male ranges overlap with females and other males. May use up to 40 nests/ year in hollow trees, rotted stumps, buildings or bird nests. When breeding females prefer to nest in large tree cavities with small entrances. Forages preferentially in rough barked trees, large logs and dead standing trees (Soderquist and Rhind 2008).	Low	No mallee or rainforest vegetation occurs within the proposal site. Large home range suggests the proposal site may be a thoroughfare to increasingly suitable habitat. An abundance of hollows also occurs within the site. Despite being targeted during site surveys, the species was not found. The nearest record to the proposal site within the locality is 6 km.
<i>Phascolarctos cinereus</i>	Koala	Mammal	V	V	Habitat known to occur within area	-	Y	13	178	Occurs from coast to inland slopes and plains. Restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from < 2 to several hundred ha.	Low	Low number of feed trees occur within the proposal site. Not recorded during targeted surveys, nor were any signs of the species found (scats, scratches etc.).
<i>Planigale maculata</i>	Common Planigale	Mammal	V	-	-	Y	-	-	-	Occurs in coastal north-eastern NSW, coastal east Queensland and Arnhem Land. The species reaches its confirmed southern distribution limit on the NSW lower north coast however there are reports of its occurrence as far south as the central NSW coast west of Sydney. Common Planigales inhabit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water. They are active at night and during the day shelter in saucer-shaped nests built in crevices, hollow logs, beneath bark or under rocks.	Low	No suitable habitat present within the proposal site
<i>Potorous tridactylus tridactylus</i>	Long-nosed Potoroo	Mammal	V	V	Habitat may occur within area	-	-	-	-	Restricted to east of the Great Dividing Range, with annual rainfall >760 mm. Inhabits coastal heath and dry and wet sclerophyll forests. Requires relatively thick ground cover and appears restricted to areas of light and sandy soil (Johnston 2008). Feeds on fungi, roots, tubers, insects and their larvae, and other soft-bodied animals in the soil.	None	No suitable habitat within the subject site due to historical disturbance of the site. The dry sclerophyll forests within the subject site lack dense groundcover to provide for the species. No previous records within the subject site.
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	Mammal	-	V	Habitat known to occur within area	-	-	7	604	Occurs in disjunct, coastal populations from Tasmania to Queensland. In NSW inhabits a variety of coastal habitats including heathland, woodland, dry sclerophyll forest with a dense shrub layer and vegetated sand dunes (Wilson and Bradtke 1999). Populations may recolonise/ increase in size in regenerating native vegetation after wildfire, clearing and sandmining. Presence strongly correlated with understorey vegetation density, and high floristic diversity in regenerating heath (Lock and Wilson 1999).	Low	Species prefers coastal habitats. No heathland habitat present. Open grassland not typically associated with this species.

Scientific Name	Common Name	Taxonomy	BC Act statu	EPBC Act s	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	Mammal	V	V	Roosting known to occur within area	Y (Breeding)	Y (foraging)	335	0	Roosts in camps within 20 km of a regular food source, typically in gullies, close to water and in vegetation with a dense canopy. Forages in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths, swamps and street trees, particularly in eucalypts, melaleucas and banksias. Highly mobile with movements largely determined by food availability (Eby and Law 2008). Will also forage in urban gardens and cultivated fruit crops.	Recorded	Found on site during targeted surveys. Previous records with a high number of individuals also indicate historical presence. Known foraging Eucalypt species occur within the proposal site. No camps or breeding habitat found on site.
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat	Mammal	V	-	-	-	Y	9	5660	Migrates from tropics to SE Aus in summer. Forages across a range of habitats including those with and without trees, from wet and dry sclerophyll forest, open woodland, Acacia shrubland, mallee, grasslands and desert. Roosts communally in large tree hollows and buildings (Churchill 2008).	Moderate	Suitable foraging and some roosting habitat present within site. Also likely to utilise the wetland areas within and adjacent to the proposal site for foraging. Despite not being recorded during site surveys, a moderate number of previous records within approximately 5.5 km to the proposal site suggests a possible occurrence of the species.
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	Mammal	V	-	-	-	Y	46	66	Occurs on the east coast and Great Dividing Range. Inhabits a variety of habitats from woodland to wet and dry sclerophyll forests and rainforest, also remnant paddock trees and timber-lined creeks, typically below 500 m asl. Forages in relatively uncluttered areas, using natural or man-made openings in denser habitats. Usually roosts in tree hollows or fissures but also under exfoliating bark or in the roofs of old buildings. Females congregate in maternal roosts in suitable hollow trees (Hoye and Richards 2008, Churchill 2008).	Moderate	Despite not being recorded during site surveys, a high number of previous records within close proximity to the proposal site suggests it may occur.
<i>Caretta caretta</i>	Loggerhead Turtle	Marine reptile	E	E	-	-	-	1	9276	In Australia, the Loggerhead Turtle occurs in the waters of coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western Australia. Nesting populations are known from southern Queensland and Western Australia. Loggerhead Turtles are carnivorous, feeding primarily on benthic invertebrates in habitat ranging from nearshore to 55 m.	None	No suitable habitat present within the subject site
<i>Delma impar</i>	Striped Legless Lizard	Reptile	V	V	Habitat may occur within area	Y	-	-	-	Occurs in the Southern Tablelands, South-west Slopes and possibly the Riverina. Found in natural or secondary grassland or open areas in grassy eucalypt woodland. May occur in modified grasslands with high exotic grass cover. Shelters in base of grass tussocks, under rocks or logs or in soil cracks (Smith and Robertson 1999).	Low	Despite small amount of habitat present within the proposal site, this species was not observed during targeted surveys. These areas also lack high abundance of rocks and logs due to the disturbed nature of the site.
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	Reptile	V	-	-	-	Y	-	-	A patchy distribution from north-east Queensland to the north-eastern quarter of NSW. In NSW it has historically been recorded from as far west as Mungindi and Quambone on the Darling Riverine Plains, across the north west slopes, and from the north coast from Queensland to Sydney. A small number of historical records are known for the New England Tablelands from Glenn Innes and Tenterfield; however, the majority of records appear to be from sites of relatively lower elevation. Although the Pale-headed snake distribution is very cryptic, it now appears to have contracted to a patchy and fragmented distribution. Found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest. In drier environments, it appears to favour habitats close to riparian areas. Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees. The Pale-headed Snake is a highly cryptic species that can spend weeks at a time hidden in tree hollows.	Moderate	Small number of tree hollows that could provide potential habitat. Dry eucalypt forests and woodlands occur in the proposal site, most of which are not located near riparian areas. The species was also not found during targeted surveys.

Appendix B

Survey results

Table B.11.1 Flora species list

GF	Family	Exotic	Scientific name	Common Name
FG	Adiantaceae	-	<i>Cheilanthes sieberi</i>	Rock Fern
EX	Apocynaceae	-	<i>Gomphocarpus fruitocosus</i>	Narrowleaf Cotton Bush
EX	Asteraceae	*	<i>Anagallis arvensis</i>	Scarlet Pimpernel
HT	Asteraceae	*	<i>Bidens pilosa</i>	Cobbler's Pegs
SG	Asteraceae	-	<i>Cassinia aculeata</i>	Dolly Bush
EX	Asteraceae	*	<i>Cirsium vulgare</i>	Spear Thistle
EX	Asteraceae	*	<i>Conyza bonariensis</i>	Flaxleaf Fleabane
EX	Asteraceae	*	<i>Facelis retusa</i>	Annual trampweed
EX	Asteraceae	*	<i>Gamochaeta americana</i>	Cudweed
EX	Asteraceae	*	<i>Gamochaeta calviceps</i>	Cudweed
EX	Asteraceae	*	<i>Hypochaeris radicata</i>	Catsear
EX	Asteraceae	*	<i>Latuca serriola</i>	Latuca
HT	Asteraceae	*	<i>Senecio madagascariensis</i>	Fireweed
EX	Asteraceae	*	<i>Sonchus oleraceus</i>	Milk Thistle
EX	Brassicaceae	*	<i>Lepidium africanum</i>	Common Peppercross
FG	Campanulaceae	-	<i>Wahlenbergia gracilis</i>	Sprawling Bluebell
EX	Caryophyllaceae	*	<i>Cerastium glomeratum</i>	Mouse-ear Chickweed
SG	Celastraceae	-	<i>Denhamia silvestris</i>	Narrow-leaved Orangebark
FG	Chenopodiaceae	-	<i>Einadia hastata</i>	Berry Saltbush
FG	Chenopodiaceae	-	<i>Einadia nutans</i>	Climbing Saltbush
FG	Commelinaceae	-	<i>Commelina cyanea</i>	Native Wandering Jew
HT	Cyperaceae	*	<i>Cyperus eragrostis</i>	Umbrella Sedge
GG	Cyperaceae	-	<i>Gahnia clarkeii</i>	Rough Saw Sedge
SG	Ericaceae	-	<i>Leucopogon juniperinus</i>	Prickly Beard-heath
SG	Ericaceae	-	<i>Styphelia triflora</i>	Pink Five-Corners
SG	Fabaceae (Faboideae)	-	<i>Daviesia ulicifolia</i>	Gorse Bitter Pea
SG	Fabaceae (Faboideae)	-	<i>Dillwynia retorta</i>	-
OG	Fabaceae (Faboideae)	-	<i>Glycine clandestina</i>	Twining glycine
OG	Fabaceae (Faboideae)	-	<i>Hardenbergia violacea</i>	False Sarsaparilla
EX	Fabaceae (Faboideae)	*	<i>Lotus subbiflorus</i>	Hairy Birds-foot Trefoil
SG	Fabaceae (Faboideae)	-	<i>Oxylobium cordifolium</i>	Heart-leaved Shaggy Pea
SG	Fabaceae (Faboideae)	-	<i>Pultenaea spinosa</i>	A Bush Pea
EX	Fabaceae (Faboideae)	*	<i>Trifolium repens</i>	-
EX	Fabaceae (Faboideae)	*	<i>Trifolium sp.</i>	-
SG	Fabaceae (Mimosoideae)	-	<i>Acacia parvipinnula</i>	Silver-stemmed Wattle
SG	Fabaceae (Mimosoideae)	-	<i>Acacia ulicifolia</i>	Prickly Moses
FG	Goodeniaceae	-	<i>Goodenia rotundifolia</i>	

GF	Family	Exotic	Scientific name	Common Name
FG	Hydrocharitaceae	-	<i>Ottelia ovalifolia subsp. ovalifolia</i>	Swamp Lily
HT	Iradaeaceae	*	<i>Romulea rosea</i>	Onion Grass
GG	Juncaceae	-	<i>Juncus sp.</i>	A Rush
GG	Juncaceae	-	<i>Juncus usitatus</i>	-
OG	Lauraceae	-	<i>Cassytha glabella</i>	-
FG	Lobeliaceae	-	<i>Pratia purpurascens</i>	Whiteroot
GG	Lomandraceae	-	<i>Lomandra confertifolia</i>	Matrush
GG	Lomandraceae	-	<i>Lomandra cylindrica</i>	-
GG	Lomandraceae	-	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush
GG	Lomandraceae	-	<i>Lomandra multiflora</i>	-
GG	Lomandraceae	-	<i>Lomandra obliqua</i>	-
EX	Malvaceae	*	<i>Sida rhombifolia</i>	Paddy's Lucerne
TG	Myrtaceae	-	<i>Angophora floribunda</i>	Rough-barked Apple
TG	Myrtaceae	-	<i>Corymbia maculata</i>	Spotted Gum
TG	Myrtaceae	-	<i>Eucalyptus acmenoides</i>	White Mahogany
TG	Myrtaceae	-	<i>Eucalyptus agglomerata</i>	Blue-leaved Stringybark
TG	Myrtaceae	-	<i>Eucalyptus capitellata</i>	Brown Stringybark
TG	Myrtaceae	-	<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark
TG	Myrtaceae	-	<i>Eucalyptus fibrosa</i>	Red Ironbark
TG	Myrtaceae	-	<i>Eucalyptus punctata</i>	Grey Gum
SG	Myrtaceae	-	<i>Leptospermum polygalifolium</i>	-
SG	Myrtaceae	-	<i>Leptospermum polygalifolium subsp. polygalifolium</i>	-
SG	Myrtaceae	-	<i>Melaleuca nodosa</i>	-
SG	Myrtaceae	-	<i>Melaleuca sieberi</i>	-
TG	Oleaceae	-	<i>Notelaea longifolia</i>	Large Mock-olive
FG	Onagraceae	-	<i>Ludwigia peploides</i>	Water Primrose
FG	Orchidaceae	-	<i>Microtis parviflora</i>	Slender Onion Orchid
FG	Orchidaceae	-	<i>Thelymitra pauciflora</i>	Slender Sun Orchid
FG	Oxalidaceae	-	<i>Oxalis perennans</i>	-
EX	Oxalidaceae	*	<i>Oxalis sp.</i>	-
FG	Phormiaceae	-	<i>Dianella caerulea</i>	Blue Flax-lily
FG	Phormiaceae	-	<i>Dianella longifolia</i>	-
FG	Phormiaceae	-	<i>Dianella revoluta</i>	Blueberry Lily
FG	Phyllanthaceae	-	<i>Poranthera microphylla</i>	
SG	Pittosporaceae	-	<i>Bursaria spinosa</i>	Native Blackthorn
SG	Pittosporaceae	-	<i>Pittosporum undulatum</i>	Sweet Pittosporum
EX	Plantaginaceae	*	<i>Plantago lanceolata</i>	Lamb's Tongues
FG	Plantaginaceae	-	<i>Veronica plebeia</i>	Trailing Speedwell
EX	Poaceae	*	<i>Aira caryophyllea</i>	Silvery Hairgrass

GF	Family	Exotic	Scientific name	Common Name
HT	Poaceae	*	<i>Andropogon virginicus</i>	Whisky Grass
GG	Poaceae	-	<i>Aristida vagans</i>	Threeawn Speargrass
EX	Poaceae	*	<i>Briza major</i>	-
EX	Poaceae	*	<i>Briza minor</i>	Shivery Grass
EX	Poaceae	*	<i>Bromus cartharticus</i>	Prairie Grass
HT	Poaceae	-	<i>Cenchrus clandestinum</i>	-
GG	Poaceae	-	<i>Cymbopogon refractus</i>	Barbed-wire Grass
GG	Poaceae	-	<i>Cynodon dactylon</i>	Common Couch
EX	Poaceae	*	<i>Dactylis glomerata</i>	Cocksfoot
GG	Poaceae	-	<i>Dichelachne micrantha</i>	Shorthair Plumegrass
GG	Poaceae	-	<i>Echinopogon caespitosus</i>	Bushy Hedgehog-grass
GG	Poaceae	-	<i>Echinopogon ovatus</i>	Forest Hedgehog Grass
HT	Poaceae	*	<i>Ehrharta erecta</i>	Panic Veldtgrass
GG	Poaceae	-	<i>Entolasia stricta</i>	Wiry Panic
GG	Poaceae	-	<i>Eragrostis brownii</i>	Brown's Lovegrass
GG	Poaceae	-	<i>Lachnagrostis filiformis</i>	
GG	Poaceae	-	<i>Microlaena stipoides</i>	Weeping Grass
HT	Poaceae	*	<i>Paspalum dilatatum</i>	Paspalum
EX	Poaceae	*	<i>Setaria parviflora</i>	-
GG	Poaceae	-	<i>Sporobolus creber</i>	Slender Rat's Tail Grass
GG	Poaceae	-	<i>Themeda triandra</i>	-
EX	Poaceae	*	<i>Vulpia bromoides</i>	Squirrel Tail Fesque
HT	Polygonaceae	*	<i>Rumex acetocella</i>	Sheep Sorrel
FG	Polygonaceae	-	<i>Rumex brownii</i>	Swamp Dock
EX	Primulaceae	*	<i>Lysimachia arvensis</i>	-
SG	Proteaceae	-	<i>Hakea sericea</i>	Needlebush
FG	Ranunculaceae	-	<i>Ranunculus inundatus</i>	River Buttercup
FG	Ranunculaceae	-	<i>Ranunculus plebeius</i>	Forest Buttercup
FG	Rubiaceae	-	<i>Pomax umbellata</i>	Pomax
SG	Rutaceae	-	<i>Zieria smithii</i>	-
EG	Salviniaceae	*	<i>Azolla filiculoides</i>	Azolla
EX	Solanaceae	*	<i>Solanum mauritianum</i>	Tobacco Bush
EX	Solanaceae	*	<i>Solanum nigrum</i>	Black-berry Nightshade
FG	Solanaceae	-	<i>Solanum prinophyllum</i>	Forest Nightshade
SG	Thymelaeaceae	-	<i>Pimelea linifolia</i>	Slender Rice Flower
HT	Verbenaceae	*	<i>Lantana camara</i>	Lantana
EX	Verbenaceae	*	<i>Verbena bonariensis</i>	Purpletop
FG	Violaceae	-	<i>Viola hederacea</i>	Ivy-leaved Violet

Growth form - *TG=Tree; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other

Fauna species (recorded across entire Hydro site)

V = Listed as vulnerable species, E = Endangered, CE = Critically endangered

BC Act = Biodiversity Conservation Act 2017

EPBC Act = Environment Protection and Biodiversity Conservation Act 1999

Table B.11.2 Fauna species recorded in and adjacent to proposal site

Class	Scientific name	Common name	Status		Observation type
			BC Act	EPBC Act	
Aves	<i>Acanthiza pusilla</i>	Brown Thornbill	-	-	Observed
Aves	<i>Acanthiza reguloides</i>	Buff-rumped Thornbill	-	-	Observed
Aves	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	-	-	Observed
Aves	<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk	-	-	Observed
Aves	<i>Accipiter novaehollandiae</i>	Grey Goshawk	-	-	Observed
Aves	<i>Acridotheres tristis</i>	Common Myna	-	-	Observed
Aves	<i>Alisterus scapularis</i>	Australian King-Parrot	-	-	Observed
Aves	<i>Amblyornis newtonianus</i>	Superb Fairy-wren	-	-	Heard
Aves	<i>Anas castanea</i>	Chestnut Teal	-	-	Observed
Aves	<i>Anas gracilis</i>	Grey Teal	-	-	Observed
Aves	<i>Anas superciliosa</i>	Pacific Black Duck	-	-	Observed
Aves	<i>Anthochaera carunculata</i>	Red Wattlebird	-	-	Observed
Aves	<i>Aquila audax</i>	Wedge-tailed Eagle	-	-	Observed
Aves	<i>Ardea ibis</i>	Cattle Egret	-	-	Observed
Aves	<i>Ardea intermedia</i>	Intermediate Egret	-	-	Observed
Aves	<i>Ardea pacifica</i>	White-necked Heron	-	-	Observed
Aves	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	-	-	Observed
Aves	<i>Cacatua sanguinea</i>	Little Corella	-	-	Observed
Aves	<i>Calyptorhynchus funereus</i>	Yellow-tailed Black-Cockatoo	-	-	Observed
Aves	<i>Chenonetta jubata</i>	Australian wood duck	-	-	Observed
Aves	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	-	-	Observed
Aves	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	-	-	Observed
Aves	<i>Corcorax melanorhamphos</i>	White-winged Chough	-	-	Observed
Aves	<i>Cormobates leucophaeus</i>	White-throated Treecreeper	-	-	Observed
Aves	<i>Corvus coronoides</i>	Australian Raven	-	-	Observed
Aves	<i>Corvus orru</i>	Torresian Crow	-	-	Observed
Aves	<i>Cracticus nigrogularis</i>	Pied Butcherbird	-	-	Observed
Aves	<i>Cracticus torquatus</i>	Grey Butcherbird	-	-	Observed
Aves	<i>Cygnus atratus</i>	Black Swan	-	-	Observed
Aves	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	-	-	Observed
Aves	<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	-	Observed
Aves	<i>Dendrocygna eytoni</i>	Plumed Whistling-Duck	-	-	Observed
Aves	<i>Dicaeum hirundinaceum</i>	Mistletoebird	-	-	Observed

Class	Scientific name	Common name	Status		Observation type
			BC Act	EPBC Act	
Aves	<i>Elseya melanops</i>	Black-fronted Dotterel	-	-	Observed
Aves	<i>Eolophus roseicapilla</i>	Galah	-	-	Observed
Aves	<i>Eopsaltria australis</i>	Eastern Yellow Robin	-	-	Observed
Aves	<i>Eudnamys orientalis</i>	Eastern Koel	-	-	Observed
Aves	<i>Eurystomus orientalis</i>	Dollarbird	-	-	Observed
Aves	<i>Falco cenchroides</i>	Nankeen Kestrel	-	-	Observed
Aves	<i>Falco longipennis</i>	Australian hobby	-	-	Observed
Aves	<i>Fulica atra</i>	Eurasian Coot	-	-	Observed
Aves	<i>Geopelia humeralis</i>	Bar-shouldered Dove	-	-	Observed
Aves	<i>Geopelia placida (striata)</i>	Peaceful Dove	-	-	Observed
Aves	<i>Gerygone albogularis</i>	White-throated Gerygone	-	-	Observed
Aves	<i>Glossopsitta concinna</i>	Musk Lorikeet	-	-	Observed
Aves	<i>Glossopsitta pusilla</i>	Little Lorikeet	V	-	Observed
Aves	<i>Grallina cyanoleuca</i>	Magpie-lark	-	-	Observed
Aves	<i>Gymnorhina tibicen</i>	Australian Magpie	-	-	Observed
Aves	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	V	-	Observed
Aves	<i>Haliastur sphenurus</i>	Whistling Kite	-	-	Observed
Aves	<i>Hirundo neoxena</i>	Welcome Swallow	-	-	Observed
Aves	<i>Lalage tricolor</i>	White-winged Triller	-	-	Observed
Aves	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	-	-	Observed
Aves	<i>Malurus lamberti</i>	Variiegated Fairy-wren	-	-	Observed
Aves	<i>Manorina melanocephala</i>	Noisy Miner	-	-	Observed
Aves	<i>Manorina melanophrys</i>	Bell Miner	-	-	Observed
Aves	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	-	-	Observed
Aves	<i>Merops ornatus</i>	Rainbow Bee-eater	-	-	Observed
Aves	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater	-	-	Observed
Aves	<i>Neochmia temporalis</i>	Red-browed Finch	-	-	Observed
Aves	<i>Ocyphaps lophotes</i>	Crested Pigeon	-	-	Observed
Aves	<i>Oriolus sagittatus</i>	Olive-backed Oriole	-	-	Observed
Aves	<i>Pachycephala rufiventris</i>	Rufous Whistler	-	-	Observed
Aves	<i>Pardalotus striatus</i>	Striated Pardalote	-	-	Observed
Aves	<i>Pelecanus conspicillatus</i>	Australian Pelican	-	-	Observed
Aves	<i>Phalacrocorax carbo</i>	Great Cormorant	-	-	Observed
Aves	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	-	-	Observed
Aves	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	-	-	Observed
Aves	<i>Phaps chalcoptera</i>	Common Bronzewing	-	-	Observed
Aves	<i>Philemon corniculatus</i>	Noisy Friarbird	-	-	Observed
Aves	<i>Phylidonyris niger</i>	White-cheeked Honeyeater	-	-	Observed
Aves	<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	-	-	Observed

Class	Scientific name	Common name	Status		Observation type
			BC Act	EPBC Act	
Aves	<i>Platycercus eximius</i>	Eastern Rosella	-	-	Observed
Aves	<i>Podargus strigoides</i>	Tawny Frogmouth	-	-	Observed
Aves	<i>Pomatostomus temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	-	Observed
Aves	<i>Porphyrio porphyrio</i>	Purple Swamphen	-	-	Observed
Aves	<i>Psophodes olivaceus</i>	Eastern whipbird	-	-	Observed
Aves	<i>Rhipidura albiscapa</i>	Grey Fantail	-	-	Observed
Aves	<i>Rhipidura leucophrys</i>	Willie Wagtail	-	-	Observed
Aves	<i>Sericornis frontalis</i>	White-browed Scrubwren	-	-	Heard
Aves	<i>Threskiornis spinicollis</i>	Straw-necked Ibis	-	-	Observed
Aves	<i>Todiramphus sanctus</i>	Sacred Kingfisher	-	-	Observed
Aves	<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet	-	-	Observed
Aves	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	-	-	Observed
Aves	<i>Tyto javanica</i>	Eastern Barn owl	-	-	Observed
Aves	<i>Vanellus miles</i>	Masked lapwing	-	-	Observed
Aves	<i>Zosterops lateralis</i>	Silvereeye	-	-	Observed
Amphibians	<i>Litoria quiritatus</i>	Screaming tree frog	-	-	Heard
Amphibians	<i>Crinia signifera</i>	Common Eastern Froglet	-	-	Observed
Amphibians	<i>Litoria caerulea</i>	Green Tree Frog	-	-	Observed
Amphibians	<i>Limnodynastes dumerilii</i>	Eastern Banjo Frog	-	-	Observed
Amphibians	<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	-	-	Observed
Amphibians	<i>Platyleptrum ornatum</i>	Ornate Burrowing Frog	-	-	Observed
Amphibians	<i>Litoria peronii</i>	Peron's Tree Frog	-	-	Observed
Amphibians	<i>Uperoleia laevigata</i>	Smooth Toadlet	-	-	Trapped and heard
Amphibians	<i>Limnodynastes peronii</i>	Brown-striped Frog	-	-	Observed
Amphibians	<i>Limnodynastes tasmaniensis</i>	Spotted Marsh Frog	-	-	Heard
Amphibians	<i>Litoria tyleri</i>	Tyler's Tree Frog	-	-	Heard
Reptilia	<i>Pogona barbata</i>	Bearded Dragon	-	-	Observed
Reptilia	<i>Chelodina longicollis</i>	Eastern Snake-necked Turtle	-	-	Observed
Reptilia	<i>Ctenotus robustus</i>	Robust Ctenotus	-	-	Trapped
Reptilia	<i>Eulamprus quoyii</i>	Eastern Water-skink	-	-	Observed
Reptilia	<i>Lampropholis delicata</i>	Dark-flecked Garden Sunskink	-	-	Trapped
Reptilia	<i>Amphibolurus muricatus</i>	Jacky Lizard	-	-	Observed
Reptilia	<i>Varanus varius</i>	Lace Monitor	-	-	Observed
Reptilia	<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	-	-	Observed
Reptilia	<i>Furina diadema</i>	Red-naped snake	-	-	Observed
Mammalia	<i>Antechinus stuartii</i>	Brown Antechinus	-	-	Observed
Mammalia	<i>Rattus rattus</i>	Black Rat	-	-	Observed
Mammalia	<i>Trichosurus vulpecula</i>	Common Brushtail Possum	-	-	Observed

Class	Scientific name	Common name	Status		Observation type
			BC Act	EPBC Act	
Mammalia	<i>Sminthopsis murina</i>	Common Dunnart	-	-	Trapped
Mammalia	<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	-	-	Observed
Mammalia	<i>Vombatus ursinus</i>	Common Wombat	-	-	Observed
Mammalia	<i>Macropus giganteus</i>	Eastern grey kangaroo	-	-	Observed
Mammalia	<i>Lepus europaeus</i>	Brown Hare	-	-	Observed
Mammalia	<i>Oryctolagus cuniculus</i>	Rabbit	-	-	Observed
Mammalia	<i>Vulpes vulpes</i>	Fox	-	-	Observed
Mammalia	<i>Macropus rufogriseus</i>	Red-necked Wallaby	-	-	Observed
Mammalia	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	-	-	Observed
Mammalia	<i>Petaurus breviceps</i>	Sugar Glider	-	-	Trapped
Mammalia	<i>Wallabia bicolor</i>	Swamp Wallaby	-	-	Observed
Mammalia	<i>Chalinolobus morio</i>	Chocolate Wattled Bat	-	-	Acoustic Recording
Mammalia	<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed Bat	V	-	Acoustic Recording
Mammalia	<i>Vespadelus pumilus</i>	Eastern Forest Bat	-	-	Acoustic Recording
Mammalia	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V	-	Acoustic Recording
Mammalia	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	-	-	Acoustic Recording
Mammalia	<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	Observed
Mammalia	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	-	-	Acoustic Recording
Mammalia	<i>Miniopterus australis</i>	Little Bentwing-bat	V	-	Acoustic Recording
Mammalia	<i>Myotis macropus</i>	Southern Myotis	V	-	Observed

Appendix C

BAM calculator data

Table C.1 Vegetation integrity plot data

plot	pct	area	patchsize	conditionclass	zone	easting	northing	bearing	compTree	compShrub	compGrass	compForbs	compFerns	compOther	strucTree	strucShrub	strucGrass	strucForbs	strucFerns	strucOther	funLargeTrees	funHollowtrees	funLitterCover	funLenFallenLogs	funTreeStem5to9	funTreeStem10to19	funTreeStem20to29	funTreeStem30to49	funTreeStem50to79	funTreeRegen	funHighThreatExotic
3a_4	1591	2.79	101	Intact	56	361599	6372649	240	2	7	6	5	0	0	25.0	64.5	36.3	0.5	0.0	0.0	1	0	56.0	9.0	1	1	1	1	1	1	22.2
3a_1	1591	2.79	101	Intact	56	361296	6372762	20	5	12	5	4	0	2	28.1	55.5	20.2	1.1	0.0	0.2	2	0	77.0	37.0	1	0	1	1	1	0	0.0
3a_2	1591	2.79	101	Intact	56	361349	6372791	51	3	6	4	5	0	1	24.0	65.9	37.4	0.6	0.0	0.3	3	0	89.0	22.0	0	1	1	1	1	0	0.9
5b_8	1600	5.48	101	Underscrubbed	56	361659	6373096	315	2	6	8	6	0	1	13.0	0.9	62.8	1.7	0.0	0.1	3	1	32.0	16.0	0	0	0	1	1	0	3.4
5b_10	1600	5.48	101	Underscrubbed	56	361440	6373209	4	2	3	5	10	0	0	21.0	0.7	80.2	20.8	0.0	0.0	2	0	46.0	3.0	0	0	1	1	1	0	3.1
5b_11	1600	5.48	101	Underscrubbed	56	361241	6373090	110	1	1	4	8	1	1	25.0	0.1	45.2	3.7	0.3	0.1	4	0	51.2	1.0	0	0	1	1	1	0	0.8
3c_1	1600	4.44	101	Regrowth	56	361393	6372730	117	1	5	4	2	1	0	0.2	37.4	25.8	0.6	0.8	0.0	0	0	21.0	0.0	0	0	0	0	0	1	7.3
9b_1	1600	4.44	101	Regrowth	56	361632	6373197	78	0	1	8	1	1	1	0.0	10.0	23.9	0.1	0.1	0.1	0	0	7.0	0.0	0	0	0	0	0	0	15.1
7a_2	1736	0.30	101	Disturbed	56	361106	6372905	180	0	0	3	3	1	0	0.0	0.0	35.1	17.5	45.0	0.0	0	0	0.0	0.0	0	0	0	0	0	0	6.0
9a_1	1600	43.35	101	exotic	56	361590	6372904	117	0	0	3	1	1	0	0.0	0.0	35.1	0.1	0.1	0.0	0	0	5.0	0.0	0	0	0	0	0	0	15.0
5c_3	1600	43.35	101	exotic	56	361522	6372880	135	0	0	4	2	1	0	0.0	0.0	10.4	0.6	0.2	0.0	0	0	29.0	0.0	0	0	0	0	0	0	2.1
5c_4	1600	43.35	101	exotic	56	361192	6373027	200	0	0	4	1	1	0	0	94.2	0.1	0.6	0	0	0	0	1.4	0	0	0	0	0	0	0	2.7
5c_5	1600	43.35	101	exotic	56	361781	6372855	304	0	0	4	1	0	0	0	72	0.1	0.0	0.0	0.0	0	0	1.8	0.0	0	0	0	0	0	0	7.2

Appendix D

Assessment of planted vegetation

Table D.1 Decision making key used to assess planted vegetation within the development site (pathway through key highlighted in yellow).

1	Does the planted native vegetation occur within an area that contains a mosaic of planted and remnant native vegetation and which can be reasonably assigned to a PCT known to occur in the same IBRA subregion as the proposal?	<p>i) Yes The planted native vegetation must be allocated to the best-fit PCT and the BAM must be applied.</p> <p>ii) No Go to 2</p>
2	Is the planted native vegetation: a. planted for the purpose of environmental rehabilitation or restoration under an existing conservation obligation listed in BAM Section 11.9(2.), and b. the primary objective was to replace or regenerate a plant community type or a threatened plant species population or its habitat?	<p>i) Yes The planted native vegetation must be assessed in accordance with Chapters 4 and 5 of the BAM. ii.</p> <p>ii) No..... Go to 3.</p>
3	Is the planted/translocated native vegetation individuals of a threatened species or other native species planted/translocated for the purpose of providing threatened species habitat under one of the following: a. a species recovery project b. Saving our Species project c. other types of government funded restoration project d. condition of consent for a development approval that required those species to be planted or translocated for the purpose of providing threatened species habitat e. legal obligation as part of a condition or ruling of court. This includes regulatory directed or ordered remedial plantings (e.g. Remediation Order for clearing without consent issued under the BC Act or the Native Vegetation Act) f. ecological rehabilitation to re-establish a PCT or TEC that was, or is carried out under a mine operations plan, or g. approved vegetation management plan (e.g. as required as part of a Controlled Activity Approval for works on waterfront land under the NSW Water Management Act 2000)?	<p>i) Yes The planted native vegetation must be assessed in accordance with Chapters 4 and 5 of the BAM. Biodiversity Assessment Method 77</p> <p>ii.) No..... Go to 4.</p>
4	Was the planted native vegetation (including individuals of a threatened flora species) undertaken voluntarily for revegetation, environmental rehabilitation or restoration without a legal obligation to secure or provide for management of the native vegetation?	<p>i. Yes..... Go to D.2 Assessment of planted native vegetation for threatened species habitat (the use of Chapters 4 and 5 of the BAM are not required to be applied).</p> <p>ii. No..... Go to 5</p>
5	Is the native vegetation (including individuals of a threatened flora species) planted for functional, aesthetic, horticultural or plantation forestry purposes? This includes examples such as: windbreaks in agricultural landscapes, roadside plantings (including street trees, median strips, roadside batters), landscaping in parks, gardens and sport fields/complexes, macadamia plantations or teatree farms?	<p>i. Yes Go to D.2 Assessment of planted native vegetation for threatened species habitat (the use of Chapters 4 and 5 of the BAM are not required to be applied). – Planted vegetation within the site includes horticultural plantings and roadside screening plantings.</p> <p>Assessment of planted native vegetation for threatened species habitat has been completed in accordance with appendix D2 and is including in section 6.1.5.</p> <p>ii. No..... Go to 6.</p>

Appendix E

Assessments of significance for MNES

Threatened fauna

Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable species

Distribution

The Grey-headed Flying-fox population throughout Australia is spatially structured into colonies (Parry-Jones & Wardle 2004). However, no separate or distinct populations occur due to the constant genetic exchange and movement between camps over the entire species' geographic range, indicating one single interbreeding population (Webb & Tidemann 1995; DSE 2005).

In winter, the species congregates in coastal lowlands north of the Hunter Valley and is occasionally found on the south coast of NSW (associated with flowering Spotted Gum (*Corymbia maculata*) and on the northwest slopes (generally associated with flowering White Box (*Eucalyptus albens*) or Mugga Ironbark (*Eucalyptus sideroxylon*)) (NSW DECCW 2010).

Habitat requirements

The Grey-headed Flying-fox roosts in congregations (camps) typically located near water, such as lakes, rivers or the coast (van der Ree et al. 2005). Camps can occur in a variety of vegetation types including; rainforest, Melaleuca stands, mangroves and riparian vegetation (Nelson 1965; Ratcliffe 1931). The species is also known to roost and forage in highly modified urban areas (Birt et al. 1998; Tidemann & Vardon 1997; van der Ree et al. 2005).

The Grey-headed Flying-fox is a canopy-feeding frugivore and nectarivore, which primarily feeds on blossom from Myrtaceous species (Eby 1998). The species is highly mobile and utilises a range of vegetation including rainforests, open forests, closed and open woodlands, Melaleuca swamps and Banksia woodlands. The species is also known to feed on introduced tree species in urban areas and commercial fruit crops. None of the species the Grey-headed Flying-fox feed on flower continuously throughout the year. As a result the species developed complex migration behaviours due to ephemeral and patchy food resources (Duncan et al. 1999; Eby 1996, 1998; Nelson 1965; Parry-Jones & Augee 1992; Spencer et al. 1991).

The species has historically been subject to culling as a result of impacts to commercial fruit crops. However, in more recent times non-lethal methods of crop protection such as full exclusion netting have been used to prevent damage to crops (OEH 2015).

The primary food source is blossom from Eucalyptus and related genera but in some areas it also utilises a wide range of rainforest fruits (Eby 1998). None of the vegetation communities used by the Grey-headed Flying-fox produce continuous foraging resources throughout the year. As a result, the species has adopted complex migration traits in response to ephemeral and patchy food resources (Duncan et al. 1999; Eby 1996, 1998; Nelson 1965; Parry-Jones & Augee 1992; Spencer et al. 1991).

Habitat within proposal site

The proposal site contains foraging habitat for this species. This habitat includes a number of tree species that would provide food for this species at certain times of the year when in fruit/flower. None of the tree species within the site have been identified as significant tree species for the Grey-headed Flying-fox (Peggy & Law 2008). Within the proposal site this species is associated with PCT 1600 (TBDC). Within areas of PCT 1600 there is suitable foraging habitat for the species within vegetation zones 1 (VZ 2 would not provide foraging habitat for this species as it does not contain any trees). The total area of foraging habitat for this species within the proposal site is 5.48 ha.

EPBC Act - Assessment of Significance - Grey-headed Flying-fox (*Pteropus poliocephalus*)

According to the DoE (2013) 'significant impact criteria' for vulnerable species, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

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

The Grey-headed Flying fox feeds on nectar and pollen from flowers of canopy trees and fleshy fruits from rainforest trees and vines. The species generally moves through the landscape feeding on suitable trees when they come into flower/fruit. The proposal would involve the removal of approximately 5.48 hectares of potential foraging habitat for this species. This habitat includes a number of tree species that would provide food for this species at certain times of the year when in fruit/flower, including *Eucalyptus fibrosa* (Broad-leaved Ironbark) and *Corymbia maculata* (Spotted Gum) which are recognised as providing abundant and seasonally important resources for the species (Eby and Law 2008).

The Grey-headed Flying-fox has been recorded foraging within and adjacent to the proposal site. Grey-headed Flying-fox camps are known to occur within the locality at East Cessnock, Lorn, Maitland (Hannan St) and Stockington. The closest known Grey-headed Flying-fox camp is located at East Cessnock. This camp is mapped on the National Flying-fox monitoring viewer as a nationally important camp and lies approximately 10 km southwest of the study area (DoE 2020).

Given the high mobility of this species and the proximity of large areas of native vegetation containing foraging habitat in the locality (including Mt Sugarloaf Flora and Fauna Reserve, Lower Hunter National Park, Cessnock State Forest and Werakata National Park), habitat within the proposal site would make a minor contribution to maintenance of the Grey Headed Flying Fox population.

The proposal would not isolate any areas of habitat or cause significant habitat fragmentation that would affect the breeding, foraging or dispersive movements of this highly mobile species.

Given that the proposal would not impact on any roosting or breeding sites for this species and the large areas of native vegetation in the locality that would provide foraging habitat for this species, the removal of 5.48 hectares of potential foraging habitat for the proposal would be unlikely to lead to a long-term decrease in the size of the population.

Reduce the area of occupancy of an important population

The proposal would not reduce the area of occupancy of this highly mobile species. The 5.48 hectares of potential foraging habitat that would be impacted would constitute a very small proportion of the available foraging habitat within the locality, is not at the edge of the species' known range and would not create any barriers to movement or isolate any areas of habitat for this mobile species.

Fragment an existing important population into two or more populations

The proposal would not isolate or fragment the existing population of this highly mobile species.

The Grey-headed Flying-fox is a highly mobile species that is capable of accessing isolated patches of foraging habitat within urban areas. The species is known to regularly travel distances of 50 kilometres from roost sites to access seasonal foraging resources (Eby, 1996). At a local scale, the proposal may widen some existing gaps in vegetation, however the resulting gap in vegetation cover would be readily traversed by these highly mobile, aerial species. The proposed action would not impact on any camp/roost sites for this species. The action would not prevent Grey-headed Flying-fox individuals from travelling between camps and foraging habitat.

It is therefore highly unlikely that the proposal would cause fragmentation of the Grey-headed Fox population into two or more populations.

Adversely affect habitat critical to the survival of the species

The Grey-headed Flying fox requires a temporal sequence of productive foraging habitats linked by migration corridors or stopover habitats combined with suitable roosting habitat in close proximity to foraging areas (DoEE 2017).

The draft recovery plan for Grey-headed Flying-fox, identifies habitat critical to the survival of Grey-headed Flying-fox as vegetation communities that contain important winter and spring flowering myrtaceous species. PCT 1600 within the proposal site contains a low abundance of Spotted Gum (*Corymbia maculata*) which has been identified as an important winter foraging species for the Grey-headed Flying fox (Eby and Law 2008).

The resources present in the proposal site, however occur in very low abundance and are minor in comparison to available similar foraging resources in nearby areas, including conserved habitat in Mt Sugarloaf Flora and Fauna Reserve, Lower Hunter National Park, Cessnock State Forest and Werakata National Park .

In this context the removal of 5.48 hectares of potential foraging habitat containing a small number of important feed trees is unlikely to adversely affect critical habitat for the Grey-headed Flying fox within the region.

Disrupt the breeding cycle of an important population

Grey-headed Flying-foxes are seasonal breeders with a single breeding event per-year. Females generally reach sexual maturity in their second year and pregnant females will give birth to a single pup generally between October to December (DoEE 2017). Flying-foxes have been known to abort fetuses and have premature births in response to environmental stress (DoEE 2017).

There are three Grey-headed Flying-fox camps known to support breeding females (maternity camps) within or close by the locality; East Cessnock, Lorn, Maitland (Hannan St), Stockington. Of these camps, East Cessnock is known to support breeding females (maternity camp) and is mapped as critical for survival of the species. However, no camps occur within the proposal site.

EPBC Act - Assessment of Significance - Grey-headed Flying-fox (*Pteropus poliocephalus*)

The proposal site is likely to be used by the Grey-headed Flying-foxes from the surrounding camps for foraging habitat. However, the foraging habitat within the locality would likely provide sufficient ample foraging resources. Considering this, the proposal is unlikely to disrupt the breeding cycle of the Grey-headed Flying-fox. Furthermore, the proposal would not create a barrier to migratory or dispersal movements for this species that could interfere with breeding behaviours.

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

The proposal would remove 5.48 hectares of potential foraging habitat for the Grey Headed Flying-fox. The proposal would not isolate any areas of habitat for this highly mobile species. Due to the large area of potential alternative foraging habitat within the locality, and the highly mobile nature of the species, the removal of 5.48 hectares of potential foraging habitat it is unlikely to result in the decline of the species.

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

Slight increases in the incidence of weeds in adjacent vegetation may occur as a result of vegetation clearing. Weed control measures would be implemented to mitigate this risk. The introduction and/or spread of weeds is not likely to tangibly decrease the value of potential foraging habitat for this species as: there is already a high abundance of weeds within the local area, mainly comprising exotic groundcover species of agricultural landscapes, and the species relies on canopy vegetation. The introduction of new infestations or increase in the severity of weed infestations is not likely to impact on the foraging resources available to Grey-headed Flying-fox.

Invasive fauna species, including predators such as cats and foxes, are already present within the study area and locality. The proposed action is unlikely to result in changes that would favour feral animals, nor is the proposed action likely to increase the incidence of invasive predators, or introduce new invasive species in the area.

Introduce disease that may cause the species to decline

Grey-headed Flying-foxes are reservoirs of a number of diseases including Australian bat lyssavirus, Hendra virus and Menangle virus. Although lyssavirus can cause clinical disease and mortality in Grey-headed Flying-foxes the incidence of disease in populations is generally low (<1%) and the virus is thought to be generally in equilibrium with the population (DECCW 2007). It has however been noted that when flying-foxes are exposed to significant ecological stress the incidence of lyssavirus can increase and the population can be impacted (DECCW 2007). The proposed action is unlikely to result in ecological stresses to any of the nearby flying-fox populations such that the instances of lyssavirus would significantly increase.

There are no clinical disease or mortality in flying-foxes associated with Hendra or Menangle virus, regardless the proposal is not likely to lead to an increase in either of these viruses within the Grey-headed Flying-fox population.

Construction activities have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*) and Myrtle Rust (*Uredo rangellii*) into areas of adjacent foraging habitat for this species. These pathogens could result in a decline in health and/or mortality of flying fox feed trees. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. Mitigation measures, including strict hygiene protocols for plant and machinery, and restrictions on imported fill would be implemented to prevent the introduction of Phytophthora and/or Myrtle Rust.

No diseases that may cause the species to decline are likely to become established in the study area as a result of the proposed action.

Interfere substantially with the recovery of the species

As discussed above, foraging habitat within the study area is consistent with the definition of habitat critical to the survival of the Grey-headed Flying-fox as it contains winter flowering feed trees. The proposal is therefore inconsistent with one of the stated objectives of the draft recovery plan (DoEE 2017), which is to '*identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes throughout their range*'. With clearing of vegetation containing winter flowering feed trees of particular concern. Although the proposal site contains the winter flowering species *Corymbia maculata* (Spotted Gum) that could be utilised by Grey-headed Flying-fox individuals of this species occur in very low numbers through the site. The 5.48 hectares of potential foraging habitat within the proposal site is minor in proportion of available foraging habitat for this highly mobile species within the locality. It is therefore considered unlikely, that the proposed action would substantially interfere with the recovery of the species.

Conclusion of Assessment of Significance

On consideration of the above criteria, the proposed action is unlikely to have a significant effect on the Grey-headed Flying-fox given that:

- Vegetation to be removed comprises a negligible proportion of potential foraging habitat present in surrounding areas and the broader locality
- The proposed action would not form a barrier to the movement of this highly mobile species
- The proposed action would not affect movements between nearby campsites and foraging habitat that occurs within the locality
- No known breeding or roosting habitat would be removed or adversely affected by the proposed action.

Swift Parrot (*Lathamus discolor*) - critically endangered species

Distribution

The Swift Parrot breeds in Tasmania during the summer and the entire population migrates north to southeast mainland Australia for the winter, with the majority being found in Victoria and NSW (DEE 2019b).

Habitat Requirements

While on the mainland, Swift Parrots are nomadic, spending weeks or months at some sites and only a few hours at others, determined by the supply of nectar (Parks 2010). On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations (EES 2019b). Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Corymbia maculata*), Red Bloodwood (*Corymbia gummifera*), Forest Red Gum (*Eucalyptus tereticornis*), Mugga Ironbark (*Eucalyptus sideroxylon*), and White Box (*Eucalyptus albens*) (EES 2019b). Commonly used lerp infested trees include Inland Grey Box (*Eucalyptus microcarpa*), Grey Box (*Eucalyptus moluccana*), Blackbutt (*Eucalyptus pilularis*) and Yellow Box (*Eucalyptus melliodora*). The Swift Parrot returns to some foraging sites on a cyclic basis depending on food availability (EES 2019b).

The extent of habitat use in each region varies according to food availability and competition, with Swift Parrots briefly passing through some habitats feeding opportunistically, and remaining in other habitats foraging for several days, weeks or months. The Hunter Valley has been identified as providing important winter foraging resources for the Swift Parrot.

Habitat in the proposal site

No Swift Parrot individuals have been recorded within the study area during any of the many surveys that have been completed within or adjacent to the proposal site.

Of the PCTs that occur within the site, PCT 1600 is known to provide habitat for the Swift Parrot. Within the proposal site vegetation zones 1 would provide potential foraging habitat for this species. A total of 5.48 ha of potential foraging habitat would be impacted by the proposal none of which is mapped as important habitat for this species (DPIE 2021f). The potential foraging habitat within the proposal site includes areas in poor condition due to clearing and under-scrubbing for agricultural purposes as well as intact, good quality remnants. PCT 1600 within the proposal site contains only a small number of individuals of the one species (*Corymbia maculata* (Spotted Gum)) identified as an important feed tree species for the Swift Parrot.

EPBC Act - Assessment of Significance - Swift Parrot (*Lathamus discolor*)

According to the DoE (2013) 'significant impact criteria' for critically endangered species, an action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of a population

The EPBC Act defines a 'population of a species' as an occurrence of the species in a particular area which includes but is not limited to geographically distinct regional populations or collections of local populations or a population, or collection of populations, that occur within a particular bioregion" (DoE 2013). The Swift Parrot occurs as single, migratory population that disperses widely in Victoria and New South Wales. Small numbers of this species are often observed in the Australian Capital Territory and south eastern Queensland and less often in south eastern South Australia. (Saunders and Tzaros 2011). All individuals are considered to be part of the one population.

The Swift Parrot has not been recorded during any of the numerous ecological assessments that have been completed within the Hydro site. The closest record of the species is from approximately 2 km south of the proposal site within the township of Kurri Kurri. There are also numerous records from approximately 4 km south-west of the site within a large patch of native vegetation that forms part of the Hunter Economic Zone (HEZ).

There is a total of 5.48 ha of potential foraging habitat for the Swift Parrot within the proposal site, most of this habitat contains a low abundance of key foraging resources for the species. Of the 5.41 ha of potential foraging habitat none has been mapped as important habitat (DPIE 2021f). The proposal would not remove any known breeding habitat for the species.

EPBC Act - Assessment of Significance - Swift Parrot (*Lathamus discolor*)

Regional vegetation mapping indicates that within the Hunter IBRA subregion there is approximately 46,565 ha of habitat that contains key foraging species for the Swift Parrot (BCS 2021). The removal of 5.48 ha of potential foraging habitat of foraging resources would reduce the available foraging habitat within the Hunter IBRA subregion by about 0.01 percent. This habitat loss will decrease the availability of winter forage for individual birds that disperse throughout the area during winter. It is unlikely however that this small reduction in potential foraging habitat would lead to a long-term decrease in the size of the Swift Parrot Population.

Reduce the area of occupancy of a population

The distributional range of the Swift Parrot extends from Tasmania through parts of Victoria and NSW to southeast Queensland. Within this range, the area of occupancy for the species would include breeding grounds in Tasmania, migration routes and foraging habitats on mainland Australia. The proposal site is not at the edge of this range.

The proposal would result in the removal of 5.48 ha of potential foraging habitat which includes a small number of Spotted Gum which is a known key feed species for the Swift Parrot.

No Swift Parrots have been recorded utilising the proposal site during any of the numerous surveys that have been completed through the Hydro site over many years. There is no evidence of frequent or long-term occupancy of the proposal site by the species.

Regional vegetation mapping indicates that within the Hunter IBRA subregion there is approximately 46,565 ha of habitat that contains key trees species for the Swift Parrot (BCS 2021). The removal of 5.48 ha of potential habitat containing a low abundance of foraging resources would reduce the available foraging habitat within the Hunter IBRA subregion by about 0.01 percent. This reduction in potential habitat would not substantially reduce or fragment the extent of habitat in the Hunter IBRA subregion or otherwise reduce the area of occupancy of this highly mobile species.

Fragment an existing population into two or more populations

The Swift Parrot is a highly mobile species that routinely traverses large expanses of open water and open country, including Bass Strait, agricultural land and other clearings during its annual migration. The Swift Parrot would rely on 'stepping stones' of suitable foraging and roosting habitat during migrations and is thought to prefer 'corridors' of woodland vegetation over which to traverse. While the proposal would, in places widen an existing gap, dispersal or movement of the Swift Parrot across the landscape is unlikely to be affected as clearings created by the proposal would not be of a scale that would isolate habitat with respect to this species. The removal of 5.48 ha of potential habitat would not substantially increase the risk or energy cost of migration. As such, the proposal would not fragment the existing population into two or more populations.

Adversely affect habitat critical to the survival of the species

The *Recovery Plan for the Swift Parrot* (Swift Parrot Recovery Team 2001) notes the important breeding habitats for the species within Tasmania and important foraging habitats within mainland Australia.

The proposal would remove 5.48 ha of potential foraging habitat for the species, none of which has been mapped as important habitat, and is therefore unlikely to impact on habitat critical to the survival of the species.

Disrupt the breeding cycle of a population

Breeding does not occur on mainland Australia. Adult birds would only occur within the study area as part of seasonal foraging behaviour during winter.

Habitat loss could decrease the availability of winter forage for individuals that may disperse throughout the region during winter. The reduced availability of foraging habitat, particularly during poor flowering seasons and/or drought periods, could theoretically reduce the health and condition of adult birds, which could in turn, lead to poor condition and reduced breeding success. However due to the relatively low abundance of key feed species within the proposal site it is unlikely that the condition and health of individuals that may forage in the study area on occasion would be compromised to the extent that breeding success of individuals would be affected. Furthermore, the proposed action would not fragment a population of the Swift Parrot or create a barrier to local or regional movements of the species between foraging and breeding areas.

Given the above points, the proposal is unlikely to disrupt the breeding cycle of a population of Swift Parrot

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

The removal of 5.48 ha of potential foraging habitat will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Regional vegetation mapping indicates that within the Hunter IBRA subregion there is approximately 46,565 ha of habitat that contains key trees species for the Swift Parrot (BCS 2021). The removal of 5.48 ha of potential habitat containing a low abundance of foraging resources would reduce the available foraging habitat within the Hunter IBRA subregion by about 0.01 percent

Within the Hunter region potential foraging resources occur within a number of reserves including Mt Sugarloaf Flora and Fauna Reserve, Lower Hunter National Park, Cessnock State Forrest and Werakata National Park and further throughout the region, including extensive areas in Yengo and Wollemi National Parks.

EPBC Act - Assessment of Significance - Swift Parrot (*Lathamus discolor*)

This species is highly mobile and has a home range spanning several hundreds of kilometres. The removal of 5.48 ha of potential foraging habitat represents a small fraction of the potential foraging habitat for the species and is unlikely to cause a decline in the population of Swift Parrot.

Given that no breeding habitat would be impacted and that no areas of habitat would become isolated, it is unlikely that the proposal would result in the overall decline of the species.

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

A number of invasive flora species have been recorded in the proposal area and are known from the locality. A vegetation management plan would be produced as part of the proposal and would include guidance on managing transmission of plant propagules (e.g. seeds, spores and suckers) to mitigate the risk of invasive species becoming established or spreading throughout areas of adjacent vegetation. Introduction and spread of weeds is unlikely to substantially impact foraging habitat for this species.

The proposal site is located in close proximity to urban areas, therefore invasive fauna species such as feral cats, wild dogs and foxes are common within the locality. The proposal would be unlikely to increase the risk of predation by these species or result in new incursions of invasive fauna species that would become established in Swift Parrot habitat.

Introduce disease that may cause the species to decline

Psittacine beak and feather disease is a common and potentially deadly disease of parrots. Susceptibility to the infection may be influenced by environmental factors, such as climate, nutrition, habitat quality and social factors (DEH 2005).

The proposal is unlikely to introduce Psittacine beak and feather disease, however cumulative impacts of further land clearing and impacts on habitat has the potential to increase susceptibility of individuals.

Interfere substantially with the recovery of the species

Habitat loss is a key factor in the current threatened status of the Swift Parrot. The proposal would remove 5.48 ha of potential foraging habitat containing a low abundance of preferred feed species for this species. This vegetation has been impacted by past clearing and none has been mapped as important habitat for the species.

This habitat loss will slightly decrease the availability of winter foraging resources for individual Swift Parrots that disperse throughout the region during winter. Given the abundance of alternative foraging habitat in the locality it is unlikely that the removal of this small amount of potential foraging habitat would substantially interfere with the recovery of the species.

Conclusion of Assessment of Significance

The proposal is unlikely to result in a significant impact on the Swift Parrot as:

Vegetation to be removed comprises a small proportion of potential foraging habitat present in surrounding areas and the broader locality

The proposed action would not form a barrier to the movement of this highly mobile species or substantially increase the risk or energy cost of migration

The proposal would remove only a very small area of potential foraging habitat containing a low abundance of key winter feed species.

Regent Honeyeater (*Anthochaera phrygia*) – Critically endangered species

Characteristics and distribution

The Regent Honeyeater (*Anthochaera phrygia*) is a medium-sized honeyeater with predominantly black plumage with bright yellow edges to the wing and tail feathers. The distribution of the species is extremely patchy with contractions in the home range of the species having been observed in past decades (Franklin et al. 1989).

The Regent Honeyeater formerly occurred throughout south-eastern Australia in the Adelaide region to 100 km north of Brisbane, Queensland. The population has been continually contracting with the species northern extent primarily restricted to Gore-Karara region south of Brisbane and the species no longer observed in South Australia (Franklin et al., 1989).

The Regent Honeyeater occurs as a single population with exchanges of individuals between regularly used areas (Garnett et al., 2011). The total Regent Honeyeater population is estimated to be fewer than 1,000 individuals however may be as low as 350-400 individuals (Crates et al., 2017).

Habitat Requirements

There are few known key breeding regions remaining for the Regent Honeyeater: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley, the Bundarra-Barraba region near Gunnedah, the Hunter Valley and the Burraborang Valley. In NSW the distribution is very patchy and mainly confined to the vicinity of breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests (EES 2019a).

The timing of breeding varies between regions, and appears to correspond with the flowering of key eucalypt and mistletoe species (Franklin et al., 1989; Geering & French 1998). Breeding mostly occurs during spring and summer, from August to January (Franklin et al., 1989). While nectar flows are important for breeding, some pairs have been recorded to successfully fledge their young using insects and lerps only (Geering & French 1998).

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. 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, including creek flats, broad river valleys and lower slopes. Regent honeyeaters may use different areas in different years depending on food resources (DoE 2016).

Key eucalypt species include Mugga (or Red) Ironbark (*Eucalyptus sideroxylon*), Yellow Box (*Eucalyptus melliodora*), White Box (*Eucalyptus albens*), Yellow Gum (*Eucalyptus leucoxylon*) Spotted Gum (*Corymbia maculata*) and Swamp Mahogany (*Eucalyptus robusta*). Nectar and fruits from Mistletoes including Needle-leaf Mistletoe (*Amyema cambagei*), Box Mistletoe (*Amyema miquelii*) *Amyema pendula* Long-flower Mistletoe (*Dendrothoe vitellina*) are also utilised (EES 2019a). When nectar is scarce lerp and honeydew can comprise a large proportion of the diet. Insects make up about 15% of the total diet and are important components of the diet of nestlings.

Lower Hunter Spotted Gum forests in the Hunter Valley have recently been demonstrated to support regular breeding events of regent honeyeaters (Roderick et al 2014). Flowering of associated species such as thin-leaved stringybark (*Eucalyptus eugenioides*) and other stringybark species, and broad-leaved ironbark (*Eucalyptus fibrosa*) can also contribute important nectar flows at times (DotE 2016).

Habitat within the proposal site

Of the PCTs that occur within the proposal site the Regent Honeyeater is known to be associated with PCT 1600 (DPIE 2020a) Within the proposal there are several small patches of PCT 1600 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter that contain occasional *Corymbia maculata* (Spotted Gum) individuals as well as *Eucalyptus fibrosa* (Red Ironbark).

There is at total of approximately 5.48 ha of potential foraging habitat for the Regent Honeyeater within the proposal site, most of this habitat however contains a low abundance of key foraging resources for the Regent Honeyeater. None of the potential foraging habitat within the site has been mapped as important habitat for Regent Honeyeater (DPIE 2021f).

The National Recovery Plan for the Regent Honeyeater states that any areas where the species is likely to breed or forage is considered critical habitat for the species. The plan notes that habitat within the Hunter Valley would be critical to the survival of the Regent Honeyeater.

EPBC Act - Assessment of Significance

Regent Honeyeater (*Anthochaera phrygia*)

According to the DoE (2013) 'significant impact criteria' for critically endangered species, an action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of a population of a species

The EPBC Act defines a 'population of a species' as an occurrence of the species in a particular area which includes but is not limited to geographically distinct regional populations or collections of local populations or a population, or collection of populations, that occur within a particular bioregion (DoE 2013).

The Regent Honeyeater occurs as a single population with exchanges of individuals between regularly used areas (Garnett et al., 2011). The total Regent Honeyeater population is estimated to be no more than 1000 birds, however numbers may be as low as 350-400 individuals (Roderick et al 2014, Crates et. al., 2017).

The Regent Honeyeater has not been recorded during any of the numerous ecological assessments that have been completed within the within or adjacent to the proposal site. The closest record of the species is from approximately 6 km south of the proposal site within the township of Kurri Kurri. There are also numerous records including observations of breeding from approximately 9 km south-west of the site within a large patch of native vegetation that forms part of the Hunter Economic Zone (HEZ).

There is at total of 5.48 ha of potential foraging habitat for the Regent Honeyeater within the proposal site, most of this habitat however contains a low abundance of key foraging resources for the Regent Honeyeater. Of the 5.48 ha of potential foraging habitat within the site none has been mapped as important habitat (DPIE 2021f).. The proposal would not remove any known breeding habitat for the species. Due to the close proximity of the proposal site to known breeding habitat for the Regent Honeyeater there is the possibility that breeding individuals i within the Lower Hunter breeding population may forage at the proposal site. Due to the low abundance of foraging resources within the site and the presence of much higher quality habitat within the locality, it is highly unlikely that the site would be used by Regent Honeyeaters for breeding.

Regional vegetation mapping indicates that within the Hunter IBRA subregion there is approximately 39,162 ha of habitat that contains key trees species for the Regent Honeyeater (BCS 2021b). The removal of 5.48 ha of potential habitat containing a low abundance of foraging resources would reduce the available foraging habitat within the Hunter IBRA subregion by about 0.01 percent. It is unlikely that this reduction in potential foraging habitat would lead to a long term decrease in the size of the Regent Honeyeater population.

Reduce the area of occupancy of the species

The distributional range of the Regent Honeyeater extends from parts of Victoria, through NSW to southeast Queensland. The area of occupancy is estimated at 300,000 km². The extent of occurrence is likely to be declining based on historical declines and the present status of the species (DoE 2016).

The proposal would result in the removal of 5.48 ha of potential foraging habitat which includes known scattered individuals of the important feed species *Corymbia maculata* (Spotted Gum) and *Eucalyptus fibrosa* (Broad-leaved Ironbark).

No Regent Honeyeaters have been recorded utilising the proposal site during any of the numerous surveys that have been completed through and adjacent to the proposal site over many years. There is therefore no evidence of frequent or long-term occupancy of the proposal site by the species.

Regional vegetation mapping indicates that within the Hunter IBRA subregion there is approximately 39,162 ha of habitat that contains key trees species for the Regent Honeyeater. The removal of 5.48 ha of potential habitat containing a low abundance of foraging resources would reduce the available foraging habitat within the Hunter IBRA subregion by about 0.01 percent. It is therefore unlikely that this reduction in potential habitat would substantially reduce the area of occupancy of this highly mobile species.

Fragment an existing population into two or more populations

The Regent Honeyeater occurs as a single population with exchanges of individuals between regularly used areas (Garnett et al., 2011). This species is capable of moving long distances to occupy new locations in response to changing food availability (Roderick et al 2013). There is an estimated 20,985 ha of available potential Regent Honeyeater foraging and breeding habitat in the Hunter IBRA subregion including large areas within close proximity to the proposal site. Vegetation proposed to be cleared occurs as small scattered remnants within agricultural paddocks. Highly mobile species such as the Regent Honeyeater are expected to be less impacted by fragmentation and this species is well-adapted to accessing widely spaced habitat resources given its mobility and preference for seasonal foraging resources. The removal of 5.48 ha of potential habitat would not substantially increase the risk or energy cost of movement. Given the clearing occurs on the edge of patches, the high mobility of the species, and large areas of alternative habitat within the locality, the proposal is would not result in fragmentation of the population into two or more populations.

EPBC Act - Assessment of Significance

Adversely affect habitat critical to the survival of the species

The National Recovery Plan for the Regent Honeyeater specifies that any breeding or foraging habitat in areas where the species is likely to occur (as defined by the distribution map provided in Figure 2 of the Recovery Plan) is considered critical to the survival of the species (DotE 2016). The proposal site contains tree species that could provide foraging resources for the Regent Honeyeater (*Corymbia maculata* and *Eucalyptus fibrosa*) and is within the area mapped as key breeding habitat within the Hunter Valley on Figure 2 of the Recovery Plan. As such the proposal site meets the definition of critical habitat for the Regent Honeyeater. The removal of 5.48 ha of potential habitat with a low abundance of tree species that could provide foraging resources would comprise a minor adverse effect on habitat critical to the survival of the species.

Disrupt the breeding cycle of the population

Numerous field surveys of the Hydro site have not found any evidence of Regent Honeyeater breeding (nests or pairs) within the proposal site. However, as mentioned above there is known breeding habitat for the Regent Honeyeater within close proximity to the site (9 km to the south). Although it is unlikely that the species would utilise the site for breeding due to the relatively low abundance of key feed species and the disturbed nature of the vegetation, the site could provide a small contribution to the overall foraging resources of breeding pairs within the locality. Given the small areas of disturbed potential foraging habitat that would be removed relative to the large areas of higher quality foraging habitat in the locality is highly unlikely that the removal of 5.48 ha of marginal foraging habitat from the site would disrupt the breeding cycle of the Regent Honeyeater population.

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

The proposal would remove of 5.48 ha of marginal foraging habitat for the Regent Honeyeater. The potential habitat within the site contains a low abundance of preferred feed species for the species and no known breeding habitat would be removed.

The proposal would remove small patches of potential habitat that may contribute to cumulative fragmentation of habitat in the landscape. Given the high mobility of the species however it is unlikely that the proposal would lead to any fragmentation or isolation of any habitat for this species.

Given the small areas of disturbed potential foraging habitat that would be removed relative to the large areas of higher quality foraging habitat in the locality is highly unlikely that the removal of 5.48 ha of marginal foraging would decrease the availability or quality of habitat to the extent that the species is likely to decline.

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

A number of invasive flora species have been recorded in the proposal area and are known from the locality. A vegetation management plan would be produced as part of the proposal and would include guidance on managing transmission of plant propagules (e.g. seeds, spores and suckers) to mitigate the risk of invasive species becoming established or spreading throughout areas of adjacent vegetation. Introduction and spread of weeds would be unlikely to substantially impact foraging habitat for this species.

The proposal site is located in close proximity to urban areas, therefore invasive fauna species such as feral cats, wild dogs and foxes are common within the locality. The proposal would be unlikely in new incursions of invasive fauna species that would become established in Regent Honeyeater habitat.

Introduce disease that may cause the species to decline

No diseases are likely to be introduced as part of the proposal. A detailed assessment of the disease risk to the Regent Honeyeater was conducted by Jakob-Hoff et al. (2014) and identified the release of birds in captive breeding programs as the main vector for the transmission of diseases into the wild population. As no captive Regent Honeyeaters are being released as part of this proposal it is unlikely that any diseases that would affect the local wild population would occur.

Interfere substantially with the recovery of the species

The proposal would result in the clearing of 5.48 ha of marginal foraging habitat for the Regent Honeyeater. The removal of this habitat is not likely to interfere substantially with the recovery of the species.

Conclusion of Assessment of Significance

The proposal is unlikely to result in a significant impact on the Regent Honeyeater as:

- Although the proposal will remove a very small amount of marginal foraging habitat defined by DAWE as critical to this species (as it occurs in the Hunter Valley). Due to the disturbed nature of this vegetation and low abundance of feed trees the vegetation to be removed comprises a very small proportion of foraging habitat present in surrounding areas and the broader locality.
- The proposed action would not form a barrier to the movement of this highly mobile species
- The proposed action is unlikely to disrupt the breeding cycle of the species
- The proposed action is unlikely to interfere substantially with the recovery of the species

Assessment of Significance for Migratory Species potentially impacted by proposed action

White-bellied Sea-Eagle (*Haliaeetus leucogaster*)

The White-bellied Sea-eagle (*Haliaeetus leucogaster*) is a large raptor with a wingspan of up to 220 cm. It feeds opportunistically on a variety of fish, reptiles, birds, mammals, crustaceans and carrion (del Hoyo et al. 1994; Ferguson-Lees & Christie 2001; Marchant & Higgins 1993; Rose 2001).

Some White-bellied Seas-Eagles may travel several hundred kilometres in order to find foraging and breeding habitat with reports of one individual being recorded travelling from its natal territory at Cowell, South Australia to Fraser Island, Queensland, a distance of approximately 3000 km (Marchant & Higgins 1993).

The main threats to the White-bellied Sea-Eagle are the loss of habitat due to land development, and the disturbance of nesting pairs by human activity (DotE 2020).

Migratory Species
<p>The Significant Impact Guidelines 1.1 (DotE 2013) lists criteria which are used to determine whether an action is likely to have a significant impact on migratory species. An action is considered likely to result in a significant impact on migratory species if there is a real chance or possibility that it will:</p> <p>Substantially modify and/or destroy an area of important habitat for a migratory species</p> <p>An area of 'important habitat' for a migratory species is defined in the Significant Impact Guidelines (DotE 2013) as: 'Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species'.</p> <p>The White-bellied Sea-eagle generally forages and breeds in habitats near the coast and within coastal lowland areas. The study area provides some marginal foraging habitat for this species with water fowl, mammal and reptile species occurring within the study area. However, the study area is unlikely to support a significant proportion of the total population of this species.</p> <p>The proposed action would reduce the area of potential foraging habitat for these species by a small amount relative to the potential habitat within the locality. No breeding habitat for this specie would be impacted by the proposal. Habitat within the proposed action site is not considered critical during the lifecycle of the White-bellied Sea-eagle.</p> <p>'Habitat utilised by a migratory species which is at the limit of the species range'.</p> <p>Habitat within the proposed action site is not at the limit of the species range. Distribution of habitat for this species extends well beyond the proposal site throughout coastal Australia and larger inland water courses.</p> <p>'Habitat within an area where the species is declining'.</p> <p>Populations of the White-bellied Sea-Eagle are considered relatively stable (DAWE 2020a and DAWE 2020b). The proposal would therefore not impact on habitat of a species that is in decline.</p>
<p>Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species</p> <p>The proposed action would not seriously disrupt the lifecycle of an ecologically significant proportion of the population of the White-bellied Sea-Eagle. Given the relatively small area of marginal foraging habitat of potential habitat that would be impacted by the proposal it is unlikely that it would support an ecologically significant proportion of the population of either of these species.</p>
<p>Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species</p> <p>It is possible that the proposed action would result in slight increases in the incidence of weeds in vegetation immediately surrounding the study area. The Construction Environmental Management Plan (CEMP) for the proposal would include measures to prevent the spread of weeds, including hygiene procedures for equipment, footwear and clothing, and weed disposal protocols. This would minimise the potential for invasive species to establish in potential foraging habitat for these species.</p>
<p>Conclusion of Assessment of Significance</p> <p>Consideration of the DotE (2013) 'significant impact criteria' indicates that the proposed action is unlikely to impose a significant impact on the White-bellied Sea-eagle as it would not:</p> <ul style="list-style-type: none"> – Substantially modify and/or destroy an area of important habitat for these species, noting that vegetation within the study area is only likely to represent marginal foraging habitat for these species. Given the extensive other areas of foraging habitat in the locality it is unlikely that impacts from the proposal would be significant to this species. – The study area does not comprise important habitat for White-bellied Sea-eagle – Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of any of these species – Result in an invasive species that is harmful to the species becoming established in an area of important habitat.

Appendix F

**Species expert assessment of Regent
Honeyeater and Swift Parrot habitat**



Dr Ross Crates
6/15 Cook Street
Randwick
Sydney 2031
11th October 2021

To whom it may concern,

I hereby confirm that the plant community types and vegetation condition of land centred at -32.7757, 151.5218 does not constitute important foraging or breeding habitat for the swift parrot *Lathamus discolor* or regent honeyeater *Anthochaera phrygia*.

I conducted a visit to this site on 6th October 2021 and found the habitat within this development footprint primarily comprises dense shrubby understorey dominated by *Melaleuca* species. The canopy is sparse, comprising less than 20 trees of *Eucalyptus punctata x canaliculata*, none of which are mature or old growth. See accompanying images below.

In my opinion, the loss of this habitat as a consequence of the Hydro development with the Maitland Local Government Area would not represent a serious and irreversible impact on the regent honeyeater or swift parrot. I am recognised as an expert on both species by the New South Wales Biodiversity Conservation Trust. Please find my curriculum vitae accompanying this letter.

Yours sincerely,

R A Crates

Dr Ross Crates

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Appendix G

Assessment of Green and Golden Frog habitat and Green-thighed Frog Habitat by Species Expert (Frank Lemckert)

MEMORANDUM

TO Arien Quin

FROM Frank Lemckert

DATE 19 January 2022

PURPOSE

Habitat assessment for threatened frogs

SUBJECT Expert Advice Report - Green and Golden Bell Frog and Green-thighed Frogs for the Kurri Kurri Smelter re-development.

1. Introduction

Eco Logical Australia (ELA) was engaged by GHD to undertake an assessment of the habitats available for the Green and Golden Bell Frog (GGBF), *Litoria aurea*, and Green-thighed Frog (GTF), *Litoria brevipalmata*, within lands enclosed by the proposed “Development Boundary” of the BioCertification area located at Loxford NSW (refer to Figure 1). The work was completed by ELA’s accredited expert in these two species, Dr Frank Lemckert, who was also engaged to provide an assessment of adequacy of previous surveys and the potential for those surveys to have detected both species. The aim of this report is to provide GHD with expert advice as to whether the two species would likely be present on the site and if further survey for either species is warranted and, if so, provide recommendations on how any such survey should be completed.

Hence this work consisted of two parts. One was to undertake a site inspection of the lands enclosed within the development boundary and areas within 200 m of the boundary (study area) in order to provide an expert assessment of the potential for each species to be present and breeding on the site in the current conditions. The second was to review reporting on the surveys completed previously on this site for the GGBF to provide an expert view as to whether those would likely have detected the frogs if they were present. And if not, provide an expert view as to what other surveys would be required in order to provide a sufficient level of certainty as to whether the GGBF is present or absent.

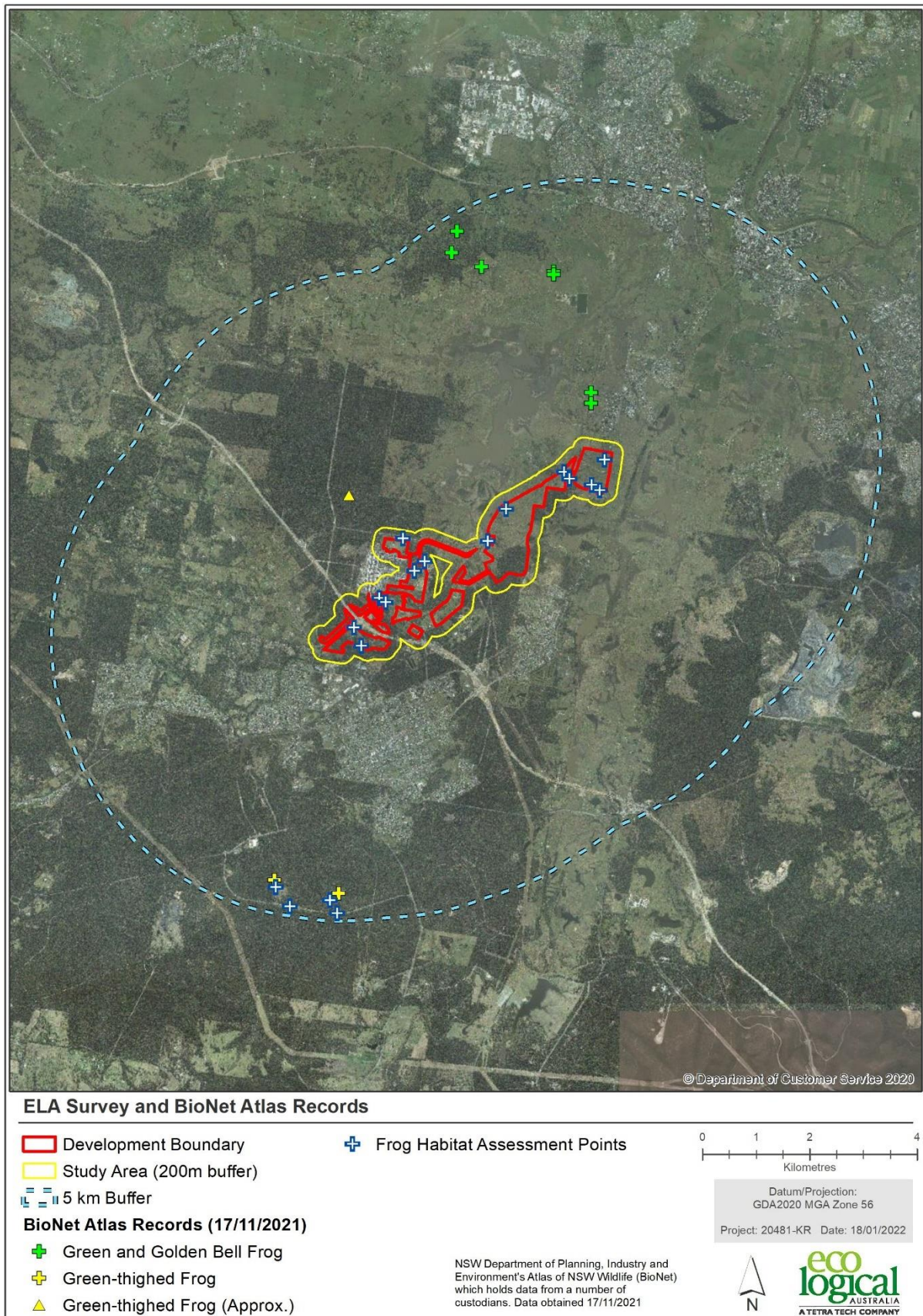


Figure 1. Study area, inspection points and records of the GGBF and GTF available on BioNet

2. Habitat Requirements

2.1.1. Green and Golden Bell Frog

Breeding sites for the GGBF include a wide range of natural water bodies and the species has been recorded inhabiting all but fast flowing streams (White and Pyke 1996). It also inhabits many human-created environments, including highly disturbed sites such as abandoned mines and quarries (Pyke et. al. 2002), as well as artificial wetlands that have been created at both Kooragang Island (Hamer et. al. 2002) and Sydney Olympic Park (Darcovich and O’Meara 2008). White and Pyke (1996) undertook a review of the known breeding habitat of the GGBF and found that they preferred to breed in water bodies that were still, shallow, ephemeral, unshaded, with aquatic plants and free of the Plague Minnow (*Gambusia holbrooki*) and other predatory fish. This study also found that breeding occurs in a significantly higher proportion of sites with ephemeral (temporary) ponds, rather than sites with fluctuating or permanent ponds. Hamer et. al. (2002) found a similar result for the GGBF populations at Kooragang Island where larger males would move to ephemeral water bodies to breed when they were available, although reproduction was also associated with permanent water bodies. The frogs in that study also tended to remain relatively faithful to one water body. The presence of the Plague Minnow does not exclude GGBF from breeding in a water body, but success appears to be dependent on the presence of more complex aquatic vegetation, which allows the GGBF to breed successfully (Hamer et. al. 2002). Hence the Plague Minnow does still appear to be a sole determinant of the likely presence of the GGBF in most situations.

The GGBF is unusual for an Australian frog in that the species appears to remain generally associated with water bodies, remaining within the riparian zone unless migrating between water bodies. Most frogs migrate 50-300 m from the breeding site to settle into recognisably different complementary non-breeding habitat in which they spend the majority of the year (Lemckert 2004). Terrestrial habitats immediately adjacent to water bodies (< 50 m) are typically used for foraging and shelter and preferably consist of grassy areas and vegetation no higher than woodlands and contain a range of diurnal shelter sites such as logs, rocks or dense vegetation (White and Pyke 1996). However, there are observations of GGBF moving into taller forests (e.g. dry sclerophyll forest at Nowra; M. Greenlees Pers. Comm. and dense woodlands at Meroo; F. Lemckert Pers. Obs.) and even foraging in suburban backyards (DEC 2005). This again demonstrates the adaptability and lack of habitat specificity of this frog.

Adult frogs show a strong site fidelity in regards to returning to the same ponds over time (Hamer et al. 2008), but their movements around those ponds and immediately adjacent areas are relatively random for most individuals and especially juveniles (F. Lemckert Pers. Obs.). Females though, have been observed to congregate together into specific shelter and foraging sites in areas immediately adjacent to breeding sites (Hamer 1998, Pyke and White 2001).

Another unusual aspect of the GGBF is its well-known habit of basking, typically within areas of aquatic vegetation, in order to increase body temperatures (Pyke and White 2001). Basking in frogs is unusual (being generally nocturnal), but such activities in ectotherms typically allow for periods of greater activity or faster digestion of food items. Whilst the importance of this activity for its physiological requirements is not known, individual GGBF appear to bask regularly. On this basis, it is likely that basking is an important physiological activity for the GGBF. Basking typically occurs within or on the edge

of emergent aquatic vegetation, which likely allows individuals the option to make a rapid escape from diurnal predators. The presence of water bodies that contain emergent vegetation are known important determinants of the presence of GGBF (White and Pyke 1996; Hamer et al. 2002) and form an important resource for the GGBF and in the consideration of their potential presence.

Christy (2001) and Muir (2008) state that terrestrial movements of the GGBF are primarily undertaken through more open environments that contained patches of shelter such as rocks, logs or ponds or areas of thick vegetation. Such habitats provide relatively little impediment to the movements of frogs but allow for individuals to seek shelter as required. Terrestrial movements are typically undertaken at night and are most likely associated with rainfall events (F. Lemckert Pers. Obs.) which would provide protection against desiccation.

Mahony (1999) cautions that the studies that have been carried out since the declines of the GGBF do not necessarily identify the actual preferred requirements of the species. He notes that the changed environment and factors causing the declines may have “altered” the optimal habitats for the species in comparison to their habitat use patterns prior to the declines. This is based on the fact that the use of ephemeral breeding sites was not noted for the bell frog group in earlier habitat descriptions. Such altered habitat use has been noted for other species such as *Litoria lorica* that now is only present in open rocky streams whereas it was once known as a rainforest stream species (Puschendorf et al 2011). This change is attributed to the impacts of the chytrid fungus, with the frog only surviving in a relatively extreme environment where the fungus is affected by the hotter conditions. Given the chytrid fungus appears also to have been at least a significant contributor (and probably the major one) to the decline of the GGBF, there is a significant potential that the GGBF is now living successfully only in a different set of environments to what it historically did. However, that is unlikely to ever be confirmed.

A critical consideration in the likely presence/absence of the GGBF are metapopulation dynamics. The GGBF is considered to follow a classical metapopulation structure with the “local” population consisting as a series of patchy populations within the larger metapopulation. Individuals move regularly between a mosaic of wetlands across a broad area throughout a single breeding season (Hamer et al. 2008; Hamer & Mahony 2010). There is high site-specific population turnover with local extinctions being balanced by colonisations by regularly dispersing individuals, but with the overall population remaining stable. There are core sites that provide ongoing and regular reproductive success and that maintain long-term populations, but a major part of the population dynamics is driven by inter-year success of breeding at a range of available breeding sites, with years of very good reproductive success leading to opportunities to expand ranges and colonise new sites. On Kooragang Island, GGBF typically reside in permanent waterbodies where they exhibit high site fidelity, but during periods of high rainfall disperse over several hundred metres to breed at ephemeral water bodies that have flooded (Hamer et al. 2008). Reproductive activity (e.g. calling) typically occurs over several nights at these ephemeral waterbodies, with individuals returning to core permanent waterbodies. In times of poor rainfall, the core sites become the refuges for the species and Valdez et al. (2015) found that probability of occupancy of a site increased at large and permanent wetlands.

Following on from this is the identified need for connected sites to allow this population interaction. Hamer (2016) found that the presence of the GGBF at sites at Nowra was dependent on accessibility of ponds, a factor mediated both by the presence of vegetation and the extent of roads in the area, with

the presence of roads providing a likely serious barrier to pond use. The presence of vegetation directly around ponds correlated significantly with the potential for greater species diversity. The type of pond available also was important, with the species avoiding steep sided concrete ponds. The apparent negative impacts of roads was confirmed in follow up work (Hamer 2018) where it was again found that the extent of accessible habitat (habitat close to ponds and not isolated from the pond by a road) positively influenced the likelihood of pond occupancy. Extinctions of GGBF were significantly more likely to occur at ponds in areas with higher densities of roads, but were significantly less likely at ponds with higher aquatic vegetation cover. The spatial arrangement of wetlands and the extent of wetlands measured in a 1 km radius has been found to be an important predictor of pond occupancy by GGBF in studies by Hamer et al. (2002), Hamer and Mahony (2010) and Valdez et al. (2015) with more ponds, ponds in closer proximity and already occupied ponds increasing the potential for the GGBF to be present or occupy a previously unoccupied pond (Puschendorf et al. 2011).

2.1.2. Green-thighed Frog

The habitat requirements of the GTF have received much less attention than the GGBF, but still appear to be moderately well understood. The species is one of only a handful of eastern temperate Australian species that exhibit “explosive” breeding. Males congregate around large, temporary pools that form only after very heavy rainfall events (Barker et al. 1995; Lemckert et al. 2006) and calling generally lasts for only one or two nights and reproduction is highly variable. In the area from Coffs Harbour down to the Central Coast of NSW Lemckert et al. (2006) found breeding sites for the GTF were typically partly or wholly within rainforest or wet sclerophyll forest or in wet gully lines (Lemckert et al. 2006). The species appears to move into more open forests in the northern half of its distribution, but has been rarely recorded in such locations in the southern half of its range.

Lemckert et al. (2006) recorded that the GTF typically call and breed in depressions adjacent to streams (e.g. old billabongs), but that human created depressions, such as flooded road verges or excavated hollows were also used. Most pools contained relatively little emergent vegetation and contained a base made up of leaf litter and woody debris (Lemckert et al. 2006). A couple of known sites located not directly in the native vegetation, but instead immediately adjacent to it.

Based on the work of Ledlin (1997) and Lemckert et al (2006), this species appears to breed essentially only in relatively large ephemeral pools – typically sites that are at least 10 m long, 5 m wide and have water depths of greater than 30 cm. These sites fill only after sustained rains or bursts of heavy rain, usually being identified by falls of over 50 mm and often closer to 100 mm over 24-48 hours. This appears likely to be a response to such a highly specific set of breeding conditions that require sites that will hold water for a sufficiently long period to ensure tadpoles can reach metamorphosis.

The non-breeding habitat use for this GTF has only really been assessed through a radio-tracking study by Lemckert and Slatyer (2002). This study found tracked frogs remained within areas of forest where frogs foraged and moved through low vegetation 59% of the time, at heights between 10 cm and 150 cm above the ground. Daytime shelter sites were either under dense leaf litter or in thick vegetation, both of which provide good camouflage and moist conditions that minimise desiccation risks. The work indicated that cover, in the form of thick leaf litter or dense low vegetation, may be a critical requirement for the survival of the Green-thighed Frog (Lemckert and Slatyer (2002).

3. Site Inspection

Dr Lemckert conducted an assessment of the available habitats in the “Development Area” and 5km buffer zone (in accordance with NSW Biodiversity Assessment Methods, DPIE 2020) with GHD ecologist Arien Quin on the 16th of November 2021. The inspection involved driving around the study area to observe the range of different vegetation and habitat types present within the actual development area as well as any potential breeding habitats located within 200 m of its boundary that frogs in the development area might migrate to for breeding (see Figure 1). A visual inspection was undertaken of water bodies and riparian areas as they were encountered, resulting in stops at 15 locations with the aim being to obtain a detailed understanding of the potential breeding sites (temporary and permanent water bodies) that are present in the study area and assess how suitable these sites are for breeding for either species. The quality of the water bodies present was also assessed for non-breeding breeding habitat for the GGBF and to provide connectivity across the landscape, which is important for the GGBF. The habitats within the surrounding 50-100 m of the water bodies were also assessed for potential foraging and shelter and habitats for the GTF and to allow migration between water bodies for the GGBF. The range of different habitats investigated can be seen in the photo plates provided in Appendix 1.

4. Survey Review

The following documents were reviewed for the surveys conducted in the study area to date:

- Cenwest 2004. Hydro Aluminium Kurri Kurri: Terrestrial Vertebrate Fauna Assessment. Report prepared by Cenwest Environmental Services.
- ELA 2016. Hydro Aluminium Kurri Kurri Biodiversity Certification Assessment Report. Prepared for Hydro Aluminium Kurri Kurri Pty Ltd.
- GHD 2021. Hydro Aluminium Kurri Kurri Pty Ltd Biodiversity Certification Assessment Report. Report prepared by GHD.

The previous survey results were taken into account to consider how well the GGBF had been surveyed overall in the area in the last 10 years (recognising that five years is the typically accepted time-frame that survey data is considered as “current”). The Cenwest (2004) report was looked at to provide some historical context about the presence of the GGBF and the GTF in the study area.

5. Results

5.1. Green and Golden Bell Frog Habitat

The study area contained a range of ponds and streams with still or slow moving pools that could potentially provide suitable breeding habitat for the GGBF. Figure 2 provides a map of the locations of water bodies inspected and examples of these are shown in Plates 2, 4, 9, 10, 11, 12 & 14 that are provided in Appendix 1. These ponds include significant areas of emergent vegetation that the GGBF prefer for daytime shelter and for males to hold onto when calling. These ponds varied greatly in size and were scattered widely across the study area and so provide a mosaic of ponds and pools that are close enough (less than 500 m apart) for GGBF to reasonably easily migrate between.

The study area also includes large areas of suitable non-breeding habitat in the form of ponds with emergent vegetation, creek lines with riparian vegetation and adjacent grassy paddocks with some embedded remnant vegetation. This provides a mosaic of both shelter sites at the ponds and streams and immediately adjacent grassland and open woodland foraging habitat that the frogs can move into each night to forage.

The habitat was assessed as good quality non-breeding habitat but provides compromised breeding habitat as follows:

- The major problem identified in the site inspection was the widespread nature of the Plague Minnow, *Gambusia holbrooki*. This fish was ubiquitous and evident in high density in almost all potential breeding habitats. The presence of this species typically precludes significant reproduction for the GGBF as it eats the eggs and tadpoles, and sites with the Plague Minnow are rarely used for breeding. Only one pond was located that clearly did not have the Plague Minnow, which is the pond shown in Plates 10 and 11.
- Furthermore, permanent streams were also seen to contain large numbers of European Carp (*Cyprinus carpio*) which is a species that also impacts on the GGBF and its breeding through eating the eggs and tadpoles and making the water turbid. Hence the breeding habitat throughout the study area is compromised as breeding habitat for the GGBF.
- In regards to non-breeding habitat, as noted above the area contains a diversity of water bodies that are spread across the landscape and provide good connectivity. This included a range of streams that can form longer movement corridors (e.g. Plates 7 and 8). The presence of the Plague Minnow does not affect the adults and sub-adults and they can move relatively freely in such environments. Furthermore, the presence of a patchwork of native vegetation and cleared paddocks provides good habitat for foraging and shelter for frogs when moving around or between water bodies. So the habitat within the study area is very good non-breeding habitat for the GGBF.

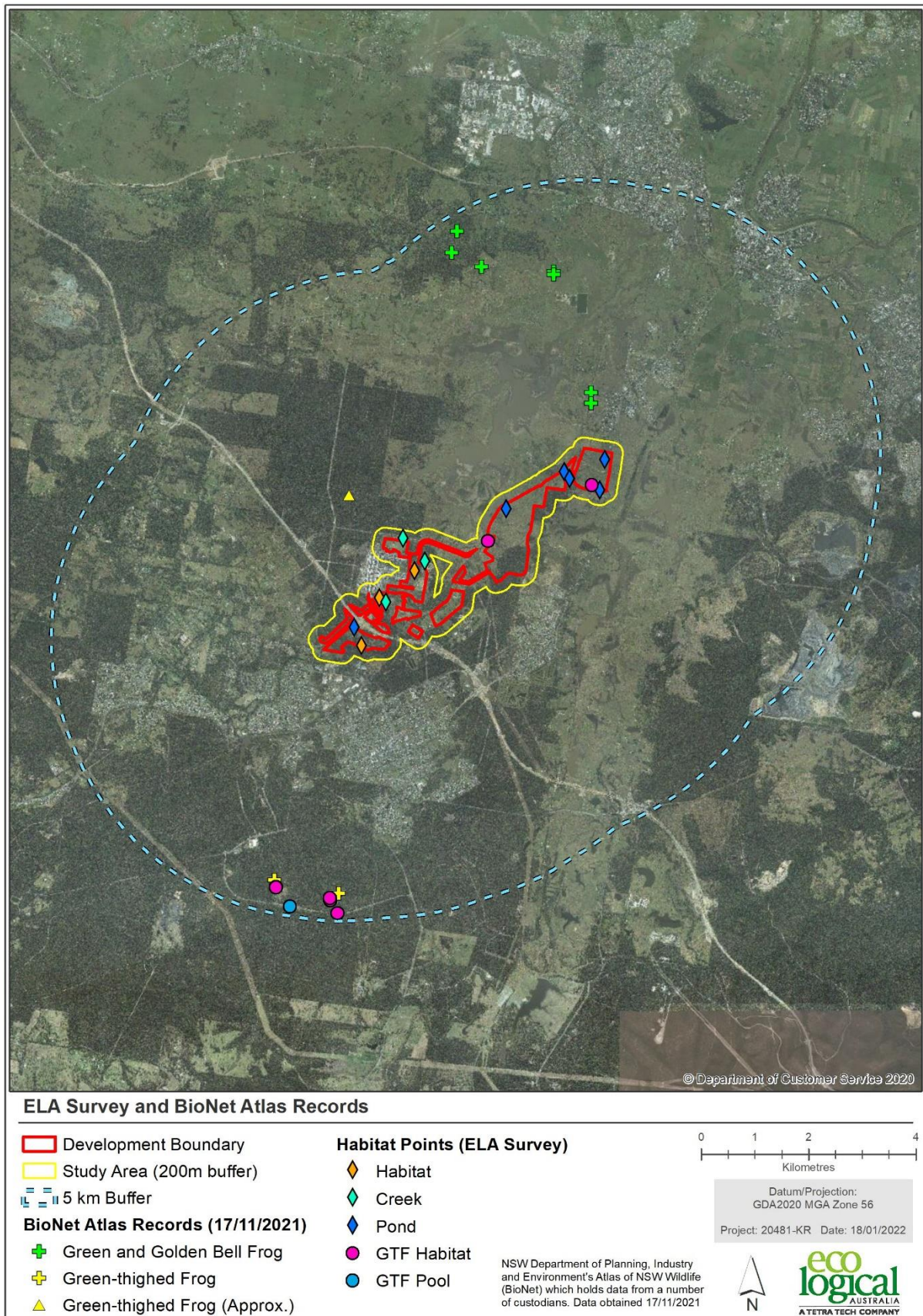


Figure 2. Locations of water bodies and habitat points looked at during site inspection

5.2. Green-thighed Frog Habitat

The study area contains no evident suitable breeding habitat for the GTF. The species requires larger ephemeral water bodies within or adjacent to areas of enclosed vegetation. There were no such areas located anywhere within the areas of habitat that were viewed or would be likely anywhere else. Ephemeral water bodies were actually notable for their absence, despite significant recent rainfalls that should have at least partly filled smaller ephemeral pools and the streams were noted for being full. Only one area within the proposed development footprint showed any similarity to suitable breeding habitat (Plates 13 and 14; northern GTF habitat point in Figure 2). It is an area of more enclosed riparian vegetation with paperbarks that has a moderate shrub layer within that vegetation and the drainage line has a number of ponds. These appear to be semi-permanent however and occur along the flow line and consequently that contain the Plague Minnow. The presence of this pest species again would impact severely on the GTF and it is highly unlikely the GTF would use these locations for breeding.

The site inspection found limited non-breeding habitat for the GTF. Few areas were observed that provided the wetter riparian vegetation that the species appears to require in this part of its range. As the Plates in general show, the environment is mostly paddocks or woodlands to dry eucalypt forests. Plate 5 shows the typical grassy understorey that does not provide the cover that the GTF uses for foraging and shelter.

As a contrast, two known GTF locations were visited in the Kurri Kurri Area (two southern points in Figure 1) to assess the habitat present there. These sites can be seen in Plates 15 and 16 and are very typical of GTF habitat found elsewhere, having a denser shrubby understorey and a good cover of leaf litter. They also contain numerous depressions that can flood after heavy rains and so provide the GTF with its preferred breeding habitat. No such habitat was evident anywhere in the study area.

5.3. Survey Review for the Green and Golden Bell Frog

The survey requirements for GGBF are outlined in the BAM guidelines published after the three listed surveys reviewed (DPIE 2020). The intent of the guidelines is to ensure that surveys are conducted multiple times over a period that will provide differing environmental conditions, and that surveys are conducted during the breeding season to maximise the probability of detection.

The review considered whether the existing survey effort met the intent of the 2020 survey guidelines (DPIE 2020).

The BAM frog survey guidelines provide the following requirements for the GGBF that should be completed over a minimum 14 day period:

Table 1: BAM Survey Guidelines for the Green and Golden Bell Frog (DPIE 2020)

Species		Survey Methods	
Green and Golden Bell Frog, <i>Litoria aurea</i> .		500m transect of suitable breeding habitat 50 m2 water surface (tadpoles)	
Aural-visual surveys	Nov. – March	480 mins	4

Species		Survey Methods	
Acoustic recorder	Nov. – March	154 recorder days	1 x 14 days
Tadpole search	Nov. – March	10 mins/50 m2 of surface area	Up to 2

Survey methods: Aural-visual or acoustic recorder surveys can be completed along the edges of suitable breeding habitat or, if feasible, through shallow wetlands. Tadpole surveys can be used to replace up to two of the aural-visual surveys. Tadpole searches should target areas of shallow and open water where the tadpoles are likely to congregate. If the plague minnow (*Gambusia holbrooki*) is present this method is not recommended. The presence of the plague minnow should be recorded.

Surveys should sample the available range of waterbodies on the subject land. Sweep netting should target areas of open water.

Potential habitat: Suitable breeding and non-breeding shelter habitat consists of any waterbody with emergent aquatic vegetation and without the plague minnow (*Gambusia holbrooki*), although the green and golden bell frog will still occasionally breed in sites with this introduced pest fish. Foraging habitat and migratory habitat are areas of native and non-native vegetation.

The guidelines also state the following in regards to survey conditions:

2.5 OPTIMISE THE METEOROLOGICAL CONDITIONS FOR THE SURVEY

Frogs are particularly responsive to climatic conditions. Being ectotherms with permeable skin makes them prone to desiccation and lower activity during cooler, dry conditions. Surveys during dry, windy and/or cold conditions, when frogs reduce activity, should be avoided. Note that windy conditions not only desiccate frogs, but also disperse calls. Calling is energetically costly for males and they will reduce calling in conditions that minimise breeding opportunity.

5.3.1. GHD surveys

The review of the surveys conducted previously by GHD indicated that call playback surveys targeting GGBF and GTF were completed on the 26th of November 2019 and between the 24th and 28th of February 2020. The report indicates also that this resulted in a total of five hours of amphibian surveys. This covers the correct survey period for the GGBF. The report states that only two constructed detention ponds would be impacted by the development and surveys targeted those two locations. If that is the case then the level of effort provided would be adequate for the detection of frogs at these two ponds and the surveys were spread over an extended period of time that would assist in detecting the species. However, other ponds and streams were evident within the development area and would potentially be impacted by any proposed works. These appear to have only been the subject a much reduced survey effort. If development will impact potential breeding habitat outside the two ponds and identified as

potential GGBF habitat in this assessment then the level of survey effort has not been to the usually accepted level.

No GGBF were recorded through the GHD survey (GHD 2021).

GHD also conducted active searches of woody debris, loose bark and other ground litter throughout the subject site targeting threatened frogs for a total of five person hours. This method is unlikely to produce records for the GGBF, which stays close to water bodies, and so does not provide any greater certainty for determining the presence/absence of the species.

In regards to the conditions at the time of the surveys, the GHD report (GHD 2021) notes that:

The Kurri Kurri area received approximately 47 mm of rainfall the week prior to the 24 – 28 February 2020 fauna surveys. In addition, there was a further 9 mm of rain recorded during the February surveys. Although the site was still considerably dry as a result of long term drought, these rainfall events resulted in suitable conditions to complete frog surveys within the site”.

This level of rainfall would likely have resulted in any GGBF present becoming active and initiate foraging and dispersal between nearby water bodies. This would have made them more easily spotted during visual searches of water bodies. It is not likely that this level of rainfall would have initiated calling activity based on the observation that the site was still dry. The GGBF will preferably used flooded and ephemeral areas for breeding and these would not have been available for breeding under these conditions. The dry conditions would also likely have curtailed the movements of frogs to more distant ponds to initiate breeding as the dry ground would have desiccated individuals and the absence of pooled water would not have provided sites to re-hydrate. So calling seems unlikely to have occurred and assisted in detecting the species. However, it is noted that the species is relatively easy to detect at water bodies regardless of calling activity.

5.3.2. Eco Logical Australia surveys

Eco Logical conducted aural-visual surveys with call playback between the 26th of November 2014 and the 29th of January 2015. The report detailing this work (ELA 2016) notes that this survey targeted lentic habitats and associated vegetation broadly within this study area and were conducted over 6 separate nights. Calls of the GGBF were played at each location for a minimum of 5 minutes followed by at least 5 minutes of listening, repeated at least once. Aquatic vegetation in the water bodies and bank areas were then searched by torchlight over a minimum of 1 hour.

The timing of the ELA surveys fits into the appropriate survey period but the actual number of nights surveys were conducted at any one site was not specified. The indications were that sites were surveyed between 1 and 3 nights each. This provides some level of replication between sites and the effort put in of more than one hour per site would likely be adequate for the size of water bodies evident in the study area. The report does note that the water storage areas within and adjacent to the smelter were surveyed for three nights, which would be the same ponds targeted by GHD. Therefore, those sites were surveyed on multiple occasions over the two studies. It is noted that these surveys were completed more than five years ago and so do not meet the standard accepted requirement of occurring within the last five years if they are to be used in assessments.

No GGBF were located through the ELA surveys, which is consistent with the records that the GGBF has not been detected for more than 10 years and is considered broadly absent from this part of the Hunter Valley.

A nocturnal driving transect was conducted by ELA through the study area on the night of 16 December 2014 to detect amphibian and reptile species foraging on or crossing roads. Again, this survey method does not really provide a significant addition to the detection rates of the GGBF.

5.3.3. Cenwest surveys

The surveys conducted by Cenwest in 2004 provided for reptile and amphibian surveys at 10 sites in spring and autumn and with a specific targeted amphibian survey conducted from the 21st to the 26th of November 2003 after a significant rainfall event. The methods are not described in clear detail as to what methods were undertaken at each point or how much effort and the number of repeat surveys were conducted for each point. Hence it is not possible to understand the true survey effort completed. These surveys also did not detect the GGBF at any location, although GTF were collected in a pitfall trap to the north of the study area. It would appear at least that the GGBF was not present in any significant number even at this time.

6. Discussion

6.1. Presence of the Green and Golden Bell Frog

The surveys indicated there is no current high quality breeding habitat present for the GGBF in the study area. Despite there being many potential water bodies present for breeding, the presence of the Plague Minnow and Carp means that it is unlikely that the GGBF can successfully breed in the area and that the ponds in general are constantly re-stocked with fish as a result of floodwaters entering them. Only one pond was located that may have been free of introduced fish, which provides little opportunity for the species to maintain a population, even though there is ample habitat for foraging and shelter and the ponds and creeks appear to provide good connectivity.

Furthermore, the GGBF is now found almost exclusively in locations 10 km or less (Mahony et al. 2013) from the coast, presumably due to the effects of the amphibian chytrid fungus that is attenuated by the presence of salt in the environment. The location of the study area is well beyond 10 km from any salt water and this correlates well with the absence of records for the GGBF in the broader (10 km radius) locality over the last 10 years, with the last record on BioNet for the locality being from 2008. The indications are that all populations in the Hunter Valley away from the coast are likely to be extinct. A discussion with Dr Michael Mahony indicated that the Gillieston Heights population was present prior to the development of the area, but that there were no known records in recent times, which fits with a failure to detect the species by the most recent surveys. This all suggests that the GGBF is no longer present in the study area due to a combination of the effects of the chytrid fungus, the presence of introduced fish and land development. Until pests and disease are controlled it is unlikely that the species can re-establish itself in the study area, even with otherwise favourable habitat being present.

6.2. Presence of the Green-thighed Frog

The habitat assessments indicated that there is not suitable breeding habitat for this species within the study area. The GTF relies on larger and longer-lasting ephemeral ponds located within area of wetter forest with dense understorey and leaf litter. Such habitats were not seen present anywhere during the inspection. The habitats available contrasted markedly with the habitats present at two reference sites visited some 10 km to the south of the study area, where there was a clearly suitable environment of depressions that could flood located within areas of riparian vegetation with a denser ground cover. This indicates that the GTF would not breed within the study area.

The records of two individuals caught in a pitfall trap by Cenwest (2004) demonstrate that the species is or at least has been present within the locality. However, these are the only records from close to the study area and are > 500 m from the proposed development site. The absence of any suitable breeding habitat within the study area or within 200 m of it would indicate that the GTF does not use the study area for any important activities as part of its life-cycle. It is expected to typically travel no more than 100-200 m from its breeding site and breeding habitat is not located close enough to the study area to expect any frogs to use the available habitats on any more than a very irregular and transient basis.

6.3. Previous Surveys for the Green and Golden Bell Frog

The previous surveys for the GGBF carried out by GHD and Eco Logical Australia provided a moderate level of effort to detect the GGBF on the site. They were carried out at the correct time off the year and used methods recognised as suitable to detect the GGBF. The effort placed into each site does not generally meet the standard of survey effort recommended under the current BAM guidelines, but this was not a requirement at the time of the studies being undertaken.

Both studies provide some replication of survey effort at some of the potential GGBF breeding sites and extended their surveys over multiple periods that would have assisted in reducing the potential for the survey conditions alone to cause a negative result.

The meteorological conditions that the surveys were carried out under were varied and would likely have been suitable for GGBF to be active, although it was likely the GGBF would have been calling through the GHD surveys as conditions were dryer. However, and as previously noted, this species is usually detected visually even when not calling and so would be expected to have been detected if it was present.

The skill and experience of the surveyors is the main other consideration in the studies completed. My understanding is that the surveys for GHD were completed by Ben Lewis and Luke O'Brien and both of these ecologists have demonstrated knowledge and experience in surveying for GGBF and GTF. The surveyors used by ELA included Daniel McKenzie and Antony Von Chrismar who both have significant experience with frog surveys. Therefore both teams of surveyors had sufficient skill and experience to be expected to find GGBF and GTF if the effort and conditions were appropriate.

Of specific relevance however is Section 6.1 of this report that provides a consideration of the potential for the GGBF to be present within the study area given the noted extinctions away from coastal areas since the 1990s resulting from the amphibian chytrid fungus.

7. Conclusion

The study area contains a range of water bodies that could provide breeding habitat for the GGBF and that includes streams, pools and ponds.. The number and location of water bodies present in the study area indicates also that there is good landscape connectivity that the GGBF prefers. However, the widespread presence of introduced predatory fish and particularly the Plague Minnow indicates that suitable breeding habitat is highly constrained for the GGBF and there is little chance for consistent successful breeding to take place to maintain a local metapopulation.

In addition, the location of the study area more than 10 km from a coastal location strongly suggests that any local metapopulation of the GGBF will have been and would continue to be affected by the amphibian chytrid fungus that has caused extinctions of populations of the GGBF across its range. It is most likely that the local population is currently extinct as a result of the effects of the chytrid fungus. This correlates with the absence of any records for this species from locality since 2008 and it is reasonable to conclude that the GGBF is no longer present in the study area.

The survey efforts completed for the GTF by both GHD and Eco Logical Australia were not undertaken after periods of sufficiently heavy rainfall to expect this species to be detected. However, the habitat assessment indicates a lack of potential ephemeral breeding sites being present within the study area. The alternative reference sites provide for habitat that is not present in the study area, even though the species has previously been recorded within 1-2 km to the north of the study area by Cenwest in 2004. It is considered that the GBF does not use the study area to support any important parts of its life-cycle.

8. References

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APPENDIX 1: PLATES OF SITES AND MAP OF PLATE LOCATION



Plate 1. Woodland vegetation on the study site.



Plate 2. Large reed filled water body that is suitable breeding habitat for the Green and Golden Bell Frog except for the presence of the Plague Minnow.



Plate 3. Typical dry woodland lower storey vegetation and ground cover lacking shrubs and thicker layer of leaf litter.



Plate 4. Permanent ponded area present in study area that is suitable for breeding for the Green and Golden Bell Frog except for the presence of the Plague Minnow. Note the presence of large areas of emergent vegetation.



Plate 5. Grassy woodland habitat typical of areas with retained native vegetation.



Plate 6. Dense regenerating understorey with litter and some shrub cover, but without suitable breeding habitat for the Green-thighed Frog.



Plate 7. Permanent creek in study area that contained the Plague Minnow.



Plate 8. Stream running through study area that contained the Plague Minnow and European Carp.



Plate 9. Ponded water within cleared fields within the study area



Plate 10. Pond at Gillieston Heights (note housing development in background).



Plate 11. Edge of pond at Gillieston Heights.



Plate 12. Large permanent pond in study area. Note pond has little emergent vegetation making it less suitable Green and Golden Bell Frog habitat.



Plate 13. Large permanent pond within best, but still not adequate, Green-thighed Frog habitat. Note the better canopy coverage.



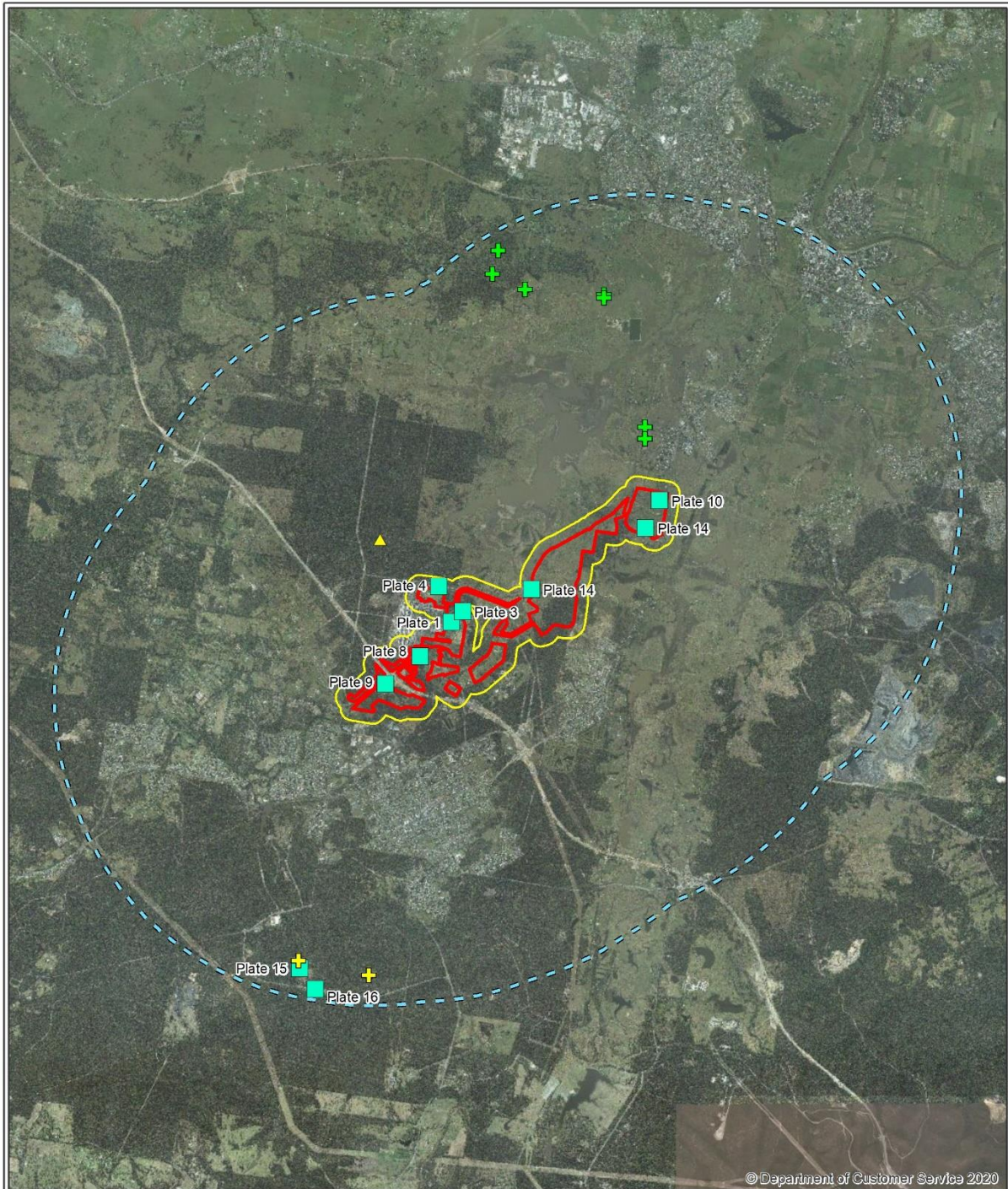
Plate 14. Wetter riparian habitat in the study area that provided the best, but still not adequate habitat for the Green-thighed Frog. Note the leaf litter, but still not good shrub layer



Plate 15. Example of known Green-thighed Frog breeding habitat located 10 km to the south of the study area. Note the denser canopy and depressions with leaf litter.



Plate 16 Example of known Green-thighed Frog breeding habitat located 10 km to the south of the study area showing filled depressions and thicker shrub layer.



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Photo Points

- Development Boundary
- Study Area (200m buffer)
- 5 km Buffer
- Photo Points (ELA Survey)



Datum/Projection:
GDA2020 MGA Zone 56
Project: 20481-KR Date: 18/01/2022

BioNet Atlas Records (17/11/2021)

- + Green and Golden Bell Frog
- + Green-thighed Frog
- ▲ Green-thighed Frog (Approx.)

NSW Department of Planning, Industry and Environment's Atlas of NSW Wildlife (BioNet) which holds data from a number of custodians. Data obtained 17/11/2021



Appendix H

BAM credit reports

Proposal Details

Assessment Id

00029358/BAAS17098/21/00029359

Assessor Name

Arien Quin

Proponent Name(s)

Jeffrey Bretag

Assessment Revision

4

BOS entry trigger

BOS Threshold: Area clearing threshold

Proposal Name

Regrowth Kurri Kurri - BDAR

Assessor Number

BAAS17098

Report Created

16/02/2022

Assessment Type

Part 4 Developments (General)

BAM data last updated *

24/11/2021

BAM Data version *

50

BAM Case Status

Finalised

Date Finalised

16/02/2022

* 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.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
Nil		
Species		
Nil		

Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

BAM Biodiversity Credit Report (Variations)

PCT

No Changes

Predicted Threatened Species Not On Site

Name

Calyptorhynchus lathami / Glossy Black-Cockatoo

Grantiella picta / Painted Honeyeater

Calidris tenuirostris / Great Knot

Limicola falcinellus / Broad-billed Sandpiper

Limosa limosa / Black-tailed Godwit

Xenus cinereus / Terek Sandpiper

Calidris ferruginea / Curlew Sandpiper

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
1600-Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	53.5	142	43	185.00
1591-Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	3.5	0	107	107.00
1736-Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	0.3	0	4	4.00

BAM Biodiversity Credit Report (Variations)

1591-Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter	Like-for-like credit retirement options					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions This includes PCT's: 1591, 1598, 1603, 1605, 1691, 1692, 1749	-	1591_Intact	No	107	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options					
	Formation	Trading group	Zone	HBT	Credits	IBRA region
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1591_Intact	No	107	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1600-Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	Like-for-like credit retirement options					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions This includes PCT's: 1590, 1592, 1593, 1600, 1602	-	1600_Unde rscrubbed	Yes	142	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions This includes PCT's: 1590, 1592, 1593, 1600, 1602	-	1600_Regrowth	No	43	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions This includes PCT's: 1590, 1592, 1593, 1600, 1602	-	1600_exotic	No	0	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Variation options					
Formation	Trading group	Zone	HBT	Credits	IBRA region
Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1600_Underscrubbed	Yes (including artificial)	142	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1600_Regrowth	No	43	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Variations)

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1600_exotic	No	0	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1736-Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter	Like-for-like credit retirement options					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 780, 781, 782, 828, 1071, 1735, 1736, 1737, 1738, 1739, 1740, 1741, 1742, 1911	-	1736_Disturbed	No	4	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options					
Formation	Trading group	Zone	HBT	Credits	IBRA region	
Freshwater Wetlands	Tier 3 or higher threat status	1736_Disturbed	No	4	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.	

Species Credit Summary

BAM Biodiversity Credit Report (Variations)

Species	Vegetation Zone/s	Area / Count	Credits
Myotis macropus / Southern Myotis	1591_Intact, 1600_Underscrubbed, 1736_Disturbed	6.5	175.00
Petaurus norfolcensis / Squirrel Glider	1591_Intact, 1600_Underscrubbed	4.5	128.00

Credit Retirement Options Like-for-like options

Myotis macropus/ Southern Myotis	Spp		IBRA region
	Myotis macropus /Southern Myotis		Any in NSW
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.	
Petaurus norfolcensis/ Squirrel Glider	Spp		IBRA region
	Petaurus norfolcensis /Squirrel Glider		Any in NSW

BAM Biodiversity Credit Report (Variations)

Petaurus norfolcensis/ Squirrel Glider	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00029358/BAAS17098/21/00029359	Regrowth Kurri Kurri - BDAR	24/11/2021
Assessor Name	Report Created	BAM Data version *
Arien Quin	16/02/2022	50
Assessor Number	BAM Case Status	Date Finalised
BAAS17098	Finalised	16/02/2022
Assessment Revision	Assessment Type	BOS entry trigger
4	Part 4 Developments (General)	BOS Threshold: Area clearing threshold

* 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	TEC name	Current Vegetation integrity score	Change in Vegetation integrity (loss / gain)	Area (ha)	Sensitivity to loss (Justification)	Species sensitivity to gain class	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAI	Ecosystem credits
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Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter

3	1591_Intact	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	61.3	61.3	3.5	PCT Cleared - 26%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00		107
										Subtotal	107	

Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter

1	1600_Underscrubbed	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	49.9	49.9	5.7	PCT Cleared - 71%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00		142
2	1600_Regrowth	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	19.2	19.2	4.5	PCT Cleared - 71%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00		43

5	1600_exotic	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	4.6	4.6	43.3	PCT Cleared - 71%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00		0
										Subtotal	185	
Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter												
4	1736_Disturbed	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	35.9	35.9	0.25	PCT Cleared - 80%	High Sensitivity to Potential Gain	Endangered Ecological Community	Not Listed	2.00		4
										Subtotal	4	
										Total	296	

Species credits for threatened species

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	Sensitivity to loss (Justification)	Sensitivity to gain (Justification)	BC Act Listing status	EPBC Act listing status	Potential SAI	Species credits
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<i>Myotis macropus / Southern Myotis (Fauna)</i>									
1591_Intact	61.3	61.3	2.7			Vulnerable	Not Listed	False	84
1600_Underscrubbed	49.9	49.9	3.5			Vulnerable	Not Listed	False	87
1736_Disturbed	35.9	35.9	0.25			Vulnerable	Not Listed	False	4
								Subtotal	175
<i>Petaurus norfolcensis / Squirrel Glider (Fauna)</i>									
1591_Intact	61.3	61.3	2.7			Vulnerable	Not Listed	False	84
1600_Underscrubbed	49.9	49.9	1.8			Vulnerable	Not Listed	False	44
								Subtotal	128

Biodiversity payment summary report

Assessment Id	Payment data version	Assessment Revision	Report created
00029358/BAAS17098/21/00029359		4	16/02/2022
Assessor Name	Assessor Number	Proposal Name	BAM Case Status
Arien Quin	BAAS17098	Regrowth Kurri Kurri - BDAR	Finalised
Assessment Type	Date Finalised	BOS entry trigger	
Part 4 Developments (General)	16/02/2022	BOS Threshold: Area clearing threshold	

PCT list

Price calculated	PCT common name	Credits
Yes	1591 - Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter	107
Yes	1600 - Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	185
Yes	1736 - Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter	4

Species list

Price calculated	Species	Credits
Yes	<i>Myotis macropus</i> (Southern Myotis)	175
Yes	<i>Petaurus norfolcensis</i> (Squirrel Glider)	128

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

Assessment Id	Proposal Name
00029358/BAAS17098/21/00029359	Regrowth Kurri Kurri - BDAR

Biodiversity payment summary report

IBRA sub region	PCT common name	Threat status	Offset trading group	Risk premium	Administrative cost	Methodology adjustment factor	Price per credit	No. of ecosystem credits	Final credits price
Hunter	1591 - Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter	Yes	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	18.83%	\$97.60	1.0623	\$2,997.08	107	\$320,687.28
Hunter	1600 - Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	Yes	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	18.83%	\$98.78	1.5042	\$3,033.34	185	\$561,167.20



Biodiversity payment summary report

Hunter	1736 - Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter	Yes	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	15.97%	\$308.38	1.9060	\$9,248.98	4	\$36,995.94
								Subtotal (excl. GST)	\$918,850.42
								GST	\$91,885.04
								Total ecosystem credits (incl. GST)	\$1,010,735.46

Species credits for threatened species

Species profile ID	Species	Threat status	Price per credit	Risk premium	Administrative cost	No. of species credits	Final credits price	
10549	Myotis macropus (Southern Myotis)		\$741.31	20.6900%	\$80.00	175	\$170,570.23	
10604	Petaurus norfolcensis (Squirrel Glider)		\$495.24	20.6900%	\$80.00	128	\$86,746.26	
							Subtotal (excl. GST)	\$257,316.49



Biodiversity payment summary report

	GST	\$25,731.65
Total species credits (incl. GST)		\$283,048.14
		Grand total
		\$1,293,783.60



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