Appendix L
Terrestrial flora and fauna – Biodiversity Development Assessment Report

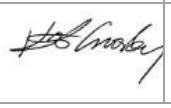
Billabong Creek Regulators

Biodiversity Development Assessment Report

NSW Department of Climate Change, Energy, the Environment and Water

October 2024



Project name		3Rivers - NSW SDLAM Engineering Services					
Document title		Billabong Creek Regulators | Biodiversity Development Assessment Report					
Project number		12537654					
File name		12537654-REP_Billabong Creek BDAR.docx					
Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
S4	0	B Harrington J Russo M Weerakoon	K Crosby		D Chubb		20/8/2024
S4	1	B Harrington J Russo M Weerakoon	K Crosby		D Chubb		14/10/2024

GHD Pty Ltd | ABN 39 008 488 373

133 Castlereagh Street, Level 15

Sydney, New South Wales 2000, Australia

T +61 2 9239 7100 | **F** +61 2 9239 7199 | **E** sydmail@ghd.com | **ghd.com**

© GHD 2024

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Acronyms and abbreviations

Term	Definition
AHD	Australian height datum
BAM	Biodiversity Assessment Method
BAM-C	Biodiversity Assessment Method credit calculator
BC Act	*Biodiversity Conservation Act 2016 (NSW)*
BC Regulation	Biodiversity Conservation Regulation 2017 (NSW)
BCD	Biodiversity, Conservation and Science Directorate of the NSW Department of Climate Change, Energy, the Environment and Water
BCS	The former Biodiversity, Conservation and Science group of the NSW Department of Climate Change, Energy, the Environment and Water
BDAR	Biodiversity Development Assessment Report
BOAMS	Biodiversity Offsets and Agreement Management System
BOM	Bureau of Meteorology
BOS	Biodiversity Offsets Scheme
CAZ	Construction activity zone
CEEC	Critically endangered ecological community
CEMP	Construction Environmental Management Plan
CEWO	Commonwealth Environment Water Office
Cth. DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DBH	Diameter at breast height over bark
DNG	Derived Native Grassland
DPE	NSW Department of Planning and Environment, now renamed as the Department of Planning, Housing and Infrastructure
DPHI	NSW Department of Planning, Housing and Infrastructure
DPI	The former NSW Department of Planning and Industry
DPIE	NSW Department of Planning, Industry and Environment (formerly known as NSW Department of Planning and Environment)
EEC	Endangered ecological community
EIS	Environmental impact statement
EP&A Act	*Environmental Planning and Assessment Act 1979 (NSW)*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)*
FM Act	*Fisheries Management Act 1994* (NSW)
GDA	Geocentric Datum of Australia
GDEs	Groundwater dependent ecosystems
GIS	Geographic Information System
GL	Gigalitre
ha	Hectare – a non-SI metric unit of area equal to a square with 100-metre sides primarily used in the measurement of land
HTE	High Threat Exotic
HTW	High threat weed

Term	Definition
IBRA	Interim Biogeographic Regionalisation for Australia
KTP	Key Threatening Process
km	kilometre
km^2	Square kilometres
LEP	Local Environment Plan
LGA	Local government area
LLS Act	*Local Land Services Act 2013 (NSW)*
m	metres
m^3	Square metres
MGA	Map Grid of Australia
MNES	Matters of national environmental significance
NPW Act	*National Parks and Wildlife Act 1974 (NSW)*
NSW	New South Wales
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water (formerly Water Infrastructure NSW)
OEH	Office of Environment and Heritage (now NSW DCCEEW)
PCT	Plant community type
SAII	Serious and irreversible impact
SAT	Spot Assessment Techniques
SDLAM	Sustainable diversion limit adjustment mechanism
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State environmental planning policy
SPRAT	Species Profile and Threats Database
SSI	State Significant Infrastructure
SVTM	State Vegetation Type Map
TBDC	Threatened Biodiversity Data Collection
TEC	Threatened ecological community

Glossary

Term	Description
Anabranch	A section of a river or stream that diverts from the main channel of the watercourse and rejoins downstream.
Clearing area	This is the area required to construct the proposed infrastructure. Within this area it is assumed that all vegetation would be removed, including trees and ground cover vegetation. Borrow pits also include a clearing area. However this is a conservative assumption and contractors would be encouraged to avoid removal where they can (through proposed mitigation measures).
Commonwealth Environmental Water Holder	The Commonwealth Environmental Water Holder is a statutory position established under the *Water Act 2007* (Cth) responsible for managing the Commonwealth's environmental water holdings. These water holdings are used to protect or restore environmental assets of the Murray-Darling Basin.
Construction activity zone (CAZ)	The area surrounding and including the 'clearing area' that would be used for construction purposes e.g., laydown, site sheds, parking. It is assumed topsoil will need to be removed / cleared, with some re-grading to create level areas with grubbing and clearing of small shrubs/grasses. Trimming of trees may be required. Tree removal would not occur in portions of the CAZ outside of a clearing area.
Cumulative impacts	The combined impacts of the proposed project on a matter with other relevant future proposed projects (see the Department's Cumulative Impact Assessment Guidelines for State Significant Projects).
Proposal footprint	The disturbance area includes all locations where the proposal directly impacts the land surface or water body. This includes clearing areas, construction activity zones, access tracks and power supply routes.
Efficiency measure	A measure to provide more water for the environment by making water delivery systems for irrigation more efficient. This can include replacing or upgrading on-farm irrigation, or lining channels to reduce water losses within an irrigation network.
Entitlement	The volume of water authorised to be taken and used by an irrigator or water authority; includes bulk entitlements, environmental entitlements, water rights, sales water and surface-water and groundwater licenses.
Environmental flow	Any river flow pattern provided with the intention of maintaining or improving river health.
Fish passage	The ability of fish or other aquatic species to move through an aquatic system.
Fishway	Structures placed on or around constructed barriers (such as dams or weirs) to give fish the opportunity to move past the barrier.
The proposal	The construction and operation of the two regulators and supporting infrastructure.
The proposal footprint	The footprint that would be directly affected by construction and the location of operational infrastructure.
Regulator	A gated structure used to actively manage or control the amount of water that flows from one location to another.
Regulated	A water system in which water is stored or flow levels are controlled through the use of structures such as dams, regulators and weirs.
Sustainable diversion limit adjustment mechanism	A mechanism under the Murray-Darling Basin Plan that allows the sustainable diversion limit to be adjusted under certain circumstances.
Study area	The area investigated for this assessment which includes the proposal footprint and surrounding area, with the potential to be directly or indirectly affected by the proposal.
Weir	A low barrier or dam that is built across a watercourse and is designed to store water, control or alter the flow of water in a creek.

Declarations

Certification under Section 6.15 of the *Biodiversity Conservation Act 2016*

I, Kirsten Crosby, certify that this report has been prepared based on the requirements of, and information provided under, the Biodiversity Assessment Method and clause 6.15 of the *Biodiversity Conservation Act 2016* (BC Act).

In preparing this assessment I have acted in accordance with the Accredited BAM Assessor Code of Conduct.

I declare that I have considered the circumstances and there is no actual, perceived or potential conflict of interest.



Signature

Date: 11 October 2024

BAM Assessor Accreditation no: BAAS17011

Contents

1. Introduction 1
1.1 Overview 1
1.2 Structure of this report 1
1.3 Summary of the proposal 3
1.3.1 Location 3
1.3.2 Key features of the proposal 3
1.3.3 Timing 4
1.3.4 Operation 4
1.4 Secretary's environmental assessment requirements 7
1.5 Scope and limitations 8

2. Methods 9
2.1 Legislative and policy context to the assessment 9
2.1.1 Biodiversity Conservation Act 2016 9
2.1.2 Biosecurity Act 2015 9
2.1.3 Environment Protection and Biodiversity Conservation Act 1999 10
2.1.4 State Environmental Planning Policy (Biodiversity and Conservation) 2021 10
2.2 Study area 11
2.3 Desktop assessment 11
2.3.1 Data review 11
2.3.2 Background research 12
2.4 Field surveys 13
2.4.1 Survey overview 13
2.4.2 Vegetation and flora surveys 15
2.4.3 Terrestrial fauna surveys 16
2.5 Weather conditions 19
2.6 Credit calculations 21
2.6.1 Predicted threatened species (ecosystem credit entities) 21
2.6.2 Candidate threatened species (species credit entities) 22
2.6.3 Assessor's use of judgement 22
2.7 Assumptions 23
2.8 Staff qualifications 23

Stage 1: Biodiversity assessment 25

3. Site context 25
3.1 Assessment area 25
3.2 Landscape features 29
3.2.1 Rivers, streams, estuaries and wetlands 29
3.2.2 Habitat connectivity 29
3.2.3 Karst, caves, crevices, cliffs, rocks or other geological features of significance 30
3.2.4 Areas of outstanding biodiversity value 30
3.2.5 NSW (Mitchell) landscape 30

4. Native vegetation, threatened ecological communities and vegetation integrity 31
4.1 Native vegetation extent 31
4.2 Plant community types 33

4.2.1 Overview 33
4.2.2 Justification of PCT selection 34
4.3 Vegetation zones 37
4.3.1 Overview 37
4.3.2 Vegetation integrity (vegetation condition) 42
4.3.3 Vegetation zone descriptions 43
4.4 Threatened ecological communities 63
5. Habitat suitability for threatened species 64
5.1 Identification of threatened species for assessment 64
5.1.1 Ecosystem credit species 64
5.1.2 Species credit species 77
5.2 Presence of candidate species credit species 88
5.3 Matters of National Environmental Significance 124
5.3.1 Threatened ecological communities 124
5.3.2 Threatened species 124
5.3.3 Migratory shorebird species 125
5.3.4 Migratory terrestrial species 126
6. Identifying prescribed impacts 127
6.1 Introduction 127
6.2 Threatened biota that may be subject to prescribed impacts 127
6.3 Prescribed impacts assessment 128
Stage 2: Impact assessment (biodiversity values and prescribed impacts) 133
7. Avoid and minimise impacts 133
7.1 Introduction 133
7.2 Avoid and minimise direct and indirect impacts 133
7.2.1 Proposal location and design 133
7.2.2 Assessment of evolution of the proposal design 135
7.2.3 Summary of measures to avoid and minimise impacts 136
8. Impact assessment 138
8.1 Direct impacts 138
8.1.1 Summary 138
8.2 Indirect impacts 144
8.3 Prescribed impacts 145
8.3.1 Potential for significant residual prescribed impacts 153
8.4 Cumulative impacts 154
8.4.1 Overview 154
8.4.2 Scoping of future projects 154
8.5 Mitigating residual impacts – management measures and implementation 158
9. Impact summary 163
9.1 Assessment for serious and irreversible impacts on biodiversity values 163
9.1.1 SAII assessment for Plains-wanderer 164
9.2 Offset requirement for impacts under the BC Act 167
9.2.1 Impacts on native vegetation (ecosystem credits) 167
9.2.2 Impacts on threatened species and their habitat (species credits) 173
9.2.3 Indirect and prescribed impacts 173
9.3 Impacts that do not need further assessment under the BC Act 174
9.4 Offsets for MNES 174

9.5 Approach to retiring offsets 177
10. Summary and conclusions 178
10.1 Introduction 178
10.2 Existing environment 178
10.3 Impacts summary 178
10.4 Mitigation 179
10.5 Offset requirement 180
11. References 181

Table index

Table 1.1 Standard construction hours 4
Table 1.2 Relevant Secretary's environmental assessment requirements 7
Table 2.1 Survey techniques and timing 13
Table 2.2 Site data collected within each plot 15
Table 2.3 Confidence ratings applied to calls 18
Table 2.4 Benchmark classes based on cumulative rainfall in preceding year 19
Table 2.5 Weather conditions during the survey period (BOM 2023c) 20
Table 2.6 Staff qualifications and proposal roles 23
Table 3.1 Summary of landscape features present within the proposal footprint 25
Table 3.2 Mitchell landscapes 30
Table 4.1 Hartwood non-native vegetation description 31
Table 4.2 Plant community types in the proposal footprint 33
Table 4.3 Vegetation zones and other map units in the proposal footprint 38
Table 4.4 Vegetation integrity scores 42
Table 4.5 Hartwood vegetation zone descriptions 43
Table 4.6 Wanganella vegetation descriptions 53
Table 5.1 Predicted ecosystem credit species 65
Table 5.2 Candidate species credit entities 78
Table 5.3 Targeted species credit matter survey techniques and effort 88
Table 5.4 Determining the presence of candidate species credit matters at the proposal footprint 93
Table 5.5 Candidate species credit matters recorded in the proposal footprint 111
Table 5.6 Threatened species listed under the EPBC Act that may occur at the proposal footprint 124
Table 5.7 Migratory shorebird species listed under the EPBC Act that may occur at the proposal footprint 125
Table 6.1 Threatened species potentially subject to prescribed impacts 127
Table 6.2 Prescribed impacts 129
Table 7.1 Avoidance 134
Table 7.2 Avoidance and minimisation measures for direct, indirect and prescribed impacts 137
Table 8.1 Summary of residual direct impacts 138
Table 8.2 Direct impacts associated with proposed activities 141
Table 8.3 Impacts to vegetation integrity 142
Table 8.4 Summary of residual indirect impacts 144
Table 8.5 Summary of potential prescribed impacts 145

Table 8.6	Residual prescribed impacts – vehicle strikes	152
Table 8.7	Summary of prescribed impacts	153
Table 8.8	Cumulative impact scoping summary	155
Table 8.9	Summary of proposed mitigation and management measures for residual impacts (direct, indirect and prescribed)	158
Table 9.1	Entities at risk of an SAII	163
Table 9.2	Assessment of serious and irreversible impacts for the Plains-wanderer	164
Table 9.3	Impacts that require an offset – ecosystem credits	169
Table 9.4	'Like-for-like' ecosystem credits required to offset impacts of the proposal	171
Table 9.5	Impacts that require an offset – species credits	173
Table 9.6	Impacts that do not need further assessment for ecosystem credits	174

Figure index

Figure 1.1	Location of the proposal	2
Figure 1.2	Hartwood site map	5
Figure 1.3	Wanganella site map	6
Figure 3.1	Hartwood location map	27
Figure 3.2	Wanganella location map	28
Figure 4.1	Hartwood vegetation zones	61
Figure 4.2	Wanganella vegetation zones	62
Figure 5.1	Hartwood September threatened flora survey effort	102
Figure 5.2	Hartwood December to March threatened flora survey effort	103
Figure 5.3	Wanganella September threatened flora survey effort	104
Figure 5.4	Wanganella December to March threatened flora survey effort	105
Figure 5.5	Hartwood fauna survey effort	106
Figure 5.6	Wanganella fauna survey effort	107
Figure 5.7	Hartwood threatened flora	108
Figure 5.8	Hartwood threatened fauna and habitat resources	109
Figure 5.9	Wanganella threatened fauna and habitat resources	110
Figure 5.10	Hartwood Southern Bell Frog species polygons	117
Figure 5.11	Hartwood Plains-wanderer species polygons	118
Figure 5.12	Hartwood Southern Myotis species polygons	119
Figure 5.13	Hartwood Slender Darling-pea species polygons	120
Figure 5.14	Wanganella Little Eagle (nesting) species polygons	121
Figure 5.15	Wanganella Southern Bell Frog species polygons	122
Figure 5.16	Wanganella Bush Stone-curlew species polygons	123
Figure 9.1	Hartwood thresholds for assessing and offsetting impacts	175
Figure 9.2	Wanganella thresholds for assessment and offsetting impacts	176

Appendices

Appendix A BDAR requirements compliance
Appendix B Threatened species assessment
Appendix C Species recorded in the study area
Appendix D Vegetation integrity plot data
Appendix E Microbat call analysis results
Appendix F Audiomoth Report
Appendix G BAM Calculator Reports
Appendix H EPBC Act Assessments of Significance

1. Introduction

1.1 Overview

The NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW) is proposing to replace two existing weirs along Billabong Creek with new regulators (the proposal). The two existing weirs to be demolished are Hartwood Weir and Wanganella Weir. These structures are situated on Billabong Creek within the Yanco Creek system in south-west NSW (refer Figure 1.1).

These weirs were built in the early 20th century and have been used to regulate flows through Billabong Creek, create weirs pools for irrigation and, in the case of Wanganella Weir, provide town water supply. The weirs are currently in states of declining condition and functionality, and are barriers to the movement of fish through the creek. Their condition limits their ability to regulate flows through the Yanco Creek system and leads to inefficiencies in how water is delivered to the environment and irrigators.

The new regulators would be automated and remotely operated meaning that operators could control the delivery of water more efficiently. The proposal is needed to improve the operator's ability to deliver the right amount of water to the right place at the right time. The new regulators would also feature fishways to support fish movement past the new structures. The regulators would be owned and operated by WaterNSW.

The proposal is subject to environmental and planning approvals in accordance with the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The proposal is State significant infrastructure (SSI), and the Minister for Planning is the approval authority. An environmental impact statement (EIS) is required to accompany the application for approval of the proposal.

The EIS must be accompanied by a 'Biodiversity Development Assessment Report' (BDAR) prepared by an accredited assessor in accordance with the BAM 2020 (DPIE 2020b). This BDAR describes the ecological values at the site, with particular focus on plant community types (PCTs), threatened ecological communities, populations, and species. It assesses the impact of the proposal on biodiversity values, documents the steps taken to avoid and minimise impacts to biodiversity values, describes and quantifies the biodiversity credits required to offset the residual impacts of the proposal on biodiversity values.

1.2 Structure of this report

The structure of this BDAR is as follows:

– Assessment approach:
  - section 1 – provides an introduction to the proposal and the assessment
  - section 2 – describes the methodology for the assessment
– BAM Stage 1: Biodiversity assessment:
  - section 3 – describes the context for the site and landscape-scale inputs to the biodiversity assessment
  - section 4 – describes the existing environment of the proposal footprint including vegetation and threatened ecological communities and site-scale inputs to the biodiversity assessment
  - section 5 – describes the extent and quality of habitat for threatened and migratory species at the proposal footprint including consideration of species credit matters
  - section 6 – identifies prescribed impacts that are relevant to the assessment
– BAM Stage 2: Impact assessment (biodiversity values and prescribed impacts):
  - section 7 – outlines steps taken to avoid and minimise potential impacts on biodiversity values
  - section 8 – assesses the impacts of the construction and operation of the proposal and presents mitigation measures for potential impacts
  - section 9 – presents a summary of impacts pursuant to the assessment and offsetting thresholds set out in the BAM and the quantum of biodiversity credits required as offsets for residual impacts on threatened biota and their habitats
  - section 10 – presents conclusions of the assessment pursuant to the key requirements of the BAM and related legislation and policy.

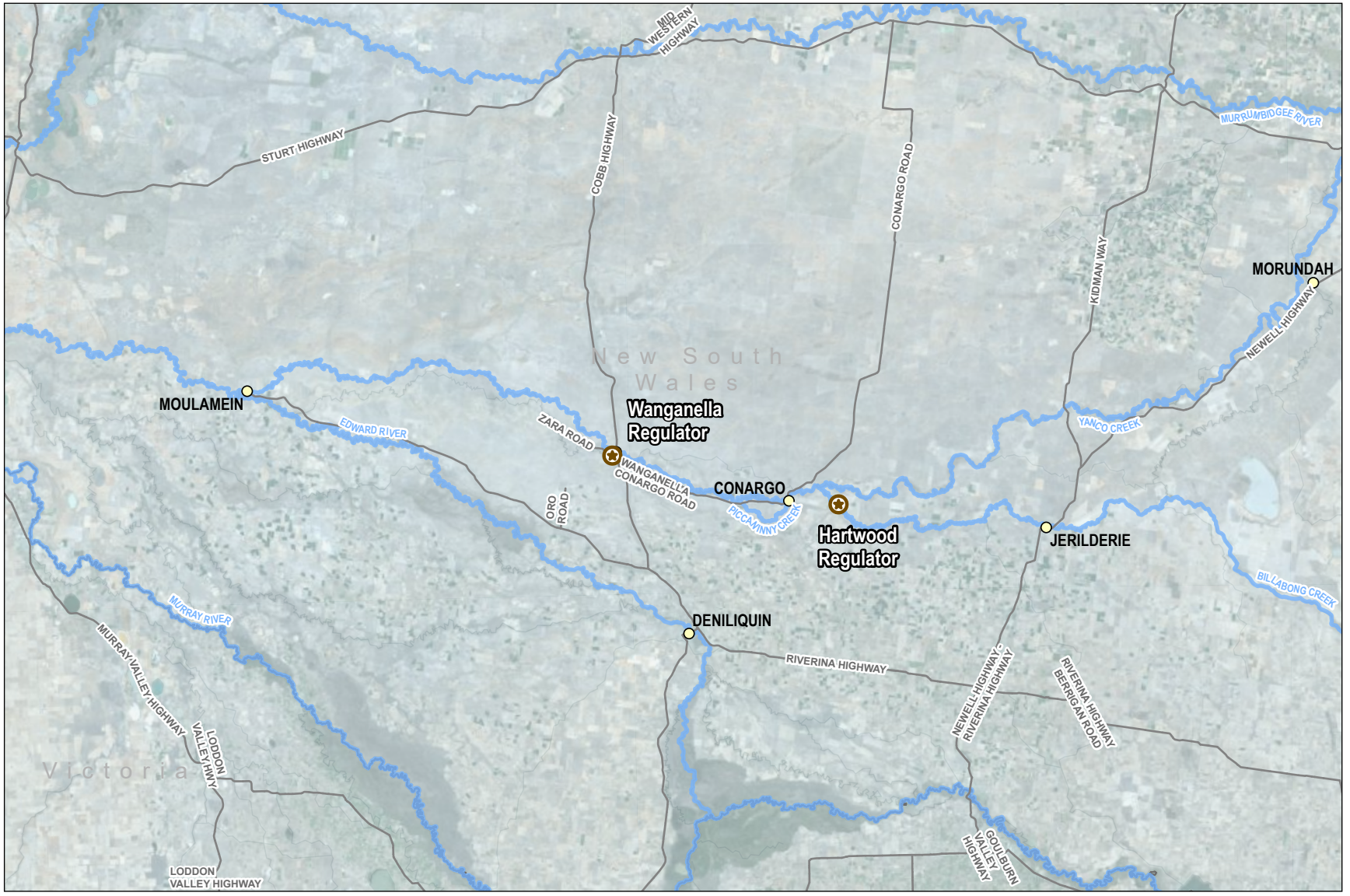


Figure 1.1 Location of the proposal

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

© Department of Customer Service 2020, Vicmap, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS;18/03/2024 8:52 AM rvillalon \\ghdnetghd\AU\Sydney\Projects\21\12537654\GIS\Maps\Deliverables\SDLAM_Yanco\12537654_RFS083_Billabong_BDAR.aprx

1.3 Summary of the proposal

1.3.1 Location

The proposal is located on Billabong Creek, which is part of the Yanco Creek system in south-west New South Wales (NSW). The Yanco Creek system forms a part of the Murray-Darling Basin. An overview of the location of the proposal is shown in Figure 1.1.

The proposal is located within the local government area (LGA) of Edward River.

1.3.2 Key features of the proposal

As discussed in section 1.1, the proposal involves replacing two existing weirs along Billabong Creek with new regulators including fishways. The key features of the two proposed regulators are similar and would include:

- concrete piers with maintenance bulkhead slots
- automated lay-flat gates across the crest of the structure to assist with flow management and downstream fish passage
- a low turbulence 'keyhole' type vertical slot fishway with allowances for variable headwater to provide upstream fish passage
- automated sidewinder gates within the vertical slot fishway to allow for variable headwater conditions
- fixed concrete crests on the opposite side of the gates to the vertical slot fishway
- concrete apron downstream of the structure
- concrete wingwalls upstream and downstream of the structure
- access from a trafficable deck for maintenance (Hartwood Regulator only)
- pedestrian walkway access part way across Wanganella Regulator structure to facilitate housing of gate actuators and for maintenance
- walkway grating over gates to facilitate operations and maintenance
- crushed rock maintenance pads, access and turnaround areas adjacent to the structure
- rip rap and rock beaching upstream and downstream of structure for erosion protection
- control house
- sheet pile cut-off walls beneath the structure
- fencing of the structures to prevent public access
- SCADA control system.

The proposal would also involve the following elements:

- Power supply to the regulators would be provided by a mix of underground and overhead electricity cables connecting the structures to the grid.
- Access to the regulators would require permanent tracks for maintenance and some additional tracks to support construction only.
- The existing Forest Creek block bank, associated with the Hartwood Regulator, would be upgraded to include a spillway structure with two reinforced concrete sills infilled with rock beaching and crushed rock.
- A flood bypass channel would be constructed to reduce potential upstream flooding impacts from the Wanganella Regulator. The channel would enable flood waters to drain between the billabongs in the Wanganella Reserve during flood events. It would be 85 metres long, around 40 metres wide and 1.7 metres deep and located north of the Wanganella Tip. Once completed, the channel sides and base would be natural and vegetated with appropriate local native species.
- An existing borrow pit on lot 56 / DP756322 near Hartwood Weir that would be extended to provide material for the construction of Hartwood Regulator and Forest Creek block bank. Additional material may be used from a borrow pit near Wanganella Swamp for construction of Wanganella Regulator. Use of the Wanganella Swamp borrow pit is being assessed as part of a different proposal and will be subject to a separate approval.

The location of the existing weirs, proposed infrastructure and the indicative construction footprints, are shown on Figure 1.2 and Figure 1.3.

1.3.3 Timing

Construction of the proposal is anticipated to start in 2025, and be completed by 2026. The construction period is anticipated to be around 18 months.

Standard construction hours would be adopted in accordance with the *Interim Construction Noise Guideline* (ICNG) (DECC 2009) as shown in Table 1.1. Most construction activities would be undertaken during this time.

Table 1.1 Standard construction hours

Day	Start time	Finish time
Monday to Friday	7am	6pm
Saturday	8am	1pm
Sundays and public holidays	No regular work	

Notwithstanding this, the *Interim Construction Noise Guideline* (DECC 2009) acknowledges that the following activities may need to be undertaken outside the recommended construction hours:

– emergency work
– delivery of oversized plant or structures
– works for which it can be demonstrated that there is a need to operate outside the recommended standard hours.

1.3.4 Operation

The proposal would be operated in accordance with the operating requirements established with the new asset owner and developed in consultation with key stakeholders. These operating requirements are known as the Yanco Creek System Operations Plan. The plan would take into account the regulation requirements at each regulator, as well as constraints such as limits to rates of rise and fall to accommodate fish breeding requirements.

The proposed regulators would provide greater control of water levels which would be operated to meet environmental and water supply objectives.

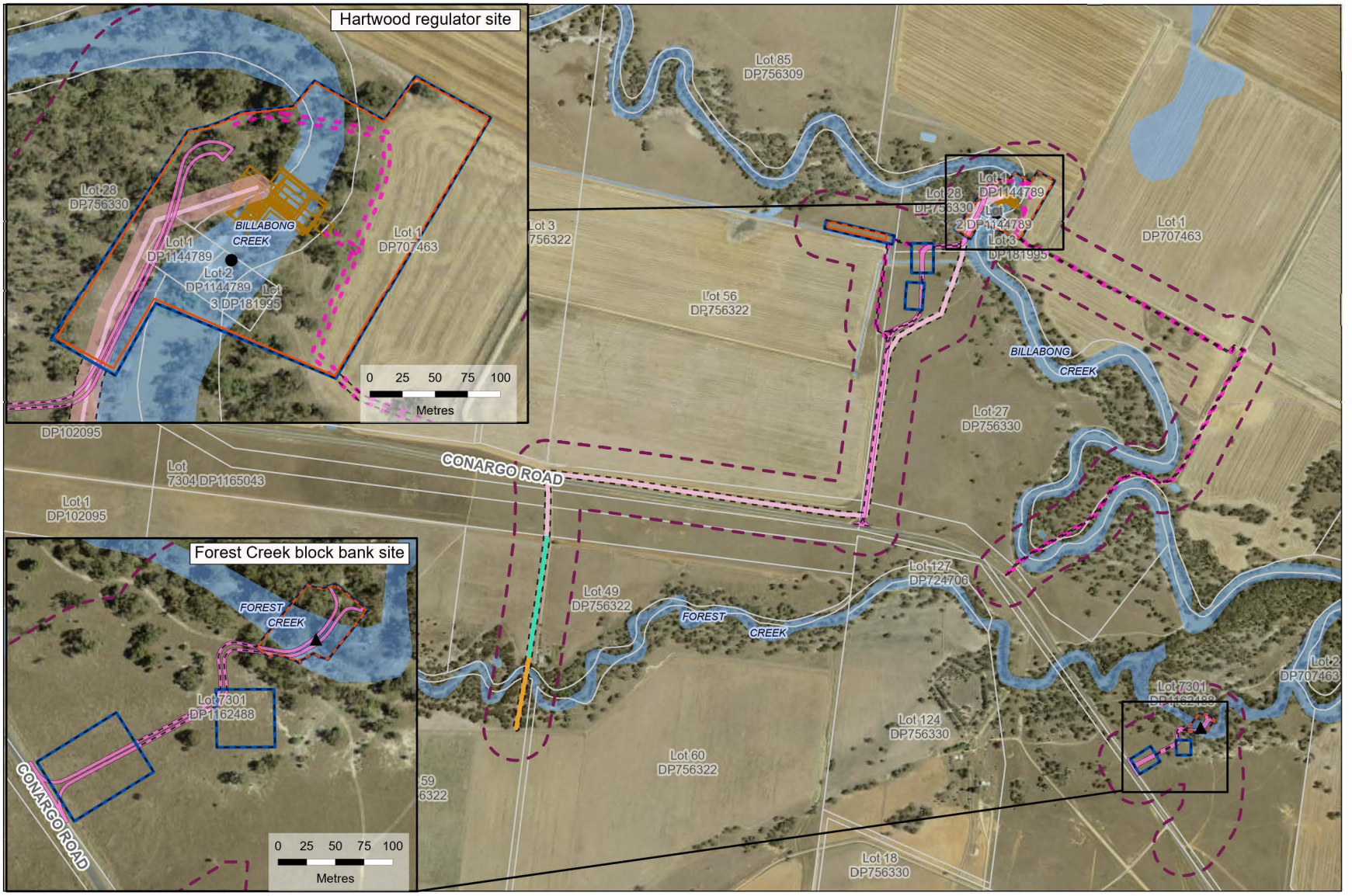
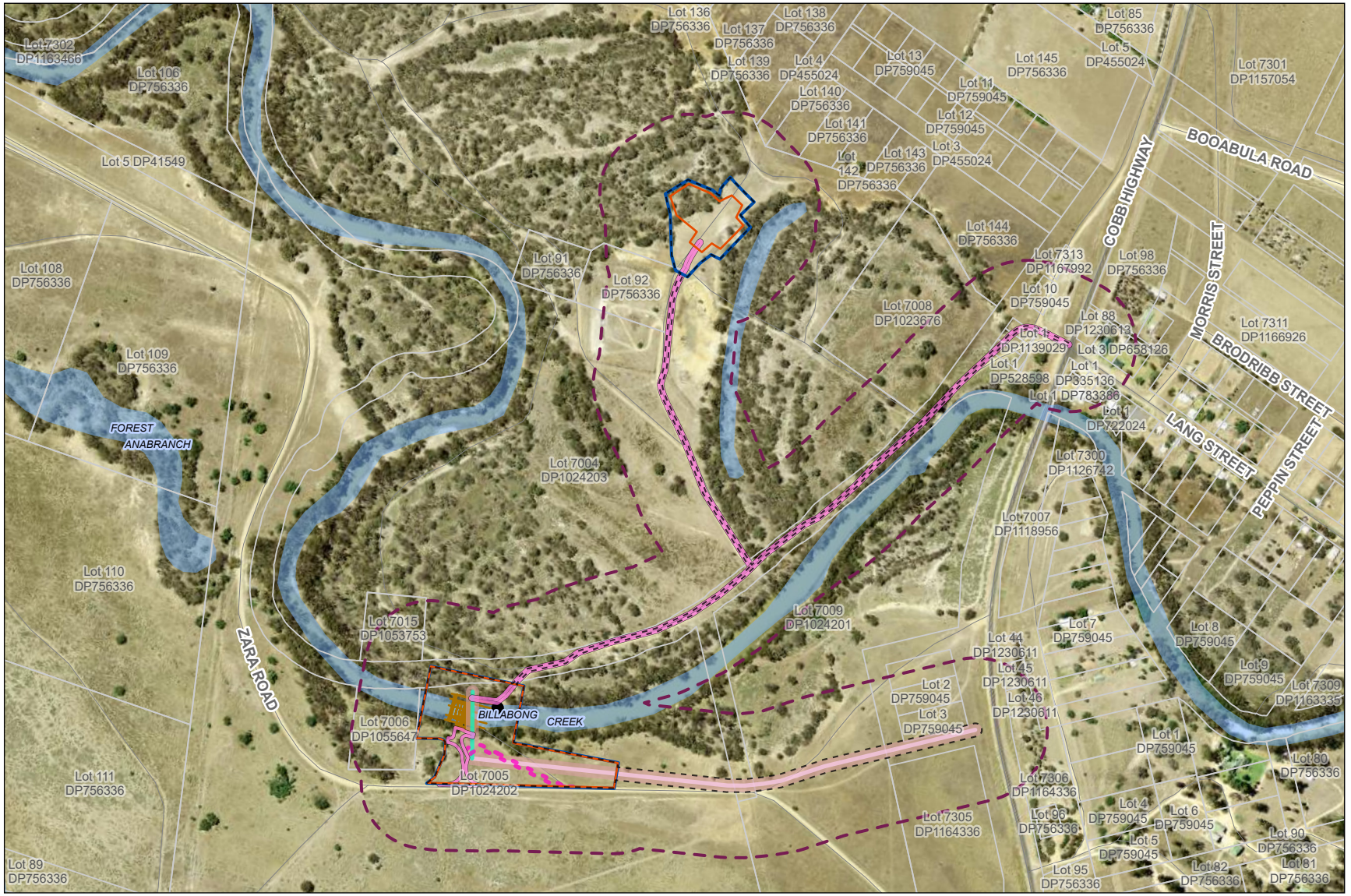


Figure 1.2 Hartwood site map

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein



Proposal

- Proposed Wanganella regulator
- Proposal footprint
- Study area
- Construction activity zone
- Clearing area

Power supply (11kV)

- Overhead power supply route
- Underground power supply route
- Power supply vegetation clearance corridor

Access tracks

- Construction only
- Construction plus O&M

Existing features

- Existing weir
- Lot
- Water bodies
- Main road

N

GDA2020 MGA Zone 55

A4 Scale: 1:9,000

0 75 150 225 300

Metres

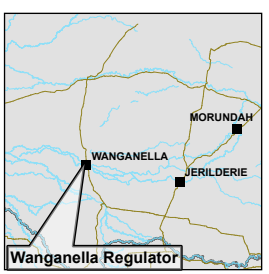


Figure 1.3 Wanganella site map

3Rivers

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

© Department of Customer Service 2020;18/03/2024 7:11 AM rvillalon \\gldnefilgld\AUSydney\Projects\21\12537654\GIS\Maps\Deliverables\SDLAM_Yanco\12537654_RFS083_Billabong_BDAR.aprx

1.4 Secretary's environmental assessment requirements

This BDAR has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs). Table 1.2 outlines the requirements relevant to this assessment. The assessment also considers requirements raised by the NSW Department of Primary Industries (DPI) – Agriculture, DPI – Fisheries' and the Department of Planning and Environment Biodiversity and Conservation Division.

Table 1.2 Relevant Secretary's environmental assessment requirements

Requirements	Where addressed in this report
Statutory and Strategic Context	
Address the statutory provisions applying to the development contained in all relevant environmental planning instruments, including: State Environmental Planning Policy (Biodiversity and Conservation) 2021	Throughout this BDAR.
Biodiversity assessment	
19. Assessment of biodiversity impacts must include the following:	-
Biodiversity impacts related to the proposed development are to be assessed in accordance with Section 7.9 of the *Biodiversity Conservation Act 2016* using the Biodiversity Assessment Method (BAM) 2020 and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the *Biodiversity Conservation Act 2016* (s6.12), Biodiversity Conservation Regulation 2017 (s6.8) and the BAM.	Throughout this BDAR.
The BDAR must document the application of the 'avoid, minimise and offset' framework including assessing all direct, indirect, uncertain and prescribed impacts in accordance with the BAM.	Section 7 Section 8.1 Section 8.2 Section 8.3
The BDAR must include details of the measures proposed to address the offset obligation as follows; – The total number and classes of biodiversity credits required to be retired for the development/project; – The number and classes of like-for-like biodiversity credits proposed to be retired; – The number and classes of biodiversity credits proposed to be retired in accordance with the variation rules; – Any proposal to fund a biodiversity conservation action.	Section 9.2 Table 9.3 Table 9.4 Section 9.5
Any proposal to make a payment to the Biodiversity Conservation Fund.	Section 9.5
If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits.	N/A
The BDAR must be submitted with all digital spatial data associated with the survey and assessment as per Appendix K of the BAM.	Appendix A Digital spatial data has been uploaded via the Biodiversity Offsets and Agreement Management System (BOAMS).
The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under s6.10 of the Biodiversity Conservation Act 2016.	Section 2.8
Assessment of terrestrial, riparian and floodplain biodiversity and ecology that addresses all direct, indirect, and prescribed impacts of the project on flora and fauna, threatened species, populations, and communities for the construction and operation of the project, including flow dependent and groundwater dependent ecosystems.	Section 4 Section 5 Section 6 Section 8.1 Section 8.2 Section 8.3

Requirements	Where addressed in this report
An aquatic ecological assessment prepared in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management (2013), addressing all direct and indirect impacts of the project and associated works on Key Fish Habitat and associated flora and fauna including threatened species, populations, and communities during construction and operation for the life of the assets.	Not included in this BDAR. See Appendix K of the EIS.
An assessment of impacts during construction and operation of the project and associated works on river hydrology, hydraulics (lotic and lentic flow profiles), geomorphology, and water quality and associated impacts on flow-dependent ecological communities.	Section 6 Section 8.3 See also Appendix G and Appendix K of the EIS.
Assessment of impacts of changes to the extent of project influence up and down stream. This must be informed by the flooding assessment required by these SEARs	Section 6 Section 8.3 See also Appendix G and Appendix K of the EIS.
Detailed assessment, design, construction, operation and monitoring of suitable fish passage and fishways at each of the proposed regulators, and any works on instream structures associated with the proposal including additional regulator modifications and block banks, to ensure the safe and effective upstream and downstream movement of native fish 30 mm to 1000 mm across all flow ranges.	Not applicable to this BDAR. See Appendix K of the EIS.
An Aquatic Biodiversity Offsets Strategy that is adequately funded to mitigate and manage impacts of the Billabong Creek Regulators project during construction and subsequent operation, focusing on protecting and improving the biodiversity and conservation values of Billabong Creek, its biota, and associated riparian zones in the medium to long term.	Not applicable to this BDAR. See Appendix K of the EIS.
Flooding	
14. The EIS must assess the impacts on the proposed development on flood behaviour, to the extent of project influence up and down stream, including:	
F Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to, upstream or downstream of the site.	Section 8.3

1.5 Scope and limitations

The 3Rivers Joint Venture (3Rivers), a joint venture between Jacobs Group (Australia) Pty Limited and GHD Pty Ltd has been engaged to provide certain Engineering and Approvals Services for the NSW Sustainable Diversion Limit Adjustment Mechanism (SDLAM) program in accordance with the Agreement between 3Rivers and the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) (the client).

This report has been prepared by GHD for the client, and may only be used and relied on by the client for the purpose agreed between 3Rivers and the client as set out in section 1 of this report.

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

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

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

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 1 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

2. Methods

2.1 Legislative and policy context to the assessment

2.1.1 Biodiversity Conservation Act 2016

The NSW *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, or BOS), 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). These are discussed further below.

Biodiversity Offset Scheme and Biodiversity Assessment Methodology

The BC Act, together with the *Biodiversity Conservation Regulation 2017*, provides a mechanism to address impacts on biodiversity from land clearing associated with development, clearing or conferral of biodiversity certification. 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, to ensure that the impacts of development, clearing or biodiversity certification will result in no net loss of biodiversity. The scheme creates a market framework for the conservation of biodiversity values and the offsetting of development impacts, by establishing the mechanisms to offset impacts of development, clearing or biodiversity certification through biodiversity credit trading such that there is no net loss of biodiversity values. The scheme 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 BAM underpins the BOS and establishes a standard method to address the loss of biodiversity and threatened species. 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 credit calculator, or BAM-C) which processes site survey and assessment data. The credit 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 proposal footprint or will be generated at a stewardship site. The BAM must be applied by a person accredited under the BC Act.

2.1.2 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.

Priority weeds were recorded in the study area. Legal requirements to minimise the potential for the introduction and/or spread of weeds as a result of the proposal are discussed in section 8.4.

2.1.3 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 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
– identification of suitable impact mitigation and environmental management measures for threatened and migratory biota, where required
– assessment of the significance of impacts on potentially affected MNES.

This proposal has been referred to the Australian Minister for the Environment based on the above considerations (reference number EPBC 2024/09939). The referral decision provided on 17 September 2024 is that the proposal is not a controlled action. No further assessment or approval under the EPBC Act is required.

2.1.4 State Environmental Planning Policy (Biodiversity and Conservation) 2021

Chapter 3 and 4, Koala habitat protection 2020 and 2021 of the State Environmental Planning Policy (Biodiversity and Conservation) 2021 (the BC SEPP) aim to encourage the conservation and management of areas of natural vegetation that provide habitat for Koalas to support a permanent free-living population over their present range and reverse the current trend of Koala population decline. The proposal is not development requiring consent and so these chapters of the BC SEPP do not formally apply. However, the requirements for Koala habitat protection have been considered in general in this BDAR to help confirm that the proposal is consistent with the aim of conserving Koala populations and habitat.

Chapter 3 'Koala habitat protection 2020' is relevant to the proposal as it is on rural zoned land (RU1 Primary Production) in the Edward River LGA.

The proposal footprint contains potential Koala habitat as the feed tree species River Red Gum (*Eucalyptus camaldulensis*) is present as greater than 15% of the total number of trees in the upper vegetation strata present in areas of PCT 7 and PCT 10 (see Chapter 4, Chapter 5 and Appendix C).

Targeted Koala surveys were conducted with reference to the Koala Biodiversity Assessment Survey Guide (DPE 2022b) and in accordance with the requirements for species credit matters under the BAM (see section 2.4.3). No evidence of Koalas was recorded despite targeted survey (see Chapter 5). There are no known records of the Koala from the study area, and no records of the species within 20 km within the last 20 years on the NSW BioNet database (NSW DCCEEW 2024a). The proposal footprint does not contain core Koala habitat, meaning an area of land with a resident population of Koalas, as evidenced by attributes such as breeding females, being females with young, and recent sightings of and historical records of a population.

Therefore with reference to Chapter 3 'Koala habitat protection 2020' of the BC SEPP:

– Development consent could be granted for the proposal; and
– A Koala plan of management would not be required.

2.2 Study area

For the purposes of the assessment the proposal footprint, operation footprint, and study area have been defined as follows:

- **Proposal footprint** – the area directly impacted by proposed work, including the removal of structures (demolition area), temporary compound areas, access tracks, and installation of structures. Equivalent to the 'subject land' for the assessment as defined in the BAM. The maximum extent of the proposal footprint is shown on and Figure 1.1 and Figure 1.2 has been included in BAM-C calculations, however the exact locations and layout of work areas would be determined prior to construction. The proposal footprint is located across two sites; Hartwood and Wanganella. The proposal footprint is further broken down into:
  - **Construction activity zone (CAZ):** the broad area in which removal and installation of structures and associated activity would occur. The CAZ includes:
    - **Clearing area:** the portion of the CAZ in which trees would need to be removed and/or soil would be excavated for contractor activities. The remainder of the CAZ outside clearing areas would be subject to short term impacts such as grubbing and clearing of small shrubs/grasses, trimming of vegetation, movement of vehicles and stockpiling of materials only.
  - **Access tracks:** the route for construction of new access tracks or improvements to existing tracks, to make them suitable for the construction activities. It is assumed all tracks would be five metres wide. Upgrades may include some light grading, resurfacing and compaction. Tree trimming may be required.
  - **Power supply:** Each site would require electricity supplied to the regulators including both overhead and underground cables. A corridor for the power supply is assumed to be 20 metres wide, within which all vegetation is assessed as being cleared to maintain necessary minimum safety clearances.
- **Study area** – is the area investigated which includes the proposal footprint and surrounding area, with the potential to be directly or indirectly affected by the proposal. The area of investigation covered by this biodiversity assessment comprised the parcels of land that were considered for construction of the proposal and the associated area that may be affected (directly or indirectly) by the proposal nominally comprising a 200 metre buffer area around the proposal footprint as shown in Figure 1.1 and Figure 1.2.
- **Avoidance footprint** – is the portion of the study area that has not been included in the construction footprint and would not be directly affected or subject to notable indirect impacts arising from the proposal. Includes plant communities, habitat resources and other features of the natural environment that have been specifically avoided in the design of the proposal within and around the Hartwood and Wanganella sites. The avoidance footprint also includes two other sites (Caroonboon and Piccaninny weirs), which have been removed from the final proposal design.
- **Assessment area** – is the area investigated in accordance with the BAM, encompassing the construction footprint and study area plus the 1,500 metre buffer area surrounding the construction footprint, patch size polygon and surrounding land included in the assessment of site context as shown in Figure 3.1 and Figure 3.2.
- **Locality** – the area within a 10 kilometre radius of the proposal footprint.
- **Operation footprint** – the area affected by the operation of the proposal i.e. the areas and features of the natural environment that would be affected by the operation of the regulators and associated hydrological regime.

2.3 Desktop assessment

2.3.1 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.

Information sources used in the preparation of this report include:

– NSW BioNet Atlas for records of threatened biota previously recorded in a 10-kilometre radius around the proposal footprint (searched March 2024) (NSW DCCEEW 2024a) and Threatened Biodiversity Data Collection (TBDC) profiles of threatened species listed under the BC Act (NSW DCCEEW 2024b)
– The NSW State Vegetation Type Map (SVTM) (DPE 2022a) to identify candidate plant community types (PCTs) in the study area and to map native vegetation extent
– NSW BioNet Vegetation Classification (DPE 2023a) descriptions and characteristic plant species lists to identify and map PCTs at fine scale in the study area
– The BAM – Important Areas viewer spatial database of identified important habitat for threatened species (DPE 2023b)
– EPBC Act Protected Matters Search Tool – for a 10 kilometre radius around the proposal footprint (searched March 2024) (Commonwealth DCCEEW 2024a)
– EPBC Act Species profile and threats database, online profiles (SPRAT) (Commonwealth DCCEEW 2024b) and Register of Critical Habitat (Commonwealth DCCEEW 2024c)
– the list of candidate species credit-type species and predicted species identified by the BAM-C.

The threatened biota and migratory species identified in the desktop assessment are presented in Appendix B. Following collation of database records and threatened species and community profiles, a list of threatened species requiring assessment was compiled according to the 'steps for identifying habitat suitability for threatened species' in the BAM. This was further refined following field surveys and identification and assessment of habitat present within the proposal footprint. A likelihood of occurrence ranking was attributed to biota based on this information and used to compile lists of 'predicted threatened species' (that is, ecosystem credit species) and 'candidate threatened species' (that is, species credit entities requiring targeted survey) according to Step 2 'assessment of habitat constraints' of the BAM.

2.3.2 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
– 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
– 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
– 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.

The background research included analysis of the following information sources:

– NSW (Mitchell) Landscapes mapping Version 3.1 (DPIE 2016) and Descriptions for NSW (Mitchell) Landscapes Version 2 (DECC 2002)
– Interim Biogeographic Regionalisation of Australia (IBRA version 7.0) mapping
– initial BAM calculations
– Atlas of Groundwater Dependent Ecosystems (GDE) (BOM 2024)
– conservation advice and recovery plans of local threatened biota to confirm conservation status of Threatened Ecological Communities (TECs) and to understand threats and impacts on threatened biota
– aerial photograph imagery of the proposal footprint and buffer area.

Information specific to the Yanco River, Billabong Creek and other association watercourses was also reviewed to collect additional information regarding the biodiversity values of the region, and the operation of the river system. Documents reviewed included:

– *Report on waterbirds breeding during the environmental flooding of the Wanganella wetlands in the spring/summer of 2020/2021* (Maher 2021)
– *Yanco Creek and Tributaries; Intensive frog surveys of creek and farm dam habitats 2019-20* (Turner et al 2020)

– *Yanco-Billabong Creek broad-scale wetland monitoring project: Frog communities of the Yanco-Billabong creek system* (Walcott et al 2018)
– *Movement patterns of Southern Bell Frogs (*Litoria raniformis) *in response to flooding* (Wassens et al 2008)
– *Flow Monitoring Evaluation Research Fridays Spring 2021: Biodiversity in the Basin* (Commonwealth DCCEEW 2021)
– NSW DCCEEW (2023) *Yanco Creek System operations plan (Draft)*
– Jacobs (2024a) *Billabong Creek Regulators Hydrology and Surface Water Resources Assessment* (Appendix G to the EIS)
– Jacobs (2024b) *Billabong Creek Regulators Surface Water Quality and Aquatic Ecology Assessment* (Appendix K to the EIS).

2.4 Field surveys

2.4.1 Survey overview

Staged surveys within the study area were conducted with reference to the BAM and appropriate threatened species survey guidelines for targeted species. Flora and fauna surveys were conducted under the Department of Planning and Environment Scientific License SL100146.

Survey effort that has directly contributed to this BDAR is summarised in Table 2.1 and is described in detail below. Detailed vegetation threatened flora traverses and threatened fauna surveys were also conducted at Caroonboon and Picaninny regulator sites between June 2022-February 2023, prior to these sites being removed from the proposal. Section 5.1.2 provides a summary of the candidate threatened species (i.e. species credit matters) that were considered during field surveys and section 5.2 presents targeted survey effort and results. Scanned field data sheets and GPS tracklogs demonstrating survey effort and coverage of the study area have been submitted for approval along with this BDAR.

Table 2.1 Survey techniques and timing

Survey stage	Date	Survey Technique
Hartwood		
Preliminary investigation of biodiversity values and vegetation integrity assessment	24 February 2022	Vegetation zone mapping Vegetation integrity plots
Preliminary investigation of biodiversity values	8 June 2022	Vegetation zone mapping Vegetation integrity plots Rapid biodiversity value assessment Habitat assessment
Winter targeted species credit surveys	22-23 August 2022	Diurnal bird surveys Scat searches Spotlighting and call playback Frog audio-visual surveys AudioMoth surveys Habitat assessment including systematic candidate nest tree census
Vegetation integrity assessment and Spring targeted species credit surveys	Flora 19-22 September 2022 Fauna 19-20 September 2022	Systematic threatened flora traverses Diurnal bird survey Koala SAT Streamside searches/audio-visual surveys Spotlighting and call playback
Summer targeted species credit surveys	1-2 March 2023	Diurnal bird surveys Spotlighting and call playback Frog audio-visual surveys

Survey stage	Date	Survey Technique
Vegetation integrity assessment and threatened flora surveys	6, 7, 9 March 2023	Vegetation integrity plots Systematic threatened flora traverses
Spring targeted species credit surveys, vegetation integrity assessment including in additional borrow pit footprint	25-29 September 2023	Vegetation zone mapping Vegetation integrity plots Systematic threatened flora traverses Vegetation integrity plots
Summer targeted threatened flora surveys	11, 13, 14 December 2023	Systematic threatened flora traverses
Summer targeted microbat surveys	18-23 January 2024	Anabat microbat call recording
Vegetation integrity assessment and threatened flora surveys in additional power supply footprint	7 February 2024	Vegetation zone mapping Vegetation integrity plots Habitat assessment including nest tree census Systematic threatened flora traverses
Wanganella		
Preliminary investigation of biodiversity values and vegetation integrity assessment	22 February 2022	Vegetation zone mapping Vegetation integrity plots
Preliminary investigation of biodiversity values	7 June 2022	Vegetation zone mapping Vegetation integrity plots Rapid biodiversity value assessment Habitat assessment
Winter targeted species credit surveys	22-25 August 2022	Diurnal bird surveys Scat searches Spotlighting and call playback Streamside searches/audio-visual surveys Audiomoth surveys Systematic nest tree census Habitat assessment including systematic candidate nest tree census
Vegetation integrity assessment and Spring targeted species credit surveys	Flora 19-22 September 2022 Fauna 19-21 September 2022	Threatened flora traverses Diurnal bird survey Spotlighting and call playback Anabat microbat call recording
Summer targeted fauna species credit surveys	28 Feb, 1 March 2023	Diurnal bird surveys Spotlighting and call playback Frog audio-visual surveys
Vegetation integrity assessment and threatened flora surveys	7 March 2023	Systematic threatened flora traverses Vegetation integrity plots
Spring targeted species credit surveys, vegetation integrity assessment including in additional flood bypass channel footprint	25-29 September 2023	Systematic threatened flora traverses Vegetation integrity plots Nest tree census Spotlighting and call playback Frog audio-visual surveys
Summer targeted threatened flora surveys	12-13 December 2023	Systematic threatened flora traverses
Summer targeted microbat surveys	18-23 January 2024	Anabat microbat call recording

2.4.2 Vegetation and flora surveys

Vegetation mapping

Regional vegetation mapping (DPE 2022a) was ground-truthed in the field to verify community type and boundaries, floristic and structural homogeneity within patches and to update mapping as required. Vegetation mapping was undertaken via systematic walked transects across the entire proposal footprint and by walking the boundary of likely vegetation units, based on aerial photograph interpretation. 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.

Native vegetation communities in the study area were assigned to the closest equivalent Plant Community Type (PCT) held in the BioNet Vegetation Classification database (DPE 2023a). The closest equivalent PCT for each vegetation community was determined through a comparison of the floristic descriptions of PCTs in the database with the vegetation integrity plot data collected from the site. In addition to floristic and structural similarity, the landscape position, soil type and other diagnostic features of the vegetation communities on the sites were also compared to the descriptions in the database to determine the most suitable PCT. Threatened ecological communities (TECs) as defined in NSW and Commonwealth legislation were also identified.

The native vegetation in the proposal footprint was then stratified into vegetation zones in accordance with the BAM. A vegetation zone is defined in the BAM as a relatively homogenous area that is the same PCT and has the same broad condition state. Each vegetation zone was assigned a patch size in accordance with Subsection 4.3.2 of the BAM. Justification for selected PCTs and condition classes is provided in section 4.2.2.

Vegetation integrity survey plots (assessing site condition)

Following the stratification of the proposal footprint into vegetation zones, plot surveys were conducted in accordance with the BAM to obtain vegetation integrity data for the calculation of biodiversity credits. The sampling was undertaken using 20 x 20 metre plots nested within a larger 20 x 50 metre plot.

Vegetation integrity was calculated by assessing ten attributes used to evaluate vegetation function, composition and structure (refer Table 2.2). These attributes were then assessed against benchmark values using the BAM-C.

All flora species recorded within each plot were allocated a growth form group and designated as either native, exotic or high threat weeds (HTWs) in accordance with defined lists obtained from the BAM-C. Plant identification and nomenclature follows keys and taxonomy in PlantNET (RBGT 2023).

Table 2.2 Site data collected within each plot

Attribute	Area assessed
Native plant species richness	20 X 20 metre plot
Percentage foliage cover for each species	20 X 20 metre plot
Estimated number of individuals for each species	20 X 20 metre plot
Number of large trees	50 X 20 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 (HTE) vegetation cover	50 X 20 metre plot
Hollow bearing trees	50 X 20 metre plot

The survey effort undertaken to address the minimum plot sampling required by the BAM is summarised in Table 4.3 the locations of the survey plots are shown in Figure 4.1 and Figure 4.2. Plots were located away from ecotones, tracks and track edges or other disturbed areas where possible, however given the agricultural setting, this was not always possible.

Threatened flora searches

Potential candidate species credit entities for the proposal footprint were identified with reference to the BAM. 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 footprint was identified based on the desktop assessment results and the species credit entities identified by preliminary BAM-C calculations. Habitat for these species was identified and assessed based on threatened species database records and threatened species profiles (NSW DCCEEW 2024a,d) and the experience and judgement of GHD ecologists.

Targeted searches were undertaken for threatened flora species that were either predicted to occur at the site by the BAM-C or identified during the desktop review as having potential to occur within the study area given known distributions, previous records in the locality and habitat requirements for each species. Habitat was inspected with reference to threatened species survey guidelines (DPIE 2020a) and included systematic coverage of the proposal footprint with appropriately spaced parallel traverses and in the appropriate season for each candidate threatened flora species.

Section 5.1.2 provides a summary of the candidate threatened flora species that were considered during field surveys and section 5.2 presents targeted survey effort and results.

2.4.3 Terrestrial fauna surveys

Fauna survey methods are described below. Section 5.1.2 provides a summary of the candidate threatened fauna species that were considered during field surveys and section 5.2 presents targeted survey effort and results.

Habitat constraints assessment

Fauna habitat assessments were undertaken throughout the study area 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 (that is, those determined as having the potential to occur within the proposal footprint following the desktop review) were identified prior to fieldwork. Habitat criteria were based on information provided in NSW DCCEEW and Cth DCCEEW 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:

- trees with bird nests, hollows or other potential fauna roosts with a particular focus on candidate species credit matters such as hollows potentially suitable as threatened forest owl or cockatoo nests and threatened raptor nest trees
- rock outcrops, caves 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
- evidence of activity such as feeding scars, scratches and diggings
- specific food trees and evidence of foraging.

The locations and quantitative descriptions of significant habitat features were captured with on the Field Maps app and photographed where appropriate.

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 surveys, for instance fallen timber was scanned and/or turned for reptiles and mature trees and stags were scanned for roosting birds and nests.

Diurnal bird surveys

Targeted surveys for diurnal birds were undertaken throughout the proposal footprint in August and September 2022 as well as March and September 2023.

Surveys followed the area search method over at least one hour, and birds were identified by observation with binoculars and/or call identification. Diurnal bird surveys also included searches for signs indicative of particular threatened species, including searching for evidence of feeding, foraging and signs of bird presence, such as pellets, whitewash, nests etc. All opportunistic observations of birds were recorded during all field surveys.

Nest tree census

A 'systematic nest tree census' was conducted over the entire proposal footprint and accessible vegetation in adjoining areas to help determine the presence of threatened species nest trees to inform the assessment of species credits over multiple seasons between August 2022 and February 2024. All mature trees were inspected for the presence of stick nests and/or hollows. Any large stick nests and hollow bearing trees were mapped and data collected on tree species, diameter at breasts height and number of hollows in the size classes >20 cm, 15-20 cm, 5-15 cm and <5 cm. Data was collected using the Field Maps application along with GPS locations of habitat features and resources.

Nest tree census surveys included targeted effort within the breeding season to detect evidence of nesting birds as noted in the TBDC profiles for target species such as the presence of a male and female; or any adult with nesting material; or an individual on a large stick nest in the top half of the tree canopy; or pairs displaying (soaring, diving, engaging in chases, or a male observed calling in flight with a female begging from tree) (NSW DCCEEW 2024a). Additional surveys were conducted outside the breeding season for target species, aligned with diurnal bird survey effort, habitat searches and all other time spent on site. These additional survey periods contributed to the overall effort for species credit matters through observation of candidate nest trees with suitable large stick nests or hollows that could be used for breeding at other times of year.

The TBDC notes that where a breeding site has been identified in accordance with the BAM the species polygon should include a buffer by mapping a circular polygon with a radius of up to 500 metres (depending on the species) around the nest tree, with raptors having the large buffer areas (greater than 200 metres). This buffer includes habitat suitable for roosting, guarding, feeding, grooming perches and fledgling requirements (NSW DCCEEW 2024a). As such the systematic nest tree census included inspection of candidate trees within a 500 metre radius of the proposal footprint when on public land and properties that contain the proposal footprint and in line of sight using binoculars when the buffer area extended onto adjoining private property.

Nest trees were inspected during all survey rounds following mapping of candidate trees including during dedicated diurnal bird surveys, threatened flora traverses and opportunistically during all other time spent in the study area.

Spot Assessment Technique

Spot Assessment Techniques (SAT) surveys were conducted over the August and September 2022 survey rounds with reference to the Koala Biodiversity Assessment Survey Guide (DPE 2022b). Given the irregular and linear shape of the proposal footprint, SAT locations were distributed randomly within the proposal footprint, and not within grid intersections prescribed in the survey guide.

Spotlight surveys

Spotlight survey transects were conducted on foot over August and September 2022, March 2023 and September 2023 targeted survey rounds with a particular focus on the threatened frog, owl and arboreal mammal species listed in Table 5.4 and with reference to the TBDC (NSW DCCEEW 2024a), *Threatened frogs Biodiversity Assessment Method survey guide* (DPIE 2022a) and Koala *Biodiversity Assessment Method survey guide* (DPIE 2022b).

Spotlight surveys including dedicated listening periods for fauna vocalisations. Mammals and nocturnal birds were identified by observation under spotlight or by vocalisations heard whilst spotlighting by walking slowly and quietly through potential habitat. Surveyors carried headtorches / hand-held torches with a >300 lumen output.

Call playback

Nocturnal call playback surveys were conducted over August and September 2022, March and September 2023 targeted survey rounds period targeting the Bush-stone Curlew (*Burhinus grallarius*), Barking Owl (*Ninox connivens*), Masked Owl (*Tyto novaehollandiae*) and Koala (*Phascolarctos cinereus*).

Surveys involved an initial listening period of five minutes, followed by call playing for three minutes, followed by a listening period of five minutes (undertaken separately for each species), with a final listening period of approximately 10 minutes. Calls were played through a portable MP3 player or smart phone connected to a 45-watt megaphone or a Wonderboom 'Ultimate Ears' speaker. All potential habitat in the immediate area was then scanned for 10 minutes using spotlights.

Microchiropteran bat survey

Bat calls were recorded during field surveys using Anabat Express detectors in September 2022 and February 2024.

Stationary Anabat recordings were undertaken within the proposal footprint as shown on Figure 5.7, Figure 5.8 and Figure 5.6. Recording commenced at least half an hour before dusk and continued until the following morning.

Calls were identified using zero-crossing analysis and AnalookW software (version 4.2n, Chris Corben 2017) by visually comparing the time-frequency graph and call characteristics (e.g. characteristic frequency and call shape) with reference calls and/or species call descriptions from available reference material.

The Bat calls of NSW: Region based guide to the echolocation calls of microchiropteran bats (Pennay *et al*., 2004) was used to assist call analysis. Call identification was also assisted by consulting distribution information for possible species (Pennay et al. 2004; Churchill 2008; Van Dyck *et al*. 2013) and records from BioNet (October 2016). No reference calls were collected during the survey.

A call (pass) was defined as a sequence of three or more consecutive pulses of similar frequency and shape. Calls with less than three defined consecutive pulses of similar frequency and shape were not unambiguously identified to a species but were used as part of the activity count for the survey area. Due to variability in the quality of calls and the difficulty in distinguishing some species the identification of each call was assigned a confidence rating (see Mills *et al*. 1996; Duffy *et al*. 2000) as summarised in Table 2.3. Due to the absence of reference calls from the study area, high level of variability within a bat call and overlap in call characteristics between some species, a conservative approach was taken when analysing calls. Species nomenclature follows van Dyck *et al*. (2013) and Reardon *et al*. (2014).

Table 2.3 Confidence ratings applied to calls

Identification	Description
D – Definite	Species identification not in doubt.
PR – Probable	Call most likely to represent a particular species, but there exists a low probability of confusion with species of similar call type or call lacks sufficient detail.
SG – Species Group	Call made by one of two or more species. Call characteristics overlap making it too difficult to distinguish between species e.g. *Chalinolobus gouldii* / *Mormopterus ozimops* sp. *Nyctophilus* sp. The calls of *Nyctophilus geoffroyi* / *gouldi* cannot be distinguished during the analysis process and are therefore lumped together. *Nyctophilus sp* / *Macropus*. The calls of these species can be easily confused during the analysis process and are therefore often lumped together.

AudioMoth survey

Audiomoth devices were deployed in the August 2022 and March 2023 survey rounds to provide additional survey effort for nocturnal birds and the Koala, and the complement other survey methods such as spotlighting and call playback. Sites were located within riparian vegetation or adjacent to Billabong Creek in the vicinity of the proposed regulator sites or access tracks.

Prior to field deployment all devices were programmed to record 12 hours a day. During August 2023 surveys, each AudioMoth device was programmed using the AudioMoth Configuration App (Version 1.7.1., Open Acoustic Devices), as follows:

– Sample rate: 32000 Hz (32 kHz)
– Gain: medium-high

– Enable sleep/record cycle: on (Sleep duration: 5 seconds / Record duration: 55 seconds thus each file is 55 seconds)
– Enable filtering: band pass (0.4 kHz – 15.0 kHz)
– Audiomoths were reconfigured for March 2023 surveys to record for two minutes every 15 minutes.

AudioMoths were housed inside the AudioMoth IPX7 waterproof case, with the microphone adjacent to a small hole. All devices were strapped to a tree trunk or limb no wider than 30 cm diameter at a height of 1.5 metres and at least five metres away from dense foliage. Photographs of the location and the device in situ were recorded. All devices were retrieved after two nights.

Opportunistic observations

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.

2.5 Weather conditions

Field surveys were conducted across the study area between February 2022 and February 2024, with targeted surveys for species credit matters commencing in August 2022. 2022 was exceptionally wet with the state-averaged annual total being the second highest on record (since 1900), and the Riverina had its highest annual rainfall on record. In the Murray–Darling Basin flooding occurred over prolonged periods, or on multiple occasions (BOM 2023b). Weather hampered surveys in some instances, and flooding prevented access to the study area for several months (October 2022 – February 2023).

Bureau of Meteorology (BOM) records for survey dates are outlined in Table 2.4. Weather observations were recorded from Deniliquin Airport (Station 074258) (BOM 2023c), located around 50 kilometres to the south and south-west of the study area.

Prolonged dry conditions may, in general, have a negative effect on the ability to accurately detect target threatened flora species or calculate VI, particularly in semi-arid regions. Cumulative rainfall recorded at Deniliquin (BOM 2023b) for 12 months prior to mapping vegetation zones and sampling vegetation integrity plots in February 2022, March 2023 and September 2023 was compared with wet or dry rainfall year thresholds to reflect climatic variation in accordance with the *Guidance for assessors and decision-makers in applying modified benchmarks to assessments of vegetation integrity* (DPIE 2020c) and section 1.4.2(3) of the BAM. As shown in Table 2.4, average rainfall at the study area has exceeded the wet rainfall year threshold for relevant PCTs and IBRA regions (DPE 2022c) in the 12 months preceding each of the key survey rounds in which VI plot data was collected (BOM 2023b). Therefore, wet year benchmarks have been adopted in BAM-C calculations and throughout this BDAR.

The rainfall data in Table 2.4 also confirms that conditions would have been suitable for detection of candidate threatened flora, if present, including species that are only likely to be detectable after seasonal rainfall, such as Slender Darling Pea (*Swainsona murrayana*), or when floodplain depressions contain water, such as Austral Pillwort (*Pilularia novae-hollandiae*) (NSW DCCEEW 2024b). Surveys for the Southern Bell Frog (*Litoria raniformis*) were also conducted in optimal conditions.

Table 2.4 Benchmark classes based on cumulative rainfall in preceding year

Weather Station	PCT ID	Wet rainfall year threshold (cumulative total over 12 months mm) (DPE 2022c) (mm)	Cumulative rainfall for 12 months preceding February 2022 (mm) (BOM 2023b) (mm)	Cumulative rainfall for 12 months preceding March 2023 (mm) (BOM 2023b) (mm)	Cumulative rainfall for 12 months preceding September 2023 (mm) (BOM 2023b) (mm)
Deniliquin 074258	7	458	473	630.6	606.4
	10	458	473	630.6	606.4
	13	415	473	630.6	606.4
	17	402	473	630.6	606.4
	44	455	473	630.6	606.4

Weather Station	PCT ID	Wet rainfall year threshold (cumulative total over 12 months mm) (DPE 2022c) (mm)	Cumulative rainfall for 12 months preceding February 2022 (mm) (BOM 2023b) (mm)	Cumulative rainfall for 12 months preceding March 2023 (mm) (BOM 2023b) (mm)	Cumulative rainfall for 12 months preceding September 2023 (mm) (BOM 2023b) (mm)
	46	455	473	630.6	606.4
	160	402	473	630.6	606.4

Weather conditions during the field survey period based on daily weather conditions at Deniliquin (BOM 2023c) are summarised in Table 2.5.

Rainfall and gusty winds hampered the quality of Audiomoth data for a period of ~3 hrs on the night of 22 August 2022. This did not impact survey coverage for the Koala as this species was also surveyed using scats searches and spotlighting throughout the proposal footprint. Mid-week rainfall within the September 2022 survey round prevented access to Carroonboon and Picaninny sites and truncated surveys at Hartwood, due to poor road conditions (various local roads closed due to heavy rain/flooding). Survey effort at the Wanganella site was not affected that week.

Table 2.5 Weather conditions during the survey period (BOM 2023c)

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall previous 24 hours (mm)	Rainfall previous 7 days (mm)
Hartwood				
08/06/2022	2.4	12.1	1.6	14.0
22/08/2022	5.3	19.6	1	4.4
23/08/2022	5	12.2	12.2	4.4
19/09/2022	4.5	16.3	3	15.2
20/09/2022	4	19.9	0.2	18.2
21/09/2022	10.6	17	11.2	18.4
22/09/2022	12	22.4	1.2	29.6
23/09/2022	12.5	21.6	0	27.4
27/02/2023	12.4	28.9	0	0
01/03/2023	11.8	28.3	0	0
02/03/2023	10.7	29.5	0	0
06/03/2023	13.7	26.2	0.8	0
09/03/2023	6.2	23.9	0	0.8
25/09/2023	9.2	24.7	0	0
28/09/2023	4.5	26.2	0	0
11/12/2023	21.0	35.2	0	6.0
13/12/2023	26.1	37.7	0	12.0
14/12/2023	16.7	29.2	0	12.0
18/1/2024	10.7	25.4	1.0	2.8
19/1/2024	9.3	28.1	4.2	7.0
20/1/2024	12.7	33.1	0.2	7.2
21/1/2024	17.8	29.6	0	5.4
22/1/2024	11.3	29.5	0	5.4
23/1/2024	10.5	35.1	0	5.4
7/2/2024	9.9	29.2	5.6	5.6

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall previous 24 hours (mm)	Rainfall previous 7 days (mm)
Wanganella				
07/06/2022	4.2	12.1	0	0
22/08/2022	5.3	19.6	1	4.4
23/08/2022	5	12.2	12.2	4.4
19/09/2022	4.5	16.3	3	15.2
20/09/2022	4	19.9	0.2	18.2
21/09/2022	10.6	17	11.2	18.4
22/09/2022	12	22.4	1.2	29.6
23/09/2022	12.5	21.6	0	27.4
27/02/2023	12.4	28.9	0	0
01/03/2023	11.8	28.3	0	0
07/03/2023	12.7	25.3	0.8	0.8
26/09/2023	8.3	27.9	0	0
27/09/2023	7	23.5	0	0
12/12/2023	23.2	38.7	6.0	12.0
13/12/2023	26.1	37.7	0	12.0
18/1/2024	10.7	25.4	1.0	2.8
19/1/2024	9.3	28.1	4.2	7.0
20/1/2024	12.7	33.1	0.2	7.2
21/1/2024	17.8	29.6	0	5.4
22/1/2024	11.3	29.5	0	5.4
23/1/2024	10.5	35.1	0	5.4

2.6 Credit calculations

BAM credit calculations were completed by Ben Harrington (accredited assessor number BAAS17023) in accordance with the BAM and using the Credit calculator Version 1.4.0.00 and version 1.2 benchmark data.

The credit calculations Parent case ID for the proposal is 00033952. Assessment cases were created as follows:

– Wanganella – 00033952/BAAS23017/23/00044378 Version 1
– Hartwood – 00033952/BAAS23017/23/00044379 Version 1.

Two cases were created to allow for staging of construction at the two sites if necessary. The biodiversity credit report and predicted and candidate threatened species reports are included in Appendix G.

2.6.1 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 subject land, the BAM-C generates a list of threatened fauna species that are predicted to utilise the proposal footprint (that is, 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, records during the surveys, and the knowledge and experience of the assessor. Targeted surveys are not required under the BAM for these species as they are assumed to be present.

Targeted surveys may, however, be required if the predicted species are also listed under the EPBC Act, to assess the significance of impacts in accordance with the *MNES Significant impact guidelines 1.1 – Environment Protection and Biodiversity Conservation Act 1999* (DotE 2013). A range of methods were employed to ensure appropriate survey effort for EPBC Act threatened species including diurnal bird surveys and nest tree census for threatened and migratory bird species and threatened frog aural visual surveys (see section 2.4.3).

2.6.2 Candidate threatened species (species credit entities)

Threatened species that cannot reliably be predicted to occur on a proposal footprint based on PCT, distribution and habitat criteria are identified by the TBDC as 'species credit' entities. In some circumstances, the particular habitat components of species assessed for ecosystem credit species, such as the breeding habitat of cockatoos or important habitat for the Plains-wanderer (*Pedionomus torquatus*), are also assessed for species credits.

The credit calculator references geographic, vegetation and habitat data for the proposal footprint to generate a list of the species credit entities that may occur (ie the 'potential candidate threatened species'). Searches of threatened species databases were also completed to identify any additional potential candidate threatened species (to those generated by the credit calculator) that are known or predicted to occur in the locality. The likelihood of occurrence of potential candidate threatened species were reviewed, giving consideration to the habitats available in the study area (refer to likelihood of occurrence tables in Appendix B).

2.6.3 Assessor's use of judgement

The BAM-C calculations were finalised by Ben Harrington using credit calculator version 1.4.0.00, BAM data version 61, based on the data and assumptions presented throughout this BDAR. The biodiversity credit report is included in Appendix G.

On 1 February 2023, the BAM-C was updated to include Version 1.2 benchmarks. During the designated transitional period, assessors with in-progress assessments on the date that the BAM-C Version 1.2 benchmarks update occurs may opt to manually modify benchmarks and continue to apply (the previous) Version 1.1 benchmarks. To be eligible to apply transitional arrangements to a BAM-C case, the assessor must finalise the BAM-C assessment prior to 2 August 2023 and submit the certified Biodiversity Assessment Report (BAR) prior to 16 August 2023 (NSW DCCEEW 2024e). The BAM-C case for the proposal was commenced prior to 1 February 2023 however was not finalised prior to 16 August 2023 and so the version 1.2 benchmarks have been retained in the BAM-C.

Accredited assessors also made the following judgements and/or assumptions while completing this BDAR:

- Manual addition of a hollow bearing tree record in a VI plot sampled in the proposal footprint to ensure compliance with the BAM (section 4.3.4 *5. The assessor must ensure that all function attributes relevant to the PCT, including the presence of any hollow bearing trees, are captured within a minimum of one plot. 8-12. 8. The assessor must assess the vegetation zone for the presence of hollow bearing trees. 11. Where hollow bearing trees are present within a vegetation zone, the assessor must include a hollow bearing tree in at least one plot for that zone*) (DPIE 2020a) as follows:
  - A hollow bearing tree record was added to plot F6 to ensure that Wanganella Zone 2 (PCT 10_moderate) was recognised as containing hollow bearing trees.
- Omission of data from J2 sampled in June 2022 because it may have included locally degraded native vegetation associated with informal tracks that intersected part of the plot and/or seasonally very high exotic plant cover and low native plant cover.
- Inclusion of data from VI plots sample outside of the final proposal footprint included in this BDAR but located in adjacent patches of similar vegetation.
- Mapping of Bush Stone-curlew (*Burhinus grallarius*) species polygons at the Wanganella site based on personal communication of an observation and photograph of a Bush Stone-curlew in February 2023 in River Red Gum-Black Box woodland around 300 metres to the east of the proposal footprint. The species identity and location was confirmed in discussion with GHD ecologists. This record of the species is in the same broad patch of native vegetation as the proposal footprint, associated with the Billabong Creek riparian corridor.

– Discounting of the presence of the Bush Stone-curlew at the Hartwood site, despite personal communication of an observation at Wanganella, based on sufficient targeted survey effort at the Hartwood site in appropriate seasons in accordance with the TBDC (NSW DCCEEW 2024a) and the 45 kilometres distance between the sites.
– Discounting of the presence of the Southern Myotis (*Myotis macropus)* at the Wanganella site, despite a record at Hartwood, based on sufficient targeted survey effort at the Hartwood site in appropriate seasons in accordance with the TBDC (NSW DCCEEW 2024a) and the 45 kilometres distance between the sites.

2.7 Assumptions

A 'proposal footprint' polygon (that is, direct and indirect disturbance footprint) was prepared for the proposal based on proposal layout and design data provided by NSW DCCEEW. It is assumed that the description and spatial data accurately represent the extent of direct impacts arising from the proposal and so these data have been used to calculate the extent of removal of vegetation and habitat arising from the proposal using GIS. These calculations have in turn been relied upon in the BAM-C calculations and the determination of key thresholds such as whether the proposal would have a direct impact on a threatened species, whether the buffer area between built structures and adjoining native vegetation would be sufficient to mitigate against indirect impacts, whether biodiversity offsets are required for a particular impact and whether a particular impact is likely to be significant. The assessment conclusions may change as a result of the provision of an updated proposal footprint layout and/or spatial data.

The assessment of operational impacts including changes to hydrology, hydraulics and fish passage is based on:

– NSW DCCEEW (2023) *Yanco Creek System operations plan (Draft) September 2023*
– Jacobs (2024a) *Billabong Creek Regulators Hydrology and Surface Water Resources Assessment* (Appendix G to the EIS)
– Jacobs (2024b) *Billabong Creek Regulators Surface Water Quality and Aquatic Ecology Assessment* (Appendix K to the EIS).

It is assumed that the proposal would affect hydrological processes through contribution to the regulation of the system in accordance with the Operation Plan (DCCEEW 2023). Operation of the proposal would result in minor overall changes to the hydrology of the system, improved delivery of Environmental Water Requirements (Jacobs 2024a) and improved connectivity of aquatic habitat (Jacobs 2024b). Based on these inputs it is assumed that operation of the proposal would not have an adverse effect on wetland dependent species or their habitats.

2.8 Staff qualifications

This BDAR and associated credit calculations has been prepared and certified by Ben Harrington (accredited assessor number BAAS17023). The credit calculator and BDAR were peer reviewed by Kirsten Crosby (accredited assessor number BAAS17011).

Qualifications of GHD ecologists who completed field surveys and report inputs are presented in Table 2.6.

Table 2.6 Staff qualifications and proposal roles

Name	Position/Proposal role	Qualifications	Relevant experience
Kirsten Crosby	Technical director - Biodiversity / accredited assessor, co-lead author of BDAR, fauna and flora surveys, credit calculations, technical review of report inputs	BSc. PhD. BAM Assessor Accreditation (BAAS17011)	18+ years
Ben Harrington	Technical director – Biodiversity / accredited assessor, co-lead author of BDAR, flora and fauna surveys, credit calculations, technical review of report inputs	BSc. MSc. BAM Assessor Accreditation (BAAS17023)	20+ years
Jessie Russo	Senior ecologist / accredited assessor, contributing author of BDAR, flora surveys	BEnvSc. BAM Assessor Accreditation (BAAS23017)	6+ years

Name	Position/Proposal role	Qualifications	Relevant experience
Mal Weerakoon	Senior ecologist / contributing author of BDAR, fauna surveys	BSc., MSc.	10 + years
Kelly Dalton	Senior ecologist / fauna surveys	BSc. (Hons)	16 years
Tom Fee	Ecologist / Vegetation mapping / flora and fauna surveys	BSc. GDip. VQA Accredited Assessor	8+ years
Lukas Fellows	Ecologist / fauna surveys	BSc. MSc.	5+ years
Cindy Murphy	Ecologist / flora surveys	BSc.	5+ years
Patrick Costello	Ecologist / flora surveys	BSc.	5+ years
Keeley Dart	Environmental consultant / fauna surveys	B.SciAg. (Hons)	3+ years
Melissa Wood	Ecologist / fauna surveys	BSc.	2+ years
Rhys Cairncross	Ecologist / fauna surveys	BSc.	2+ years
Bryan Rees	Graduate ecologist / flora and fauna surveys.	Bsc. GradDipSus	1+ years
Craig Grabham	Senior ecologist / Microbat call recording analysis	B.AppSc.	22+ years
John Kershaw	Senior ecologist (Jacobs) / flora surveys	B.Cons Eco	17+ years

Stage 1: Biodiversity assessment

3. Site context

The BAM requires the assessment of landscape features to establish the site context, describe the biodiversity values of the proposal footprint and assess the impacts of the proposal on the proposal footprint. Landscape features within the proposal footprint, assessment area and proposal footprint relevant to the BAM calculations are discussed in the following sections.

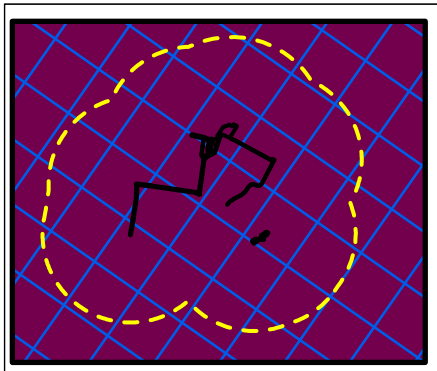
3.1 Assessment area

The assessment areas are defined as the area of land within the 1500 metre buffer area surrounding the subject land for each site-based development as shown on Figure 3.1 and Figure 3.2. A summary of the landscape features associated with the study area of the proposal is provided in Table 3.1. Individual landscape features are described in more detail throughout the sections below including justifications for the use of data entered in the BAM-C. No additional or specific landscape features are identified in the SEARs.

Table 3.1 Summary of landscape features present within the proposal footprint

Landscape features	Hartwood	Wanganella
Method applied for site context components	Site-based	Site-based
Interim Biogeographic regionalisation of Australia (IBRA) bioregion	Riverina	Riverina
IBRA subregion	Murrumbidgee	Murrumbidgee
LGA	Edward River	Edward River
Mitchell landscape	Murrumbidgee Channels and Floodplains	Murrumbidgee Channels and Floodplains
% native vegetation extent within buffer area	40 % (872 hectares (ha) of the 2185 ha buffer area)	82 % (1011 ha of the 1240 ha buffer area)
Rivers, streams and estuaries	Billabong Creek, Forest Creek	Billabong Creek, Forest Anabranch
Wetlands	No significant named wetlands, however, a small ephemeral wetland occurs in the centre of one of the CAZs in the south-eastern section of the site.	No significant named wetlands, however, a small ephemeral wetland occurs the north-western section of the study area (adjacent to the northernmost CAZ).
Connectivity features	Riparian vegetation associated with Yanco Creek, Billabong Creek and Forest Creek provide the key habitat connectivity in the locality. These generally provide east-west connectivity, with anabranches providing connections between the two creeks. In the proposal footprint itself, canopied vegetation along Billabong Creek runs in a north-westerly direction. Remaining land in the proposal footprint is a combination of cropped land and native grassland and shrubland vegetation.	Riparian vegetation associated with Billabong Creek and the Forest Anabranch provide the key habitat connectivity in the locality. These generally provide east-west connectivity. Canopied vegetation extends away from the creek on the northern bank and is part of a larger area of Crown Land associated with Wanganella weir. Remaining land in the proposal footprint is a combination of cropped land and native grassland and shrubland vegetation.

Landscape features	Hartwood	Wanganella
Areas of geological significance or soil hazard features	Soil landscapes for the proposal footprint and surrounding buffer area indicate that the soils have low erosional risk and low acid sulphate potential. There are no areas of geological significance of relevance to the site.	Soil landscapes for the proposal footprint and surrounding buffer area indicate that the soils have low erosional risk and low acid sulphate potential. There are no areas of geological significance of relevance to the site.
Areas of outstanding biodiversity value	No areas identified under the BC Act as being of outstanding biodiversity value have been mapped in the proposal footprint.	No areas identified under the BC Act as being of outstanding biodiversity value have been mapped in the proposal footprint.
Other landscape features	Nil	Nil

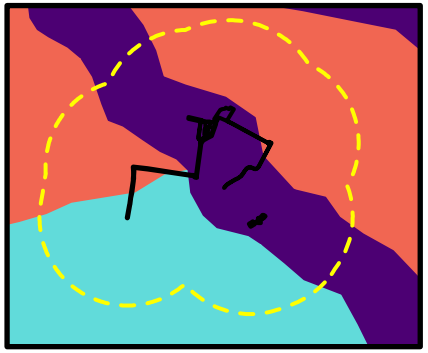


IBRA subregion

Murrumbidgee

IBRA region

Riverina



NSW (Mitchell) landscapes

- Murrumbidgee Channels and Floodplains
- Murrumbidgee Depression Plains
- Murrumbidgee Scalded Plains



Legend

- Proposal footprint
- Study area
- 1500m buffer area
- Patch size (>100 ha)
- Native vegetation extent
- Watercourse
- Riparian buffer
- Main road
- Habitat connectivity

N

GDA2020 MGA Zone 55

A4 Scale: 1:46,000

0 300 600 900 1,200

Metres

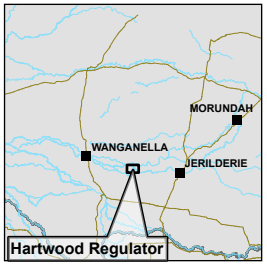
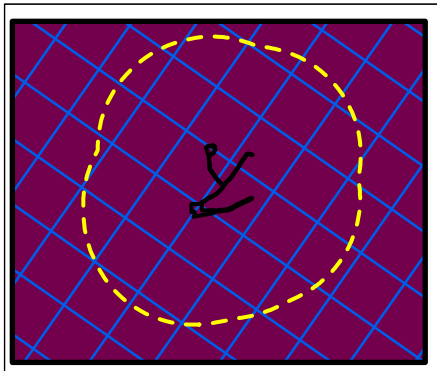


Figure 3.1 Hartwood location map

3Rivers

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

Maxar; 18/03/2024 5:03 PM rvillalon
\\ghdnet\ghd\AU\Sydney\Projects\21\12537654\GIS\Maps\Deliverables\SDLAM_Yanco\12537654_RFS083_Billabong_BDAR.aprx

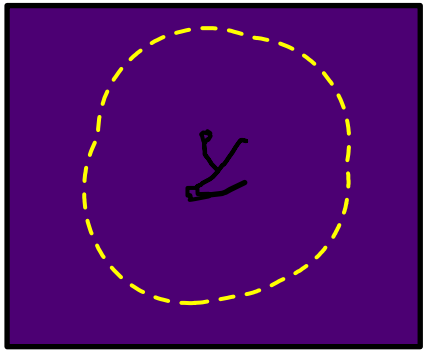


IBRA subregion

Murrumbidgee

IBRA region

Riverina



NSW (Mitchell) landscapes

Murrumbidgee Channels and Floodplains



Legend

- Proposal footprint
- Study area
- 1500m buffer area
- Native vegetation extent
- Patch size (>100 ha)
- Watercourse
- Riparian buffer
- Main road
- Habitat connectivity

N

GDA2020 MGA Zone 55

A4 Scale: 1:35,000

0 300 600 900 1,200

Metres

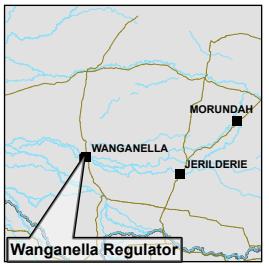


Figure 3.2 Wanganella location map

3Rivers

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

Earthstar Geographics;19/03/2024 10:31 AM rvillalon \\ghdnet\ghd\AU\Sydney\Projects\21\12537654\GIS\Maps\Deliverables\SDLAM_Yanco\12537654_RFS083_Billabong_BDAR.aprx

3.2 Landscape features

3.2.1 Rivers, streams, estuaries and wetlands

The Yanco Creek System is located in the NSW Riverina and comprises a creek and floodplain system that commences at the Murrumbidgee River at Yanco Weir located about 20 kilometres west of Narrandera. In total, it comprises over 800 kilometres of creek frontage covering a distance of 250 kilometres. It flows from east to west and eventually meets the Edward River (part of the Murray River system) at Moulamein (Business case for modernising supply systems for effluent creeks – Murrumbidgee River, NSW DPIE, 2015).

The Yanco Creek System is a complex, braided system of interconnecting creeks and anabranches. Main branches of the system include the Yanco, Colombo, Billabong and Forest Creeks. At Hartwood, Billabong Creek flows from the south-east to the north-west, with Forest Creek leaving Billabong Creek near the existing block bank and flowing in a westerly then south-westerly direction (see Figure 3.1). At Wanganella, Billabong Creek flows from the east and then to the north-west. Downstream of the proposal footprint at Wanganella the Forest Anabranch diverts from the main creek and flows west (see Figure 3.2). Eight Mile Creek (which also hosts Wanganella Swamp) flows from the south into the Forest Anabranch, downstream of the proposal footprint.

Prior to the 1850s, Yanco Creek only connected with the Murrumbidgee River during floods and Billabong Creek was regularly reduced to deeper waterholes in summer. From the 1850s onwards, the creek underwent modifications over time to enable water delivery for stock and domestic use and irrigation and it became a perennially flowing system. The creek system supports numerous irrigation offtakes and canals, irrigation areas and water pumps. The creek also has numerous structures and flow blockages. Some of the structures are actively used to redirect flow and create weir pools that are used for irrigation or domestic use however, some are defunct and no longer serve a purpose.

Various wetlands are associated with Billabong Creek and other watercourses in the study area (Forest Creek Working Group 2000). These include:

– relatively small wetlands that have formed in natural depressions that were once part of an ancestral stream course
– wetlands of various depths that result from flooding of low-lying areas that contain one, or a series, of flood runners, and typically receive water on a seasonal basis
– flood-out areas that only receive water during high flows
– swamps that contain both permanent and semi-permanent areas of water.

There are no nationally or internationally listed important wetlands at or near the proposal site (DAWE 2020b).

3.2.2 Habitat connectivity

Native vegetation extent was mapped across the assessment area using the SVTM (DPE 2022a) as a base map that was adjusted within the proposal footprint based on the results of the desktop assessment and air photo interpretation. Patch size polygons were mapped in accordance with the BAM to include native vegetation in the proposal footprint that has a gap of less than 100 metres from the next area of native vegetation (or ≤ 30 metres for non-woody ecosystems). Native vegetation and patch size polygons are shown on Figure 3.1 and Figure 3.2.

Habitat within the proposal footprint is connected to extensive areas of similar riparian and floodplain habitat in the surrounding locality. Extensive vegetation clearing has occurred for agriculture and various infrastructure but cover of remnant and regenerating native vegetation has been retained. Habitat connectivity is maintained across and beyond the assessment area. All vegetation zones at the proposal footprint have a patch size of >101 ha.

The riparian corridors of Billabong Creek and its tributaries lie adjacent to the proposal footprint and may have particular value as fauna movement corridors. The Forest Creek system forms an important riverine corridor of Black Box (*Eucalyptus largiflorens*) woodland (Forest Creek Working Group 2000). Riparian vegetation at the Wanganella site occurs within the Wanganella Recreation Reserve (R88408).

3.2.3 Karst, caves, crevices, cliffs, rocks or other geological features of significance

No karst, caves, crevices, cliffs, rocks or other geological features of significance occur within the proposal footprint or assessment area.

3.2.4 Areas of outstanding biodiversity value

No areas of outstanding biodiversity value, as identified under the BC Act, occur within the proposal footprint or assessment area.

3.2.5 NSW (Mitchell) landscape

The majority of the construction footprint and the entire Wanganella study area is located within the Murrumbidgee Channels and Floodplains NSW (Mitchell) Landscape (DPIE 2016). Murrumbidgee Channels and Floodplains is the Mitchell landscape for both the Hartwood and Wanganella BAM-C assessment cases. Small areas of other landscapes also occur in the study area surrounding the Hartwood regulator site. Landscapes at the study area are shown on Figure 3.1 and Figure 3.2 and described in Table 3.2. Field observations of soil and geomorphology and floristic plot data confirm that the study area matches the description of the Murrumbidgee Channels and Floodplains Mitchell landscape provided in Table 3.2.

Table 3.2 Mitchell landscapes

Mapped landscape (DPIE 2016)	Description (DECC 2002)
Murrumbidgee Channels and Floodplains	Comprises Quaternary alluvium on seasonally inundated floodplains, active and inactive channels, billabongs, levees and swamps of the Murrumbidgee River and its effluent streams. Relief to 10m. Includes scalded alluvial flats, broad elevated floodplains and associated relict channels. Grey and brown clay with occasional areas of low sandy rise. Open forest of River Red Gum (*Eucalyptus camaldulensis*), river cooba (*Acacia stenophylla*), cooba (*Acacia salicina*), lignum (*Muehlenbeckia cunninghamii*), nitre goosefoot (*Chenopodium nitrariaceum*) with numerous grasses along the channels and floodplain. Black box (*Eucalyptus largiflorens*) woodland with lignum, nitre goosefoot, thorny saltbush (*Rhagodia spinescens*), old man saltbush (*Atriplex nummularia*) and annual saltbushes (*Atriplex sp*.) on more distal floodplains and back plains. Cumbungi (*Typha orientalis*), common reed (*Phragmites australis*) and nardoo (*Marsilea drummondii*) in flooded depressions
Murrumbidgee Scalded Plains	Quaternary alluvial plains with extensive scalding interpreted as relic floodplains or terraces. Grey, brown and red cracking clays, red brown texture-contrast soils with scalds. Levees traces evident, relief generally <1m, up to 5m on associated pans, swamps and lunettes. Low shrublands and grasslands of bladder saltbush (*Atriplex vesicaria*), other annual saltbushes (*Atriplex* sp.), numerous burrs (*Sclerolaena* sp.), cottonbush (*Maireana aphylla*), bush minuria (*Minuria cunninghamii*), white-top grass (*Austrodanthonia caespitosa*), windmill grass (*Chloris truncata*), and hill wallaby grass (*Austrodanthonia eriantha*).
Murrumbidgee Depression Plains	Quaternary alluvial plains with numerous circular depressions interpreted as high floodplains or low terraces beyond the reach of average floodwaters, relief to 10m. Grey to brown clays and clay loams with linear patterns of sandy prior streams. Now extensive grasslands of white-top, windmill grass, sand broom, and spear grasses, heavily grazed and invaded by exotic species. Reported to have originally been myall (*Acacia pendula*), old man saltbush (*Atriplex nummularia*) and bladder saltbush (*Atriplex vesicaria*). Sandy ridges of prior streams support patches of white cypress pine (*Callitris glaucophylla*), with needlewood (*Hakea leucoptera*), western pittosporum (*Pittosporum phylliraeoides*) and spear grasses *(Austrostipa* sp.).

4. Native vegetation, threatened ecological communities and vegetation integrity

4.1 Native vegetation extent

The following section describes the extent of native vegetation at the proposal footprint that requires assessment according to Chapter 4 of the BAM. Native vegetation extent was initially mapped across the proposal footprint using the SVTM (DPE 2022a) and high-resolution aerial photographs and then ground-truthed and adjusted based on the GHD site surveys. Native vegetation cover is shown on Figure 4.1 and Figure 4.2 and described in sections 4.2 and 4.3.

The proposal footprint contains large areas of cleared and degraded land that support agricultural production and cattle grazing areas as well as areas of native vegetation. Native vegetation is predominantly associated with the riparian corridor of Billabong Creek and Forest Anabranch Creek which intersect the regulator sites.

Areas that are not native vegetation do not require assessment according to Chapter 4 of the BAM. Areas that have been mapped as not native vegetation include cropped agricultural land, formed tracks, hard stand areas and compacted bare earth.

Guidance provided by NSW DCCEEW (2024c), defines areas that are comprised of less than 15% native vegetation are to be mapped as 100% exotic and excluded from the calculation of native vegetation extent. Agricultural land at Hartwood was sampled with VI plots JR_10, JR_11 and JR_14 to help confirm that these areas do not meet the definition of native vegetation requiring further assessment under the BAM. The VI plots showed the total cover of native vegetation ranged between 0.1 and 5.3 % (Table 4.1, Appendix D). These areas are heavily degraded and disturbed as a result of ongoing agricultural production. Areas of non-native vegetation at Hartwood are described in detail in Table 4.1. Given the small area of non-native vegetation in the proposal footprint, a land categorisation assessment was not considered necessary for this BDAR.

Non-native vegetation at Wanganella is restricted to formed tracks, hard stand areas and compacted bare earth that are clearly free of any native vegetation cover and as such were not sampled with plots or described in detail.

Table 4.1 Hartwood non-native vegetation description

Non-native vegetation in agricultural land	
Plant community type	N/A
PCT ID	Non-native vegetation. Treated as PCT 10 and 13 for the purposes of calculating VI.
Photo	

Non-native vegetation in agricultural land	
Survey effort (PCT 10)	JR14
Survey effort (PCT 13)	JR10, JR11
Conservation significance	Non-native vegetation.
Patch size	0 ha
Condition	Non-native – grass, forb and shrub composition was well below benchmark – grass, forb and shrub structure was well below benchmark – no fallen logs recorded – no trees present – total cover of native vegetation ranged between 0.1 and 5.3 %.
Current vegetation integrity score (PCT 10)	5
Current vegetation integrity score (PCT13)	0.1
Landscape position	Mid elevations on the Billabong Creek and Forest Creek floodplains, outer floodplains and minor drainage channels with infrequent inundation by floodwater where the original native vegetation was cleared.
Structure	Exotic grassland or herb land derived from clearing of Black box woodland wetland with extensive areas of ploughed cropland and bare earth. Certain areas are dominated by cover of exotic annual grasses, but this would be likely to vary with season and/or rainfall in recent months. Would periodically have high cover of exotic crop species.
Over-storey	Absent.
Mid-storey	Absent.
Groundcover	Dominated by exotic species (50.4 to 121.8% cover in plots sampled). Grasses: very sparse cover of Hairy Panic (*Panicum effusum*), Windmill Grass (*Chloris divarica*), Common Spike-rush (*Eleocharis acuta*), Rigid Panic (*Walwhalleya proluta*), Tufted Rush (*Juncus flavidus*). Small-flowered Wallaby-grass (*Rytidosperma setaceum*) Shrubs: very occasional Black Roly-poly (*Sclerolaena muricata*), Tangled Copperburr (*Sclerolaena divaricate*), Prickly Saltwort (*Salsola australis*) and Creeping Saltbush (*Atriplex semibaccata*). Herbs: low species richness and cover of Small White Sunray (*Rhodanthe corymbiflora*), Yellow Wood-sorrel (*Oxalis perennans*), Caustic Weed (*Euphorbia drummondii*), Fuzzweed (*Vittadinia cuneata*), Spreading Sneezeweed (*Centipeda minima subsp. minima*), Lesser Joyweed (*Alternanthera denticulata*).
Exotic species	Locally very high cover of annual grasses such as Perennial Ryegrass (*Lolium perenne*) and the HTE Carpet Weed (*Phyla nodiflora*). Moderate cover of other environmental weeds such as Thread Iris (*Moraea setifolia*), *Medicago sp.,* Common Storksbill (*Erodium citutarium*), Vipers Bugloss (*Echium vulgare*), Wild Oats (*Avena fatua*), Prickly Sowthistle (*Sonchus asper*), Paradoxa Grass (*Phalaris paradoxa*), Paddy Melon (*Cucumis myriocarpus subsp. leptodermis*) Barley Grass (*Hordeum leporinum*), Pattersons Curse (*Echium plantagineum*), Great Brome (*Bromus diandrus*), Bathurst Burr (*Xanthium spinosum*).

4.2 Plant community types

4.2.1 Overview

The PCTs identified at the proposal footprint are summarised in Table 4.2 and mapped on Figure 4.1 and Figure 4.2 .Further discussion of threatened ecological communities listed under the BC Act and EPBC Act is provided in section 4.4.

Table 4.2 Plant community types in the proposal footprint

Plant community type	BC Act status	EPBC Act status	Extent in proposal footprint at Wanganella site (ha)	Extent in proposal footprint at Hartwood site (ha)	Total extent of PCT in proposal footprint (ha)
PCT 7: River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion	Not listed	Not listed	0.61	0.84	1.45
PCT 10: River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Not listed	Not listed	0.93	0.75	1.68
PCT 13: Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Not listed	Not listed	1.68	4.26	5.93
PCT 44: Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion	Not listed	Listed in part - Natural Grasslands of the Murray Valley Plains (CEEC). The mapped extent of PCT 44 at the study area does not comprise part of an occurrence of this CEEC.	0	0.32	0.32
PCT 46: Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	Not listed	Listed in part - Natural Grasslands of the Murray Valley Plains (CEEC). The mapped extent of PCT 46 at the study area does not comprise part of an occurrence of this CEEC.	1.89	4.78	6.67

Plant community type	BC Act status	EPBC Act status	Extent in proposal footprint at Wanganella site (ha)	Extent in proposal footprint at Hartwood site (ha)	Total extent of PCT in proposal footprint (ha)
PCT 160: Nitre Goosefoot shrubland wetland on clays of the inland floodplains	Listed in part - Artesian Springs Ecological Community in the Great Artesian Basin (CEEC). The mapped extent of PCT 160 at the study area does not comprise part of an occurrence of this CEEC.	Not listed	0.19	0	0.19

Notes: CEEC – critically endangered ecological community.

4.2.2 Justification of PCT selection

The SVTM (DPE 2022a) and analysis of aerial photography revealed the following vegetation units across the study area and associated candidate PCTs:

- **Riparian forest** in the riparian corridor of Billabong Creek and Forest Creek at both Wanganella and Hartwood mapped as:
  - PCT 2 – River Red Gum-sedge dominated very tall open forest in frequently flooded forest wetland along major rivers and floodplains in south-western NSW
  - PCT 7 – River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
- **Floodplain woodland** on the outer edges of the riparian corridor of Billabong Creek and Forest Creek mapped as:
  - PCT 10 – River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
  - PCT 13 – Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
- **Floodplain shrubland** on the inner floodplain and in depressions across the study area mapped as:
  - PCT 160 – Nitre Goosefoot shrubland wetland on clays of the inland floodplains
  - PCT 163 – Dillon Bush (Nitre Bush) shrubland of the semi-arid and arid zones
  - PCT 164 – Cotton Bush open shrubland of the semi-arid (warm) zone
  - PCT 216 – Black Roly Poly low open shrubland of the Riverina Bioregion and Murray Darling Depression Bioregion
- **Floodplain grassland** on the outer floodplain across the study area mapped as:
  - PCT 44 – Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
  - PCT 46 – Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion.

Plot data and other site observation were considered against these candidate PCTs. Characteristic species, vegetation structure, soil type and landscape position were evaluated and compared with descriptions of candidate PCTs (NSW DCCEEW 2024b) in the BioNet vegetation classification. The study area is entirely located on the floodplains of Billabong Creek and associated watercourses. The majority of the study area, including the entire Wanganella site, is located in the Murrumbidgee Channels and Floodplains Mitchell landscape. Higher elevation parts of the Hartwood site extend into the Murrumbidgee Scalded Plains and Murrumbidgee Depression Plains Mitchell landscapes (DPIE 2016; pers. obs.). Each of these landscapes contain Quaternary alluvium on periodically inundated floodplains and associated geomorphic features such as active and inactive channels,

billabongs, levees, swamps, plains and terraces (DECC 2002). The presence of these landscapes and associated soil types and geomorphic features was confirmed during field surveys. There are no distinct features such as sandy rises or dunes that may occur on the broader Murrumbidgee floodplain. In this context, landscape position relative to the main channels of waterbodies, and associated flood frequency and depth are the main factors determining the distribution of PCTs (DECC 2002; NSW DCCEEW 2024b).

The evidence used to confirm the selection of the best matching PCTs for these three vegetation units at the study area is provided below.

Riparian forest

PCT 7 – River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland was confirmed as occurring on the lower, shallow-banked side of the Billabong Creek riparian corridor and lower-level positions across the floodplain subject to relatively frequent inundation by floodwaters. These areas were separated from adjoining floodplain woodland based on a tall open forest vegetation structure, with canopy tree cover >30%, and greater than 20 metres in height, dominated by River Red Gum (*Eucalyptus camaldulensis*) with occasional Black Box (*E. largiflorens*).

PCT 7 was selected over PCT 2 – River Red Gum-sedge dominated very tall open forest because the understorey vegetation was characterised by up to 35% cover in plots of grasses such as Warrego grass (*Paspaladium jubiflorum*) and Curly windmill grass (*Enteropogon ramosus*) along with occasional shrubs, forbs and sedges. PCT 2 is present in the broader study area in areas with more frequent inundation by floodwaters, as indicated by the presence of understory vegetation characterised by dense beds of sedges such as Cumbungi (*Typha orientalis*).

Floodplain woodland

PCT 10 – River Red Gum - Black Box woodland wetland was confirmed as occurring on the higher, steeper banked side of the Billabong Creek riparian corridor, in the Forest Creek riparian corridor and mid-level positions across the floodplain where drainage is impeded, and flooding would occur moderately frequently. These areas feature woodland or open forest, with canopy tree cover around 30%, 10 to 20 metres in height, co-dominated by River Red Gum (*Eucalyptus camaldulensis*) and Black Box (*E. largiflorens*).

PCT 13 – Black Box - Lignum woodland wetland was confirmed as occurring at mid elevations on the Billabong Creek floodplain and minor drainage channels with infrequent inundation by floodwater as well as depressions where drainage is impeded. These areas feature woodland, with canopy tree cover of 10-30%, generally less than 10 metres tall, and almost entirely dominated by Black Box.

The distribution of candidate woodland PCTs closely matched the SVTM (DPE 2022a) and characteristic mid storey and groundcover species recorded in plots were a good fit for descriptions included in the BioNet VIS (NSW DPE 2023a) and so no alternative PCTs were considered.

Floodplain shrubland

PCT 160 - Nitre Goosefoot shrubland wetland was confirmed as occurring in treeless floodplain depressions at Wanganella. These areas feature tall shrubland structure, with around 20% cover of Nitre Goosefoot (*Chenopodium nitraiaceum*) 1-2 metres in height, and a moderate species richness, but low cover of other chenopod species. Plot 2 sampled in PCT 160 also featured around 20% cover of Curly Windmill Grass (*Enteropogon acicularis*) however could be readily separated from floodplain grassland PCTs by the high shrub cover. Other candidate floodplain shrubland PCTs were discounted as follows:

– PCT 163 – Dillon Bush (Nitre Bush) shrubland because of the low cover of Dillon Bush (*Nitraria billardierei*) compared to Nitre Goosefoot.
– PCT 164 – Cotton Bush open shrubland of the semi-arid (warm) zone because of the low cover of Cotton Bush (*Maireana aphylla)* compared to Nitre Goosefoot and because this PCT is lower and more open than the shrubland in the proposal footprint.
– PCT 216 – Black Roly Poly low open shrubland because of the low cover of *Sclerolaena* species compared to Nitre Goosefoot and because this PCT is lower and more open than the shrubland in the proposal footprint.

Each of these alternative PCTs 163, 164 and 216 were confirmed as present in the broader study area, and approximately matching their mapped extent in the SVTM (DPE 2022a), based on general observations of structure and species composition.

Floodplain grassland

Native, floodplain grassland areas were separated from candidate chenopod shrubland PCTs by the high native grass cover (around 50-90% cover in plots sampled) relative to shrub cover (<5% in all plots sampled).

PCT 46 – Curly Windmill Grass - speargrass - wallaby grass grassland was confirmed as occurring across the majority of the treeless parts of the study area including mid to outer portions of the Billabong Creek floodplain and areas adjoining minor drainage lines and depressions with less frequent inundation by floodwaters. PCT 46 was identified based on:

– the relatively high cover of Curly Windmill Grass (*Enteropogon acicularis*) (around 30-80% cover in the plots sampled) along with other characteristic grasses such as Speargrass (*Austrostipa scabra*) and *Walwhalleya proluta*)
– lower cover of Windmill grass (*Chloris truncata*) and Small-flower Wallaby Grass (*Rytidosperma setaceum*) (less than 5% cover in plots sampled)
– low forb cover (maximum 2.9% in plots, typically less than 1% cover).

PCT 44 – Forb-rich Speargrass - Windmill Grass - White Top grassland was mapped across limited parts of the outer portions of the Billabong Creek and Forest Creek floodplains. PCT 44 was identified based on:

– the relatively high cover of Windmill grass (*Chloris truncata*) and Small-flower Wallaby Grass (*Rytidosperma setaceum*) (over 15% total cover in plots) relative to Curly Windmill Grass (*Enteropogon acicularis*) (<8% cover in the plots) along with other characteristic grasses such as Speargrass (*Austrostipa scabra*) and *Walwhalleya proluta*
– higher forb cover (2.2-5% cover in plots) including the diagnostic species Rough Burr-daisy (*Calotis scabiosifolia*), Caustic weed (*Euphorbia drummondii*), Hoary Sunray (*Leucochrysum molle*) and Yellow Buttons (*Chrysocephalum apiculatum*).

Additional treeless areas were mapped as a derived native grassland (DNG) form of PCT 13 – Black Box - Lignum woodland wetland rather than either of the naturally occurring grassland PCTs described above. Areas of PCT 13_DNG were identified based on:

– generally lower groundcover, characterised by high cover of chenopod shrubs (around 5% to 22% cover in plots) relative to grass cover (generally <5% cover in plots)
– in areas with high total groundcover and high grass cover, higher chenopod shrub cover than would be expected in a natural grassland (around 7-22% cover in plots)
– presence of isolated remnant or juvenile Black Box in plots or in adjoining areas with equivalent elevation and distance from waterbodies
– presence of moderate condition, treed patches of PCT 13 – Black Box - Lignum woodland wetland in adjoining areas with equivalent elevation and distance from waterbodies.

Historical aerial imagery was also reviewed to assist with mapping the extent of naturally occurring floodplain grasslands versus DNG. The earliest aerial imagery available was from 1970 at Hartwood and 1971 at Wanganella and revealed an equivalent extent of treed vegetation versus grassland or low shrubland as the current extent (NSW Government 2023) and so could not provide additional information to the factors considered above.

4.3 Vegetation zones

4.3.1 Overview

PCTs identified within the study area during field surveys were further split into broad condition classes resulting in the vegetation zones as shown in Figure 4.1 and Figure 4.2 and summarised in Table 4.4. Vegetation zones were mapped and sampled separately at the Hartwood and Wanganella parts of the proposal footprint to support a separate BAM-C case for each regulator site. The structure, species composition and condition of the vegetation zones within the study area are described below. All references to condition are relative to version 1.2 'wet year' benchmark data. Plant species lists are provided in Appendix C and plot data are provided in Appendix D along with benchmark values for each PCT.

Table 4.3 Vegetation zones and other map units in the proposal footprint

Zone ID	Vegetation zone	PCT	Vegetation class	Condition	Area	VI plots required	VI plots sampled	Patch size class	PCT percentage cleared	Vegetation integrity score
Hartwood										
1	7_Moderate	7 – River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion	Inland Riverine Forests	Moderate	0.84	1	F8	>100 ha	15	82.7
2	10_Moderate	10 – River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Riverine Forests	Moderate	0.47	1	9, JR_13	>100 ha	43	74.3
3	10_Shrubland	10 – River Red Gum – Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Riverine Forests	Shrubland	0.28	1	JR_12	>100 ha	43	43.8
4	13_DNG	13 – Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Riverine Forests	DNG	1.87	1	JR_1. JR_2, JR_7, JR_9, 12	>100 ha	57	27.3

Zone ID	Vegetation zone	PCT	Vegetation class	Condition	Area	VI plots required	VI plots sampled	Patch size class	PCT percentage cleared	Vegetation integrity score
5	13_Moderate	13 – Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Riverine Forests	Moderate	2.39	2	F14, F15	>100 ha	57	64.6
6	44_Moderate	44 – Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion	Riverine Plain Grasslands	Moderate	0.32	1	K1, 10	>100 ha	73	75.9
7	46_Moderate	46 – Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	Riverine Plain Grasslands	Moderate	4.31	2	J8, F16, 11	>100 ha	20	85.4
8	46_Poor	46 – Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	Riverine Plain Grasslands	Poor	0.48	1	JR_8	>100 ha	20	44.4
		Other map units								
		Water body	n/a	Non-native	0.53	n/a	n/a	n/a	n/a	n/a
		Non-native vegetation	n/a	Non-native	3.50	n/a	JR_10, JR_11, JR_14	n/a	n/a	n/a*

Zone ID	Vegetation zone	PCT	Vegetation class	Condition	Area	VI plots required	VI plots sampled	Patch size class	PCT percentage cleared	Vegetation integrity score
Wanganella										
1	7_Moderate	7 – River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion	Inland Riverine Forests	Moderate	0.61	1	F8	>100 ha	15	47.6
2	10_Moderate	10 – River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Riverine Forests	Moderate	0.93	2	F6, JR_5	>100 ha	43	52.7
3	13_Moderate	13 – Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Riverine Forests	Moderate	0.79	2	F7, JR_6	>100 ha	57	87.6
4	13_DNG	13 – Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Riverine Forests	DNG	0.89	1	JR_3, JR_4	>100 ha	57	11.5

Zone ID	Vegetation zone	PCT	Vegetation class	Condition	Area	VI plots required	VI plots sampled	Patch size class	PCT percentage cleared	Vegetation integrity score
5	46_Moderate	46 – Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	Riverine Plain Grasslands	Moderate	1.89	2	F5, 3	>100 ha	20	89.1
6	160_Moderate	160 – Nitre Goosefoot shrubland wetland on clays of the inland floodplains	Inland Floodplain Shrublands	Moderate	0.19	1	2	>100 ha	28	97.3
		Other map units								
		Water body	n/a	Non-native	0.29	n/a		n/a	n/a	
		Non-native vegetation	n/a	Non-native	0.66	n/a		n/a	n/a	n/a

Notes: DNG – derived native grassland, meaning a vegetation zone that features a grassland structure derived from the clearing of trees in an area that would have contained woodland or forest.

* Refer to Table 4.1 for non-native vegetation description and vegetation integrity scores.

4.3.2 Vegetation integrity (vegetation condition)

Vegetation integrity (VI) scores calculated for the vegetation zones in the proposal footprint are presented in Table 4.4 below.

Table 4.4 Vegetation integrity scores

Zone ID	Vegetation zone	Composition condition score	Structure condition score	Function condition score (where relevant)[1]	Vegetation integrity score	Hollow bearing trees present?
Hartwood						
1	7_Moderate	72.3	81.3	96.3	82.7	Yes
2	10_Moderate	92.5	45.2	97.9	74.3	Yes
3	10_Shrubland	60	67.8	20.6	43.8	No
4	13_DNG	37.4	43	12.7	27.3	No
5	13_Moderate	73.9	44.6	81.9	64.6	Yes
6	44_Moderate	87.4	65.8	n/a	75.9	n/a
7	46_Moderate	85.4	83.4	n/a	85.4	n/a
8	46_Poor	23	85.7	n/a	44.4	n/a
n/a	Non-native (PCT 10_exotic for VI estimation purposes)	0	0	1.5	0.1	No
n/a	Non-native (PCT 13_exotic for VI estimation purposes)	39.8	12.8	0.3	5	No
Wanganella						
1	7_Moderate	62.1	27.2	63.8	47.6	Yes
2	10_Moderate	80.9	30.3	59.5	52.7	Yes [2]
3	13_DNG	78.3	63.3	0.3	11.5	No
4	13_Moderate	78.4	100	85.7	87.6	Yes
5	46_Moderate	92.2	86.0	n/a	89.1	n/a
6	160_Moderate	94.7	100	n/a	97.3	n/a

Notes: 1. Function score is not calculated for PCTs 44 and 46 in the Riverine Plain Grasslands vegetation formation and PCT 160 in the Inland Floodplain Shrublands vegetation formation (DPE 2023a).
2. No hollow-bearing trees were recorded in the plots sampled however hollow-bearing trees are present in the broader vegetation zone and so a hollow bearing tree record was added to plots F8 and F6 to ensure that Wanganella Zone 1 (PCT 7_moderate) and Zone 2 (PCT 10_Moderate credits were recognised as containing hollow bearing trees.

4.3.3 Vegetation zone descriptions

Table 4.5 Hartwood vegetation zone descriptions

Zone 1 – PCT 7 River Red Gum - Warrego Grass – - herbaceous riparian tall open forest wetland - moderate condition (7_Moderate)	
Plant community type	River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
PCT ID	7
Photos	
Survey effort	Plot 1
Conservation significance	Native vegetation, not a TEC.
Patch size	101 ha
Condition	Moderate – Tree and shrub composition was above or met the benchmark. – Forb and grass composition was well below the benchmark. – Tree and shrub cover was above the benchmark. – Grass and forb cover was variable, generally below the benchmark. – No ferns where recorded which is typical of this PCT – Up to 3 m of fallen logs where present, below the benchmark – Leaf litter cover was high. – A small amount of high threat exotic (HTE) cover was recorded in plots. – Hollow-bearing trees (HBTs) present including up to three per plot. – All tree stem classes present.
Current vegetation integrity score	82.7
Landscape position	Occurs on the lower, shallow-banked side of the Billabong Creek riparian corridor and lower-level positions across the floodplain subject to relatively frequent inundation by floodwaters.
Structure	Tall open forest dominated by River Red Gum (*Eucalyptus camaldulensis*) with scattered small trees and a mixed understory of native and exotic species.
Over-storey	River Red Gum (*Eucalyptus camaldulensis*)
Mid-storey	Generally absent with occasional River Cooba (*Acacia stenophylla*) and Cooba (*Acacia salicina*)

Groundcover	Grasses: high cover of Warrego Grass (*Paspaladium jubiflorum*), Curly Windmill Grass (*Enteropogon ramosus*), Fairy Grass (*Sporobolus caroli*), Alpine Grass (*Rytidosperma spp.).* The aquatic fern Common Nardoo (*Marsilea drummondii*). Herbs: sparse cover of Grassland Wood-sorrel (*Oxalis perennans*), Swamp Dock (*Rumex brownii*), Climbing Saltbush (*Einadia nutans*), Caustic Weed (*Chamaesyce drummondii*).
Exotic species	Patchy, generally low cover of Barley Grass (*Hordeum leporinum*), White Horehound (*Marrubium vulgare*), Spear Thistle (*Cirsium vulgare*), Variable Sida (*Sida corrugate),* Gooseberry Cucumber (*Cucumis myriocarpus subsp*). Leptodermis, Black-berry Nightshade (*Solanum nigrum*).
Zone 2 – River Red Gum - Black Box woodland wetland – moderate condition (10_moderate)	
Plant community type	River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
PCT ID	10
Photos	
Survey effort	Plot 9, JR_13
Conservation significance	Native vegetation, not a TEC.
Patch size	101 ha
Condition	Moderate – Tree and shrub composition was above or met the benchmark. – Forb and grass composition was well below benchmark. – Tree and shrub structure was above benchmark levels. – Grass and forb structure was significantly below benchmark levels. – No ferns where recorded which is typical of this PCT. – Liter cover was highly variable between plots and below the benchmark. – Sparse fallen log cover, well below benchmark. – HTE weed cover of 25% in the plot sampled and moderate cover throughout the zone. – Most tree stem classes present. – Abundant HBTs, including five recorded in the plot.
Current vegetation integrity score	74.3

Landscape position	Occurs on the higher, steeper banked side of the Billabong Creek riparian corridor, in the Forest Creek riparian corridor and mid-level positions across the floodplain where drainage is impeded and flooding would occur moderately frequently.
Structure	Woodland wetland dominated by River Red Gum (*Eucalyptus camaldulensis*) and Black Box (*Eucalyptus largiflorens*) with a sparse mid storey of small trees and shrubs and native and exotic understory.
Over-storey	River Red Gum, Black box
Mid-storey	River Cooba (*Acacia stenophylla*), Cooba (*Acacia salicina*)
Groundcover	Grasses: patchy cover of Curly Windmill Grass (*Enteropogon acicularis*), Warrego Grass (*Paspaladium jubiflorum*), Rats-tail Couch (*Sporobolus mitchellii*). Shrubs: irregular cover of Nitre Bush (*Chenopodium nitrariaceum*), Thorny Saltbush (*Rhagodia spinescens*), Black Roly-poly (*Sclerolaena muricata*), Ruby Saltbush (*Enchylaena tomentosa*), Creeping Saltbush (*Atriplex semibaccata*).Herbs: moderate species richness but low cover of Climbing Saltbush (*Einadia nutans*), Tarvine (*Boerhavia domini*), Tufted Burr-daisy *(Calotis scapigera*), *Dysphania pumilio*, *Oxalis perennans*, Swamp Dock (*Rumex brownii*), High Sida (*Sida trichopoda*), Grey Raspweed (*Haloragis glauca*), Caustic Weed (*Chamaesyce drummondii*).
Exotic species	Locally severe infestations of the HTE Carpet Weed (*Phyla canescens*). Occasional Paddy Melon (*Cucumis myriocarpus subsp. leptodermis*), Potato Weed (*Heliotropium europaeum*), White Horehound (*Marrubium vulgare*), Common Sowthistle (*Sonchus oleraceus*), Small-flowered Mallow (*Malva parviflora*), Wireweed (*Polygonum aviculare*) and Bathurst Burr (*Xanthium spinosum*).
Zone 3 – River Red Gum - Black Box woodland wetland – moderate condition (10_Shrubland)	
Plant community type	River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
PCT ID	10
Photos	
Survey effort	JR_12
Conservation significance	Native vegetation, not a TEC.
Patch size	101 ha
Condition	A shrubland resulting from previous clearing of woodland for the construction of the existing transmission line. – Shrub composition just below the benchmark. – Grass composition above benchmark. – Very sparse tree cover was recorded, which is typical of a Shrubland. – Tree, forb and grass structure was well below benchmark. – Shrub and fern structure was well above benchmark. – 23 m fallen logs recorded which is below benchmark. – No large mature trees present. – Leaf litter was below benchmark.

Current vegetation integrity score	43.8
Landscape position	In the Forest Creek riparian corridor where the original woodland was cleared for a transmission line.
Structure	Native grassland derived from clearing of River Red Gum - Black box woodland wetland with locally dense chenopod shrub layer and a mixed understory of native and exotic species. Certain areas were dominated by cover of exotic annual grasses, but this would be likely to vary with season and/or rainfall in recent months.
Over-storey	Very sparse, Black box (*Eucalyptus largiflorens*) seedlings
Mid-storey	Moderate cover of Nitre Goosefoot (*Chenopodium nitrariaceum*)
Groundcover	Grasses: Dominated by Warrego Grass (*Paspalidium jubiflorum*) with small patches of Speargrass (*Austrostipa scabra*), Wheatgrass (*Anthosachne scabra*) Small-flower Wallaby Grass (*Rytidosperma setaceum*) and *Juncus amabilis*. Shrubs: patchy, with occasional very high cover of Black Roly-poly (*Sclerolaena muricata*). Ferns: Sparse but constant cover of aquatic fern Common Nardoo (*Marsilea drummondii*). Herbs: Low cover of Climbing Saltbush (*Einadia nutans*), *Goodenia fascicularis* and Lesser Joyweed (*Alternanthera denticulata*).
Exotic species	Moderate cover of HTE Lippia (*Phyla canescens*) with patches of *Conyza bonariensis*, *Echium plantagineum* and Perennial Rye Grass (*lolium perenne*).
Zone 4 – PCT 13 Black box - Lignum woodland wetland – derived native grassland (DNG) condition (13_DNG)	
Plant community type	Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
PCT ID	13
Photo	
Survey effort	JR_1, JR_2, JR_7, JR_9, Plot 12
Conservation significance	Native vegetation, not a TEC
Patch size	101 ha

Condition	DNG – derived native grassland, meaning a vegetation zone that features a grassland structure derived from the clearing of trees in an area that would have contained woodland. – Tree, shrub and forb composition is well below benchmark, as typical of a DNG. – Grass composition was mostly below benchmark with one plot higher than average. – Fern composition was at or above benchmark. – Very sparse tree cover was recorded, which is typical of a DNG. – Tree and forb structure was well below benchmark. – Shrub and grass structure was highly variable, generally falling above benchmark. – Fern structure was above benchmark. – No fallen logs recorded. – No large mature trees present. – Leaf litter was variable, generally under benchmark.
Current vegetation integrity score	27.3
Landscape position	Mid elevations on the Billabong Creek floodplain, outer floodplains and minor drainage channels with infrequent inundation by floodwater as well as depressions where drainage is impeded and the original Black box woodland was cleared.
Structure	Native grassland derived from clearing of Black box woodland wetland with locally dense chenopod shrub layer and a mixed understory of native and exotic species. Certain areas were dominated by cover of exotic annual grasses, but this would be likely to vary with season and/or rainfall in recent months.
Over-storey	Very sparse, sub mature Black Box (*Eucalyptus largiflorens*)
Mid-storey	Generally absent. Occasional patches of Lignum (*Duma florulenta*) and Nitre Goosefoot (*Chenopodium nitrariaceum*).
Groundcover	Grasses: patchy cover of Hairy Panic (*panicum effusum*), Windmill Grass (*Chloris truncata*), Common Spike-rush (*Eleocharis acuta*), Rigid Panic (*Walwhalleya proluta*), Tufted Rush (*Juncus flavidus*). Small-flowered Wallaby Grass (*Rytidosperma setaceum*). Shrubs: patchy, with occasional very high cover of Black Roly-poly (*Sclerolaena muricata*), Cotton Bush (*Maireana sp*), Tangled Copperburr (*Sclerolaena divaricate*) and Creeping Saltbush (*Atriplex semibaccata*). Herbs: moderate species richness but low cover of Small White Sunray (*Rhodanthe corymbiflora*), Yellow Wood-sorrel (*Oxalis perennans*), Caustic Weed (*Euphorbia drummondii*), Fuzzweed (*Vittadinia cuneata*), Spreading Sneezeweed (*Centipeda minima subsp. minima*), Lesser Joyweed (*Alternanthera denticulata*). Ferns: occasional Common Nardoo (*Marsilea drummondii*).
Exotic species	Locally very high cover of annual grasses such as Perennial Ryegrass (*Lolium perenne*) and the HTE Carpet Weed (*Phyla nodiflora*). Moderate cover of other environmental weeds such as Thread Iris (*Moraea setifolia*) *Medicago sp.,* Common Storksbill (*Erodium citutarium*), Vipers Bugloss (*Echium vulgare*), Wild Oats (*Avena fatua*), Prickly Sowthistle (*Sonchus asper*), Paradoxa Grass (*Phalaris paradoxa*), Paddy Melon (*Cucumis myriocarpus subsp. leptodermis*) Barley Grass (*Hordeum leporinum*), Pattersons Curse (*Echium plantagineum*), Great Brome (*Bromus diandrus*), Bathurst Burr (*Xanthium spinosum*).

Zone 5 – Black Box - Lignum woodland wetland – moderate condition (13_moderate)	
Plant community type	Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion).
PCT ID	13
Photo	
Survey effort	F14, F15
Conservation significance	Native vegetation, not a TEC
Condition	Moderate – Tree composition was at or just below the benchmark. – Grass composition was at or above the benchmark. – Forb and Shrub composition was well below benchmark. – Tree, shrub and forb structure was variable and all below benchmark. – Grass structure was well above the benchmark. – Leaf litter was variable and on average above benchmark. – Fallen logs where present throughout and above the benchmark. – Large trees where above benchmark levels. – Hollows present in large trees.
Current vegetation integrity score	64.6
Landscape position	Mid elevations on the Billabong Creek floodplain and minor drainage channels with infrequent inundation by floodwater as well as depressions where drainage is impeded.
Structure	Black Box woodland wetland with a sparse chenopod shrub layer characterised by Black Box (*Eucalyptus largiflorens*) overstory with occasional Lignum (*Duma florulenta*) in the mid storey and a mixed native and exotic understory. Certain areas were dominated by cover of exotic annual grasses, but this would be likely to vary with season and/or rainfall in recent months.
Over storey	Dominated by Black Box (*Eucalyptus largiflorens*).
Mid storey	Occasional Lignum (*Duma florulenta*) and River Cooba (*Acacia stenophylla*).

Groundcover	Grasses: moderate cover and species richness including Warrego Grass (*Paspaladium jubiflorum*), Small Flowered Wallaby Grass (*Rytidosperma setaceum*), Spear Grass (*Austrostipa scabra*), Fairy Grass (*Sporobolus caroli*), Curly Windmill Grass (*Enteropogon ramosus*). Shrubs: generally sparse cover, dominated by chenopods such as Nitre Bush (*Chenopodium nitrariaceum*), Ruby Saltbush (*Enchylaena tomentosa*), Thorny Saltbush (*Rhagodia spinescens*) with Black Roly-poly (*Sclerolaena muricata*), Cotton Bush (*Maireana aphylla*), Tangled Copperburr (*Sclerolaena divaricata*), Creeping Saltbush (*Atriplex semibaccata*). Herbs: Sparse cover of Climbing Saltbush (*Einadia nutans*), Tufted Burr-daisy (*Calotis scapigera*), Tarvine (*Boerhavia domini*).
Exotic species	Locally high cover of annual grasses such as Wild Oats (*Avena fatua*), Barley Grass (*Hordeum leporinum*), Great Brome (*Bromus diandrus*) and Ryegrass (*Lolium* spp.). Occasional herbs such as White Horehound (*Marrubium vulgare*) and *Lepidium* spp,
Zone 6 – Forb-rich Speargrass – Windmill Grass – Moderate condition (44_Moderate)	
Plant community type	Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
PCT ID	44
Photo	
Survey effort	10, K1
Conservation significance	Native vegetation, not a TEC PCT 44 is associated with the Natural Grasslands of the Murray Valley Plains CEEC listed under the EPBC Act (NSW DCCEEW 2024). An assessment of the plot data for vegetation zone 6 against the Natural Grasslands of the Murray Valley Plains diagnostic characteristics and condition thresholds (TSSC 2012) confirmed that the native grassland at the proposal footprint does not meet the species composition and condition criteria for the CEEC (see section 4.4 and Appendix B, section B-2).
Patch size	101 ha
Condition	Moderate – Tree and shrub composition was at or above benchmark levels. – Grass composition was variable between plots. – Forb composition was below benchmark level. – Shrub cover was variable between plots. – Grass and forb cover where well below benchmark levels. – No large trees present. – No fallen logs present. – Litter cover was below benchmark levels.
Current vegetation integrity score	75.9

Landscape position	Mid to outer floodplain, minor drainage lines and depressions with less frequent inundation by floodwaters.
Structure	Native grassland. Certain areas were dominated by cover of exotic annual grasses, but this would be likely to vary with season and/or rainfall in recent months.
Over-storey	Absent
Mid-storey	Absent
Groundcover	Grasses: high cover of Small-flowered Wallaby Grass (*Rytidosperma setaceum*), Coolah Grass (*Walwhalleya proluta),* Fairy Grass (*Sporobolus caroli*) with a sparse cover of Rough Spear Grass (*Austrostipa scabra*), Windmill Grass (*Chloris truncata*) and Curly Windmill Grass (*Enteropogon acicularis*). Herbs: dominated by Rufous Stonecrop (*Crassula decumbens*), Crassula (*Crassula tetramera*), Small-flower Goodenia (*Goodenia pusilliflora*), Hoary Sunray (*Leucochrysum molle*) with a sparse cover of Rough Burr-daisy (*Calotis scabiosifolia*), Caustic Weed (*Euphorbia drummondii*), Yellow Buttons (*Chrysocephalum apiculatum*), Ferny Cotula (*Cotula bipinnata).* Shrubs: patchy shrub cover including Black Roly-poly (*Sclerolaena muricata var muria*), Soft Roly-poly (*Salsola australis*), Prickly Russian Thistle (*Salsola tragus*) and Bluebush (*Maireana spp.*).
Exotic species	Locally high cover of *Lolium* sp.*,* Barrel Medic *(Medicago truncatula), Aria* sp. Moderate to low cover of other weeds Burr Medic (*Medicago polymorpha*) *Romulea sp.,* Common Sowthistle *(Sonchus oleraceus).*
Zone 7 – Curly windmill grass – wallaby grass grassland - Moderate condition (46_moderate)	
Plant community type	46
PCT ID	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Photo	
Survey effort	F16, 11, J8
Conservation significance	PCT 46 may form part of the CEEC listed under the EPBC Act as Natural Grasslands of the Murray Valley Plains. The PCT 46 in moderate condition in the proposal footprint does not comprise part of the community (see section 4.4 and Appendix B, section B-2).
Patch size	101 ha

Condition	Moderate – Tree and shrub composition was above benchmark levels. – Grass composition was variable between plots. – Forb composition was below benchmark level. – Shrub and forb cover was well below benchmark levels. – Grass cover was generally at benchmark with the exception of one plot. – No large trees present. – No fallen logs present. – No litter cover in two of the three plots.
Current vegetation integrity score	85.4
Landscape position	Mid to outer floodplain, minor drainage lines and depressions with less frequent inundation by floodwaters.
Structure	Native grassland. Certain areas were dominated by cover of exotic annual grasses, but this would be likely to vary with season and/or rainfall in recent months.
Over-storey	Absent
Mid-storey	Absent
Groundcover	Grasses: dominated by a high cover of Curly Windmill Grass (*Enteropogon acicularis*), Windmill Grass (*Chloris truncata*), Native Millet (*Panicum decompositum*) and a sparse cover of Speargrass (*Austrostipa scabra*), Fairy Grass (*Sporobolus caroli*), Small-flower wallaby Grass (*Rytidosperma setaceum*), Redleg Grass (*Bothriochloa macra*) and *Walwhalleya proluta.* Herbs: very sparse cover of Caustic Weed (*Euphorbia drummondii*), Wooly Buttons (*Leiocarpa panaetioides*), Hairy Sida (*Sida trichopoda*), Quena (*Solanum esuriale*) and Fuzzweed (*Vittadinia cuneata*). Shrubs: sporadic cover includes Cotton Bush (*Maireana aphylla*), Black Roly-poly (*Sclerolaena muricata*), Copperburr (*Maireana sclerolaenoides*), Thorny Saltbush (*Rhagodia spinescens*) and Black Cotton Bush (*Maireana decalvans*).
Exotic species	Low cover of Subterranean Clover (*Trifolium subterraneum*), White Clover (*Trifolium repens*), Perennial Ryegrass (*Lolium perenne*), Wimmera Ryegrass (*Lolium rigidum*), Winter Grass (*Poa annua*), *Romulea rosea* and Barley Grass (*Hordeum leporinum*)
Zone 8 – Curly windmill grass – wallaby grass grassland - Poor condition (46_poor)	
Plant community type	46
PCT ID	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Photo	

Survey effort	JR_8
Conservation significance	PCT 46 may form part of the CEEC listed under the EPBC Act as Natural Grasslands of the Murray Valley Plains. The PCT 46 in poor condition in the proposal footprint does not comprise part of the community (see section 4.4 and Appendix B, section B-2).
Patch size	101 ha
Condition	Poor – Tree and shrub composition was at or above benchmark levels. – Grass and forb composition was below benchmark levels. – No shrub cover present. – Grass cover at benchmark levels. – Forb cover well below benchmark levels. – No large trees present. – No fallen logs present. – Litter cover was below benchmark levels.
Current vegetation integrity score	44.4
Landscape position	Mid to outer floodplain, minor drainage lines and depressions with less frequent inundation by floodwaters.
Structure	Grassland. Extensive areas were dominated by cover of exotic annual grasses, environmental weeds and bare earth. This would be likely to vary with season and/or rainfall in recent months.
Over-storey	Absent
Mid-storey	Absent
Groundcover	Herbs: low cover of Yellow Wood-sorrel (*Oxalis perennans*), Caustic Weed (*Euphorbia drummondii*) and Jersey Cudweed (*Pseudognaphalium luteoalbum*). Grasses: dominant cover of Hairy Panic (*Panicum effusum*) with intermittent cover of Speargrass (*Austrostipa scabra*) and Windmill Grass (*Chloris truncata*).
Exotic species	Locally high cover of Wild oats (*Avena fatua*) and Perennial Ryegrass (*Lolium perenne*). Sparse cover of *Medicago sp*., Prickly Sowthistle (*Sonchus asper*) Yellow Cress (*Rorippa palustris*) and Barely Grass (*Hordeum leporinum*).

Table 4.6 Wanganella vegetation descriptions

Zone 1 – PCT 7 River Red Gum - Warrego Grass – - herbaceous riparian tall open forest wetland - moderate condition (7_Moderate)	
Plant community type	River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
PCT ID	7
Photos	
Survey effort	F8
Conservation significance	Native vegetation, not a TEC.
Patch size	101 ha
Condition	Moderate – Tree composition was above or met the benchmark. – Shrub and Grass composition was variable. – Forb composition below the benchmark. – Tree and shrub cover was above the benchmark. – Grass and forb cover was well below the benchmark. – Fern cover was above the benchmark. – Up to 1m of fallen logs where present, below the benchmark. – Leaf litter cover was highly variable. – Hollow-bearing trees (HBTs) present including up to seven per plot.
Current vegetation integrity score	47.6
Landscape position	Occurs on the lower, shallow-banked side of the Billabong Creek riparian corridor and lower-level positions across the floodplain subject to relatively frequent inundation by floodwaters.
Structure	Tall open forest dominated by River Red Gum (*Eucalyptus camaldulensis*) with scattered small trees and a mixed understory of native and exotic species.
Over-storey	River Red Gum (*Eucalyptus camaldulensis*) with low abundance of Black box (*Eucalyptus largiflorens*).
Mid-storey	Generally absent with occasional River Cooba (*Acacia stenophylla*) and Cooba (*Acacia salicina*).

Groundcover	Grasses: sparse cover of Windmill Grass (*Chloris truncata*) Red Grass (*Bothriochloa macra*) *Paspalidium distans*, Fairy Grass (*Sporobolus caroli*) and Curly Windmill Grass (*Enteropogon ramosus*). Shrubs: Ruby Saltbush (*Enchylaena tomentosa*), Spiny Saltbush (*Rhagodia spinescens*) Herbs: moderate cover of Climbing Saltbush (*Einadia nutans*) with Whiteroot (*Lobelia purpurascens*), Kidney Weed (*Dichondra repens*), Common Woodruff (*Asperula conferta*).
Exotic species	Patchy, generally low cover of White clover (*Trifolium repens*), Winter Grass (*Poa annua*), Prickly Lettuce (*Lactuca serriola*), Common Sowthistle (*Sonchus oleraceus*), Vervain (*Salvia verbenaca*) Black-berry Nightshade (*Solanum nigrum*).
Zone 2 – River Red Gum - Black Box woodland wetland – moderate condition (10_moderate)	
Plant community type	River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
PCT ID	10
Photos	
Survey effort	F6, JR_5
Conservation significance	Native vegetation, not a TEC.
Patch size	101 ha
Condition	Moderate – Tree and shrub composition was above or met the benchmark. – Forb and grass composition was well below benchmark. – Tree and shrub structure was above benchmark levels. – Grass and forb structure was variable and generally below benchmark levels. – No ferns where recorded which is typical of this PCT. – Liter cover was highly variable between plots and below the benchmark. – Sparse fallen log cover, well below benchmark. – HTE weed cover of 30% in the plot sampled. – All tree stem classes present. – No HBTs recorded.
Current vegetation integrity score	52.7

Landscape position	Occurs on the higher, steeper banked side of the Billabong Creek riparian corridor, in the Forest Creek riparian corridor and mid-level positions across the floodplain where drainage is impeded and flooding would occur moderately frequently.
Structure	Woodland wetland dominated by River Red Gum (*Eucalyptus camaldulensis*) and Black box (*Eucalyptus largiflorens*) with a sparse mid storey of small trees and shrubs and native and exotic understory.
Over-storey	River Red Gum (*Eucalyptus camaldulensis*), Black box (*Eucalyptus largiflorens*)
Mid-storey	Moderate cover of Cooba (*Acacia salicina*), sporadic cover of Lignum (*Duma florulenta*).
Groundcover	Grasses: low cover of *Austrostipa nodosa*, Smallflower Wallaby Grass (*Rytidosperma setaceum*), *Enteropogon acicularis*, Warrego Grass (*Paspalidium jubiflorum*), Speargrass (*Austrostipa scabra*). Shrubs: Patches of Black Roly-poly (*Sclerolaena muricata*), Thorny Saltbush (*Rhagodia spinescens*), and Climbing Saltbush (*Einadia nutans*). Herbs: abundant cover of *Centipeda minima* subsp*. minima*, Jersey Cudweed (*Pseudognaphalium luteoalbum*) with sparse *Oxalis perennans*, Pigweed (*Portulaca oleracea*), Forest Germander (*Teucrium racemosum*).
Exotic species	Locally severe infestations of the HTE Great Brome (*Bromus diandrus*). Occasional Trailing Verbena (*Verbena supina*), *Verbena africana*, *Medicago* sp., Wild Oats (*Avena fatua*), Barley Grass (*Hordeum leporinum*), Common Sowthistle (*Sonchus oleraceus*), Prickly Lettuce (*Lactuca serriola*) Wireweed (*Polygonum aviculare*).

Zone 3 – Black Box - Lignum woodland wetland – moderate condition (13_moderate)

Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

13



JR_6, F7

Native vegetation, not a TEC

Moderate

- Tree, shrub and grass composition was at or just below the benchmark.
- Forb composition was below the benchmark.
- Tree and shrub structure was well above benchmark.
- Grass and forb structure was variable and mostly above the benchmark
- Leaf litter was variable and on average above benchmark.
- Fallen logs where present throughout at variable levels, on average below the benchmark.

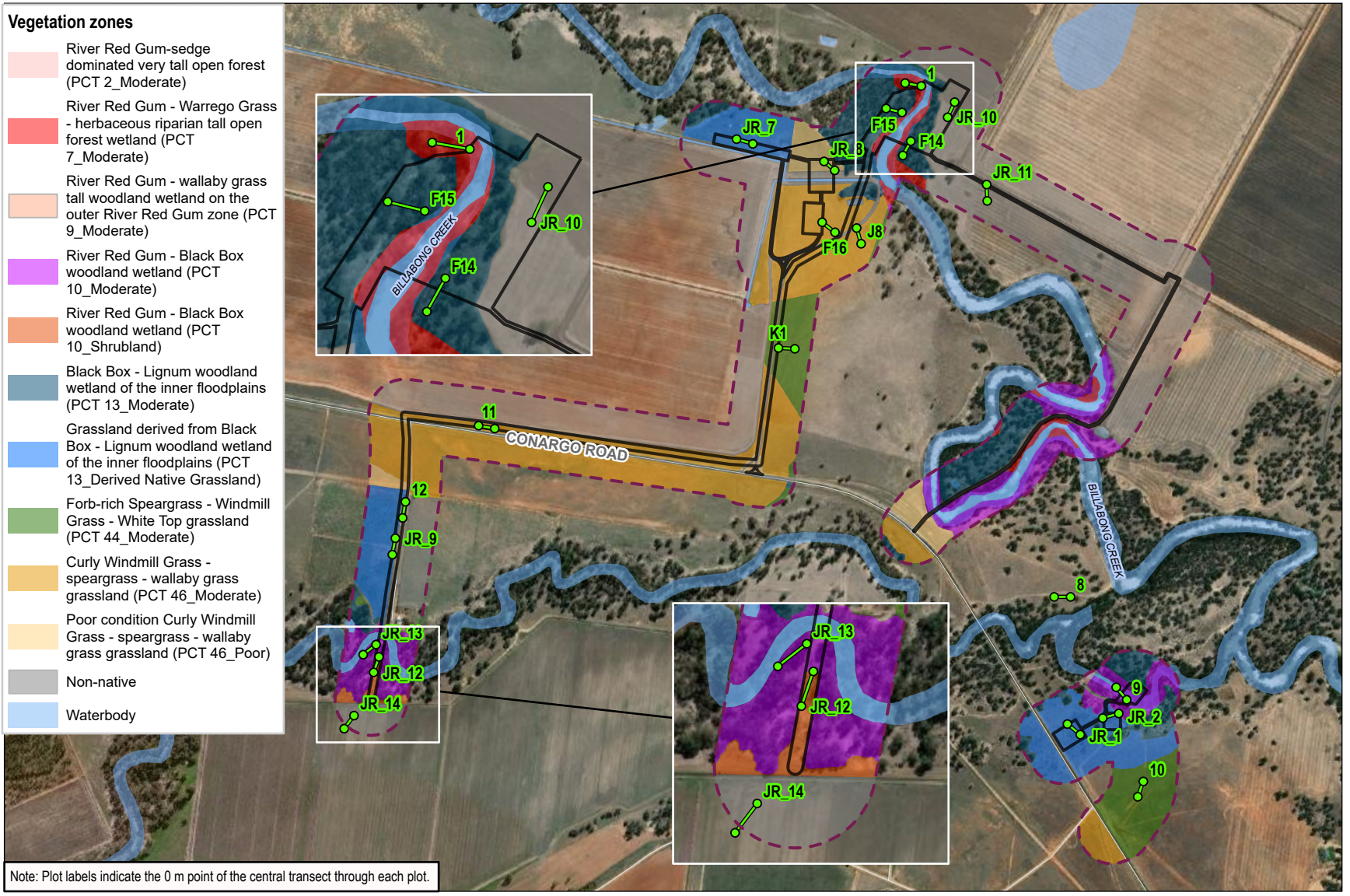
– Large trees where at or below the benchmark levels. – Hollows present in large trees.	
87.8	
Mid elevations on the Billabong Creek floodplain and minor drainage channels with infrequent inundation by floodwater as well as depressions where drainage is impeded.	
Black box woodland wetland with a sparse chenopod shrub layer characterised by Black Box (*Eucalyptus largiflorens*) overstory with occasional Lignum (*Duma florulenta*) in the mid storey and a mixed native and exotic understory. Certain areas were dominated by cover of exotic annual grasses, but this would be likely to vary with season and/or rainfall in recent months.	
Dominated by Black box (*Eucalyptus largiflorens*)	
Moderate cover of Nitre Goosefoot (*Chenopodium nitrariaceum*) and occasional Cooba (*Acacia salicina*).	
Grasses: Moderate cover and species richness of Warrego Grass (*Paspaladium jubiflorum*), Small Flowered Wallaby Grass (*Rytidosperma setaceum*), Speargrass (*Austrostipa scabra*), Fairy Grass (*Sporobolus caroli*), Curly Windmill Grass (*Enteropogon ramosus*). Shrubs: generally sparse cover, dominated by chenopods such as Nitre Bush (*Chenopodium nitrariaceum*), Ruby Saltbush (*Enchylaena tomentosa*), Thorny Saltbush (*Rhagodia spinescens*) with Black Roly-poly (*Sclerolaena muricata*), Cotton Bush (*Maireana aphylla*), Tangled Copperburr (*Sclerolaena divaricate*), Creeping Saltbush (*Atriplex semibaccata*). Herbs: Sparse cover of Climbing Saltbush (*Einadia nutans*), Tufted Burr-daisy (*Calotis scapigera*), , Tarvine (*Boerhavia domini*).	
Locally high cover of annual grasses such as Wild Oats (*Avena fatua*), Barley Grass (*Hordeum leporinum*), Great Brome (*Bromus diandrus*) and Ryegrass (*Lolium* spp.). Occasional herbs such as White Horehound (*Marrubium vulgare*) and *Lepidium spp*,	
Zone 4 – PCT 13 Black box - Lignum woodland wetland – derived native grassland (DNG) condition (13_DNG)	
Plant community type	Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
PCT ID	13
Photo	
Survey effort	JR_3, JR_4
Conservation significance	Native vegetation, not a TEC
Patch size	101 ha.

Condition	DNG – derived native grassland, meaning a vegetation zone that features a grassland structure derived from the clearing of trees in an area that would have contained woodland. – Tree and shrub composition is well below benchmark, as typical of a DNG. – Grass composition was above the benchmark. – Forb composition was variable at or below benchmark. – No tree cover was recorded, which is typical of a DNG. – Shrub cover was variable between plots. – Grass cover was well above benchmark. – Forb cover was below benchmark. – No fallen logs where recorded, as is typical of a DNG. – No large mature trees present. – Leaf litter was below benchmark.
Current vegetation integrity score	11.5
Landscape position	Mid elevations on the Billabong Creek floodplain and minor drainage channels with infrequent inundation by floodwater as well as depressions where drainage is impeded and the original Black box woodland was cleared.
Structure	Native grassland derived from clearing of Black box woodland wetland with locally dense chenopod shrub layer and a mixed understory of native and exotic species. Certain areas were dominated by cover of exotic annual grasses, but this would be likely to vary with season and/or rainfall in recent months.
Over-storey	Absent
Mid-storey	Absent
Groundcover	Grasses: High cover of *Austrostipa nodosa* with moderate patches of Lobed Wallaby Grass (*Rytidosperma auriculatum*), Windmill Grass (*Chloris truncate*). Low abundance of Ringed Wallaby Grass (*Rytidosperma caespitosum*), Small-flower Wallaby Grass (*Rytidosperma setaceum*) Shrubs: patchy, with occasional very high cover of Black Roly-poly (*Sclerolaena muricata*), Cotton Bush (*Maireana sp*) and low cover of Spiny Saltbush (rhagodia spinescens) Grey Copperburr (*Sclerolaena diacantha*) and Creeping Saltbush (*Atriplex semibaccata*). Herbs: Moderate species richness but low cover of *Crassula colorata*, *Oxalis perennans*, Pussytails (*Ptilotus spathulatus*), Drumsticks (*Craspedia globose*), Small White Sunray (*Rhodanthe corymbiflora*), *Rhodanthe diffusa* subsp*. leucactina*, Ridged Sida (*Sida cunninghamii*), Fuzzweed (*Vittadinia cuneata*), New Zealand Spinach (*Tetragonia tetragonioides*).
Exotic species	Moderate cover of Rat's Tail Fescue (*Vulpia myuros*), Red Brome (*Bromus rubens*) and low cover of other environmental weeds including Capeweed (*Arctotheca calendula*), Barley Grass (*Hordeum leporinum*), Perennial Ryegrass (*Lolium perenne*), *Medicago* sp., Thread Iris (*Moraea setifolia*).

Zone 5 – Curly windmill grass – wallaby grass grassland - Moderate condition (46_moderate)	
Plant community type	46
PCT ID	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Photo	
Survey effort	3, F5
Conservation significance	PCT 46 may form part of the CEEC listed under the EPBC Act as Natural Grasslands of the Murray Valley Plains. The PCT 46 in moderate condition in the proposal footprint does not comprise part of the community (see section 4.4 and Appendix B, section B-2).
Patch size	101 ha
Condition	Moderate – Shrub composition was above benchmark levels. – Grass composition was at or above benchmark between plots. – Forb composition was below benchmark level. – Shrub and forb cover was well below benchmark levels. – Grass cover was just below benchmark levels. – No large trees present. – No fallen logs present. – Leaf litter below benchmark levels.
Current vegetation integrity score	89.1
Landscape position	Mid to outer floodplain, minor drainage lines and depressions with less frequent inundation by floodwaters.
Structure	Native grassland. Certain areas were dominated by cover of exotic annual grasses, but this would be likely to vary with season and/or rainfall in recent months.
Over-storey	Absent
Mid-storey	Absent

Groundcover	Grasses: dominated by a high cover of Curly Windmill Grass (*Enteropogon acicularis*), Speargrass (Austrostipa scabra) and a sparse cover of Fairy Grass (*Sporobolus caroli*), Small-flower wallaby Grass (*Rytidosperma setaceum*), Redleg Grass (*Bothriochloa macra*) and *Walwhalleya proluta, Juncus flavidus,* Early Spring Grass (*Eriochloa pseudoacrotricha*), Striate Spike-sedge (*Eleocharis obicis*) and Windmill Grass (*Chloris truncata*). Herbs: very sparse cover of Hairy Sida (*Sida trichopoda*), Quena (*Solanum esuriale*), Fuzzweed (*Vittadinia cuneata*), Corrugated Sida (Sida corrugate), *Oxalis perennans*, Caustic Weed (*Chamaesyce drummondii*), Tarvine (*Boerhavia domini*), Hairy Sida (*Sida trichopoda*) and *Goodenia glauca*. Shrubs: sporadic cover includes Cotton Bush (*Maireana aphylla*), Black Cotton Bush (*Maireana decalvans*), Black Roly-poly (*Sclerolaena muricata*), Ruby Saltbush (*Enchylaena tomentosa*), Thorny Saltbush (*Rhagodia spinescens*), Creeping Saltbush (*Atriplex semibaccata*), *Salsola australis* and Tangled Copperburr *(Sclerolaena divaricate).*
Exotic species	Moderate cover of Barley Grass (*Hordeum leporinum*) and low cover of Wimmera Ryegrass (*Lolium rigidum*), Onion Grass (*Romulea rosea var. australis*), Wireweed (*Polygonum aviculare*), Potato Weed (*Heliotropium europaeum*), Spear Thistle (*Cirsium vulgare*), Wild Oats (*Avena fatua*), Common Sowthistle (*Sonchus oleraceus*), Prickly Sowthistle (*Sonchus asper*), Woolly Burr Medic (*Medicago minima*) and Paddy Melon (*Cucumis myriocarpus*).
Zone 6 – Nitre Goosefoot shrubland wetland - Moderate condition (160_moderate)	
Plant community type (DPIE 2021c)	Nitre Goosefoot shrubland wetland on clays of the inland floodplains
PCT ID	160
Photo	
Survey effort	Plot 2
Conservation significance	Native vegetation, not a TEC
Patch size	0.18
Condition	Moderate – Tree, Shrub, Grass and Forb composition all well above benchmark. – Fern composition was below benchmark. – Tree, Shrub, Grass and Forb structure all above benchmark. – Leaf litter was just below benchmark. – Fallen logs where not present. – No trees where present which is common for the pct.

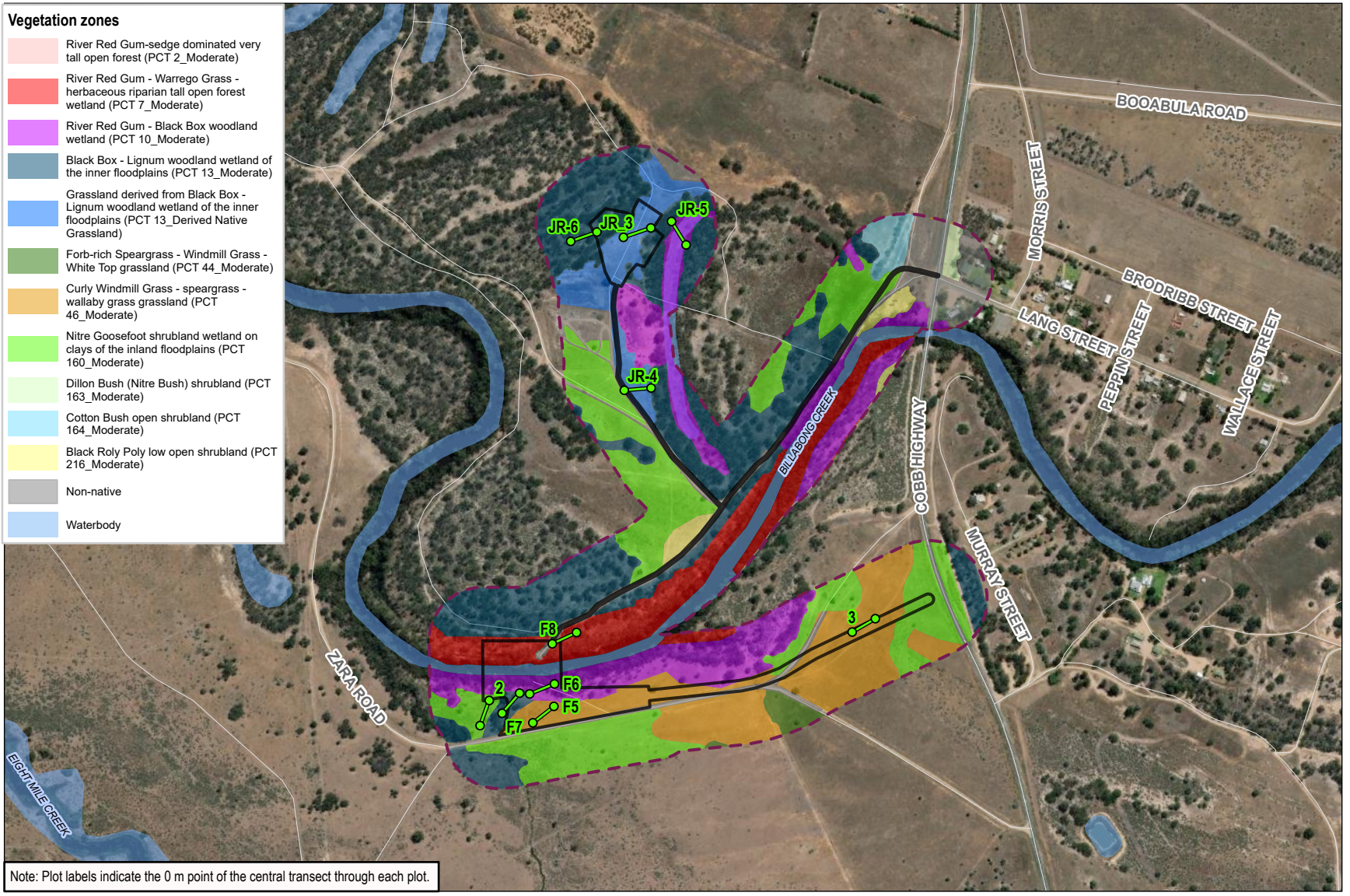
Current vegetation integrity score	97.3
Landscape position	Mid to outer floodplain, minor drainage lines and depressions with less frequent inundation by floodwaters.
Structure	Inland floodplain Shrublands characterised by an abundance of shrubs, dominated by Nitre Bush (*Chenopodium nitrariaceum*). High cover of native species with small patches of exotics present.
Over-storey	Absent
Mid-storey	Light abundance of Cooba (*Acacia salicina*)
Groundcover	Shrubs: Characterised by significant abundance of Nitre Bush (*Chenopodium nitrariaceum*) and generally dominated by Ruby Saltbush (*Enchylaena tomentosa*), Black Roly-poly (*Sclerolaena muricata*). Grasses: Dominated by Curly Windmill Grass (*Enteropogon acicularis*) with patches of Rough Spear Grass (*Austrostipa scabra*), Windmill Grass (*Chloris truncate*) and Rigid Panic (*Walwhalleya proluta).* Herbs: moderate cover of Tarvine (*Boerhavia domini*) and Quena (*Solanum esuriale*) with sparse cover of *Goodenia glauca*, *Oxalis perennans*, Hairy Sida (*Sida trichopoda*), Creeping saltbush (*Einadia nutans*), Black Cotton Bush (*Maireana decalvans*) and *Sclerolaena stelligera*.
Exotic species	Patterson's Curse (*Echium plantagineum*), Burr Medic (*Medicago polymorpha*), Wireweed (*Polygonum aviculare*), Common Sowthistle (*Sonchus oleraceus*), Potato Weed (*Heliotropium europaeum*), Paddy Melon (*Cucumis myriocarpus*) and *Trifolium sp.*



Note: Plot labels indicate the 0 m point of the central transect through each plot.

Figure 4.1 Hartwood vegetation zones

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein



Note: Plot labels indicate the 0 m point of the central transect through each plot.

Figure 4.2 Wanganella vegetation zones

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

4.4 Threatened ecological communities

There are no TECs at the Wanganella and Hartwood regulator sites or surrounding areas. No TECs were recorded in the proposal footprint or surrounding study area. There is no risk of direct or indirect impacts to any TECs from the construction or operation of the Wanganella and Hartwood regulator.

PCT 44 - Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion, and PCT 46 - Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain are identified in the TBDC as potentially associated with 'Natural Grasslands of the Murray Valley Plains' CEEC listed under the EPBC Act (NSW DCCEEW 2024a). There is not an equivalent or related TEC listed under the BC Act. An assessment of the vegetation zones that are floristically similar to the community against the diagnostic and condition criteria specified in the listing advice for the EPBC Act-listed CEEC (TSSC 2012) is provided in Appendix B-2 and summarised below.

Hartwood vegetation zone 6, PCT 44_Moderate does not meet the diagnostic and condition criteria specified in the listing advice for the EPBC Act-listed CEEC (TSSC 2012) (Appendix B-2).

Hartwood vegetation zones 7 (PCT 46_Moderate) and 8 (PCT 46_Poor) and Wanganella vegetation zone 5 (PCT 46_Moderate) do not comprise part of an occurrence of this CEEC as this vegetation does not meet the identification criteria specified in the listing advice for the EPBC Act-listed CEEC (TSSC 2012) (Appendix B-2).

Additional areas of PCT 13 Black Box woodland in DNG condition at the study area were also considered as potentially comprising the CEEC. The EPBC Act-listed CEEC does not include native grasslands derived from part-clearing of Black Box woodland or other native woodland and forest vegetation communities (TSSC 2012).

Historical aerial imagery was also reviewed to assist with mapping the extent of naturally occurring floodplain grasslands versus DNG. The earliest aerial imagery available was from 1970 at Hartwood and 1971 at Wanganella and revealed an equivalent extent of treed vegetation versus grassland or low shrubland as the current extent (NSW Government 2023) and so could not provide additional information to the factors considered in section 4.2.2 and Appendix B-2.

5. Habitat suitability for threatened species

5.1 Identification of threatened species for assessment

5.1.1 Ecosystem credit species

Based on the bioregional context for the assessment and the PCTs, patch size, vegetation cover and habitat resources present at the proposal footprint, the BAM-C generates a list of threatened fauna species that are predicted to utilise the proposal footprint (that is, potential 'predicted threatened species', or potential 'ecosystem credit entities'). The potential for these predicted threatened species to occur within the proposal footprint was further refined based on the desktop assessment, habitat resources observed during field surveys, records during the surveys, and the knowledge and experience of the assessor. Targeted surveys are not required under the BAM for these species as they are assumed to be present in the PCTs at the proposal footprint.

Table 5.1 lists all ecosystem credit species that are considered likely to occur on or use the proposal footprint, separated into lists of species for each site. The list of ecosystem credit species was compiled based on the following information as summarised in the 'Source' column of Table 5.1:

– 'BAM-C', meaning the list of potential ecosystem credit species generated by the Biodiversity Assessment Method Calculator Version 1.4.0.00 based on location and vegetation data for the proposal footprint and the Threatened Biodiversity Data Collection.
– 'Previous survey', meaning a direct observation of the species at the proposal footprint as part of a previous assessment.
– 'Current survey' meaning directly observed at the proposal footprint during field surveys conducted for the proposal.
– 'Desktop review' meaning evidence that the species would occur at the proposal footprint based on BioNet Atlas records (NSW DCCEEW 2024a) or other evidence revealed by the desktop assessment.

Predicted species from the BAM-C auto-populated list may be excluded based on geographic limitations or habitat constraints in accordance with BAM Subsections 5.2.1 and 5.2.2 (DPIE 2020a). Each of the predicted threatened species identified by the BAM-C were retained for further assessment.

No additional species were added due to being recently listed under the BC Act or EPBC Act and not yet added to the TBDC or revealed by other information sources.

The following predicted species were recorded during field surveys:

– Dusky Woodswallow (*Artamus cyanopterus cyanopterus*), observed in groups of up to six foraging in shrubland at the Wanganella site.
– Little Eagle (*Hieraaetus morphnoides*) observed foraging over riparian forest, woodland and grassland at the Wanganella site.
– Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) observed foraging over riparian forest and woodland at the Wanganella site.
– A White-bellied Sea-eagle (*Haliaeetus leucogaster*) passing through the riparian corridor at the Hartwood site.
– A Pink Cockatoo (*Lophochroa leadbeateri*) observed resting in a tree in Black Box woodland at the Wanganella site.
– Southern Whiteface (*Aphelocephala leucopsis)* recorded foraging over riparian forest, woodland and grassland at the Wanganella site.
– Inland Forest Bat (*Vespadelus baverstocki*) recorded via Probable (Pr) call on Anabat detector at the Wanganella site.
– Little Pied Bat (*Chalinolobus picatus*) recorded via Probable (Pr) call on Anabat detector at the Wanganella site.

The locations of threatened fauna observations are shown on Figure 5.8 and Figure 5.9.

The Little Eagle, White-bellied Sea-eagle and Pink Cockatoo are dual credit species, with species credits required for impacts to confirmed nesting habitat. Nesting habitat for these species is discussed in section 5.2..

Table 5.1 Predicted ecosystem credit species

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Hartwood									
Regent Honeyeater (foraging)	*Anthochaera phrygia*	CE	CE	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod	High
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 44_Mod 46_Poor 46_Mod	Moderate
Australasian Bittern	*Botaurus poiciloptilus*	E	E	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG	Moderate
Pied Honeyeater	*Certhionyx variegatus*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG	Moderate
Little Pied Bat	*Chalinolobus picatus*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	High

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Spotted Harrier	*Circus assimilis*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 44_Mod 46_Poor 46_Mod	Moderate
Varied Sittella	*Daphoenositta chrysoptera*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
White-fronted Chat	*Epthianura albifrons*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod	Moderate
Grey Falcon	*Falco hypoleucos*	V	V	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG 44_Mod 46_Poor 46_Mod	Moderate
Black Falcon	*Falco subniger*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 44_Mod 46_Poor 46_Mod	Moderate

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Painted Honeyeater	*Grantiella picta*	V	V	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
Brolga	*Grus rubiconda*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
White-bellied Sea-Eagle (foraging)	*Haliaeetus leucogaster*	V	-	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☒ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 44_Mod 46_Poor 46_Mod	High
Little Eagle (foraging)	*Hieraaetus morphnoides*	V	-	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☒ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 44_Mod 46_Poor 46_Mod	Moderate
White-throated Needletail	*Hirundapus caudacutus*	-	V	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 44_Mod 46_Poor 46_Mod	High

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Swift Parrot (foraging)	*Lathamus discolor*	E	CE	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
Pink Cockatoo (foraging)	*Lophochroa leadbeateri)*	V	E	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
Square-tailed Kite	*Lophoictinia isura*	V	-	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
Hooded Robin (south-eastern)	*Melanodryas cucullata cucullata*	V	E	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
Black-chinned Honeyeater	*Melithreptus gularis gularis*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod	Moderate
Gilbert's Whistler	*Pachycephala inornata*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG	Moderate

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Plains-wanderer (foraging)	*Pedionomus torquatus*	E	CE	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod	High
Scarlet Robin	*Petroica boodang*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod	Moderate
Flame Robin	*Petroica phoenicea*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod	Moderate
Regent Parrot (eastern subspecies) (foraging)	*Polytelis anthopeplus monarchoides*	E	V	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	No	Geographic limitations Proposal footprint not within 10 km of the junction of the Murray River	7_Mod 10_Mod 13_Mod 13_DNG 44_Mod 46_Poor 46_Mod	Moderate
Superb Parrot (foraging)	*Polytelis swainsonii*	V	V	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 44_Mod 46_Poor 46_Mod	Moderate

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☒ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG	Moderate
Australian Painted Snipe	*Rostratula australis*	E	E	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	High
Diamond Firetail	*Stagonopleura guttata*	V	V	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 44_Mod 46_Poor 46_Mod	Moderate
Freckled Duck	*Stictonetta naevosa*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
Inland Forest Bat	*Vespadelus baverstocki*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	13_Mod 13_DNG	High

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Wanganella									
Magpie Goose	*Anseranas semipalmata*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	160_Mod	Moderate
Regent Honeyeater	*Anthochaera phrygia*	CE	CE	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod	High
Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☒ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 46_Poor 46_Mod 160_Mod	Moderate
Australasian Bittern	*Botaurus poiciloptilus*	E	E	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG 160_Mod	Moderate
Pied Honeyeater	*Certhionyx variegatus*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG	Moderate
Little Pied Bat	*Chalinolobus picatus*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 160_Mod	High

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Spotted Harrier	*Circus assimilis*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 46_Poor 46_Mod 160_Mod	Moderate
Varied Sittella	*Daphoenositta chrysoptera*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
White-fronted Chat	*Epthianura albifrons*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	46_Poor 46_Mod 160_Mod	Moderate
Grey Falcon	*Falco hypoleucos*	V	V	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG 46_Poor 46_Mod 160_Mod	Moderate
Black Falcon	*Falco subniger*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 46_Poor 46_Mod 160_Mod	Moderate

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Painted Honeyeater	*Grantiella picta*	V	V	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	High
Brolga	*Grus rubiconda*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 160_Mod	Moderate
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	V	-	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 46_Mod 160_Mod	High
Little Eagle (foraging)	*Hieraaetus morphnoides*	V	-	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☒ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 46_Mod 160_Mod	Moderate
White-throated Needletail	*Hirundapus caudacutus*	-	V	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 46_Mod 160_Mod	High

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Swift Parrot (foraging)	*Lathamus discolor*	E	CE	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
Pink Cockatoo (foraging)	*Lophochroa leadbeateri)*	V	E	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☒ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
Square-tailed Kite (foraging)	*Lophoictinia isura*	V	-	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
Hooded Robin (south-eastern)	*Melanodryas cucullata cucullata*	V	E	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG	Moderate
Black-chinned Honeyeater	*Melithreptus gularis gularis*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod	Moderate
Blue-billed Duck	*Oxyurus australis*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	160_Mod	Moderate
Gilbert's Whistler	*Pachycephala inornata*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG	Moderate

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Plains-wanderer (foraging)	*Pedionomus torquatus*	E	CE	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	46_Mod	High
Scarlet Robin	*Petroica boodang*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod	Moderate
Flame Robin	*Petroica phoenicea*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod	Moderate
Regent Parrot (eastern subspecies) (foraging)	*Polytelis anthopeplus monarchoides*	E	V	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	Geographic limitations Proposal footprint not within 10 km of the junction of the Murray River	10_Mod 13_Mod 13_DNG	Moderate
Superb Parrot (foraging)	*Polytelis swainsonii*	V	V	Yes	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG 46_Mod	Moderate
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG	Moderate

Common name	Scientific name	Listing status		Dual credit species	Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID	Sensitivity to gain class
		BC Act	EPBC Act						
Australian Painted Snipe	*Rostratula australis*	E	E	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 160_Mod	Moderate
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 160_Mod	High
Diamond Firetail	*Stagonopleura guttata*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 46_Mod	Moderate
Freckled Duck	*Stictonetta naevosa*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG 160_Mod	Moderate
Inland Forest Bat	*Vespadelus baverstocki*	V	-	No	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	13_Mod 13_DNG	High

5.1.2 Species credit species

Threatened species that cannot reliably be predicted to occur on a proposal footprint based on PCT, distribution and habitat criteria are identified by the Threatened Biodiversity Data Collection as 'species credit' entities. 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.

The credit calculator references geographic, vegetation and habitat data for the proposal footprint to generate a list of the species credit entities that are predicted to occur (i.e. the 'potential candidate threatened species'). Searches of threatened species databases were also completed to identify any additional potential candidate threatened species (to those generated by the credit calculator) that are known or predicted to occur in the locality. The likelihood of occurrence of potential candidate threatened species were reviewed, giving consideration to the habitats available in the study area (refer to threatened species for assessment tables in Appendix B).

The list of potential candidate threatened species that could occur are assessed based on the habitat resources observed during field surveys. 'Confirmed' candidate threatened species require further assessment of species presence and the extent of occupied habitat in accordance with the BAM. Habitat assessment and targeted surveys must extend to areas adjoining the proposal footprint for certain matters, for instance threatened raptor nest trees, because if present a species polygon must be mapped in a buffer area of up to 300 metres around the nest tree that includes all PCTs with which the species is associated (DCCEEW 2024a). A number of species could be reliably discounted as occurring at the proposal footprint or adjoining areas based on the type and quality of habitat resources present and the habitat requirements for the species identified in the TBDC. The list of confirmed candidate threatened species is presented in Table 5.2 along with justification for excluding species from further assessment in accordance with BAM Subsections 5.2.1 and 5.2.2 (DPIE 2020a).

The following habitat types and resources are present at the proposal footprint or adjoining areas and informed the assessment of candidate threatened species:

- Inland Riverine Forests and Inland Floodplain Woodlands with extensive areas of mature and hollow-bearing trees
- Riverine Plain Grasslands including extensive areas of mature-species rich native perennial grasslands and occasional patches with high species richness and cover of herbs, particularly in PCT 44 at Hartwood
- floodplains on grey-brown or red-brown clays and claypans; semi-permanent/ephemeral wet areas
- wetland-grassland communities on grey-brown or red-brown clays and claypans
- fallen/standing dead timber including logs
- living or dead mature trees within suitable vegetation within one kilometre of rivers, lakes, large dams or creeks, wetlands and coastlines, notably associated with the riparian corridor of Billabong Creek but with all trees in the proposal footprint meeting this criteria
- hollow bearing trees including:
  - 'living or dead tree with hollows greater than 10 cm diameter'
  - 'living or dead trees with hollows greater than 20 cm diameter and greater than 4 m above the ground'
  - 'living or dead …*E. camaldulensis*… with hollows greater than 5 cm diameter, greater than 4 m above ground or trees with a DBH of greater than 30 cm'
  - 'living or dead trees with hollows greater than 20 cm diameter'
- heavy grey clay soils and claypans or shallow depressions
- waterbodies; land within 40 metres of riparian woodland on inland watercourses/waterholes containing dead or dying eucalypts in the riparian corridors of Billabong Creek and Forest Creek
- River Red Gum and Black box woodland and forest including 'nest trees - live (occasionally dead) large old trees within vegetation'
- waterbodies with permanent pools/stretches three metres or wider, including rivers, large creeks, billabongs, lagoons, estuaries, dams and other waterbodies, on or within 200 metres of the site
- koala use trees (OEH 2018), including River Red Gums
- semi-permanent/ephemeral wet areas.

The TBDC as accessed via the BAM-C (DCCEEW 2024a) also listed a number of specific geographic constraints that apply to potential species credit entities. Where appropriate the justification for excluding species based on geographic constraints is noted for individual species in Table 5.2.

Table 5.2 Candidate species credit entities

Common name	Scientific name	Listing status		Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID
		BC Act	EPBC Act				
Hartwood							
Austral Pillwort	*Pilularia novae-hollandiae*	E	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	13_Mod 13_DNG 44_Mod 46_Poor 46_Mod
Australian Bustard	*Ardeotis australis*	E	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod
Barking Owl	*Ninox connivens*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod
Bindweed	*Convolvulus tedmoorei*	E	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod
Bush Stone-curlew	*Burhinus grallarius*	E	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG
Chariot Wheels	*Maireana cheelii*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod

Common name	Scientific name	Listing status		Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID
		BC Act	EPBC Act				
Claypan Daisy	*Brachyscome muelleroides*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod
Koala	*Phascolarctos cinereus*	E	E	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod
Lanky Buttons	*Leptorhynchos orientalis*	E	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod
Little Eagle (Breeding)	*Hieraaetus morphnoides*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 44_Mod 46_Poor 46_Mod
Pink Cockatoo (Breeding)	*Lophochroa leadbeateri)*	V	E	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod
Masked Owl	*Tyto novaehollandiae*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod

Common name	Scientific name	Listing status		Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID
		BC Act	EPBC Act				
Menindee Nightshade	*Solanum karsense*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	No	Geographic limitations: the proposal footprint is not 'West of Maude'	N/A
Mossgiel Daisy	*Brachyscome papillosa*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	13_Mod 13_DNG 44_Mod 46_Poor 46_Mod
Plains-wanderer (Important habitat)	*Pedionomus torquatus*	E	CE	☒ BAM-C ☒ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod Areas mapped on the important habitat map occur within or adjacent to the proposal footprint.
Red Darling Pea	*Swainsona plagiotropis*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod
Regent Honeyeater (Important habitat)	*Anthochaera phrygia*	CE	CE	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	No	Habitat constraints: no areas mapped on the important habitat map occur within or adjacent to the proposal footprint.	N/A
Regent Parrot (eastern subspecies) (Breeding)	*Polytelis anthopeplus monarchoides*	E	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	No	Geographic limitations: the proposal footprint is not 'within 10 km of the junction of the Murray River'	10_Mod 13_Mod

Common name	Scientific name	Listing status		Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID
		BC Act	EPBC Act				
Silky Swainson-pea	*Swainsona sericea*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod
Slender Darling-pea	*Swainsona murrayana*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod
Small Scurf-pea	*Cullen parvum*	E	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG
Southern Bell Frog	*Litoria raniformis*	E	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG
Southern Myotis	*Myotis macropus*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☒ Current survey	Yes	N/A	7_Mod 10_Mod
Square-tailed Kite (Breeding)	*Lophoictinia isura*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod

Common name	Scientific name	Listing status		Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID
		BC Act	EPBC Act				
Superb Parrot (Breeding)	*Polytelis swainsonii*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 46_Poor 46_Mod
Swift Parrot (Important habitat)	*Lathamus discolor*	E	CE	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	No	Habitat constraints: no areas mapped on the important habitat map occur within or adjacent to the proposal area.	N/A
Turnip Copperburr	*Sclerolaena napiformis*	E	E	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	44_Mod 46_Poor 46_Mod
White-bellied Sea-Eagle (Breeding)	*Haliaeetus leucogaster*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 44_Mod 46_Poor 46_Mod
Winged Peppercress	*Lepidium monoplocoides*	E	E	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	13_Mod 13_DNG 46_Poor 46_Mod
Yellow Gum	*Eucalyptus leucoxylon subsp. pruinosa*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	13_Mod 13_DNG

Common name	Scientific name	Listing status		Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID
		BC Act	EPBC Act				
Wanganella							
Austral Pillwort	*Pilularia novae-hollandiae*	E	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	13_Mod 13_DNG 46_Poor 46_Mod
Australian Bustard	*Ardeotis australis*	E	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	46_Poor 46_Mod 160_Mod
Barking Owl	*Ninox connivens*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod
Bindweed	*Convolvulus tedmoorei*	E	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	46_Poor 46_Mod 160_Mod
Bush Stone-curlew	*Burhinus grallarius*	E	-	☒ BAM-C ☐ TBDC ☒ Previous survey ☐ Current survey	Yes	N/A	10_Mod 13_Mod 13_DNG
Chariot Wheels	*Maireana cheelii*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	46_Poor 46_Mod

Common name	Scientific name	Listing status		Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID
		BC Act	EPBC Act				
Claypan Daisy	*Brachyscome muelleroides*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	46_Poor 46_Mod
Koala	*Phascolarctos cinereus*	E	E	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 160_Mod
Lanky Buttons	*Leptorhynchos orientalis*	E	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	46_Poor 46_Mod
Little Eagle (Breeding)	*Hieraaetus morphnoides*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☒ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 46_Poor 46_Mod 160_Mod
Pink Cockatoo (Breeding)	*Lophochroa leadbeateri)*	V	E	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod
Masked Owl (Breeding)	*Tyto novaehollandiae*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod

Common name	Scientific name	Listing status		Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID
		BC Act	EPBC Act				
Menindee Nightshade	*Solanum karsense*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	No	Geographic limitations: the proposal footprint is not 'West of Maude	N/A
Mossgiel Daisy	*Brachyscome papillosa*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	13_Mod 13_DNG 46_Poor 46_Mod 160_Mod
Plains-wanderer (Important habitat)	*Pedionomus torquatus*	E	CE	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	No	Habitat constraints: no areas mapped on the important habitat map occur within or adjacent to the proposal area.	N/A
Red Darling Pea	*Swainsona plagiotropis*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	46_Poor 46_Mod
Regent Honeyeater (Important habitat)	*Anthochaera phrygia*	CE	CE	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	No	Habitat constraints: No areas mapped on the important habitat map occur within or adjacent to the proposal area.	N/A
Regent Parrot (eastern subspecies) (Breeding)	*Polytelis anthopeplus monarchoides*	E	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	No	Geographic limitations: the proposal footprint is not 'within 10 km of the junction of the Murray River'	N/A

Common name	Scientific name	Listing status		Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID
		BC Act	EPBC Act				
Silky Swainson-pea	*Swainsona sericea*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	46_Poor 46_Mod
Slender Darling-pea	*Swainsona murrayana*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	46_Poor 46_Mod
Small Scurf-pea	*Cullen parvum*	E	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod
Southern Bell Frog	*Litoria raniformis*	E	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☒ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 13_DNG
Southern Myotis	*Myotis macropus*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod
Square-tailed Kite (Breeding)	*Lophoictinia isura*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod

Common name	Scientific name	Listing status		Sources	Species retained for further assessment?	Reason for exclusion from further assessment	Vegetation zone ID species retained within, including PCT ID
		BC Act	EPBC Act				
Superb Parrot (Breeding)	*Polytelis swainsonii*	V	V	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 46_Poor 46_Mod
Swift Parrot (Important habitat)	*Lathamus discolor*	E	CE	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	No	Habitat constraints: No areas mapped on the important habitat map occur within or adjacent to the proposal footprint.	N/A
Turnip Copperburr	*Sclerolaena napiformis*	E	E	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	46_Poor 46_Mod
White-bellied Sea-Eagle (Breeding)	*Haliaeetus leucogaster*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	7_Mod 10_Mod 13_Mod 46_Poor 46_Mod 160_Mod
Winged Peppercress	*Lepidium monoplocoides*	E	E	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	13_Mod 13_DNG 46_Poor 46_Mod 160_Mod
Yellow Gum	*Eucalyptus leucoxylon subsp. pruinosa*	V	-	☒ BAM-C ☐ TBDC ☐ Previous survey ☐ Current survey	Yes	N/A	13_Mod 13_DNG

5.2 Presence of candidate species credit species

Table 5.4 identifies the confirmed candidate species credit species requiring assessment in accordance with BAM Subsection 5.2.4, the method used to confirm their presence and the outcome of targeted surveys. The methods employed during field surveys in accordance with relevant guidelines are described in general in section 2.4. A summary of the type and total effort of the targeted surveys completed is provided in Table 5.3 along with an assessment of the suitability of conditions for targeted survey based on the species targeted and associated survey guidelines. Daily details of weather conditions throughout survey periods are provided in Table 2.5 and targeted survey techniques and effort are summarised in Table 5.3 and Figure 5.1 to Figure 5.6 show survey effort for candidate threatened species. Scanned field data sheets and GPS tracklogs demonstrating survey effort and coverage of the study area have been submitted for approval along with this BDAR.

A summary of the survey results as related to species credit calculations is presented below.

Table 5.3 Targeted species credit matter survey techniques and effort

Survey technique	Targeted survey methods and effort	Suitability of conditions for targeted surveys
Hartwood		
Systematic threatened flora traverse	**Targeting threatened flora** Seasonal systematic parallel walking traverses for threatened flora in suitable habitat throughout the proposal footprint. 19 to 22 September 2022, 5 m to 10 m spaced traverses. 7 March 2023, 20 m spaced traverses. 25, 28 and 29 September 2023, 5 m to 10 m spaced traverses. 11, 13 and 14 December 2023, 5 m to 10 m spaced traverses. 7 February 2024, 20 m spaced traverses. **Total effort =** Coverage of the entire proposal footprint over multiple seasons as appropriate to target species.	Wet conditions during and preceding September 2022 with native forbs in flower. Drier conditions in March, September, December 2023 and February 2024 permitting full access to the study area following above-average rainfall in preceding months. Native grasses and forbs in flower. Visibility was generally good, with exotic perennial grasses reducing visibility in some areas during September and December 2023.
Diurnal bird surveys	**Targeting threatened birds** Timed area searches in suitable habitat throughout the study area in the August and September 2022 and March 2023 survey rounds. Five bird surveys (of up to one hour) on 22 and 23 August 2022. Two bird surveys (of up to one hour) on 19th and 20 September 2022). Two bird surveys (of up to one hour) on 6th and 9 March 2023. Separate area searches conducted by two ecologists per site, per survey round and in conjunction with nest tree census. **Total effort =** ~18 person-hours of area searches.	Dry conditions mostly during August 2022, but with slight gusty winds. Light drizzle recorded at end of one survey likely impeded detection of bird species. Generally overcast conditions during September 2022 and good visibility during March 2023 surveys

Survey technique	Targeted survey methods and effort	Suitability of conditions for targeted surveys
Nest tree census	**Targeting threatened birds / nest sites for dual credit species** Targeted searches for hollow-bearing trees and large nests across the proposal footprint in August and September 2022 and March 2023 survey rounds. Targeted nest tree census conducted on 22 and 23 August 2022, 19 and 20 September 2022. Targeted searches in conjunction with threatened flora traverses across the proposal footprint in September 2022, March and September 2023, December 2023 and January and February 2024 survey rounds. Separate area searches conducted by two ecologists per site, per survey round and in conjunction with diurnal bird surveys. **Total effort =** Coverage of the entire proposal footprint over multiple seasons.	Visibility was generally good, with no notable periods of fog, strong winds and/ or rain hampering detection or bird activity during systematic nest tree census in August 2022 survey round. Wet weather during September 2022 survey round likely impeded detection of nest and hollow use during opportunistic surveys. Generally overcast conditions during September 2022 likely decreased visibility at times. Visibility was good during March and September 2023 surveys, weather was dry and warm and no recent rainfall in the area.
General spotlight surveys Call playback	**Targeting threatened owls and Bush-stone Curlew** Two consecutive nights of spotlighting on 22 and 23 August 2022, 19 and 20 September 2022 by two ecologists over at least four person hours conducted between the hours of 6 – 9 PM. Two consecutive nights of spotlighting on 1 and 2 March 2023 by two ecologists over at least two hours conducted between the hours of 8 – 11 PM. Call playback session conducted per night in conjunction with spotlighting. **Total effort =** >1440 person-minutes of spotlighting across 6 replicates**.**	Generally cool and dry conditions during August and September 2022 spotlighting. Dry and warm conditions were recorded during March and September 2023 and spotlighting with no rainfall recently in the area.
Aural-visual surveys	**Targeting threatened frogs** Aural-visual surveys for the Southern Bell Frog were conducted along Billabong Creek at Hartwood. Surveys were along conducted along irrigation channels, farm dams and billabongs, as well as the block and areas of instream Typha vegetation in the study area. Two consecutive nights of active searches through areas of suitable frog habitat by two ecologists over at least one hour from on 22 and 23 August 2022 by two ecologists over at least two hours conducted between the hours of 6 – 9 PM. Two consecutive nights of spotlighting on 1 and 2 March 2023 by two ecologists over at least two person hours conducted between the hours of 8 – 11 PM. **Total effort =** >480 person minutes each night across four survey replicates	It is noted that these surveys are outside the survey period specified in the TBDC. Southern Bell Frogs were heard calling during the day in the Great Cumbung Swamp on 1 September 2022 by Kirsten Crosby and others, suggesting this species may be active in September in the region. Targeted surveys were planned for November/December 2022, however flood conditions across the study area prevented access until March 2023. The species was found to be present and active at Wanganella and also at a former site (Caroonboon), during this survey period. Given the warm and wet conditions in March 2023, and records of the species in the wider study area, the March 2023 survey round was considered a suitable survey period for the species. Some background noise recorded from the pumps at Hartwood was noted during surveys.

Survey technique	Targeted survey methods and effort	Suitability of conditions for targeted surveys
AudioMoths	**Targeting threatened owls, frogs and koala** Three AudioMoths deployed over one night between the 22-23 August 2022. Three AudioMoths deployed over eight nights between the 1-9 March 2023.	Rainfall and gusty winds hampered the quality of AudioMoth data for a period of ~3 hrs on the night of 22 August 2022. However a number of non-threatened owls and frog calls were recorded on the AudioMoths during this period; suggesting that survey conditions were suitable.
Ultrasonic call recording	**Targeting microbats** Two Anabat detectors deployed over two nights between 18-23 January 2024 Two Anabat detectors deployed over two nights between 19-21 September 2022. **Total effort =** 10 survey nights in January Additional 4 survey nights in September.	Generally warm and calm conditions
Spot Assessment technique (SAT)	**Targeting koala** SAT surveys conducted on 22 and 23 August and 20 September 2022. **Total effort =** Six SAT surveys conducted in suitable habitat	The 4.2 mm of rain fallen in the preceding 3 days of August survey unlikely to decompose scats such that they are undetectable. The 13 mm of rain fallen in the preceding 3 days of September survey unlikely to decompose scats such that they are undetectable.
Wanganella		
Systematic threatened flora traverse	**Targeting threatened flora** Seasonal systematic parallel walking traverses for threatened flora in suitable habitat throughout the proposal footprint. 19 to 22 September 2022, 5m to 10m spaced traverses. 7 March 2023, 20m spaced traverses. 26 and 27 September 2023, 5m to 10m spaced traverses. 12 to 13 December 2023, 5m to 10m spaced traverses. **Total effort =** Coverage of the entire proposal footprint over multiple seasons as appropriate to target species.	Wet conditions during and preceding September 2022 with native forbs in flower. Drier conditions in March, September, December 2023 and February 2024 permitting full access to the study area following above-average rainfall in preceding months. Native grasses and forbs in flower. Visibility was generally good, with exotic perennial grasses reducing visibility in some areas during September and December 2023.
Diurnal bird surveys	**Targeting threatened birds** Timed area searches in suitable habitat throughout the study area in August and September 2022 and March 2023 survey rounds. Three bird surveys (of up to one hour) over 22 and 23 August 2022. Two bird surveys (of up to one hour) on 19 and 21 September 2022. Two bird surveys (of up to one hour) on 1 and 7 March 2023. Separate area searches conducted by two ecologists per site, per survey round and in conjunction with nest tree census **Total effort =** ~14 person-hours of area searches.	Dry conditions mostly during August 2022, but with slight gusty winds. Generally overcast conditions during September 2022 and good visibility during March 2023 surveys

Survey technique	Targeted survey methods and effort	Suitability of conditions for targeted surveys
Nest tree surveys	**Targeting threatened birds / nest sites for dual credit species** Targeted searches for hollow-bearing trees and large nests across the proposal footprint in August and September 2022 and March 2023 survey rounds. Targeted nest tree census conducted on 22 and 23 August 2022, 19 and 21 September 2022. Targeted searches in conjunction with threatened flora traverses across the proposal footprint in September 2022, March and September 2023 and December 2023 survey rounds. Separate area searches conducted by two ecologists per site, per survey round and in conjunction with diurnal bird surveys **Total effort =** Coverage of the entire proposal footprint over multiple seasons.	Visibility was generally good, with no notable periods of fog, strong winds and/ or rain hampering detection or bird activity during systematic nest tree census in August 2022 survey round. Wet weather during September 2022 survey round likely impeded detection of nest and hollow use during opportunistic surveys. Generally overcast conditions during September 2022 likely decreased visibility at times. Visibility was good during March and September 2023 surveys, weather was dry and warm and no recent rainfall in the area.
General spotlight surveys Call playback	**Targeting threatened owls and Bush Stone-curlew** Two consecutive nights on 22 and 23 August 2022 and two non-consecutive nights 19 and 21 September 2022 of spotlighting by two ecologists over two hours conducted between the hours of 6 – 9 PM. Two non-consecutive nights of spotlighting on 1 and 7 March 2023 and two consecutive nights on 26 and 27 September 2023 by two ecologists over at least two hours conducted between the hours of 8 – 11 PM. Call playback session conducted per night in conjunction with spotlighting. **Total effort =** >1920 person-minutes of spotlighting across 8 replicates**.**	Light drizzle on 22 August 2022 may have hampered visibility. No notable periods of fog, strong winds and/ or rain hampering detection of nocturnal species in other survey rounds.
Streamside searches Audio-visual surveys Call playback	**Targeting threatened frogs** Streamside spotlighting searches for the Southern Bell Frog were conducted along Billabong Creek at Wanganella. Surveys were along conducted along irrigation channels, farm dams and billabongs. aural-visual surveys for the Southern Bell Frog was conducted on 1 and 7 March and 26 and 27 September 2023. Surveys generally extended outside the construction footprint to allow better coverage of habitats in the area, and to take into account indirect and prescribed impacts. Frogs were identified by sight and call when encountered opportunistically or surveys. Frog calls were recorded and verified using the Australian Museum's Frog ID app where possible. **Total effort** = eight survey replicates over at least 240 person minutes per replicate	It is noted that these surveys are outside the survey period specified in the TBDC. Southern Bell Frogs were heard calling during the day in the Great Cumbung Swamp on 1 September 2022 by Kirsten Crosby and others, suggesting this species may be active in September in the region. Targeted surveys were planned for November/December 2022, however flood conditions across the study area prevented access until March 2023. The species was found to be present and active at Wanganella and also at a former site (Caroonboon), during this survey period. Given the warm and wet conditions in March 2023, and records of the species in the wider study area, the March 2023 survey round was considered a suitable survey period for the species. September 2023 surveys in the additional areas added to the proposal footprint at Wanganella identified the Southern Bell Frog by call. Some supplementary noise recorded from water running down the weir wall was noted during surveys.

Survey technique	Targeted survey methods and effort	Suitability of conditions for targeted surveys
AudioMoths	**Targeting threatened owls, frogs and koala** Three AudioMoths deployed over one night between the 22-23 August 2022. One AudioMoth deployed over six nights between the 1-7 March 2023.	Rainfall and gusty winds hampered the quality of AudioMoth data for a period of ~3 hrs on the night of 22 August 2022. However a number of non-threatened owls, frog calls were recorded on the AudioMoths during this period; suggesting that survey conditions were suitable.
Ultrasonic call recording	**Targeting microbats** Two Anabat detectors deployed over two nights between 18-23 January 2024 Two Anabat detectors deployed over two nights between 19-21 September 2022. **Total effort =** 10 survey nights in January Additional 4 survey nights in September.	Generally warm and calm conditions.

Table 5.4 Determining the presence of candidate species credit matters at the proposal footprint

Common name	Scientific name	Associated PCTs at the proposal footprint	Present?	Method used to determine presence	Survey method	Recommended survey period (BAM-C / TBDC)	Timing of survey – within recommended period? (BAM-C / TBDC)	Effort
Hartwood								
Australian Bustard	*Ardeotis australis*	44.46	No	Targeted threatened species survey	Diurnal bird survey	All year	☒ Yes ☐ No	Diurnal bird surveys over at least one hour in August and September 2022, and March 2023
Claypan Daisy	*Brachyscome muelleroides*	44, 46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Nov	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023
Mossgiel Daisy	*Brachyscome papillosa*	13, 44, 46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Nov	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023
Bush Stone-curlew	*Burhinus grallarius*	7, 10, 13	No	Targeted threatened species survey	Diurnal bird surveys Call playback Spotlighting	All year	☒ Yes ☐ No	Diurnal bird surveys over at least one hour August and September 2022, March and September 2023 Call playback and spotlighting of up to 2 hours on each of August and September 2022, March and September 2023
Bindweed	*Convolvulus tedmoorei*	44, 46	No	Targeted threatened species survey	Parallel threatened flora traverses	Jun-Sep	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses September 2022 and September 2023
Small Scurf-pea	*Cullen parvum*	7, 10, 13	No	Targeted threatened species survey	Parallel threatened flora traverses	Dec-Jan	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in December 2023

Common name	Scientific name	Associated PCTs at the proposal footprint	Present?	Method used to determine presence	Survey method	Recommended survey period (BAM-C / TBDC)	Timing of survey – within recommended period? (BAM-C / TBDC)	Effort
Yellow Gum	*Eucalyptus leucoxylon* subsp. *pruinosa*	13	No	Targeted threatened species survey	Parallel threatened flora traverses	All year	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses September 2022, March 2023, September 2023, December 2023 and February 2024
White-bellied Sea-Eagle (nesting)	*Haliaeetus leucogaster*	7, 10, 13, 44, 46	No	Targeted threatened species survey	Diurnal bird surveys Nest tree census	July-December	☒ Yes ☐ No	Diurnal bird surveys over at least one hour in and nest tree census in August and September 2022, September and December 2023. Additional effort outside optimal period in March 2023.
Little Eagle (nesting)	*Hieraaetus morphnoides*	7, 10, 13, 44, 46	No	Targeted threatened species survey	Diurnal bird surveys Nest tree census	Aug-Oct	☒ Yes ☐ No	Diurnal bird surveys over at least one hour and nest tree census in September 2022 and September 2023
Winged Peppercress	*Lepidium monoplocoides*	13, 46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Dec	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in, September 2022, September 2023 and December 2023
Lanky Buttons	*Leptorhynchos orientalis*	44, 46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Nov	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023
Southern Bell Frog	*Litoria raniformis*	7, 10, 13	Yes	Targeted threatened species survey	Frog aural visual surveys Audiomoth recordings	Oct-Jan	☐ Yes ☒ No	Species detected at Wanganella site in March 2023 and September 2023 during survey outside recommended period. Species detected via Audiomoth in March 2023. Frog aural-visual surveys conducted in September 2022 did not detect the species.

Common name	Scientific name	Associated PCTs at the proposal footprint	Present?	Method used to determine presence	Survey method	Recommended survey period (BAM-C / TBDC)	Timing of survey – within recommended period? (BAM-C / TBDC)	Effort
Pink Cockatoo (nesting)	*Lophochroa leadbeateri*	7, 10, 13	No	Targeted threatened species survey	Diurnal bird surveys Nest tree census	Sep-Dec	☒ Yes ☐ No	Diurnal bird surveys over at least one hour and nest tree census in September 2022 and September 2023. Additional effort outside optimal period in March 2023
Square-tailed Kite (nesting)	*Lophoictinia isura*	7, 10, 13	No	Targeted threatened species survey	Diurnal bird surveys Nest tree census	Sep-Jan	☒ Yes ☐ No	Diurnal bird surveys over at least one hour and nest tree census in September 2022 and September 2023
Chariot Wheels	*Maireana cheelii*	44, 46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Dec	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022, September 2023 and December 2023
Southern Myotis	*Myotis macropus*	7, 10	Yes	Targeted threatened species survey	Anabat recording	Oct-March	☒ Yes ☐ No	Species detected via Anabat detector in January 2024. 10 recording nights at Hartwood in January 2024, 20 recording nights in total including effort at Wanganella site. A further 9.5 recording nights across both sites in September 2022 outside recommended survey period
Barking Owl	*Ninox connivens*	7, 10, 13	No	Targeted threatened species survey	Spotlighting Call playback Nest tree census	May-Dec	☒ Yes ☐ No o	Diurnal bird surveys over at least one hour and nest tree census in August 2022, September 2022 and September 2023. Additional effort outside optimal period in March 2023
Plains-wanderer (Important habitat)	*Pedionomus torquatus*	44,46	Yes	Targeted threatened species survey	Important habitat mapping	n/a	n/a	n/a

Common name	Scientific name	Associated PCTs at the proposal footprint	Present?	Method used to determine presence	Survey method	Recommended survey period (BAM-C / TBDC)	Timing of survey – within recommended period? (BAM-C / TBDC)	Effort
Koala	*Phascolarctos cinereus*	7, 10, 13	No	Targeted threatened species survey	Diurnal surveys Spotlighting Scat searches Audiomoth recordings	All year	☒ Yes ☐ No o	Spotlighting transects in August and September 2022 Koala SATS in August 2022
Austral Pillwort	*Pilularia novae-hollandiae*	44, 46	No	Targeted threatened species survey	Parallel threatened flora traverses	Oct-Dec	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in December 2023
Superb Parrot (nesting)	*Polytelis swainsonii*	7, 10, 13, 46	No	Targeted threatened species survey	Diurnal bird surveys Nest tree census	Sep-Nov	☒ Yes ☐ No	Diurnal bird surveys over at least one hour and nest tree census in September 2022 and September 2023 Additional effort including birds survey and nest tree census conducted outside optimal period in March 2023
Turnip Copperburr	*Sclerolaena napiformis*	44, 46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Dec	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022, September 2023 and December 2023
Slender Darling Pea	*Swainsona murrayana*	44, 46	Yes	Targeted threatened species survey	Parallel threatened flora traverses	Sep	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023
Red Darling Pea	*Swainsona plagiotropis*	44, 46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023
Silky Swainson-pea	*Swainsona sericea*	44, 46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Nov	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023

Common name	Scientific name	Associated PCTs at the proposal footprint	Present?	Method used to determine presence	Survey method	Recommended survey period (BAM-C / TBDC)	Timing of survey – within recommended period? (BAM-C / TBDC)	Effort
Masked Owl	*Tyto novaehollandiae*	7, 10, 13	No	Targeted threatened species survey	Spotlighting Call playback Nest tree census	May-Aug	☒ Yes ☐ No	Diurnal bird surveys over at least one hour and nest tree census in August 2022 Additional effort outside optimal period in September 2022, March 2023 and September 2023
Wanganella								
Australian Bustard	*Ardeotis australis*	46, 160	No	Targeted threatened species survey	Diurnal bird survey	All year	☒ Yes ☐ No	Diurnal bird surveys over at least one hour in August and September 2022, and March 2023
Claypan Daisy	*Brachyscome muelleroides*	46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Nov	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023
Mossgiel Daisy	*Brachyscome papillosa*	13, 46, 160	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Nov	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023
Bush Stone-curlew	*Burhinus grallarius*	10, 13	Yes	Assumed present	Diurnal bird surveys Call playback Spotlighting	All year	☒ Yes ☐ No	The owner of the Wanganella general store observed and photographed a Bush Stone-curlew in February 2023 around 300 m to the east of the proposal footprint. This observation is considered reliable evidence that the Bush Stone-curlew occurs at the Wanganella proposal footprint.
Bindweed	*Convolvulus tedmoorei*	46, 160	No	Targeted threatened species survey	Parallel threatened flora traverses	Jun-Sep	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023

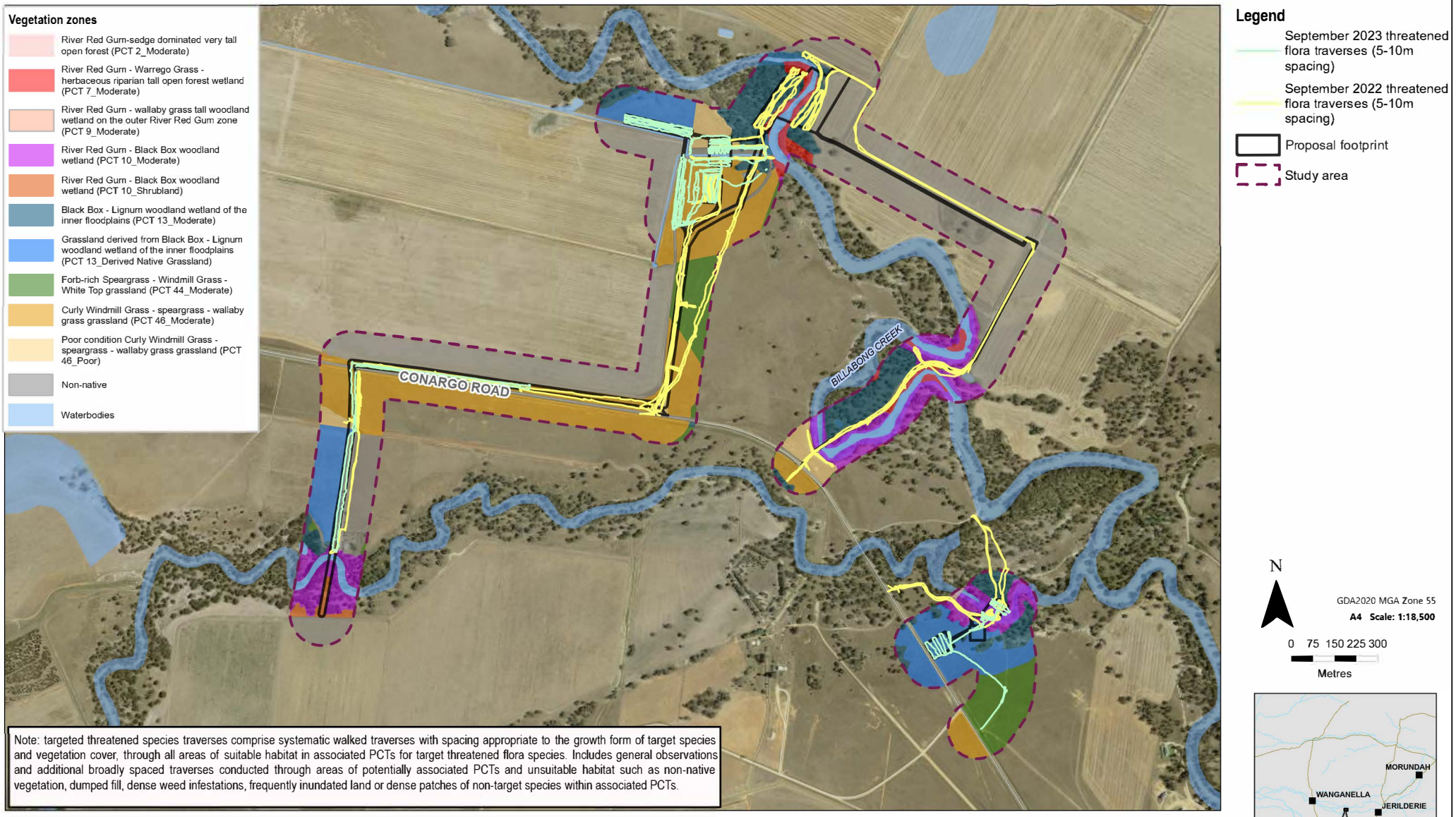
Common name	Scientific name	Associated PCTs at the proposal footprint	Present?	Method used to determine presence	Survey method	Recommended survey period (BAM-C / TBDC)	Timing of survey – within recommended period? (BAM-C / TBDC)	Effort
Small Scurf-pea	*Cullen parvum*	7	No	Targeted threatened species survey	Parallel threatened flora traverses	Dec-Jan	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in December 2023
Yellow Gum	*Eucalyptus leucoxylon* subsp. *pruinosa*	13	No	Targeted threatened species survey	Parallel threatened flora traverses	All year	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses September 2022, March 2023, September 2023, December 2023.
White-bellied Sea-Eagle (nesting)	*Haliaeetus leucogaster*	7, 10, 13, 46, 160	No	Targeted threatened species survey	Diurnal bird surveys Nest tree census	July-December	☒ Yes ☐ No	Diurnal bird survey and nest tree census in August and September 2022, September 2023 and December 2023. Additional effort outside optimal period in March 2023.
Little Eagle (nesting)	*Hieraaetus morphnoides*	7, 10, 13, 46, 160	Yes	Targeted threatened species survey	Diurnal bird surveys Nest tree census	Aug-Oct	☒ Yes ☐ No	Multiple observations of the species near large stick nest adjacent to the proposal footprint. Diurnal bird survey and nest tree census in September 2022 and September 2023. Additional effort outside optimal period in March 2023.
Winged Peppercress	*Lepidium monoplocoides*	13, 46, 160	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Dec	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in, September 2022, September 2023 and December 2023
Lanky Buttons	*Leptorhynchos orientalis*	46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Nov	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023

Common name	Scientific name	Associated PCTs at the proposal footprint	Present?	Method used to determine presence	Survey method	Recommended survey period (BAM-C / TBDC)	Timing of survey – within recommended period? (BAM-C / TBDC)	Effort
Southern Bell Frog	*Litoria raniformis*	7, 10, 13 according to the TBDC (DPE 2023a). Also 160 via direct observation.	Yes	Targeted threatened species survey	Frog aural visual surveys Audiomoth recordings	Oct-Jan	☐ Yes ☒ No	Species detected at Wanganella site in March 2023 and September 2023 during survey outside recommended period.
Pink Cockatoo (nesting)	*Lophochroa leadbeateri*	7, 10, 13	No	Targeted threatened species survey	Diurnal bird surveys Nest tree census	Sep-Dec	☒ Yes ☐ No	Diurnal bird survey and nest tree census in September 2022 and September 2023. Additional effort outside optimal period in March 2023.
Square-tailed Kite (nesting)	*Lophoictinia isura*	7, 10, 13	No	Targeted threatened species survey	Diurnal bird surveys Nest tree census	Sep-Jan	☒ Yes ☐ No	Diurnal bird survey and nest tree census in September 2022 and September 2023. Additional effort outside optimal period in March 2023.
Chariot Wheels	*Maireana cheelii*	46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Dec	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022, September and December 2023
Southern Myotis	*Myotis macropus*	7, 10	No	Targeted threatened species survey	Anabat recording	Oct-March	☒ Yes ☐ No	10 recording nights at Wanganella in January 2024, 20 recording nights in total including effort at Hartwood site. A further 9.5 recording nights across both sites in September 2022 outside recommended survey period
Barking Owl	*Ninox connivens*	7, 10, 13	No	Targeted threatened species survey	Spotlighting Call playback Nest tree census	May-Dec	☒ Yes ☐ No o	Diurnal bird survey and nest tree census in August and September 2022, September 2023. Additional effort outside optimal period in March 2023.

Common name	Scientific name	Associated PCTs at the proposal footprint	Present?	Method used to determine presence	Survey method	Recommended survey period (BAM-C / TBDC)	Timing of survey – within recommended period? (BAM-C / TBDC)	Effort
Koala	*Phascolarctos cinereus*	7, 10, 13, 160	No	Targeted threatened species survey	Diurnal surveys Spotlighting Scat searches Audiomoth recordings	All year	☒ Yes ☐ No o	Spotlighting traverses in August and September 2022, March 2023 Koala SATs in August and September 2023
Austral Pillwort	*Pilularia novae-hollandiae*	13, 46	No	Targeted threatened species survey	Parallel threatened flora traverses	Oct-Dec	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in December 2023
Superb Parrot (nesting)	*Polytelis swainsonii*	7, 10, 46	No	Targeted threatened species survey	Diurnal bird surveys Nest tree census	Sep-Nov	☒ Yes ☐ No	Diurnal bird survey and nest tree census in September 2022 and September 2023. Additional effort outside optimal period in March 2023
Turnip Copperburr	*Sclerolaena napiformis*	46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Dec	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022, September 2023 and December 2023
Slender Darling Pea	*Swainsona murrayana*	46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023
Red Darling Pea	*Swainsona plagiotropis*	46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023
Silky Swainson-pea	*Swainsona sericea*	46	No	Targeted threatened species survey	Parallel threatened flora traverses	Sep-Nov	☒ Yes ☐ No	Systematic coverage of potential habitat with traverses in September 2022 and September 2023

Common name	Scientific name	Associated PCTs at the proposal footprint	Present?	Method used to determine presence	Survey method	Recommended survey period (BAM-C / TBDC)	Timing of survey – within recommended period? (BAM-C / TBDC)	Effort
Masked Owl	*Tyto novaehollandiae*	7, 10, 13	No	Targeted threatened species survey	Spotlighting Call playback Nest tree census	May-Aug	☒ Yes ☐ No	Diurnal bird survey and nest tree census in August 2022 Additional effort outside optimal period in September 2022, March 2023 and September 2023

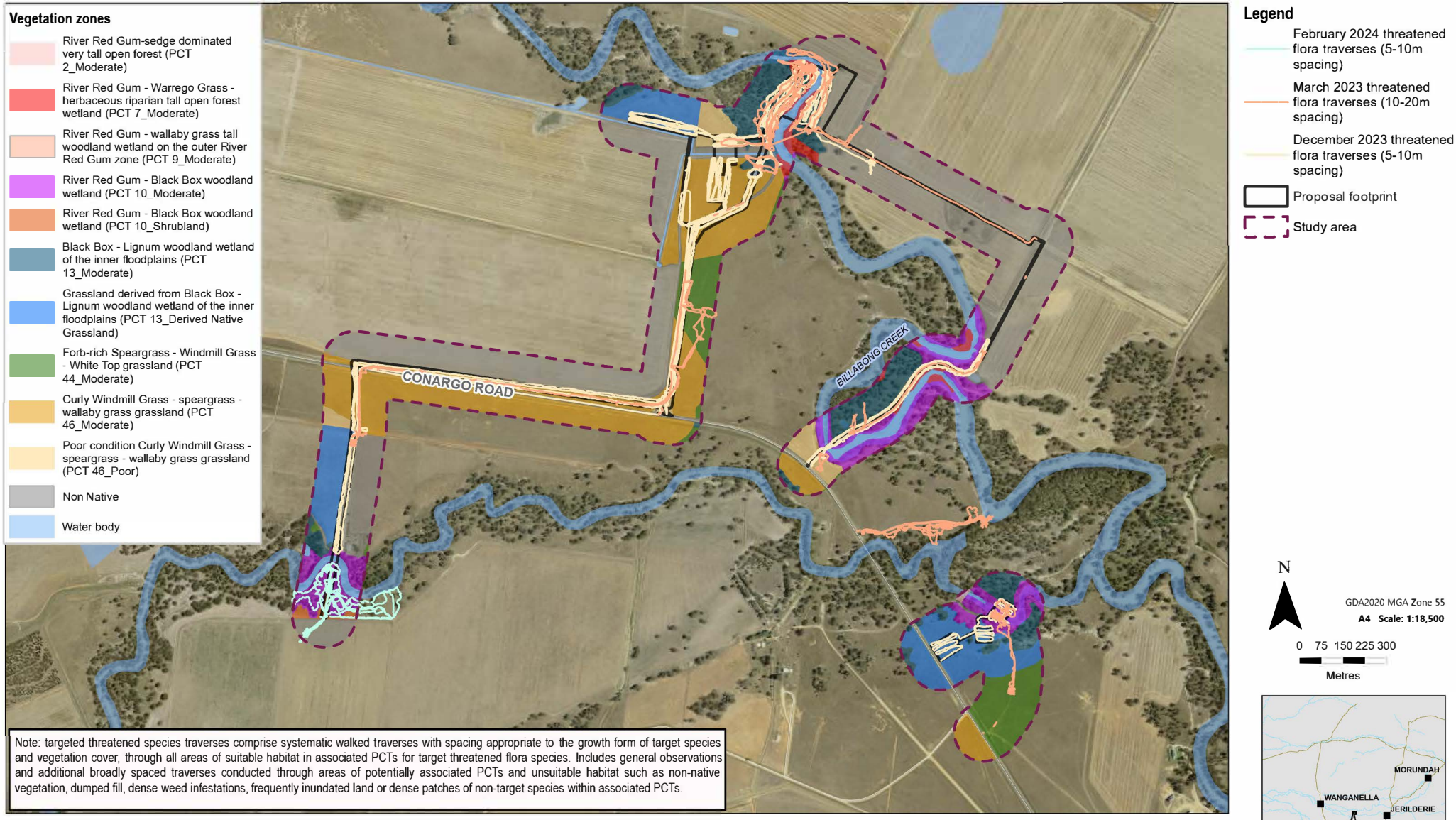
Notes: 'Parallel threatened flora traverses' comprise systematic traverses with 5-10m wide spacing through all areas of suitable habitat in associated PCTs according to the TBDC (DCCEEW 2024a). Includes general observations and additional broadly spaced traverses conducted through areas of potentially associated PCTs and unsuitable habitat such as bare earth or dense patches of non-target species within associated PCTs.
'Nest tree census' comprises systematic coverage of a 300 m buffer area surrounding the proposal footprint over the multiple rounds of field survey and identification of candidate nest trees based on presence of suitably sized trees with stick nests or appropriate hollows for the target species *and* at least one round of diurnal bird surveys *or* spotlighting and checking of candidate nest trees during the breeding-season survey period for the species as nominated in the TBDC (DCCEEW 2024a).



Note: targeted threatened species traverses comprise systematic walked traverses with spacing appropriate to the growth form of target species and vegetation cover, through all areas of suitable habitat in associated PCTs for target threatened flora species. Includes general observations and additional broadly spaced traverses conducted through areas of potentially associated PCTs and unsuitable habitat such as non-native vegetation, dumped fill, dense weed infestations, frequently inundated land or dense patches of non-target species within associated PCTs.

Figure 5.1 Hartwood September threatened flora survey effort

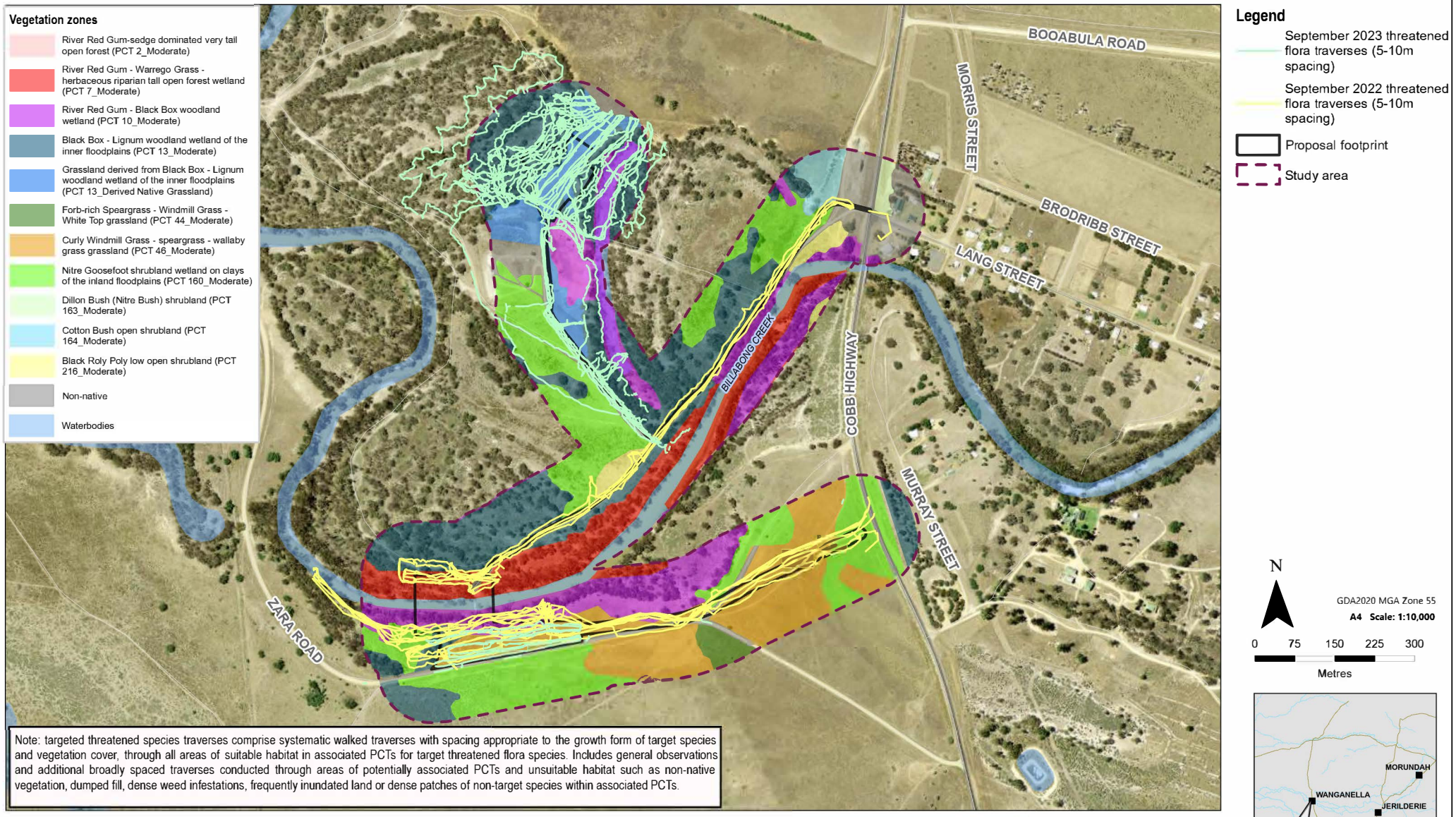
Produced by 3Rivers for the SDLAM Program. 3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein



Note: targeted threatened species traverses comprise systematic walked traverses with spacing appropriate to the growth form of target species and vegetation cover, through all areas of suitable habitat in associated PCTs for target threatened flora species. Includes general observations and additional broadly spaced traverses conducted through areas of potentially associated PCTs and unsuitable habitat such as non-native vegetation, dumped fill, dense weed infestations, frequently inundated land or dense patches of non-target species within associated PCTs.

Figure 5.2 Hartwood December to March threatened flora survey effort

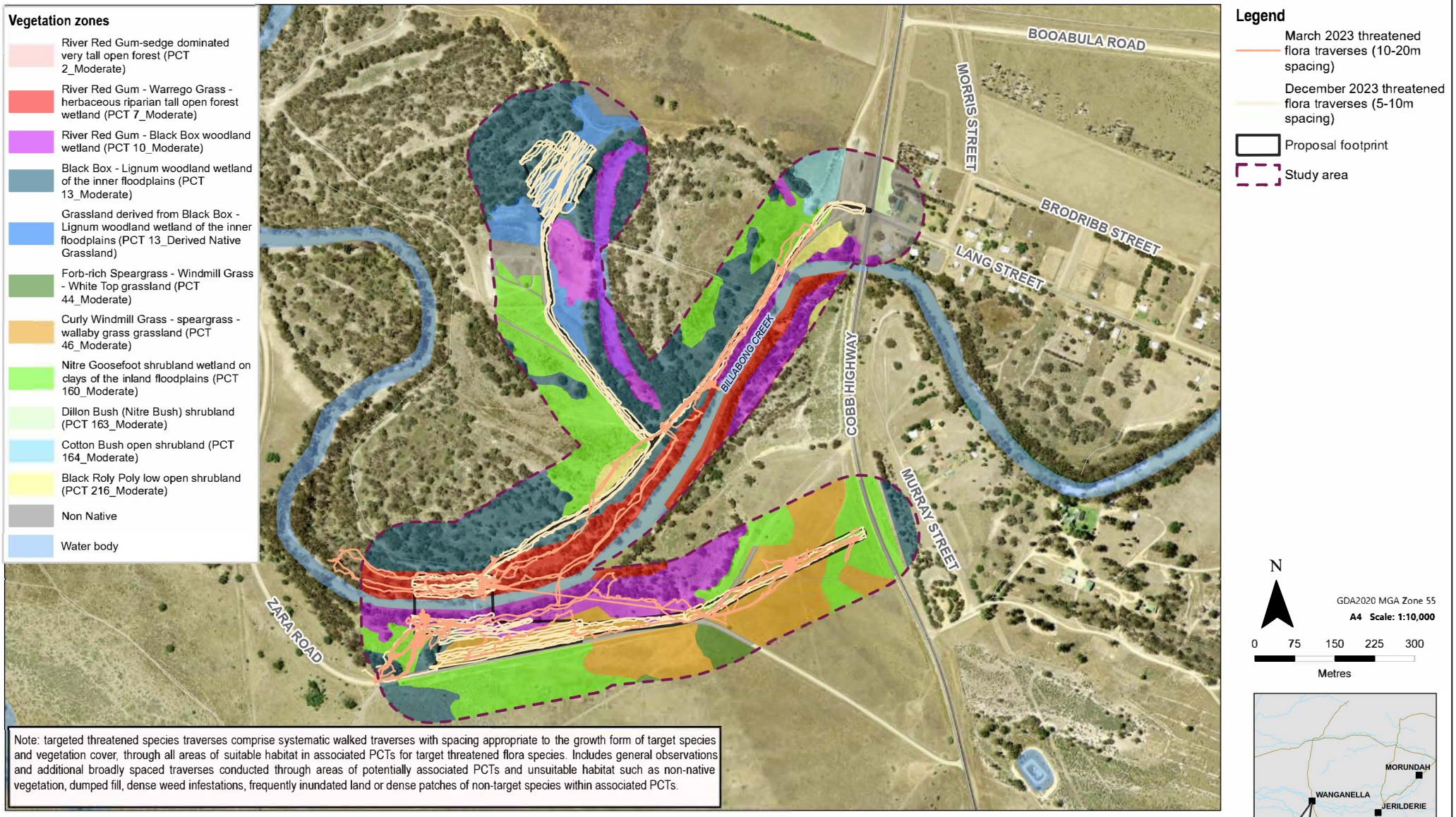
Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein



Note: targeted threatened species traverses comprise systematic walked traverses with spacing appropriate to the growth form of target species and vegetation cover, through all areas of suitable habitat in associated PCTs for target threatened flora species. Includes general observations and additional broadly spaced traverses conducted through areas of potentially associated PCTs and unsuitable habitat such as non-native vegetation, dumped fill, dense weed infestations, frequently inundated land or dense patches of non-target species within associated PCTs.

Figure 5.3 Wanganella September threatened flora survey effort

Produced by 3Rivers for the SDLAM Program. 3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein



Note: targeted threatened species traverses comprise systematic walked traverses with spacing appropriate to the growth form of target species and vegetation cover, through all areas of suitable habitat in associated PCTs for target threatened flora species. Includes general observations and additional broadly spaced traverses conducted through areas of potentially associated PCTs and unsuitable habitat such as non-native vegetation, dumped fill, dense weed infestations, frequently inundated land or dense patches of non-target species within associated PCTs.

Figure 5.4 Wanganella December to March threatened flora survey effort

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

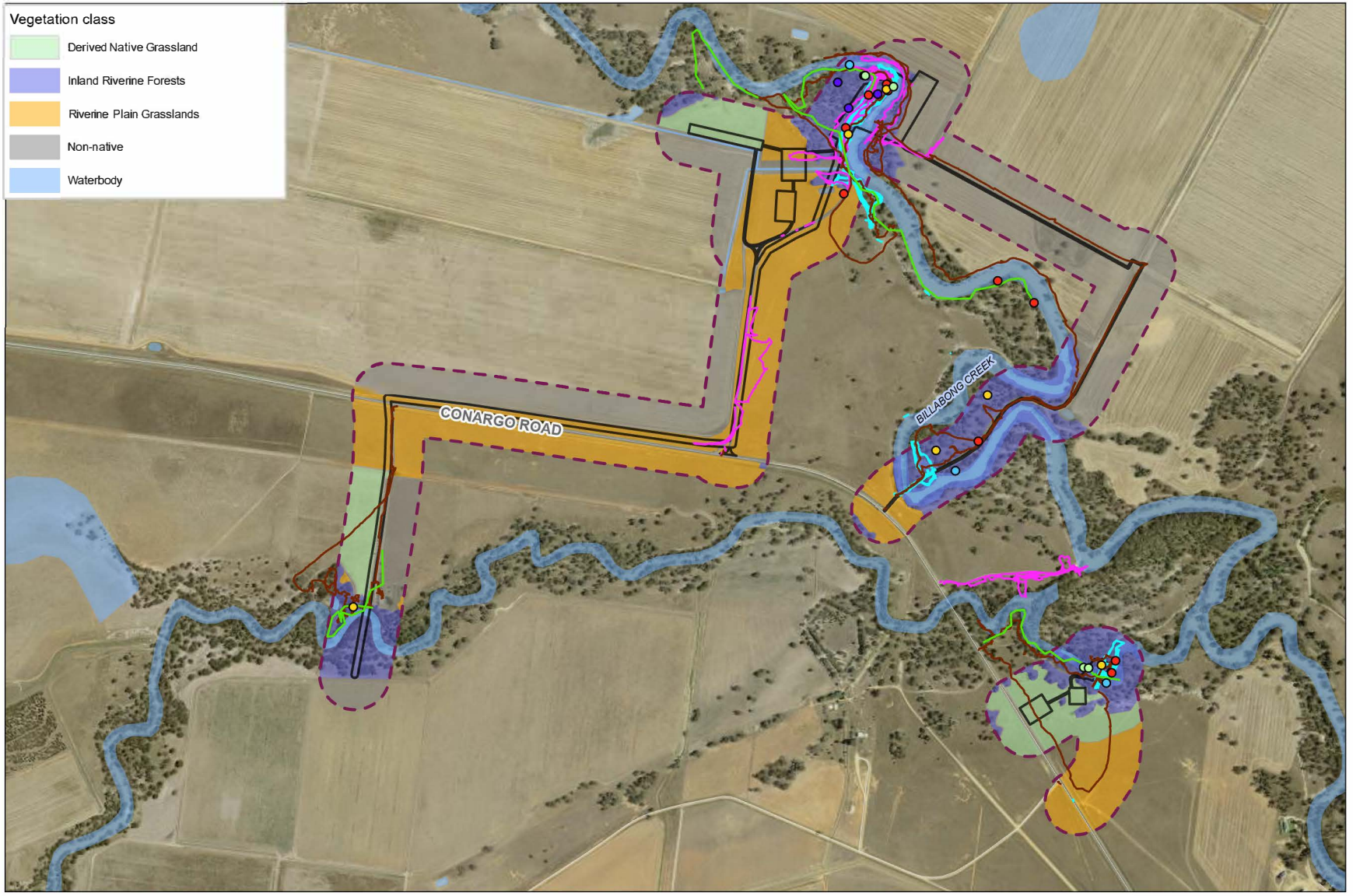


Figure 5.5 Hartwood threatened fauna survey effort

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

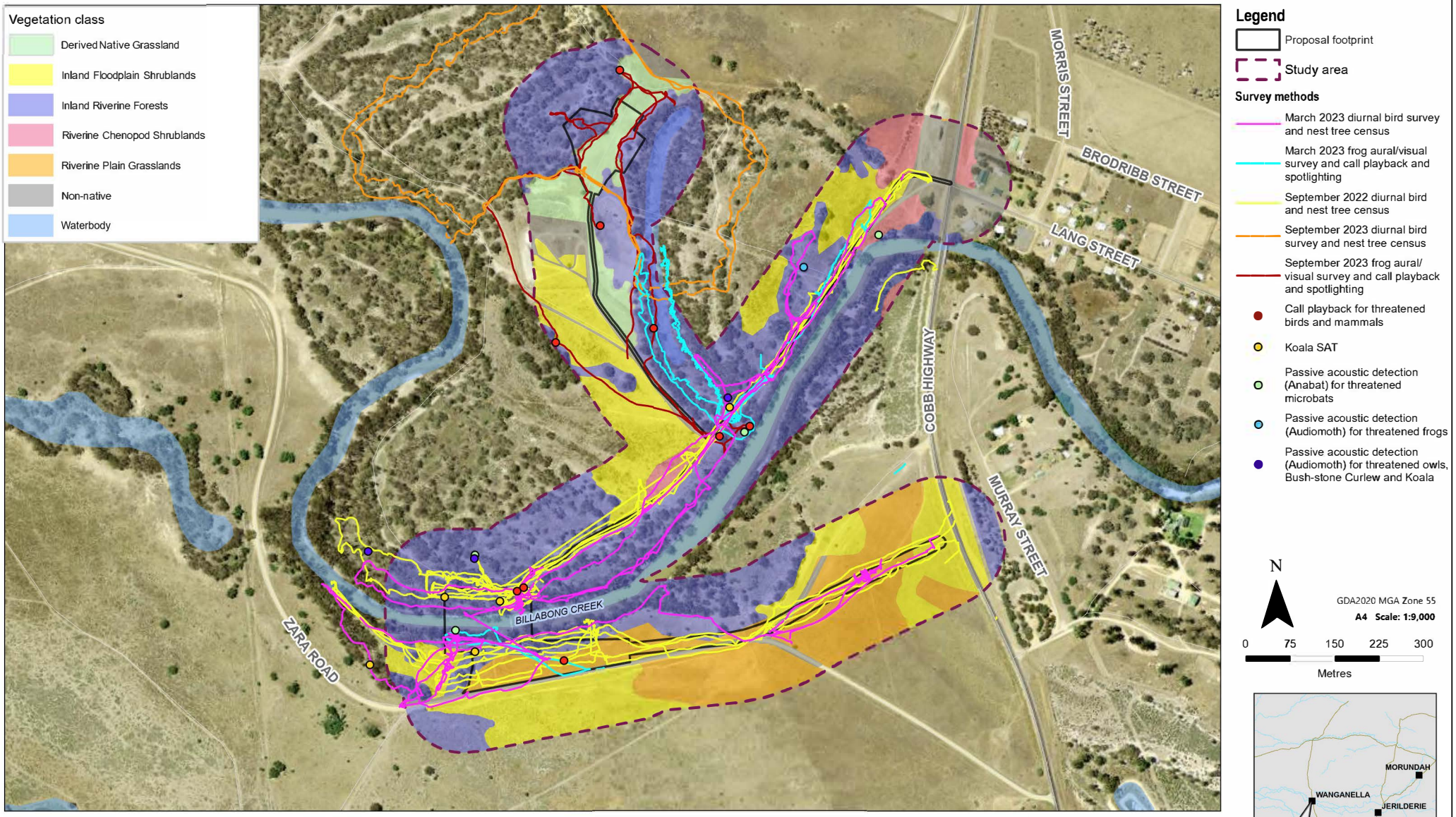


Figure 5.6 Wanganella threatened fauna survey effort

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

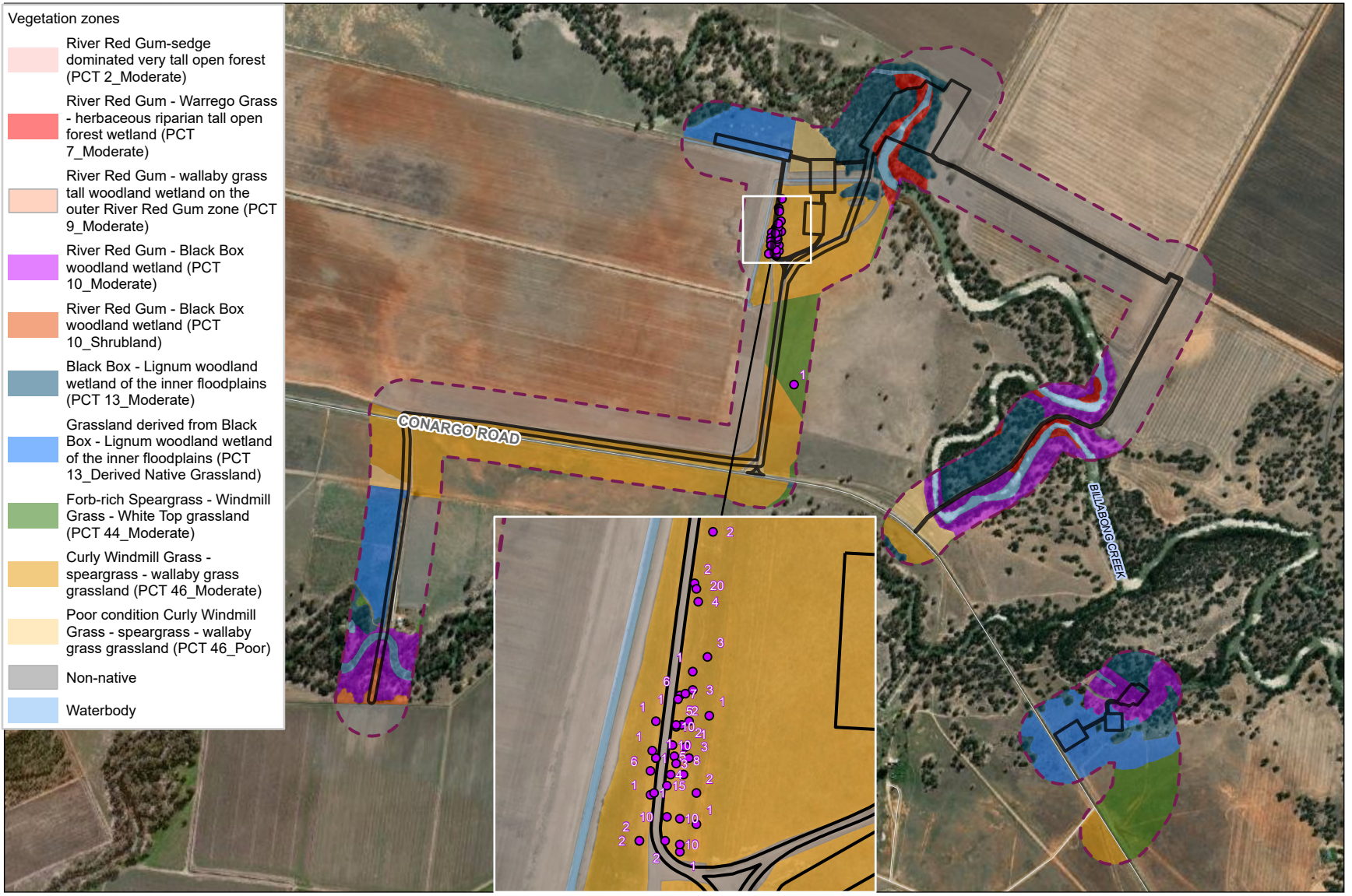


Figure 5.7 Hartwood threatened flora

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

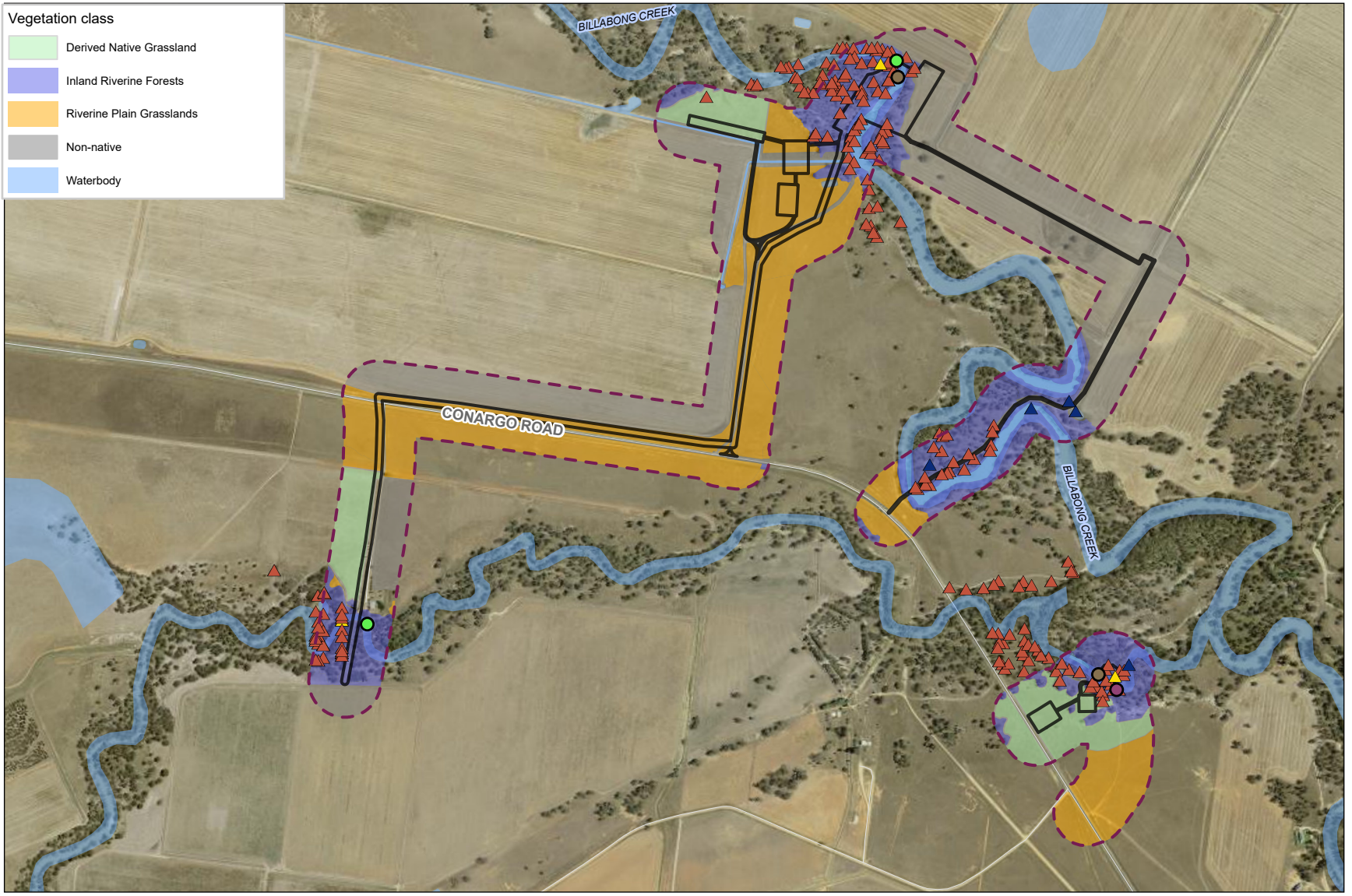


Figure 5.8 Hartwood threatened fauna and habitat resources

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

© Department of Customer Service 2020;06/05/2024 7:06 PM rvillalon \\gldnefsgld\AUSydney\Projects\21\12537654\GIS\Maps\Deliverables\SDLAM_Yanco\12537654_RFS083_Billabong_BDAR.aprx

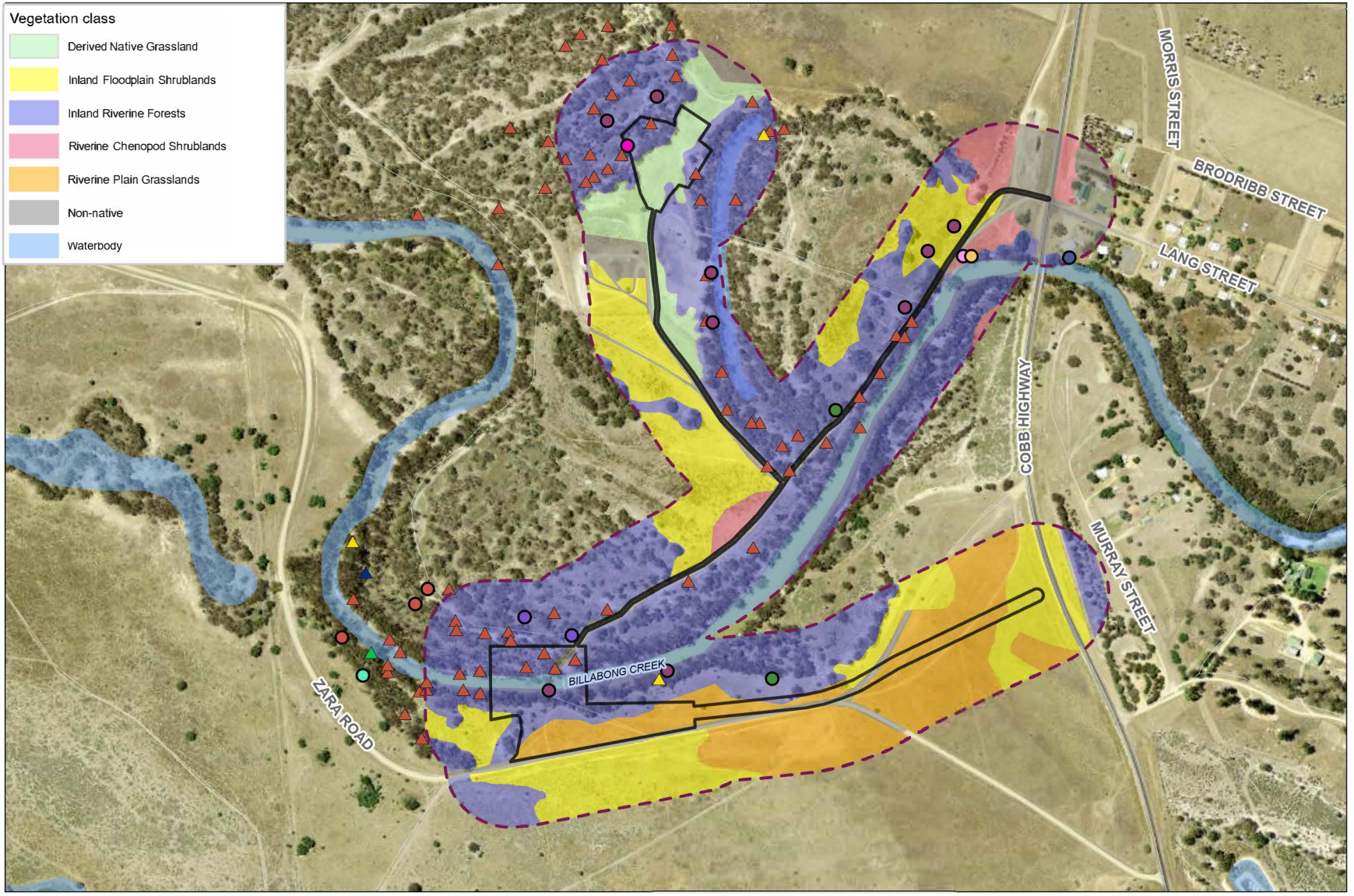


Figure 5.9 Wanganella threatened fauna and habitat resources

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

Table 5.5 Candidate species credit matters recorded in the proposal footprint

Common name	Scientific name	SAII entity	Habitat constraints / microhabitat presence in the proposal footprint	Species / population presence in the proposal footprint	TBDC / threatened species survey guidelines requirements for species polygons	Associated PCTs at the proposal footprint	Extent of impact
Hartwood							
Species credit entity recorded; species credits required							
Southern Bell Frog	*Litoria raniformis*	No	Breeding habitat Suitable breeding and non-breeding shelter in waterbodies with emergent aquatic vegetation on the margins of Billabong Creek, floodplain depressions and irrigation ditches. Foraging habitat and migratory habitat in native and non-native vegetation connected to the identified breeding habitat.	Detected by call on an Audiomoth recording device in the vicinity of the Forest Creek block bank in March 2023. Also observed downstream on the banks of Billabong Creek and associated oxbow lagoons at Wanganella and in the vicinity of Caroonboon Weir in February, March and September 2023.	The species polygon boundary should align with aquatic habitats linked directly to the record and a buffer, incorporating the PCTs with which the species is associated, of 200 metres radius from the top of bank. Where relevant this should include minimum 50-metre-wide corridors of native and non-native vegetated areas linking the available waterbodies (DPIE 2020b). A 200 m buffer has been mapped around all potential frog breeding habitat. Species polygons have been mapped to include all PCTs with which the species is associated in the proposal footprint and buffer area as shown on Figure 5.10.	7, 10, 13	5.25 ha
Southern Myotis	*Myotis macropus*	No	Waterbodies with permanent pools/stretches 3m or wider, including rivers, large creeks, billabongs, lagoons, estuaries, dams and other waterbodies, on or within 200m of the site.	Recorded at two locations over consecutive nights at Hartwood within riparian vegetation along Billabong Creek as shown in Figure 5.8 and Figure 5.12.	The species polygon boundary should align with all PCTs on the subject land with which the species is associated (as listed in the TBDC) that occur within 200 metres of the high bank, or high tide mark of creeks, rivers or other waterbodies mapped. If the species was recorded in any additional PCTs on the subject land these PCTs should also be included in the species polygon (NSW DCCEEW 2021).	7, 10, 13	3.70 ha

Common name	Scientific name	SAII entity	Habitat constraints / microhabitat presence in the proposal footprint	Species / population presence in the proposal footprint	TBDC / threatened species survey guidelines requirements for species polygons	Associated PCTs at the proposal footprint	Extent of impact
Plains-wanderer	*Pedionomus torquatus*	Yes	Important habitat for the species is mapped over part of the proposal footprint (DPE 2023b) associated with access and power supply to the Hartwood regulator.	Important habitat for the species is mapped over part of the proposal footprint (DPE 2023b). The species was not recorded despite targeted survey.	The species is considered present and the part of the proposal footprint that is within the important habitat map forms the species polygon used to generate species credits (DCCEEW 2024a). Species polygons have been mapped accordingly as shown on Figure 5.11.	44, 46	1.96 ha
Slender Darling Pea	*Swainsona murrayana*	No	Suitable habitat present.	Recorded within and adjacent to access track and power supply footprints as shown on Figure 5.7.	The species has been confirmed as absent from the majority of the potential habitat at the study area through targeted survey. No *Swainsona murrayana* individuals were recorded within the proposal footprint. A total of 172 *Swainsona murrayana* individuals were recorded in the local area, with all of these individuals outside of the direct impact area. Species polygons were mapped according to the BAM and threatened flora survey guidelines (DPIE 2020a) based on the GHD accredited assessor's assessment of the area of occupied, suitable microhabitat surrounding the identified population. The species polygon encompasses contiguous vegetation zones in which the species was detected in the proposal footprint, consistent with the species polygon guidance for the species presented in the TBDC (DCCEEW 2024b). A total of 2.22 ha of species polygons have been mapped accordingly as shown on Figure 5.13.	44, 46	2.22 ha

Common name	Scientific name	SAII entity	Habitat constraints / microhabitat presence in the proposal footprint	Species / population presence in the proposal footprint	TBDC / threatened species survey guidelines requirements for species polygons	Associated PCTs at the proposal footprint	Extent of impact
Species recorded, species credits not required							
Little Eagle (nesting)	*Hieraaetus morphnoides*	No	Candidate nest trees are present in River Red Gum and Black Box woodland and forest (PCTs 7, 10 and 13).	One individual observed soaring in the vicinity of the proposal footprint in September 2022. No active nest trees observed in the study area, or additional evidence of breeding such as begging birds of any age or sex, or an occupied nest, despite systematic nest tree census in August 2022, September 2022 and September 2023.	Species polygon should be established by providing a circular polygon with a 300 m radius around the nest tree. This includes habitat suitable for feeding/grooming perches and fledgling requirements. It does not account for foraging habitat (DCCEEW 2024a). No actual nest trees present in the study area.	N/A	Nil

Common name	Scientific name	SAII entity	Habitat constraints / microhabitat presence in the proposal footprint	Species / population presence in the proposal footprint	TBDC / threatened species survey guidelines requirements for species polygons	Associated PCTs at the proposal footprint	Extent of impact
Wanganella							
Species credit entity recorded; species credits required							
Bush Stone-curlew	*Burhinus grallarius*	No	Suitable habitat with 'fallen/standing dead timber including logs' is present in River Red Gum and Black Box woodland and forest (PCTs 7, 10 and 13).	The owner of the Wanganella general store observed and photographed a Bush Stone-curlew in February 2023 in River Red Gum-Black Box woodland around 300 m to the east of the proposal footprint. The species identity and location was confirmed in discussion with GHD ecologists. This record of the species is in the same broad patch of native vegetation as the proposal footprint, associated with the Billabong Creek riparian corridor. This observation is considered reliable evidence that the Bush Stone-curlew occurs at the Wanganella proposal footprint.	Species polygons mapped at Wanganella over all PCTs with which the species is associated according to the TBDC and containing the habitat constraint 'fallen/standing dead timber including logs' (DCCEEW 2024a) as shown on Figure 5.16.	7, 10, 13	2.12 ha

Common name	Scientific name	SAII entity	Habitat constraints / microhabitat presence in the proposal footprint	Species / population presence in the proposal footprint	TBDC / threatened species survey guidelines requirements for species polygons	Associated PCTs at the proposal footprint	Extent of impact
Little Eagle (nesting)	*Hieraaetus morphnoides*	No	Candidate nest trees are present in River Red Gum and Black Box woodland and forest (PCTs 7, 10 and 13).	Individuals observed soaring in the vicinity of the proposal footprint on multiple occasions in September 2022. A pair of birds were observed circling over a likely nest tree containing a large stick nest on multiple occasions during nest tree census and diurnal bird surveys in September 2022.	Species polygon should be established by providing a circular polygon with a 300 m radius around the nest tree. This includes habitat suitable for feeding/grooming perches and fledgling requirements. It does not account for foraging habitat (DCCEW 2024a). A 300 m buffer has been mapped around the Little Eagle nest tree. Species polygons have been mapped including all native vegetation in the proposal footprint and the buffer area as shown on Figure 5.14.	7, 10, 13, 46, 160	1.25 ha
Southern Bell Frog	*Litoria raniformis*	No	Breeding habitat Suitable breeding and non-breeding shelter in waterbodies with emergent aquatic vegetation on the margins of Billabong Creek, floodplain depressions and irrigation ditches. Foraging habitat and migratory habitat in native and non-native vegetation connected to the identified breeding habitat.	Recorded on the banks of Billabong Creek and associated oxbow lagoons in the vicinity of the Wanganella Weir and downstream in the vicinity of the Caroonboon Weir in February, March and September 2023. Also recorded via Audiomoth at Hartwood (Forest Creek block bank).	The species polygon boundary should align with aquatic habitats linked directly to the record and a buffer, incorporating the PCTs with which the species is associated, of 200 m radius from the top of bank. Where relevant this should include minimum 50-metre-wide corridors of native and non-native vegetated areas linking the available waterbodies (DPIE 2020b). A 200 m buffer has been mapped around all potential frog breeding habitat. Species polygons have been mapped to include all PCTs with which the species is associated in the proposal footprint and buffer area as shown on Figure 5.15.	7, 10, 13 according to the TBDC (DCCEEW 2024a). Also 160 via direct observation.	3.28 ha

Common name	Scientific name	SAII entity	Habitat constraints / microhabitat presence in the proposal footprint	Species / population presence in the proposal footprint	TBDC / threatened species survey guidelines requirements for species polygons	Associated PCTs at the proposal footprint	Extent of impact
Species recorded, species credits not required							
Pink Cockatoo (nesting)	*Lophochroa leadbeateri*	No	Candidate nest trees with hollows >10cm diameter present in River Red Gum and Black Box woodland and forest (PCTs 7, 10 and 13).	One individual observed foraging in September 2023. No actual nest trees observed in the study area, or additional evidence of breeding such as begging birds of any age or sex, or an occupied nest, despite systematic nest tree census in September 2022, in September 2023 at the same time as the species observation, and in December 2023.	If actual nest trees are confirmed on site, then the species polygons are to be drawn around those actual nest trees (i.e. trees that birds of the species are known to have used for nesting). The species polygons should be circular in shape and must include a buffer radius of 200 m around each actual nest tree. The shape of the buffer can be modified where an alternative shape would better meet the species needs in the context of the assessment site (DCCEWW 2024a). No actual nest trees present in the study area.	N/A	Nil

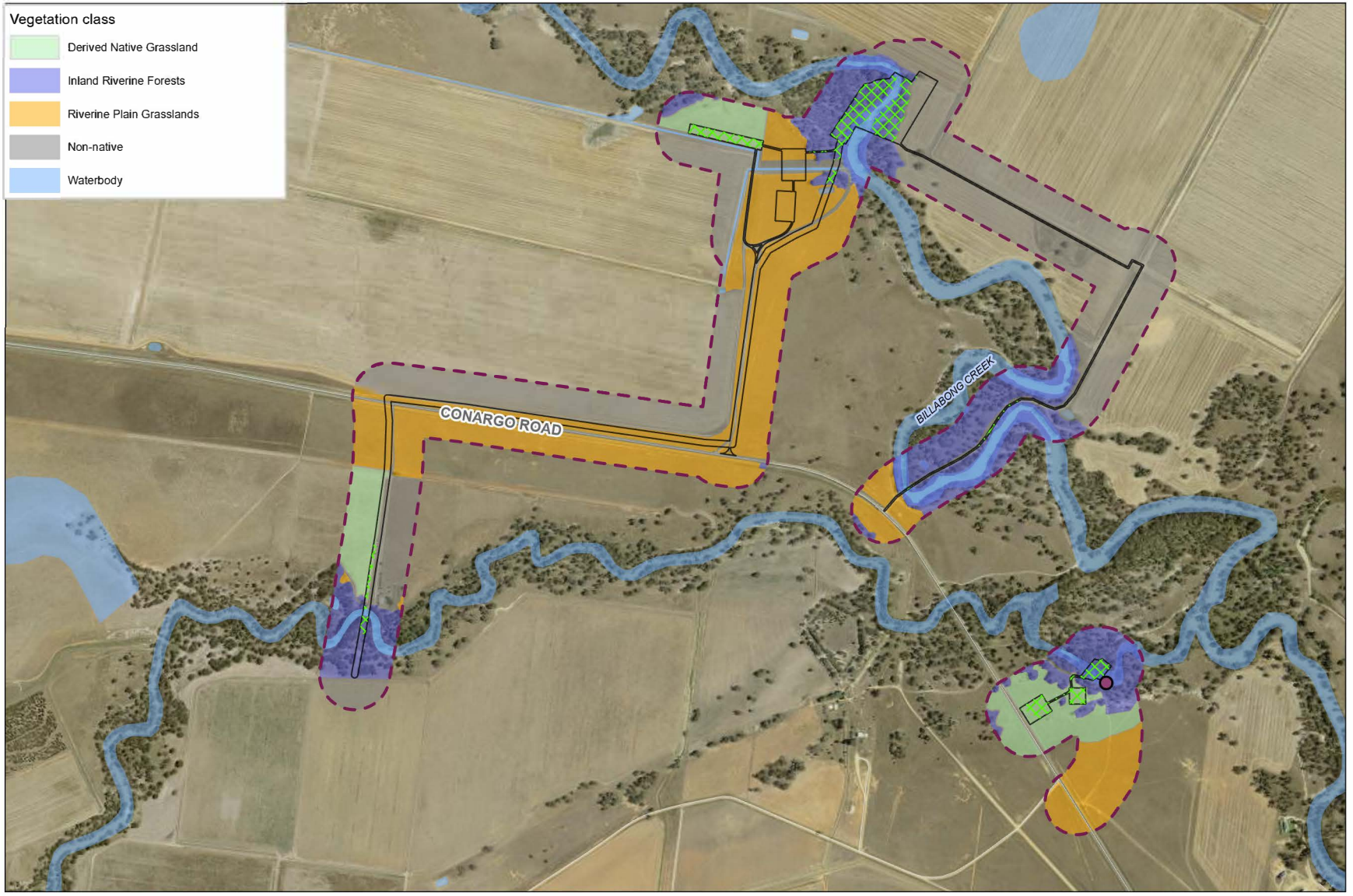
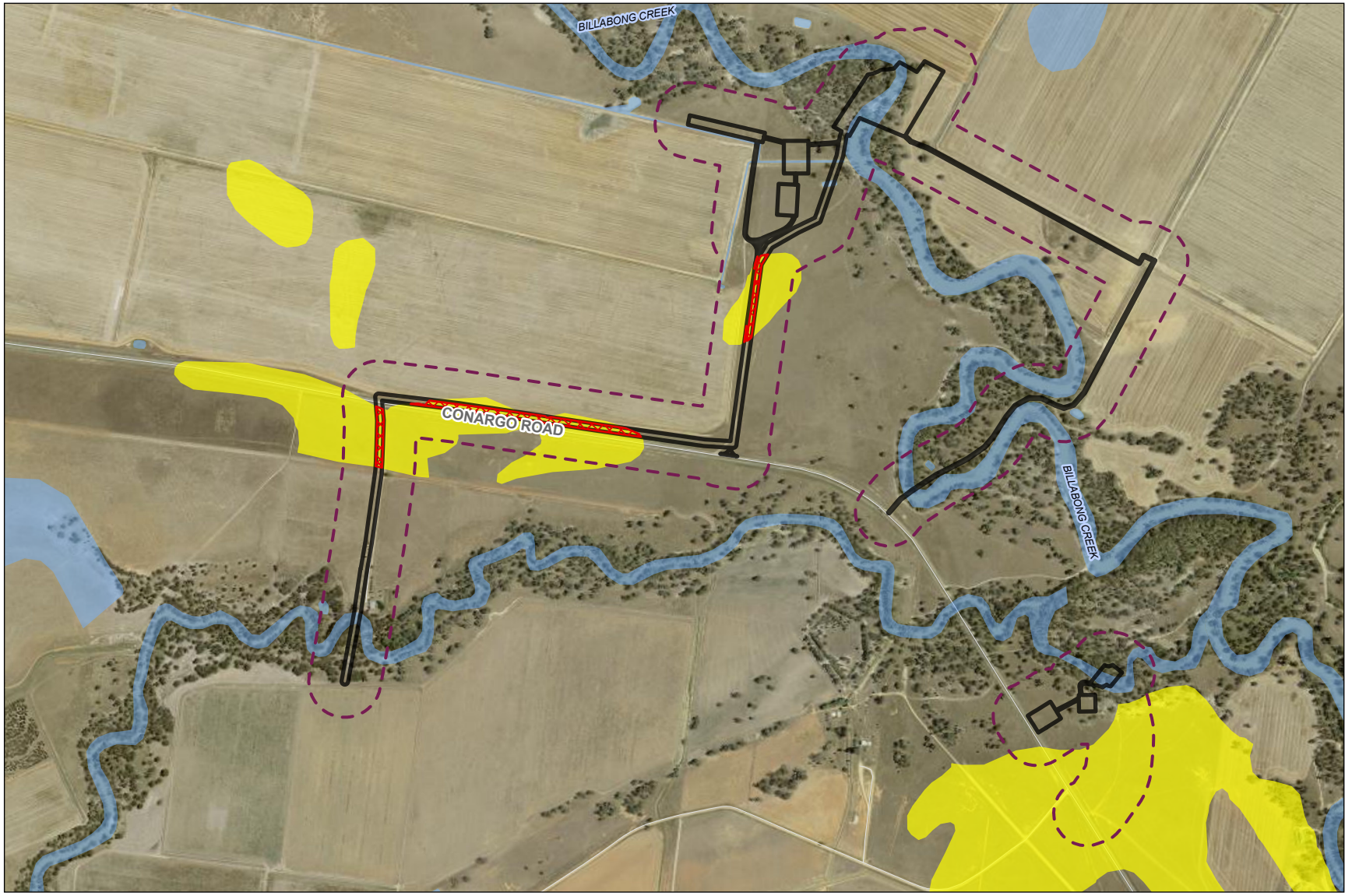


Figure 5.10 Hartwood Southern Bell Frog species polygons

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein



LEGEND

- Proposal footprint
- Study area
- Plains-wanderer species polygon
- Plains-wanderer Important Habitat Mapping

N

GDA2020 MGA Zone 55

A4 Scale: 1:18,000

0 75 150 225 300

Metres

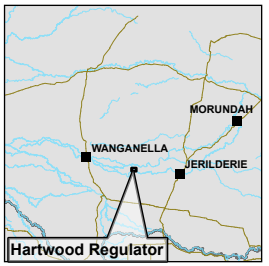


Figure 5.11 Hartwood Plains-wanderer species polygons

3Rivers

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

© Department of Customer Service 2020;25/03/2024 8:28 AM rvillalon \\ghdnetghd\AU\Sydney\Projects\21\12537654\GIS\Maps\Deliverables\SDLAM_Yanco\12537654_RFS083_Billabong_BDAR.aprx

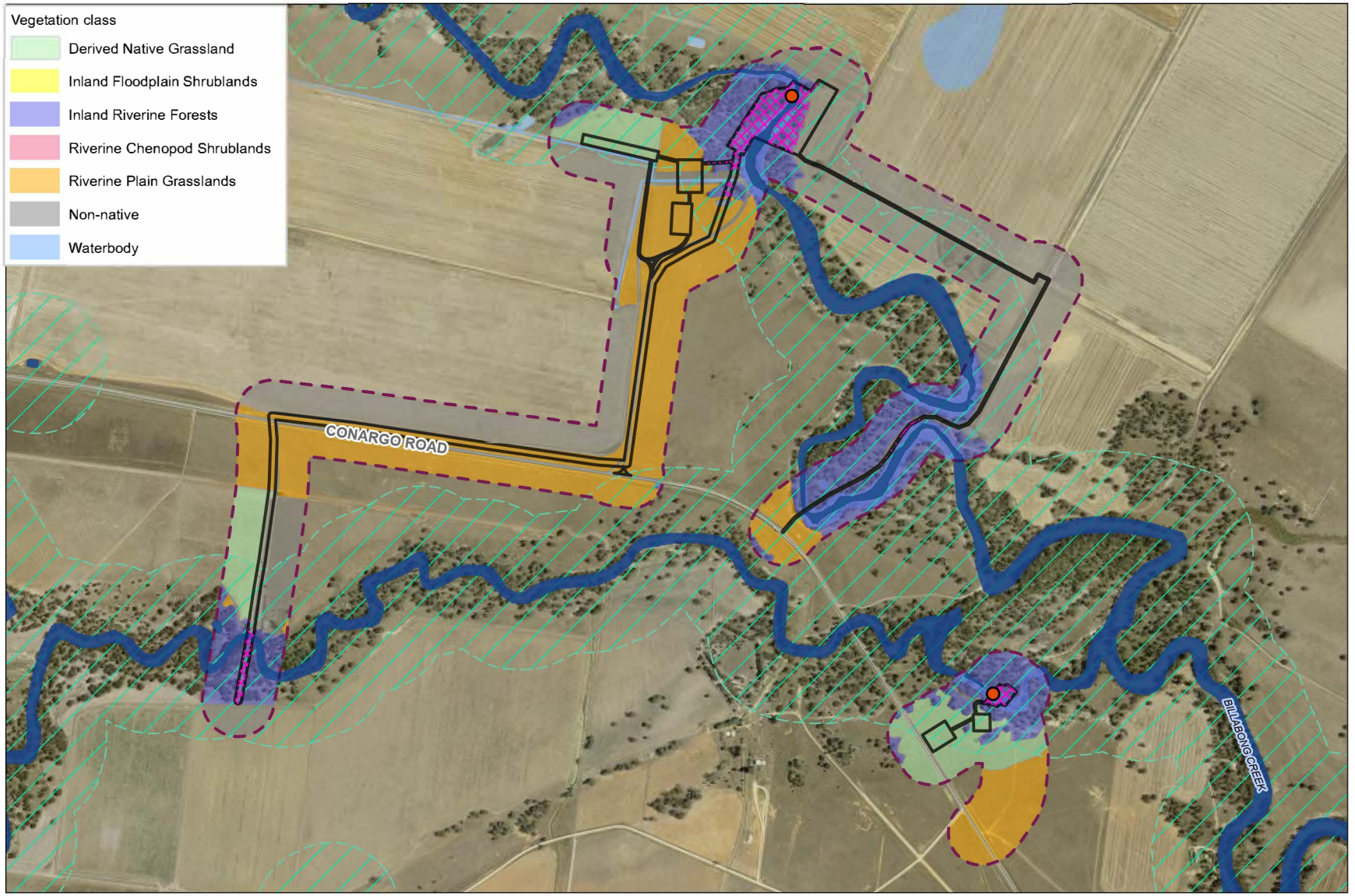


Figure 5.12 Hartwood Southern Myotis species polygons

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

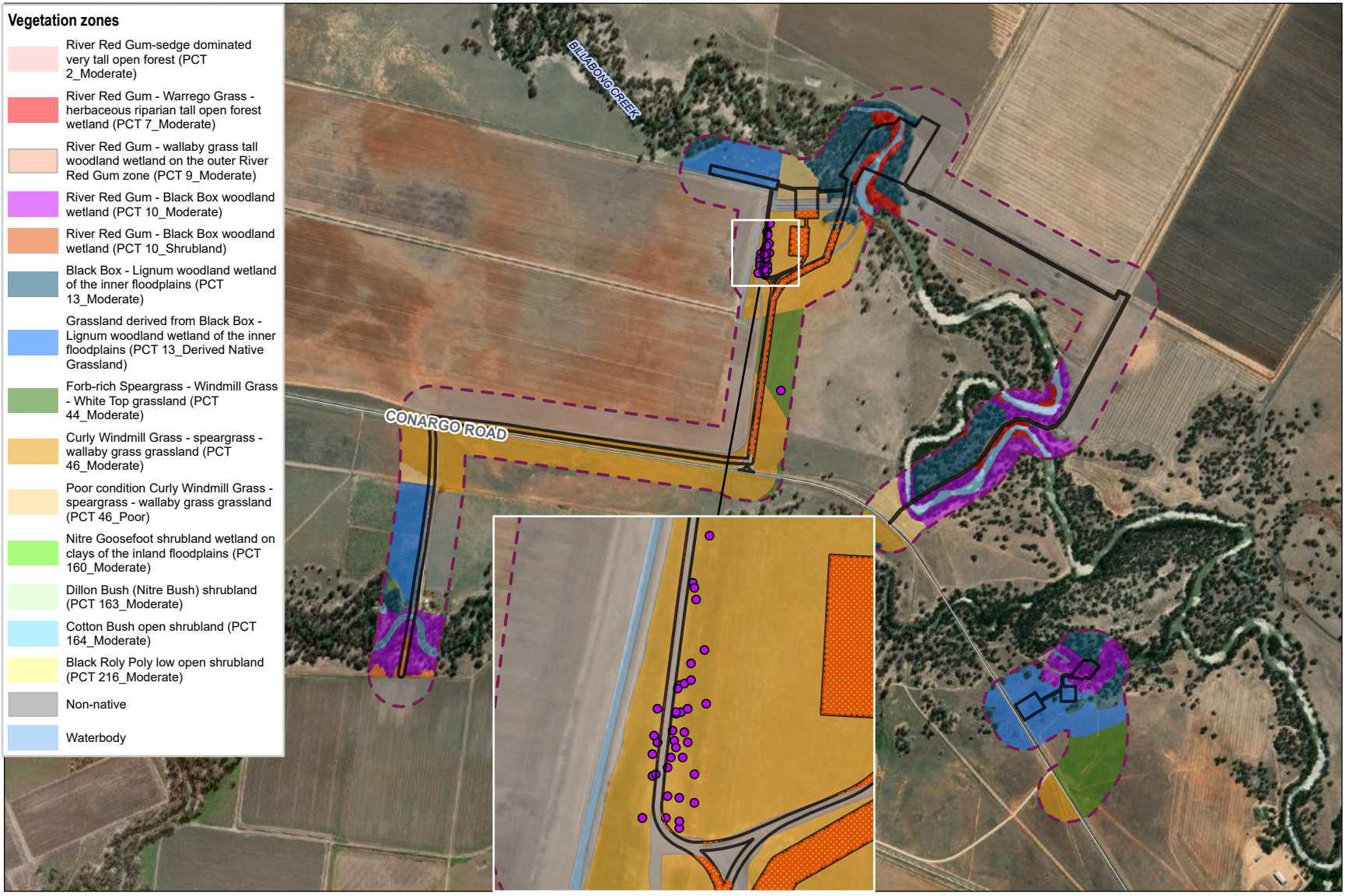


Figure 5.13 Hartwood Slender Darling-pea species polygons

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

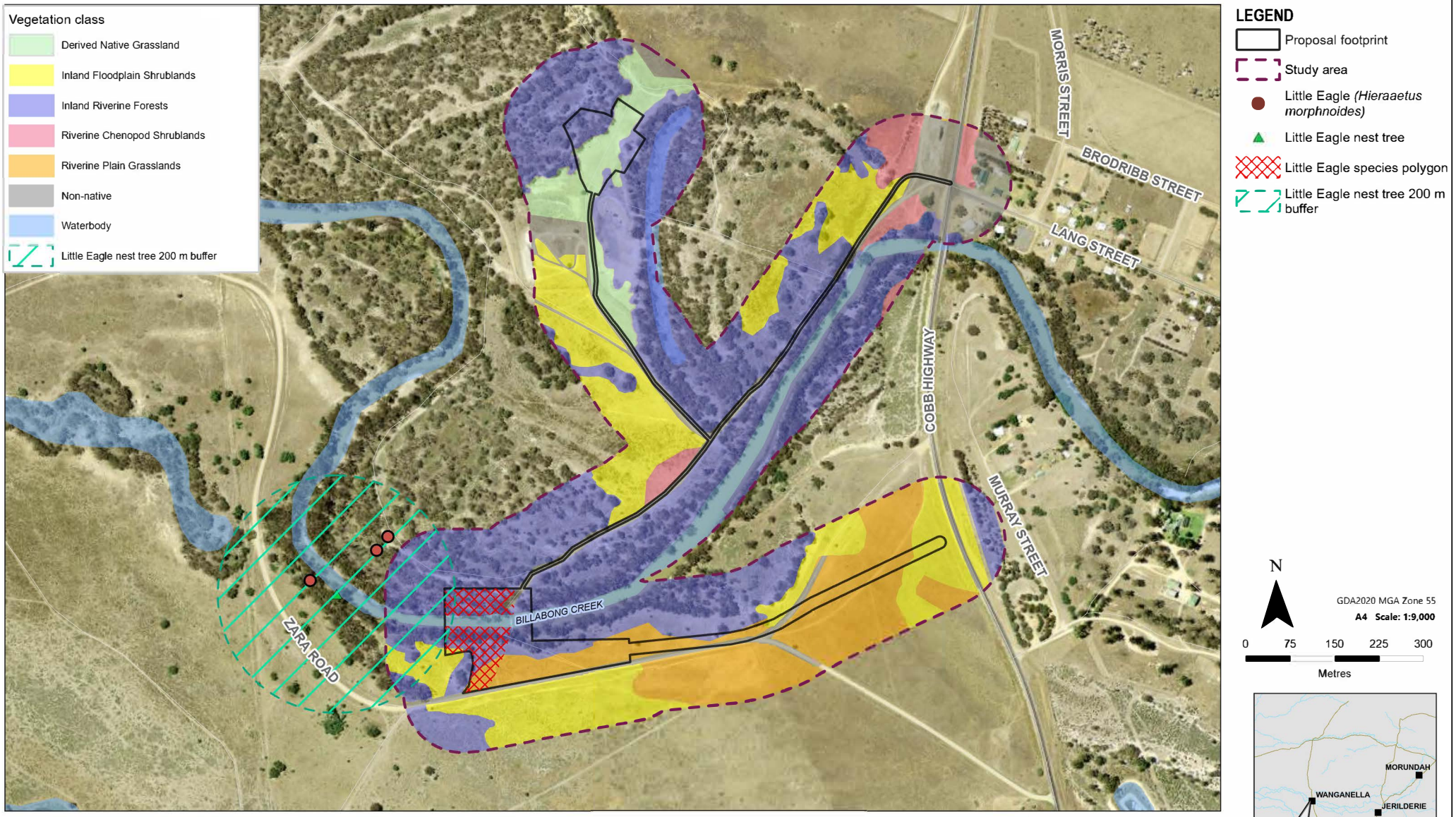


Figure 5.14 Wanganella Little Eagle species polygons

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

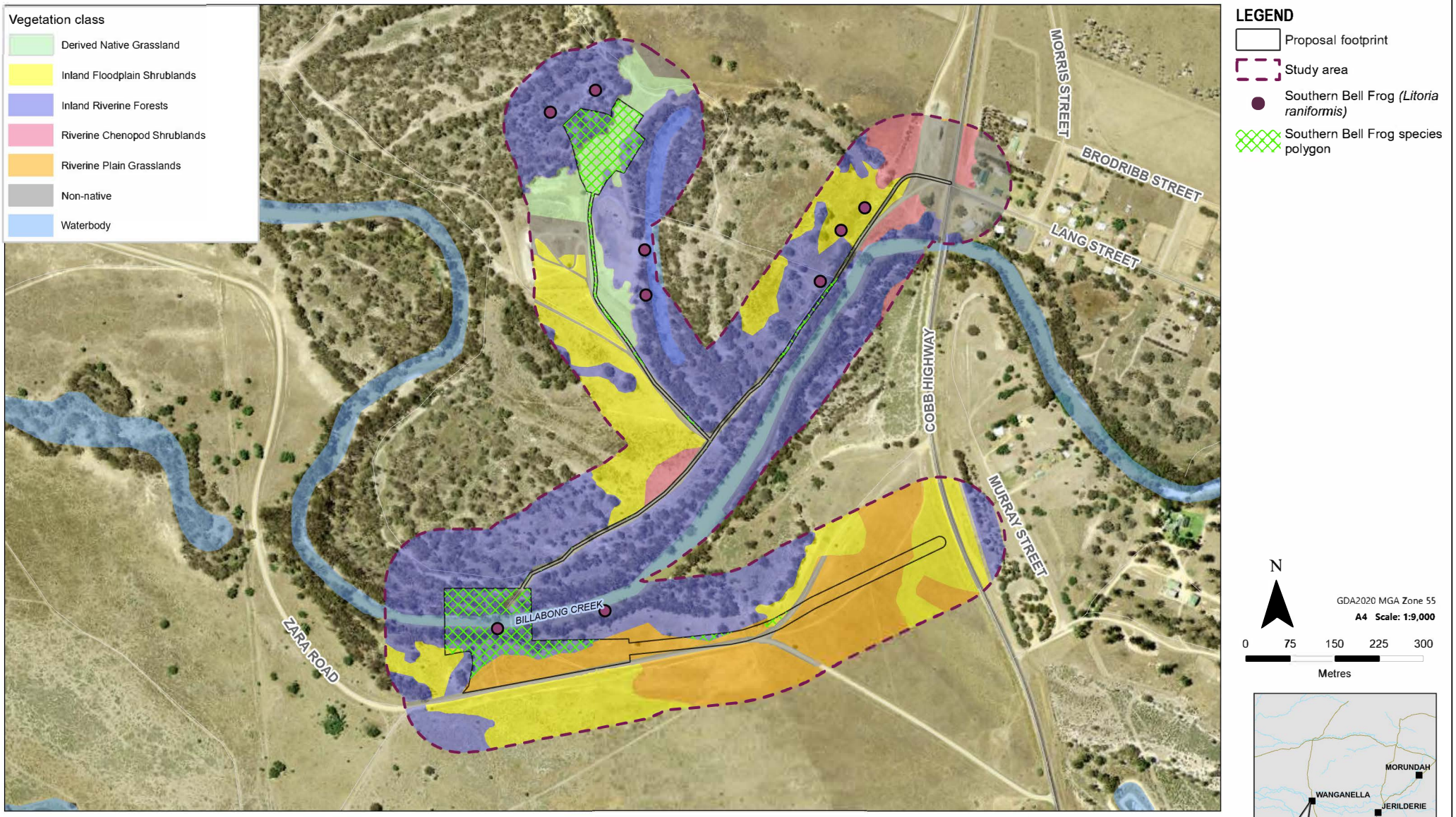


Figure 5.15 Wanganella Southern Bell Frog species polygons

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

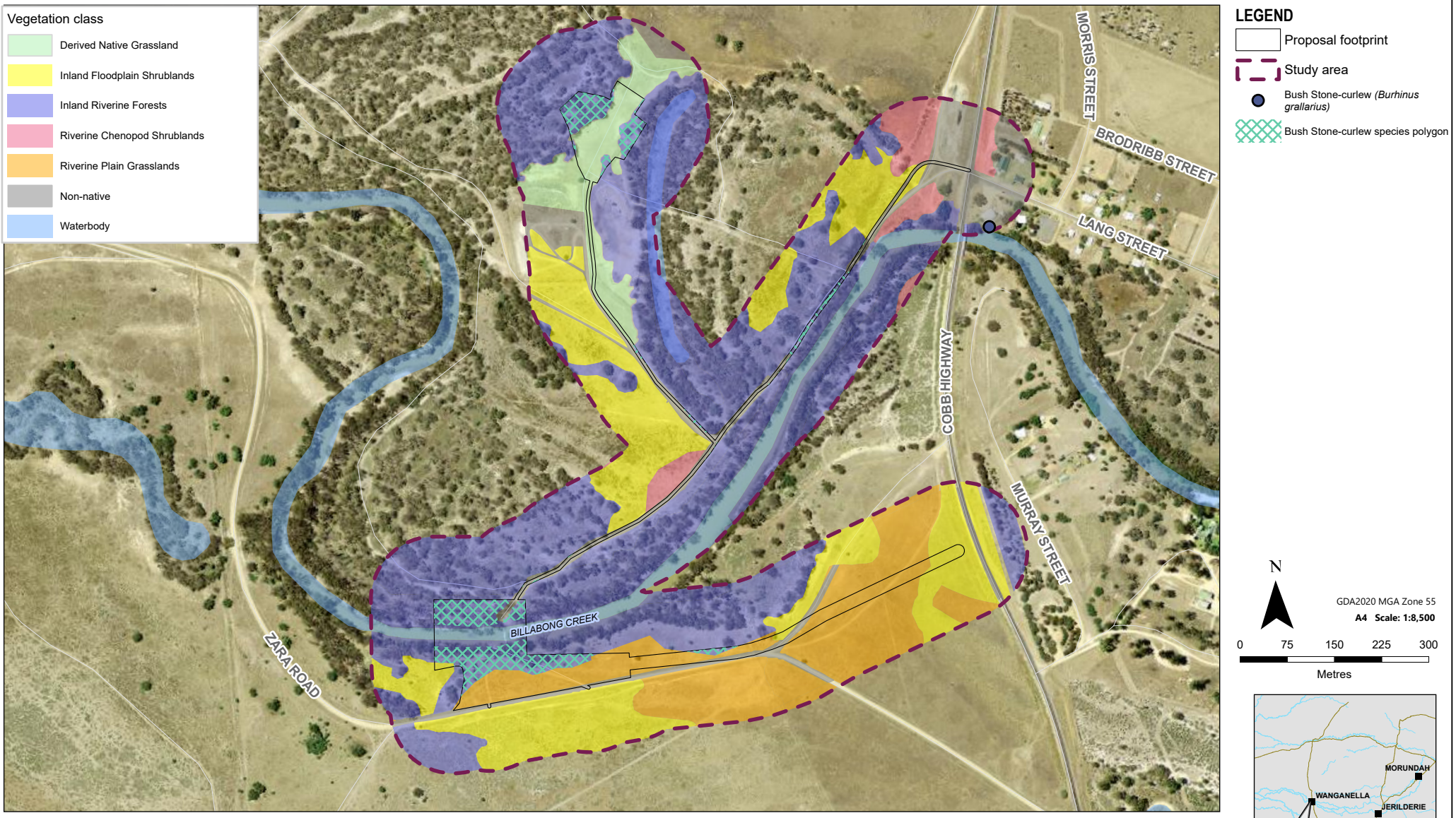


Figure 5.16 Wanganella Bush Stone-curlew species polygons

3Rivers

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

© Department of Customer Service 2020;06/05/2024 7:31 PM rvillalon \\gldnefigfsd\AUSydney\Projects\21112537654\GIS\Maps\Deliverables\SDLAM_Yanco\12537654_RFS083_Billabong_BDAR.aprx

5.3 Matters of National Environmental Significance

5.3.1 Threatened ecological communities

The study area contains potential habitat for the 'Natural Grasslands of the Murray Valley Plains' ecological community which is listed as a CEEC under the EPBC Act. While the CEEC is associated with both PCT 44 and PCT 46 which are present in the study area (NSW DCCEEW 2023a), it is subject to location and condition criteria specified in the listing advice for the community (TSSC 2012). An analysis of these location and condition criteria has confirmed that the native grassland at the proposal footprint does not comprise an occurrence of the CEEC (see Appendix section B-2). No TECs listed under the EPBC Act are present within the Hartwood or Wanganella proposal footprint

5.3.2 Threatened species

Three threatened species listed under the EPBC Act were recorded during surveys:

– The woodland bird species Southern Whiteface was recorded at Wanganella on several occasions in the August 2022 and February 2023 surveys.
– One Pink Cockatoo was observed foraging at Wanganella in September 2023.
– A population of *Swainsona murrayana* was recorded within and adjacent to access track and power supply footprints at Hartwood in September 2023.

No other threatened species listed under the EPBC were recorded at the proposal footprint. Based on the results of the site surveys and habitat assessments, there is potential habitat for several additional threatened species as summarised in Table 5.6. There are no known records of any of these species, or specific habitat features or resources at the proposal footprint that suggest that it would be important to any populations of any of these species. The fauna species listed as a 'possible' likelihood of occurrence below would not occur at the proposal footprint on a long-term basis or rely on any of the habitat resources at the proposal footprint for their persistence in the local area. They are only likely to pass over or through the proposal footprint on a transient basis (if at all) as part of their use of habitat resources in the local area. Potential impacts on threatened fauna and their habitats that have been recorded or that are a 'possible', 'likely' or 'present' likelihood of occurrence at the proposal site are considered further in section 9.4 and Appendix H. It should be noted that this likelihood of occurrence is a different threshold to that for calculating species credits according to the BAM. Certain EPBC Act-listed fauna species that are also species credit matters have been excluded through targeted survey. Specifically, there are no Pink Cockatoo nest trees or Superb Parrot nest trees requiring calculation of species credits according to the BAM. Species credits have been calculated for the Plains-wanderer, Southern Bell Frog and Slender Darling Pea according to the BAM (see section 5.2).

Various other species have been assessed to have a low potential to occur given lack of suitable habitat and/or because the proposal footprint is outside of the known geographic range of the species (see Appendix B). MNES with an 'unlikely' or 'nil' likelihood of occurrence are not considered further in this assessment. The study area does not comprise any Critical Habitat for any species as defined under section 207A of the EPBC Act included in the Register of Critical Habitat (Cth. DCCEEW 2024c).

Table 5.6 Threatened species listed under the EPBC Act that may occur at the proposal footprint

Common name	Scientific name	EPBC Act status	Likelihood of occurrence
Wetland birds			
Australasian Bittern	*Botaurus poiciloptilus*	E	Possible
Sharp-tailed Sandpiper	*Calidris acuminata*	V	Possible
Latham's Snipe	*Gallinago hardwickii*	V	Possible
Australian Painted Snipe	*Rostratula australis*	E	Possible
Common Greenshank	*Tringa nebularia*	E	Possible

Common name	Scientific name	EPBC Act status	Likelihood of occurrence
Semi-arid grassland, shrubland and woodland birds			
Southern Whiteface	*Aphelocephala leucopsis*	V	Present, recorded at Wanganella
Grey Falcon	*Falco hypoleucos*	V	Possible
Painted Honeyeater	*Grantiella picta*	V	Possible
Pink Cockatoo	*Lophochroa leadbeateri*	E	Present, recorded at Wanganella
Hooded Robin (south-eastern)	*Melanodryas cucullata cucullata*	E	Possible
Blue-winged Parrot	*Neophema chrysotoma*	V	Possible
Plains-wanderer	*Pedionomus torquatus*	CE	Assumed present at Hartwood due to mapped important areas within proposal footprint
Superb Parrot	*Polytelis swainsonii*	V	Likely
Diamond Firetail	*Stagonopleura guttata*	V	Possible
Microbat			
Corben's Long-eared Bat	*Nyctophilus corbeni*	V	Possible
Reptiles			
Grey Snake	*Hemiaspis damelii*	E	Possible
Amphibians			
Southern Bell Frog	*Litoria raniformis*	V	Present, recorded at Wanganella and Hartwood
Plants			
Slender Darling Pea	*Swainsona murrayana*	V	Present

Notes: E – endangered species; V – vulnerable species.

5.3.3 Migratory shorebird species

A critical consideration in assessing the significance of potential impacts on listed migratory shorebird species is whether or not a proposed action is likely to affect 'important habitat' (DotE 2015). Important habitat mapping by DPE (2022c) maps areas that support bird numbers exceeding the international and national significance thresholds as defined above and in the Wildlife Conservation Plan for Migratory Shorebirds (DotE 2015). The proposal footprint does not intersect any important habitat for any migratory shorebird species. However potential habitat is present for the migratory species listed in Table 5.7.

Table 5.7 Migratory shorebird species listed under the EPBC Act that may occur at the proposal footprint

Common name	Scientific name	EPBC Act status	Likelihood of occurrence
Sharp-tailed Sandpiper	*Calidris acuminata*	C, J, K	Possible
Pectoral Sandpiper	*Calidris melanotos*	J, K	Possible
Latham's Snipe	*Gallinago hardwickii*	J, K	Possible
Common Greenshank	*Tringa nebularia*	C, J, K	Possible

Notes: C=listed as a migratory species under the China-Australia Migratory Bird Agreement (CAMBA), J= listed as a migratory species under the Japan-Australia Migratory Bird Agreement (JAMBA), K= listed as a migratory species under the Korea-Australia Migratory Bird Agreement (KAMBA)

5.3.4 Migratory terrestrial species

Referral guidelines have been published for 14 migratory terrestrial species with consideration of impacts mainly based on the presence of important habitat (DotE 2015). Habitat in the proposal footprint is not likely to support an ecologically significant proportion of the population of any of these species, be of critical importance to the species at particular life-cycle stages, is not located at the limit of any of the species' range, and/or located within an area where the species is declining. As such, potential habitat in the study area is not 'important habitat' for any of these species, as defined in the guidelines (DotE 2015).

There is potential foraging or resting habitat at the proposal footprint for migratory terrestrial bird species that may occur in, or fly over, woodland and grassland habitats. None of these species would be reliant upon habitats within the proposal footprint for any part of their life cycle. They would be most likely to fly over the proposal footprint, if occurring in the locality at all, and no impact on these species is expected as a result of this proposal (Appendix B).

6. Identifying prescribed impacts

6.1 Introduction

The Biodiversity Conservation Regulation 2017 (BC Regulation) (clause 6.1) identifies additional biodiversity impacts to which the BOS applies. These 'prescribed impacts' are the impacts on biodiversity values which are not related to, or are in addition to, native vegetation clearing and habitat loss. These types of impacts are used by the decision-maker to inform the determination and conditions of consent for developments. These include:

– On the habitat of threatened entities including:
  - karst, caves, crevices, cliffs, rocks and other geological features of significance,
  - human-made structures, or
  - non-native vegetation.
– On areas connecting threatened species habitat, such as movement corridors.
– That affect water quality, water bodies and hydrological processes that sustain threatened entities.
– On threatened and protected animals from turbine strikes from a wind farm (not relevant to this proposal).
– On threatened species or fauna that are part of a TEC from vehicle strikes.

The BDAR must identify the relevant prescribed impacts and the suite of threatened species that use or rely on the habitat values or would be affected by the impact, as specified in BAM section 6. The likelihood, extent and magnitude of prescribed impacts must then be assessed using the approach specified in the BAM section 8.3.

6.2 Threatened biota that may be subject to prescribed impacts

Threatened species of relevance to this proposal are described in Table 6.1. Potentially affected threatened species were identified based on the desktop assessment (see Appendix B), site inspections and habitat assessments described above and have been grouped according to shared life histories and habitat associations.

Table 6.1 Threatened species potentially subject to prescribed impacts

Group	Species
Frogs	Southern Bell Frog (*Litoria raniformis*)
Microbats	Corben's Long-eared Bat (*Nyctophilus corbeni*) Inland Forest Bat (*Vespadelus baverstocki*) Little Pied Bat (*Chalinolobus picatus*) Southern Myotis (*Myotis macropus*) (Hartwood only) Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)
Grassland/shrubland birds	Plains-wanderer (*Pedionomus torquatus*) (Hartwood only) White-fronted Chat (*Epthianura albifrons*)
Woodland birds	Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*) Blue-winged Parrot (*Neophema chrysotoma*) Bush Stone-curlew (*Burhinus grallarius*) (Wanganella only) Diamond Firetail (*Stagonopleura guttata*) Dusky Woodswallow (*Artamus cyanopterus cyanopterus*) Flame Robin (*Petroica phoenicea*) Gilbert's Whistler (*Pachycephala inornata*) Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) Hooded Robin (south-eastern) (*Melanodryas cucullata cucullata*) Pink Cockatoo (*Lophochroa leadbeateri*) Painted Honeyeater (*Grantiella picta*) Pied Honeyeater (*Certhionyx variegatus*)

Group	Species
	Regent Honeyeater (*Anthochaera phrygia*) Scarlet Robin (*Petroica boodang*) Southern Whiteface (*Aphelocephala leucopsis*) Superb Parrot (*Polytelis swainsonii*) Swift Parrot (*Lathamus discolor*) Varied Sittella (*Daphoenositta chrysoptera*) White-fronted Chat (*Epthianura albifrons*) White-fronted Needletail (*Hirundapus caudacutus*)
Raptors	Black Falcon (*Falco subniger*) Grey Falcon (*Falco hypoleucos*) Little Eagle (*Hieraaetus morphnoides*) Spotted Harrier (*Circus assimilis*) Square-tailed Kite (*Lophoictinia isura*) White-bellied Sea-eagle (*Haliaeetus leucogaster*)
Wetland birds	Australasian Bittern (*Botaurus poiciloptilus*) Australian Painted Snipe (*Rostratula australis*) Blue-billed Duck (*Oxyurus australis*) Brolga (*Grus rubiconda*) Freckled Duck (*Stictonetta naevosa*) Latham's Snipe (*Gallinago hardwickii*) Magpie Goose (*Anseranas semipalmata*) Sharp-tailed Sandpiper (*Calidris acuminata*) Common Greenshank (*Tringa nebularia*)
Reptiles	Grey Snake (*Hemiaspis damelii*)
Flora	Slender Darling Pea (*Swainsona murrayana*)

6.3 Prescribed impacts assessment

Table 6.2 summarises the prescribed impact features listed in the BC Regulation and BAM along with an assessment of their presence or otherwise in the study area, their characteristics and location, and the threatened entities that are associated with the feature at the proposal footprint. Further discussion is provided in section 8.3.

Table 6.2 Prescribed impacts

Feature	Present	Description of feature characteristics and location	Threatened entities that use, are likely to use, or are part of the habitat feature.
Karst, caves, crevices, cliffs, rocks or other geological features of significance	No	There are no areas of karst, caves, crevices or cliffs in the proposal footprint.	NA
Human-made structures	Yes	Irrigation canals occur in farmland in the vicinity of Hartwood Weir. A pump-house and dilapidated bridge occur at Hartwood Weir Existing weirs occur at Hartwood and Wanganella sites.    	A number of irrigation canals occur in the study area. The Southern Bell Frog has been recorded using fringing vegetation along irrigation canals as over-winter habitat (Wassens 2008). Canals can also facilitate the movement of frogs throughout the landscape (Mazerolle 2005). Waterbirds such as the Australasian Bittern may forage along canals. The Southern Myotis may also forage within these canals if small fish and insects are present. The two existing weirs in the study area disrupt water flow processes and modify instream geomorphology downstream Billabong Creek. The structures themselves, may provide marginal perching habitat for a number of wetlands birds.

Feature	Present	Description of feature characteristics and location	Threatened entities that use, are likely to use, or are part of the habitat feature.
Non-native vegetation	Yes	Areas of crop and other non-native vegetation occur in parts of the study area. 	Threatened microbats, shrubland and woodland birds and raptors may travel or forage over non-native on occasion if prey species are present or while moving between adjoining areas of native vegetation. Some small woodland birds (eg White-fronted Chats) may breed in non-native vegetation (thistles etc). A proportion of the proposal footprint comprises cleared or cropped land. Small areas of planted trees (eg windbreaks) also occur. These provide foraging habitat for several threatened fauna species. Some species may also breed in non-native vegetation. Woodland birds such as the Diamond Firetail, White-fronted Chat and Superb Parrot may forage on seeds and insects within cropped and other exotic vegetation. The White-fronted Chat is also known to breed within exotic plants such as thistles. Non-native vegetation in the proposal footprint is likely to provide a small proportion of available foraging and/or breeding habitat in the locality. The Plains-wanderer prefers sparse, treeless, species-rich, lowland native grasslands, but occasionally occurs in other types of habitat: it has been recorded in cereal stubble, and amongst low crops of cereal grasses (DoE 2016). Important habitat is mapped within and in close proximity to the proposal footprint at Hartwood. The Plains-wanderer may occur in cropped land on occasion however this non-native vegetation is considered marginal habitat only. The Brolga is also known to forage in paddocks, irrigated pasture and cropped areas (DCCEEW 2024b). Various raptors hunt over non-native vegetation. The Spotted Harrier eats terrestrial birds (such as quail and pipits), mammals (rabbits and rodents), reptiles and large insects (Debus 2019). The Little Eagle forages in open woodland and adjacent areas. In Victoria the highest reporting rates for the species were in the Mid and Lower Murray Valley where wetlands and irrigated farmlands adjoin River Red Gum woodlands and forests (Emison et al 1987). In the south of its range the Little Eagle prefers young rabbits, while in the north it prefers birds, and in the arid zone reptiles (small goannas, dragons and large skinks) (Debus 2019). These species are likely to forage above and within cropped land in the proposal footprint as part of a wider foraging territory. Non-native vegetation in the proposal footprint is likely to provide a proportion of available foraging habitat in the locality. Microbats including the Large Bent-winged Bat, Little Pied bat, Inland Forest Bat and Yellow-bellied Sheath-tail Bat forage for insects in a range of habitats, including above grassland. These species fly within a few metres of the ground, catching a range of insects (Churchill 2008). These species are likely to forage above cropped land. Non-native vegetation in the proposal footprint is likely to provide a small proportion of available foraging habitat in the locality.

Feature	Present	Description of feature characteristics and location	Threatened entities that use, are likely to use, or are part of the habitat feature.
Habitat connectivity	Yes	Riparian vegetation provides connectivity of forested habitat at a regional scale 	Most threatened terrestrial species in the area are likely to rely on riparian vegetation to some degree for connectivity through the landscape. Woodland birds are the key threatened species group most likely to be impacted by potential connectivity loss as a result of the proposal. In extensively cleared areas, where riparian vegetation may form the majority of the remnant native vegetation, it may be considered a critical landscape component (Fisher and Goldney 1997). Riparian vegetation provides important movement corridors for many species. Riparian vegetation has been shown to be a key element for avian diversity, even in massively altered landscapes (Johnson et al 2007). These areas are also particularly important as drought refuges (Morton 1990 in Macleod 2002). Habitat connectivity provided by riparian vegetation is particularly important for small woodland birds.
Waterbodies, water quality and hydrological processes	Yes	The proposal footprint is located on the floodplains of Billabong Creek and Forest creek. All native vegetation and threatened species habitat in the proposal footprint is subject to, and to varying degrees dependent upon, flooding from these waterbodies. There is also a network of irrigation canals at Hartwood that would have value for native biota during wet periods. The frequency, timing, extent and depth of inundation by floodwaters influences the character and health of this habitat. The aim of the proposal is to reduce unplanned end of system flows in the Billabong Creek through replacement of existing fixed crest weirs with automatic remote controlled regulators at Hartwood and Wanganella. The gated regulators will allow regulation of flows in the lower sections of the Billabong Creek, providing river operators with greater operational flexibility to provide water to where it is needed, resulting in improvements in delivery efficiency. In doing so the proposal would affect hydrological processes.	Frogs and wetland birds rely on riverine and billabong habitats in the study area and downstream of the proposal footprint. The Southern Bell Frog would use parts of the proposal footprint for breeding, refuge and foraging habitat, where waterbodies are in close proximity. Various wetland birds may forage in the area on occasion, and may breed where habitats are suitable. The Southern Myotis forages above waterways.

Feature	Present	Description of feature characteristics and location	Threatened entities that use, are likely to use, or are part of the habitat feature.
		The proposal would potentially temporarily affect water quality in waterbodies within the proposal footprint during construction. 	
Vehicle strikes	Yes	The risk of vehicle strike currently exists in various levels along regional and local roads, and farm tracks. Increased road traffic during construction would increase the risk of vehicle strike for some species. 	Few threatened terrestrial species are likely to occur in the study area. Species such as the Plains-wanderer and Bush Stone-curlew, and raptors that forage on road kill, are at most risk of vehicle strike. The Southern Bell Frog is unlikely to be subject to vehicle strike given its predominantly nocturnal nature, while vehicle movements would occur during the day. Roads in the vicinity of the proposal footprint are shown on Figure 1.1. Despite being predominantly terrestrial species, vehicle strike is not included as a key threat in the national recovery plan for the Plains-wanderer (Commonwealth DCCEEW 2016) or for the Bush-Stone curlew (Commonwealth DCCEEW 2006). Notwithstanding this, important habitat for the Plains-wanderer is mapped in the study area, and the species may be at risk of vehicle strike. Existing risk of vehicle strike for these species is moderate to high given the vicinity of the Cobb Highway and Conargo Road to the proposal footprint.

Stage 2: Impact assessment (biodiversity values and prescribed impacts)

7. Avoid and minimise impacts

7.1 Introduction

The Yanco Creek Modernisation Project (YCMP) is investigating the modernisation of infrastructure to enable smarter use of water in the Yanco Creek System – including Billabong Creek and Forest Creek. It involves a series of initiatives aiming to improve water management as part of commitments within the Sustainable Diversion Limit Adjustment Mechanism (SDLAM) program. This project is one component of the YCMP, and aims to replace existing weirs along Billabong Creek with new regulators.

The proposal would result in direct impacts on native vegetation and threatened species habitats as shown in Figure 4.1 and Figure 4.2. There is also the potential for indirect impacts on areas of native vegetation adjacent to the proposal footprint, both during construction and from the operation of regulating weirs. The proposal will result in impacts prescribed under the Biodiversity Regulation, including impacts on non-native vegetation during construction and impacts from changes in hydrology during construction and operation.

The BAM identifies two key areas of project planning to avoid and minimise direct, indirect and prescribed impacts:

– proposal location – locating the development away from the highest biodiversity values
– proposal design – retaining biodiversity values through design features that limit vegetation clearing or reduce the amount of development within the footprint.

Specific mitigation measures are recommended to minimise likely impacts on biodiversity values. These measures are presented according to the hierarchy of avoidance and minimise of impacts, mitigation of the effect of unavoidable impacts, and finally the provision of offsets to compensate for residual impacts of the proposal.

7.2 Avoid and minimise direct and indirect impacts

7.2.1 Proposal location and design

The location of the proposal footprint is inextricably tied to the location of the existing weirs. Associated infrastructure are also tied to the location of the proposed regulators. Discussion of opportunities to avoid impacts are provided in Table 7.1.

Table 7.1 Avoidance

Action	Outcome
Details of constraints that have influenced the selection of the proposal's location	This proposal is one component of the YCMP, developed through a multi criteria assessment that considered social, cultural, environmental and economic factors. Environmental factors included aspects of native vegetation and habitat values. Decisions about locating the regulators and access routes were informed by targeting already disturbed areas or locating proposal components in close proximity to existing infrastructure.
Alternatives for the location and design of the proposal have been evaluated with evidence of analysis of social, economic and environmental considerations	Initial option selection for YCMP components, including options for new regulators on Billabong Creek, followed a multi criteria assessment process with broad stakeholder input. Further refinement of the proposal was also informed by biodiversity surveys and cultural heritage surveys. The initial findings of these field surveys and the potential for extensive adverse impacts contributed to refining the proposal from four regulators to the current two, and defined constraints at those locations. The requirements for effective fish passage at the regulators also constrained the final locations of the regulators and associated fishways within the creek
Consideration of alternative technologies to achieve the same outcome with reduced impacts	The proposal is one component of the YCMP which also includes measures to improve the management of water resources in the Yanco Creek System and provide water savings. These include improved computer aided decision making and improved system monitoring to better manage water within Billabong Creek.
Constraints for matters other than biodiversity that might restrict the availability of alternative sites or footprints	Site selection also responded to: – evidence of occupation of the land by First Nations people – recreational use of the creek – surrounding land use, including agricultural – scale of potential new weir pools and their inundation extent – the interests and inputs of land holders and other stakeholders.
Consideration of whether the areas of impact are focused away from threatened species habitat	Due to the location of the key works (replacement of the existing weirs), construction work is focussed in the riparian zone. The two new regulators are to be constructed where two existing weirs are located, rather than impacting other undisturbed locations. Where possible, access tracks have been located where tracks already exist, to minimise further clearing. The location for compound sites have been positioned to avoid clearance of trees and away from riparian habitats, where possible. The alignment of the power supply and access corridor at Hartwood was refined following ecological survey to minimise impacts on native vegetation.
Whether the proposed development makes the best use of space	Selection of vertical slot fishway design which is a more compact design, rather than alternatives such as a precast rock ramp fishway. This reduces construction impacts in the riparian zone. The fishway at Wanganella was designed for the opposite side to the public camp site to reduced public access to the fish passage part of the structure. This would provide maximum separation between the fish and the public and help to reduce incidents of vandalism.
Mechanisms to assure biodiversity values in avoided areas are not degraded or lost	The proposal is located in a range of land-holdings, including Crown Reserve and private property. Other land-uses in areas avoided by this proposal have the potential to impact biodiversity values in the future. The proponent has limited control over land use in areas not required for this proposal.

7.2.2 Assessment of evolution of the proposal design

An evaluation of the options identified in the 2015 *Business case for modernising supply systems for effluent creeks – Murrumbidgee River* (WaterNSW, 2015), was undertaken. In addition, further options developed through consultation with the Yanco Technical Advisory Group and the Yanco Stakeholder Advisory Group were also evaluated. This evaluation assessed the options based on:

– SDLAM objectives including water saving achieved, value for money and deliverability
– environmental, ecology, heritage, social, economic and outcomes
– likelihood of being approved.

A multi-criteria analysis (MCA) was carried out based on readily available desktop information, supported by technical advice as required. Following completion of the MCA, outcomes were discussed with the Yanco Stakeholder Advisory Group and the Yanco Technical Advisory Group to agree and confirm the proposed recommended options.

Through the evaluation, a number of proposals were selected as a priority for further design and assessment. These included the following infrastructure upgrades:

– Hartwood Weir: removal of part or all of the existing weir and replacement with a new regulator
– Wanganella Weir: removal of part or all of the existing weir and replacement with a new regulator
– Caroonboon Weir: removal of part or all of the existing weir and replacement with a new regulator
– Piccaninny Weir: removal of part or all of the existing weir and replacement with a new regulator.

These four infrastructure upgrades were combined into one proposal to be progressed to concept design, supported by hydrological modelling and value engineering.

The following alternatives were considered at concept design:

– location of the regulators within the creek system
– need and justification for each regulator
– core structures
– types of fish passage
– source and alignment of power supply
– access track locations
– construction methodology.

Design choices were analysed through a MCA which included environmental and ecological considerations. As a result of the analysis of alternatives and a review of the need for each new regulator, significant improvements to the concept design were identified.

Construction of the new regulators downstream of the existing weirs and in-stream construction was chosen due to this option's reduced need for earthworks, higher community support and reduced environmental and cultural heritage impacts.

The original concept design proposed in the scoping report for the EIS (GHD, 2022a), included new regulators at the Caroonboon and Piccaninny Weirs. Following the submission of the EIS scoping report additional assessment was carried out resulting in the proposed works at Caroonboon and Piccaninny being excluded from the proposal. These proposed works were excluded primarily due to:

– Impact to biodiversity. Ecology surveys undertaken for the EIS determined that significant biodiversity values may be impacted if works at these locations were progressed.
– Further hydrological modelling established the majority of water delivery efficiency could be obtained through replacement of just two weirs.
– Considerable upgrades required to access tracks and power supply constraints increasing the disturbance footprint at these two locations.

The reduced scope of the proposal provided substantial environmental benefits, in particular:

– Potential impact to biodiversity values at the locations of Caroonboon and Piccaninny Weirs would be avoided.
– Reduced social impacts from avoidance of construction activities affecting noise, air quality, local traffic conditions and land use.
– Water delivery efficiency benefits would still be obtained from construction of just Wanganella and Hartwood Regulators.

Following ecological survey further refinement of the design has included the following to further avoid ecological impacts:

– Where possible, access tracks have been located where tracks already exist, to minimise further clearing.
– The location for compound sites have been positioned to avoid clearance of trees and away from riparian habitats, where possible.
– The alignment of the power supply corridor at Hartwood was refined following ecological survey to reduce clearing of native vegetation and impacts to better condition native grasslands.
– Selection of vertical slot fishway design which is a more compact design, thus reducing impacts to the riparian zone.

7.2.3 Summary of measures to avoid and minimise impacts

The proposed action has included measures to avoid or minimise impacts through all stages of conception and design as described above. Most notably a previous proposal for a total of four regulators has been modified to the current two regulator sites as this would achieve the aim of improving ecological objectives within the Yanco Creek system with a substantial reduction in the extent of vegetation removal required for construction and operational access.

The project area and associated access and power supply requirements are defined by the location of the two existing regulators and the Forest Creek block bank. These features align with the Billabong Creek vegetated riparian corridor and so it is not possible to completely avoid removal of threatened species habitat. There are also benefits with aligning the new regulators with the location of the existing weirs, including avoidance of novel impacts in other undisturbed locations and removing the barriers to fish passage presented by the existing weirs.

Within these constraints, a 15.04 ha total disturbance footprint has been defined at Hartwood, including 10. 94 ha of native vegetation, within a project area of around 70 ha that was considered for the construction of the proposal incorporating:

– complete avoidance of removal of plants within the known *Swainsona murrayana* population and minimisation of impacts to associated floodplain grasslands habitat by aligning the power supply and access in a single corridor that encompasses existing access tracks and other non-native vegetation
– a revised access to the Forest Creek block bank that avoids mature trees and Aboriginal cultural heritage features
– definition of the smallest practical CAZs and alignment of CAZs and the borrow pit with poorer condition, treeless vegetation.

A 24.71 ha total disturbance footprint has been defined at Wanganella within a project area of around 70 ha that was considered for the construction of the proposal incorporating:

– complete avoidance of direct impacts to better quality habitat in the oxbow lagoons on the northern Billabong Creek floodplain and minimisation of impacts to floodplain vegetation by aligning the power supply and access tracks with existing access tracks and treeless or non-native vegetation
– definition of the smallest practical CAZs and alignment of CAZs and the flood bypass channel with poorer condition, treeless vegetation.

Within these maximum disturbance footprints and especially the CAZs, the extent of tree removal and trimming would be minimised as far as possible to achieve construction objectives.

A summary of measures undertaken to avoid and minimise impacts is provided in Table 7.2.

Table 7.2 Avoidance and minimisation measures for direct, indirect and prescribed impacts

Action	Outcome	Timing	Responsibility
Identification of a site with minimal biodiversity value	Not possible to fully avoid impacts noting the location of the regulators and power easement is in an extensive area of native vegetation.	Site selection	Proponent
Avoidance of impacts to vegetation through the use of existing access to the proposal footprint.	Avoiding and minimising the amount of native vegetation clearing required.	Site selection	Proponent
Minimisation of impacts to biodiversity values by avoiding higher value habitat features and resources.	Avoidance of impacts to any candidate nest trees and minimisation of impacts to *Swainsona murrayana* and better condition native grasslands	Preliminary design	Proponent
Reducing the proposal footprint and concentrating development in non-native or poor condition vegetation.	Avoiding and minimising the amount of native vegetation clearing required.	Design	Construction contractor
Providing an adequate buffer between the proposal footprint and mature trees, and water courses adjoining the proposal footprint.	Avoiding indirect impacts to retained native vegetation and water courses.	Design	Construction contractor
Preparation and implementation of a construction environmental management plan.	Minimising and managing direct and indirect impacts during construction.	Construction	Construction contractor
Preparation and implementation of an operation environmental management plan.	Minimising and managing direct and indirect impacts during operation and maintenance activities.	Operation	Proponent contractor

8. Impact assessment

8.1 Direct impacts

8.1.1 Summary

The proposal would result in direct impacts to native vegetation and associated threatened species habitat through:

– removal or modification of up to 10.94 hectares of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure

– removal or modification of up to 5.29 hectares of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure.

Residual direct impacts are summarised in Table 8.1 below.

Table 8.1 Summary of residual direct impacts

Vegetation zone	BC Act Status	EPBC Act Status	SAII Entity	Proposal phase/timing of impact (e.g. construction, operation, rehabilitation)	Extent (ha)	
					Hartwood	Wanganella
PCT 7 (moderate): River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion and compaction of the soil surface for infrastructure	Not listed	Not listed	No	Construction	0.84	0.61
PCT 10 (moderate): River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) and compaction of the soil surface for infrastructure	Not listed	Not listed	No	Construction	0.47	0.93
PCT 10 (shrubland): River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) and compaction of the soil surface for infrastructure	Not listed	Not listed	No	Construction	0.28	0

Vegetation zone	BC Act Status	EPBC Act Status	SAII Entity	Proposal phase/timing of impact (e.g. construction, operation, rehabilitation)	Extent (ha)	
					Hartwood	Wanganella
PCT 13 (DNG): Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) and compaction of the soil surface for infrastructure	Not listed	Not listed	No	Construction	1.87	0.89
PCT 13 (moderate): Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) and compaction of the soil surface for infrastructure	Not listed	Not listed	No	Construction	2.39	0.79
PCT 44 (moderate): Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion and compaction of the soil surface for infrastructure	Not listed	Listed in part - Natural Grasslands of the Murray Valley Plains (CEEC). The mapped extent of PCT 44 at the study area does not comprise part of an occurrence of this CEEC.	No	Construction	0.32	0
PCT 46 (moderate): Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion and compaction of the soil surface for infrastructure	Not listed	Listed in part - Natural Grasslands of the Murray Valley Plains (CEEC). The mapped extent of PCT 46 at the study area does not comprise part of an occurrence of this CEEC.	No	Construction	4.31	1.89

Vegetation zone	BC Act Status	EPBC Act Status	SAII Entity	Proposal phase/timing of impact (e.g. construction, operation, rehabilitation)	Extent (ha)	
					Hartwood	Wanganella
PCT 46 (poor): Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion and compaction of the soil surface for infrastructure	Not listed	Listed in part - Natural Grasslands of the Murray Valley Plains (CEEC). The mapped extent of PCT 46 at the study area does not comprise part of an occurrence of this CEEC.	No	Construction	0.48	0
PCT 160 (moderate): Nitre Goosefoot shrubland wetland on clays of the inland floodplains and compaction of the soil surface for infrastructure	Listed in part - Artesian Springs Ecological Community in the Great Artesian Basin (CEEC). The mapped extent of PCT 160 at the study area does not comprise part of an occurrence of this CEEC.	Not listed	No	Construction	0	0.19

A breakdown of the proposal footprint into various proposed activities and the associated intensity and duration of impacts is provided in Table 8.2. The BAM, in general, provides for assessment of partial vegetation removal associated with activities such as maintaining asset protection zones surrounding infrastructure or minimum safety clearances in power supply easements. This approach requires splitting of vegetation zones into management zones based on detailed design of infrastructure and associated construction footprints. This detail is not available for all elements of the proposal and so for the purposes of this BDAR it is conservatively assumed that the proposal would result in the complete clearing of the entire proposal footprint. All future composition, structure and function scores have therefore been entered as 0 for all vegetation zones as summarised in Table 8.3. This quantum of impact should be considered a conservative upper limit for the purposes of defining the maximum work area for the proposal and for calculating biodiversity offsets using the BAM-C. The actual extent, duration and significance of impacts would reflect the description of proposal features in Table 8.2 as well as measures to further avoid and minimise impacts during construction and operation.

Table 8.2 Direct impacts associated with proposed activities

Proposed activity	Intensity of impacts	Duration of impacts
Construction of the regulators, underground power supply routes and Wanganella flood bypass channel and use of borrow pits in the clearing area.	Full vegetation removal and excavation and/or compaction of soil within the clearing area polygons mapped on Figure 4.1 and Figure 4.2. This is a conservative assumption and contractors would be encouraged to avoid or minimise impacts where possible. Mature trees, topsoil and other habitat resources may be retained within this maximum impact area.	Medium term - permanent. Other than the regulator structures and their immediate vicinity, understorey vegetation would be allowed to regenerate.
Use of CAZs outside of clearing areas	CAZs outside of clearing areas would be used for construction purposes only e.g., laydown, site sheds, parking. CAZ locations have been selected to minimise the amount of tree removal required, including work areas in the vicinity of the Wanganella flood bypass channel (see Figure 1.3), and the Hartwood regulator and Forest Creek block bank (see Figure 1.2). Topsoil may need to be removed / cleared, with some re-grading to create level areas with grubbing and clearing of small shrubs / grasses. Trimming of trees may be required. Tree removal would not occur in portions of the CAZ outside of a clearing area.	Medium term. Vegetation would be allowed to regenerate.
Use of access tracks	Some upgrade works would be required to provide access during construction. This may include construction of new access tracks or improvements to existing tracks, to make them suitable for the construction activities. Upgrades may include some light grading, resurfacing and compaction. Tree trimming may be required. Operation and maintenance of the regulators would occur via a subset of the access tracks. It is assumed all tracks would be five metres wide within the corridors shown on Figure 1.2 and Figure 1.3. Within the access track corridor removal of all vegetation is assumed however the majority of the mapped corridors are aligned with existing formed tracks that would not require any vegetation clearing.	Permanent. Operation and maintenance tracks would be maintained for the life of the proposal. However, the majority of the mapped corridors are aligned with existing formed tracks that would not require any vegetation clearing and would be in the same condition as at present.
Construction of the overhead power supply.	Full vegetation removal and excavation of soil at the location of poles. Partial vegetation removal and/or compaction of soils at associated construction access and laydown areas. Direct impacts would occur within a small portion of the overhead power supply route mapped on Figure 1.2 and Figure 1.3 with minimal disturbance of vegetation likely between poles.	Short term. Other than poles and their immediate vicinity, understorey vegetation would be left undisturbed or would be allowed to regenerate.
Maintenance of minimum safety clearances within the overhead power supply corridor.	Partial vegetation removal or trimming within the corridor for the power supply, which is assumed to be 20 metres wide. Vegetation trimming or clearing would only be required to maintain minimum safety clearances of less than 2.5 metres from poles, wires and conductors associated with this 11kV power supply. Direct impacts would occur within a small portion of the overhead power supply route mapped on Figure 1.2 and Figure 1.3 with minimal disturbance of vegetation between poles. The majority of the vegetation in these areas is associated with existing power supply corridors and/or chenopod shrubland or grassland that would not require any management to maintain minimum safety clearances. Trimming or removal of trees and suppression of regrowth would be required in sections through Eucalypt woodland.	Permanent. Minimum safety clearances would be maintained in the overhead power supply corridor for the life of the proposal. However, within the majority of this corridor understorey vegetation would be retained or allowed to regenerate and would be in the same condition as at present.

Table 8.3 Impacts to vegetation integrity

Vegetation zone	Area (ha)	Before development				After development				
		Composition	Structure	Function[1]	VI score	Composition	Structure	Function[1]	VI Score	Change in VI score
Hartwood										
Zone 1 (7_Moderate)	0.84	72.3	81.3	96.3	82.7	0	0	0	0	-82.7
Zone 2 (10_Moderate)	0.47	92.5	45.2	97.9	74.3	0	0	0	0	-74.3
Zone 3 (10_Shrubland)	0.28	60	67.8	20.6	43.8	0	0	0	0	-43.8
Zone 4 (13_DNG)	1.87	37.4	43	12.7	27.3	0	0	0	0	-27.3
Zone 5 (13_Moderate)	2.39	73.9	44.6	81.9	64.6	0	0	0	0	-64.6
Zone 6 (44_Moderate)	0.32	87.4	65.8	n/a	75.9	0	0	n/a	0	-75.9
Zone 7 (46_Moderate)	4.31	85.4	83.4	n/a	85.4	0	0	n/a	0	-85.4
Zone 8 (46_Poor)	0.48	23	85.7	n/a	44.4	0	0	n/a	0	-44.4
Wanganella										
Zone 1 (7_Moderate)	0.61	62.1	27.2	63.8	47.6	0	0	0	0	-47.6
Zone 2 (10_Moderate)	0.93	80.9	30.3	59.5	52.7	0	0	0	0	-52.7
Zone 3 (13_Moderate)	0.79	78.4	100	85.7	87.6	0	0	0	0	-87.6
Zone 4 (13_DNG)	0.89	78.3	63.3	0.3	11.5	0	0	0	0	-11.5
Zone 5 (46_Moderate)	1.89	92.2	86.0	n/a	89.1	0	0	n/a	0	-89.1
Zone 6 (160_Moderate)	0.19	94.7	100	n/a	97.3	0	0	n/a	0	-97.3

The proposal would remove or modify a maximum of 16.23 ha of native vegetation at Hartwood and Wanganella as detailed in section 8.1.1. Impacts would be concentrated in areas of non-native vegetation as far as possible including the use of existing access tracks for vehicle access and the power supply easement and so the potential residual direct impacts summarised in Table 8.1 comprise a conservative upper limit. The proposal footprint contains open vegetation typical of semi-arid environments and has been modified by ongoing agricultural activities and existing infrastructure. The existing environment includes areas of non-native cropped paddocks with minimal biodiversity value (particularly at Hartwood) and so the actual area of disturbance of native vegetation and habitat resources would be less than the total proposal footprint area.

For the purposes of this BDAR it is assumed that proposal would result in the clearing of the entire proposal footprint as shown on Figure 9.1 and Figure 9.2. All future composition, structure and function scores would therefore be reduced to 0 for all vegetation zones across the entire proposal footprint as summarised in Table 8.3.

There are no threatened known threatened plant populations in or near the Wanganella site. There is a known population of Slender Darling Pea (*Swainsona murrayana*) within the Hartwood site. This species is listed as a vulnerable species under the BC Act and EPBC Act.

Surveys confirmed the presence of a number of threatened fauna listed under the NSW BC Act and Commonwealth EPBC Act within or near the study area: Bush Stone-curlew (*Burhinus grallarius*), Dusky Woodswallow (*Artamus cyanopterus cyanopterus*), Little Eagle (*Hieraaetus morphnoides*), Pink Cockatoo (*Lophochroa leadbeateri*), Grey-crowned Babber (*Pomatostomus temporalis*), Southern Myotis (*Myotis macropus*), Inland Forest Bat (*Vespadelus baverstocki*), Little Pied Bat (*Chalinolobus picatus*) and Southern Bell Frog (*Litoria raniformis*). Mapped important habitat for the Plains-wanderer (*Pedionomus torquatus*) is present at Hartwood.

A nest tree census was conducted to identify hollow-bearing trees, stick nests or other signs of breeding activity of threatened fauna that could require calculation of species credits according to the BAM. The nest tree census revealed a number of hollow-bearing trees and other candidate nest trees in or near the study area as shown on Figure 5.9. While one candidate nest tree is likely being used by Little Eagle in the study area of the Wanganella site, it would not be directly impacted as it does not occur within the proposal footprint. No direct evidence of breeding or any important habitat resources were observed to suggest that the proposal footprint is of particular importance to local populations of other threatened species.

The proposal footprint does not contain important habitat for any migratory species listed under the EPBC Act.

The proposal footprint contains habitat for the threatened fauna species listed above and other fauna of riparian and grassland environments. Habitat associated with large mature trees, understorey vegetation and shelter substrate such as fallen timber, leaf litter and grasses would be removed or modified over up to 16.28 ha within the proposal footprints. The proposal would remove a small proportion of the resources available in the local area.

Given the limited extent of removal of vegetation and potential shelter sites, there is a minor risk of direct harm to any resident fauna. The habitat resources at the proposal footprint would have minor importance to the long-term survival of threatened fauna species in the locality. The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources.

Given this minor quantum of impact and the presence of alternative habitat resources the proposal would not have an adverse effect on the life cycle of any threatened fauna species such that a viable local population of the species is likely to be placed at risk of extinction.

8.2 Indirect impacts

Table 8.4 documents the potential residual indirect impacts that could arise from the construction and operation of the proposal.

Table 8.4 Summary of residual indirect impacts

Indirect impact	Likelihood and potential consequences
Edge effects	'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. 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. Edge effects may result from the clearing of native vegetation and other construction activities at both Hartwood and Wanganella and then continue to affect vegetation and habitats retained outside the proposal footprint. A majority of the proposal footprint adjoins land that has been cleared for agriculture, road infrastructure and public recreational activities. Although large areas of native vegetation are present across the study area, smaller patches of native vegetation are already affected by edge effects and associated impacts such increased growth of exotic plants. Overall, the contribution to edge effects arising from clearing of 16.28 ha of native vegetation across both Hartwood and Wanganella would be negligible.
Introduction and spread of weeds, pests and pathogens	Disturbance associated with vegetation clearing and vehicle traffic during construction may, in general, increase the potential for the spread, introduction and establishment of weed and pest species, and diseases and pathogens. There are moderate numbers of priority weeds and high threat exotics present across the proposal footprint. The proposal has the potential to result in further spread of these weed species into native vegetation where they are not yet established or where they occur at low densities. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting weed propagules. The proposal footprint adjoins sensitive areas of native vegetation in the riparian corridor of Forest and Billabong Creek. Environmental inductions, visual barriers and/or exclusion fencing will be used to exclude personnel and vehicles from native vegetation outside the construction footprint. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned down (wash/blow down) and certified weed free prior to initial entry to site; all vehicles, plant and equipment will strictly adhere to the approved roads, tracks, easements and work areas to minimise contact with vegetation.
Noise and light impacts on fauna	Noise levels during the construction period would result in an increase above existing background levels for the duration of construction. Noise levels would vary during the construction period, with some activities being louder and producing higher levels of vibration than others. Noise, vibration, and light have been shown to have a variety of impacts on fauna, including changing foraging behaviour, impacting breeding success and changing species occurrences. Construction activities in the proposal footprint would increase noise levels in a sparsely populated agricultural landscape and would increase noise levels in the vicinity of fauna roosting and nesting habitat in the riparian corridor of Forest and Billabong Creek. Fauna most at risk would be those residing near the works area, and in particular any species that may be nesting, roosting or denning in the area, including a pair of Little Eagles, which are likely to breed within 200m of the proposal footprint at Wanganella and Southern Myotis which are likely to roost in hollow-bearing trees adjacent to and within the proposal footprint. Some fauna may vacate areas in proximity to the proposal footprint during construction. There are extensive, connected areas of alternative habitat which any displaced animals could access with minimal risk or energy cost. Lighting for night construction works has the potential to result in light spill into adjoining areas of native vegetation which may disturb resident fauna. Light generated during construction will be managed in general accordance with the requirements in Australian Standard AS 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting. Directional lighting will be used to minimise the effects of light spill outside the works area as far as possible. Light spill would only occur at dusk and shortly thereafter, with construction works to be finished by 7pm.

Indirect impact	Likelihood and potential consequences
	Given the temporary nature of the works, and the availability of alternate habitat in surrounding areas, it is unlikely the temporary increase in noise and light during construction would significantly affect fauna populations that occur in adjoining vegetation.
Erosion and sedimentation	Removal of vegetation, soil disturbance and excavation, and construction of the proposed infrastructure would expose subsoil and generate spoil material and could, in general, result in erosion and sedimentation. The proposal would be undertaken in accordance with a Construction Environment Management Plan (CEMP) and would include industry best practice methods for excavating, handling and storing soils. The proposal footprint would be rehabilitated once works are complete, and revegetation would be undertaken across portions of the proposal footprint where vegetation was cleared. Noting the gentle topography at the proposal footprint, relatively small proposed clearing areas, and short construction period construction impacts based on the indicative design layouts are expected to be limited and are likely to be sufficiently mitigated by the construction methodology. Given the limited scale of works and the proposed environmental management measures the proposal is highly unlikely to result in a tangible increase in the degree of erosion or sedimentation.

8.3 Prescribed impacts

Prescribed impacts are the impacts on biodiversity values which are not related to, or are in addition to, native vegetation clearing and habitat loss (Section 6.7 of the BAM). These types of impacts are used by the decision-maker to inform the determination and conditions of consent for developments. In general, these types of impacts affect habitat or features of the environment that are irreplaceable or otherwise important to the maintenance of biodiversity values.

The BC Regulation (clause 6.1) identifies actions that are prescribed as impacts to be assessed under the biodiversity offsets scheme. The likelihood, extent and magnitude of prescribed impacts must be assessed using the approach specified in the BAM Section 8.3. The likely effect of prescribed impacts that are relevant to the proposal is presented in Table 8.5 The suite of threatened species that may be affected by these prescribed impacts are presented in section 6.2.

The proposal will include implementation of measures to mitigate residual impacts, specified in a Construction Environmental Management Plan (CEMP). The CEMP will provide detailed environmental controls to manage key environmental issues. The CEMP will be reviewed and updated as necessary throughout the relevant phases of the modification. The CEMP will include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures for the management of flora and fauna. The mitigation and harm minimisation measures for direct, indirect and prescribed impacts are presented in Table 7.2 Table 8.9 including timing, responsibility and outcomes.

Table 8.5 Summary of potential prescribed impacts

Prescribed impact	Likelihood and consequences
Human-made structures	**Nature** The proposal includes the removal of human-made structures with some limited fauna habitat at the locations of the existing weirs and associated contractor activity zones. The Hartwood Weir and associated concrete apron and abutments and walkway includes sheltered cavities that may very occasionally be used as diurnal roosts by threatened microbats or as roost or nest sites for birds such as the Fairy Martin (*Petrochelidon ariel*). These would be flooded when river levels are high. An old wooden bridge downstream of the regulator within the clearing area would also be removed. This bridge is dilapidated, and may also contain temporary microbat roosting habitat, during low flow events. The pump-house structure adjacent to the Hartwood site would be retained. The pump -house structure may also contain potential roosting habitat for microbats, but none was observed at the time of the survey. While the Wanganella site has an instream weir, it does not contain other human-made structures that could be used as fauna habitat. An irrigation canal is present at Hartwood that may provide foraging and occasional breeding habitat for the Southern Bell Frog.

Prescribed impact	Likelihood and consequences
	Extent The proposal would involve the demolition and replacement of the weir structures at Hartwood and Wanganella. The old wooden bridge downstream of the existing weir at Hartwood would also be removed. The proposal would retain the pump-house structure and irrigation canals at the Hartwood site. The proposal would include removal or modification of the current arrangement of smaller human made structures that may be used as roosts by birds or microbats on occasion. There is a risk of direct harm to any resident bats or other native fauna roosting during construction. **Duration** This impact will be permanent. However, the proposed regulator at Hartwood would have a trafficable deck for maintenance that may provide supplementary roosting habitat for microbats following construction. **Consequences** Threatened microbat species may use human made structures as roost sites. Structures that are long-unoccupied and/or surrounded by native vegetation or other habitat resources are more likely to have value to microbat populations. Given the location of existing weir structures within the riparian corridor of Billabong Creek and adjacent to extensive areas of native vegetation and these structures may be occupied by threatened microbats and other native fauna on occasion but are unlikely to be used on a long-term basis given regular flooding. The current occupation of buildings by Fairy Martins represents this pattern of use by a native species of forested wetlands. Fauna management measures such as pre-clearing surveys would be specified in a CEMP and would help mitigate the risk of harm to any resident fauna. There is no evidence to suggest that human made structures within the proposal footprint would have particular value to local populations of threatened microbats compared to, for example, a disused mine that may represent an extensive area of roosting habitat with specific thermal properties. There are alternative habitat resources in the surrounding area including extensive areas of riparian vegetation containing hollow-bearing trees and similar human-made structures in the surrounding agricultural landscape. Removal of smaller structures and changes to the arrangement and patterns of use of buildings is likely to have a minor effect on native fauna populations.
Non-native vegetation	**Nature** The proposal footprint contains around 4.16 ha of non-native vegetation including patches of exotic plants and bare earth associated with open space and access tracks and shown in Figure 4.1 and Figure 4.2. These areas may be travelled over or through, or used occasionally as foraging habitat by threatened fauna species occupying adjoining forested wetland, woodland and riparian habitats. **Extent** Subject to design, the proposal may remove up to 4.16 ha of non-native vegetation. There is a risk of direct harm to any native fauna occupying non-native vegetation during construction and a reduction in the extent of habitat resources. No threatened fauna are likely to be resident in the areas. **Duration** Removal of non-native vegetation would be a permanent impact, however areas of impact are presented as a worst case scenario. As discussed earlier, groundcover would be able to regenerate in areas of the proposal footprint that do not have permanent structures (such as under overhead powerline easements, and in areas of the CAZ no required following construction). **Consequences** The proposal footprint may be travelled over or through or used occasionally as foraging habitat by native fauna, including a number of threatened species. Areas of non-native vegetation and cleared areas support limited shelter, roosting or breeding habitat for the species that could potentially occur and have minimal value for these species. These species or their prey may use habitat resources at the site on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the habitats present within the proposal footprint for any stage of their life cycle. Fauna management measures would be specified in a CEMP and would help mitigate the risk of harm to any resident fauna during clearing of exotic vegetation. Given the limited value of habitat resources in exotic vegetation at the proposal footprint and extensive areas of similar habitat in the surrounding agricultural landscape and more valuable resources in native vegetation, the consequences of removal or modification of non-native vegetation would be minor.

Prescribed impact	Likelihood and consequences
Habitat connectivity	**Nature** The assessment of landscape context according to the BAM is provided in section 3. Table 3.1 and Figure 3.1 and Figure 3.2 show the extent of the patch of vegetation that the proposal falls within, with extensive areas of connected vegetation surrounding the proposal footprint along Billabong Creek. Irrigated cropland to the northeast and south of the proposal footprint at Hartwood creates a significant gap in habitat that may limit movement of some fauna through the proposal footprint and the locality in these directions. There are no significant gaps in habitat near the Wanganella site. At a local scale, a network of dirt roads within the proposal footprint and various fences and other agricultural infrastructure comprise minor gaps in native vegetation cover at Hartwood and Wanganella. These would not comprise significant gaps in fauna habitat connectivity or interrupt ecological processes in the context of the semi-arid communities in the locality which naturally contain gaps in vegetation cover of a similar scale. The riparian corridor and floodplain associated with Billabong Creek, would comprise a regionally significant habitat corridor for aquatic and terrestrial species given the presence of surface water, higher overall vegetation cover and presence of large, frequently hollow-bearing trees and other habitat resources. The Billabong Creek riparian corridor forms large components of the Wanganella and Hartwood proposal footprints. There are thousands of hectares of riparian woodland, native grassland and chenopod shrubland similar to that in the proposal footprint in the locality. In this context the proposal footprint is unlikely to comprise a key link in a resource corridor, or to be critical to the ongoing connectivity of habitat in the local area. After construction, the proposal footprint would comprise small gaps in native vegetation cover. The proposal footprint would contain regulator structures, roads and power supply infrastructure as well as human activity which may limit the ability of fauna to move through the landscape. Given the Wanganella site is already highly disturbed by recreational campers, and the Hartwood site is directly adjacent to cropped lands and agricultural activities, habitat connectivity in response to operational impacts is unlikely to critically impact the ongoing habitat connectivity in the locality. Overall, the proposal is predicted to present an improvement in fish passage (60.7 km and 50.5 km respectively) within the Yanco-Billabong System and general improvements to the hydrological and hydraulic conditions within the proposal study area (Jacobs 2024a, 2024b). Noting that wetland and floodplain communities would also benefit from improved fish passage and hydrological and hydraulic conditions, the proposal would improve habitat connectivity in the longer term. **Extent** The proposed action would result in a minor impact on habitat connectivity comprising: creation or maintenance of permanent gaps in understorey vegetation up to 5 m wide along access tracks and at the regulators creation of partial gaps in vegetation cover and/or displacement of fauna from construction activity zones up to 150 m across, for a period of up to 17 months reduction in vegetation cover where trees have been removed or trimmed or groundcover has been disturbed until natural regeneration occurs. Vegetation clearing within the contractor activity zone and proposed clearing areas would reduce connectivity through the proposal footprint by decreasing shelter and creating physical barriers within these discrete areas. However, the proposal is unlikely to isolate any areas of habitat or sever any connecting links. Human activity may deter certain native fauna species from moving through the local area during construction. Impacts associated with human activity would occur for a relatively small portion of the proposal. These impacts would not be novel, noting the current agricultural use of the proposal footprint at Hartwood and the recreational use at Wanganella. Native fauna at or near the proposal footprint would be habituated to vehicle traffic and other human activity as well as the presence of domestic livestock. Species that are more sensitive to such disturbance are unlikely to be present in the local area. **Duration** Construction impacts to habitat connectivity would occur over a 17 month period. After rehabilitation, the proposal would contain native vegetation representative of the locality, with areas of the proposal footprint outside the access tracks and proposed infrastructure locations allowed to regenerate.

Prescribed impact	Likelihood and consequences
	Consequences The threatened species listed in section 6 and other native fauna species may travel over or through the proposal footprint, and groundcover vegetation, large trees and water bodies may be used as shelter by smaller species that would comprise a connecting link between any other areas of habitat upstream and downstream of Billabong Creek. These species may travel through the proposal footprint on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the connectivity provided by the proposal footprint to support their continued use of the local area. Some habitat connectivity would be retained around the proposal footprint through extensive areas of similar grassland and riparian woodland. The proposal does not include the erection of any large or hazardous structures that would increase the risk or energy cost of movement of any threatened or migratory fauna. Removal of vegetation and construction of the regulators would only result in a minor increase in the degree of fragmentation between retained areas of habitat for these species and would not result in the isolation of any habitat. The reduction in extent of habitat would be minor. The proposal would create small gaps in connectivity which would not be sufficient to interrupt any ecological process such as migration or pollination. Overall, the negative consequences of the proposal's impact on habitat connectivity would be minor and temporary. The predicted improvement in fish passage and hydrological and hydraulic conditions within the proposal study area (Jacobs 2024a, 2024b) would improve habitat connectivity in the longer term.
Waterbodies, water quality and hydrological processes	**Nature** The proposal footprint is located on the floodplains of Billabong Creek and Forest creek. All native vegetation and threatened species habitat in the proposal footprint is subject to, and to varying degrees dependent upon, flooding from these waterbodies. There is also a network of irrigation canals at Hartwood that would have value for native biota during wet periods. The frequency, timing, extent and depth of inundation by floodwaters influences the character and health of this habitat. The Yanco-Billabong Creek system is a complex, braided system of interconnecting creeks and anabranches, with Yanco, Colombo, Billabong and Forest Creeks the main branches of the system. The hydrology of the systems has been significantly altered due to the construction of Yanco Weir and 30 re-regulation weirs and associated water extraction and regulation throughout its reaches. This regulation has allowed flows to be maintained at artificially high levels in historically dry periods to meet irrigation demands and therefore the natural wet-dry cycle has effecively been removed from much of the system. As part of the current, regulated system Billabong Creek essentially forms a series of weir pools (Jacobs 2024a). Billabong Creek is broadly divided into three reaches based on hydrology, ecology and geomorphology: the upper Billabong Creek; an unregulated reach; and the regulated mid and lower Billabong Creek reaches which encompass the proposal footprint. The mid Billabong Creek extends from the Colombo Creek confluence to the Yanco Creek confluence where it is free flowing until Jerilderie Town Weir and then regulated due to a number of weirs downstream, including Hartwood Weir at the project area. Flows are diverted at Hartwood Weir into Forest Creek for irrigation and environmental watering. Lower Billabong Creek extends from the Yanco Creek confluence to where Billabong Creek discharges to the Edward River. This reach is heavily regulated with numerous weirs including Wanganella Weir pools (Jacobs 2024a). Water quality in the broader catchment and within the vicinity of the project is generally characterised by elevated turbidity which in turn is contributing to other water quality issues such as lower dissolved oxygen and elevated nutrients which are typically bound to the sediments. The elevated turbidity (sediments) appears to be a result of erosion and high flows which occur throughout the system. Weirs can lead to the increase in heavy metals stored within the river/creek substrate which is evident at Hartwood and Wanganella weirs (Jacobs 2024b). The proposal would modify the catchment and would result in local changes to waterbodies, water quality and hydrological processes through clearing of vegetation, earthworks, construction of in-stream structures and changes to the operation of the system through adjacent reaches of Billabong Creek and Forest Creek. Construction related impacts to in stream habitats and floodplain wetlands may include: – mobilisation of poor water quality to the downstream receiving environment – loss of connectivity and temporary barriers to fauna movement – direct loss or degradation of habitat features and riparian vegetation – reduced water quality and proliferation of weeds, pests and pathogens – mobilisation of built-up sediment behind existing weir resulting in smothering of organisms and infilling of pools and habitat (Jacobs 2024b).

Prescribed impact	Likelihood and consequences
	During the operational phase of the proposal, waterbodies and hydrological processes would be affected by replacement of existing fixed crest weirs with automatic remote controlled regulated weirs at Hartwood and Wanganella. The gated regulators will allow regulation of flows in the lower sections of the Billabong Creek, providing river operators with greater operational flexibility to provide water to where it is needed, resulting in improvements in delivery efficiency. In doing so the proposal would affect hydrological processes through contribution to the regulation of the system in accordance with the Operation Plan (DCCEEW 2023). **Extent** The proposal would include clearing of native and exotic vegetation and short-term exposure of soils, levelling and compaction of soil, and construction of infrastructure within a 21.28 ha proposal footprint. Construction activities would occur within and adjacent to Billabong Creek at both Hartwood and Wanganella and in general would result in changes to catchment hydrology and the risk of impacts to water quality. A breakdown of the proposal footprint into various proposed activities and the associated intensity and duration of impacts is provided in Table 8.1. Much of the indicative disturbance footprint would only be subject to partial or temporary impacts, including: – In clearing areas for construction of the regulators, underground power supply routes, Wanganella flood bypass channel and borrow pits, mature trees, topsoil and other habitat resources may be retained within this maximum impact area and, other than the regulator structures and their immediate vicinity, understorey vegetation would be allowed to regenerate. – Contractor activity zones outside of clearing areas would be used for construction purposes only (e.g., laydown, site sheds, parking) and have been selected to minimise the amount of tree removal or trimming required and would be allowed to regenerate. – Construction of the overhead power supply would require vegetation removal and excavation of soil within a small portion of the overhead power supply route. Other than poles and their immediate vicinity, understorey vegetation would be left undisturbed or would be allowed to regenerate. – Minimum safety clearances would be maintained in the overhead power supply corridor for the life of the proposal. However, the majority of the vegetation in these areas is associated with existing power supply corridors and/or chenopod shrubland or grassland that would not require any management to maintain minimum safety clearances and would be in the same condition as at present. Given the limited extent and duration of vegetation clearing and exposure of soils, industry standard measures for managing soil and surface water are likely to mitigate against any tangible impacts on the broader Billabong Creek floodplain or any waterbodies with particular habitat value. During construction of the Hartwood and Wanganella regulators respectively, existing weirs will remain in place for majority of the construction timeframe, only being demolished once the new regulator is fully installed and will therefore continue to have a significant influence on hydrology during the construction period. In addition, partial coffer damming of Billabong Creek within the construction timeframes for each respective regulator construction site will allow for passing flows to meet irrigation and consumptive demands and environmental water provisions. The proposal would also affect the hydrology of the local area by clearing, compacting and levelling land on the floodplain. Noting the minor and localised extent of such changes relative to the many thousands of hectares of catchment feeding watercourses in the locality, changes to surface water flows in the proposal footprint would have a negligible effect on the hydrology of the system. Operation impacts would extend over the proposal study area for the hydrology assessment which comprises Billabong Creek and its effluent streams from Jerilderie weir at the upstream extent of the Hartwood weir pool, to Darlot, which is anticipated to be the maximum downstream extent of effect of the operation of the Wanganella regulator (Jacobs 2024a). There will be localised (within reach) effects on hydrology within the main channels of Billabong Creek, its tributaries, Forest Creek and other effluent streams as well as floodplain billabongs with low commence to flow levels. This would include slight increases in the extent, depth and duration of inundation upstream of each regulator during periods when the water is at the full supply level of each regulator because the new regulators are higher than the structures they replace. The maximum weir pool extent above the Wanganella regulator is the Hartwood regulator and the maximum extent above the Hartwood regulator is Jerilderie weir, which is equivalent to the baseline situation. No changes to overbank flows are anticipated as a direct result of the operation of the proposal (Jacobs 2024a) and so the extent of impacts would not include mid and outer floodplain ecological communities. As such these operational impacts would not affect the terrestrial vegetation and habitats that are the subject of this BDAR. No groundwater would be intercepted or extracted for the proposal.

Prescribed impact	Likelihood and consequences
	Duration Potential impacts on water quality would occur during construction (around 18 months) and for the time taken for understorey vegetation to regenerate outside of permanent infrastructure footprints. The proposal would result in localised and temporary impacts to moderate quality wetland habitat such as small, vegetated depressions in River Red Gum and Black Box woodland, irrigation ditches and macrophyte beds on the floodplain, and the deep, steep sided and permanent water bodies of Forest Creek and Billabong Creek. There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system instruction would pause during periods of high flow. Operational impacts would occur for the life of the proposal, comprising the period that the proposed regulators would contribute to the management of the Billabong Creek system in accordance with the Operation Plan (DCCEEW 2023). The design life of the regulators is 100 years. **Consequences** Each of the threatened species that could occur at the proposal footprint would rely on watercourses and the floodplain in the vicinity of the proposal footprint as a water source, foraging habitat and shelter habitat. Potential adverse changes to water quality or hydrology would have a greater risk of impacts to wetland-breeding species such as the Southern Bell Frog (*Litoria raniformis*) and threatened waterbirds. As noted above under 'extent' there would be partial and temporary impacts to catchment hydrology and the risk of downstream effects on water quality arising from a maximum 21.28 ha proposal footprint across the Hartwood and Wanganella sites. The proposal design, including partial coffer damming of Billabong Creek, and implementation of the CEMP are likely to ensure that there are no tangible indirect impacts during construction on waterbodies, water quality and hydrological processes outside the proposal footprint. Given the limited scale and intensity of earthworks and coffer damming proposed it is unlikely that construction of the proposal would have a material adverse effect on the hydrology of Billabong Creek, either upstream or downstream. If there were to be any potential changes in the hydrology of Billabong Creek, it is considered they would be short-term (i.e. within the construction timeframes of the proposal) and would not affect environmental water provision or hydrological processes necessary for maintaining aquatic and floodplain ecological communities (Jacobs 2023b). Likely operational impacts have been modelled based on predicted changes to hydrological conditions with operation of the regulators for the proposal and other systems changes specified in the Yanco Creek System Operation Plan (DCCEEW 2023) (the 'Change Case' scenario) (Jacobs 2024a). The Change Case scenario results indicate minor alterations in mean annual flows within the Yanco Creek System. The typical temperate seasonal pattern of flows is maintained, with minimal impact on mean monthly flow volumes throughout the Yanco Creek System, including the proposal study area (Billabong Creek from Jerilderie to Darlot). The Change Case scenario results indicate the proposal does not significantly impact annual or daily flow volume variability and there are minimal impacts on daily flow sizes. Overall, the hydrological analysis suggests that while operation of the proposal will have some localised (within reach) effects on hydrology (including water balance, seasonality, flow variability, and flow sizes) the impacts are generally minor and do not significantly alter the overall hydrological characteristics of Billabong Creek within the proposal study area or the broader Yanco Billabong System. With operation of the regulators for the proposal and broader system changes, no adverse effects are expected to low flows (i.e. unnatural prolonged drying), the proportion of moderate flows ('freshes') and high flows, no material change in the overall annual flow variability within the Yanco Creek System with operation of the proposal and mostly no change or some minor improvements in the frequency in the expected frequency of over bank wetland connection or floodplain connection flows (Jacobs 2024a). The findings of the Environmental Water Requirements (EWR) analysis suggest that there are generally improvements in achieving EWRs with operation of the proposal. Overall, there is predicted to be considerable improvements in the frequency of achieving Baseflow and improvements in the frequency of achieving Native Fish Nesting Support and small freshes EWRs throughout the Yanco Creek System, including the proposal study area. Therefore, it is concluded that operation of the proposal will result in an overall improvement in the frequency of achieving EWRs for a number of EWR categories to support key ecological values of the system (Jacobs 2024a). The proposal is not anticipated to negatively affect key hydrological aspects of the Yanco Creek System, including the proposal study area, when taking into consideration potential cumulative effects associated with the Forest Creek Return Flows Project (Jacobs 2024a).

Prescribed impact	Likelihood and consequences
	Operation of the proposal would have a minor impact on the hydrology of the Billabong Creek system in the context of the current degree of regulation. No adverse operational impacts on wetland or riparian habitat for threatened species are likely to occur. Overall, the proposal is predicted to present an improvement in fish passage (60.7 km and 50.5 km respectively) within the Yanco-Billabong System and general improvements to the hydrological and hydraulic conditions within the proposal study area (Jacobs 2024a, 2024b). As described above under 'extent', these operational impacts would not affect overbank flows and as such would not affect the terrestrial vegetation and habitats that are the subject of this BDAR. The proposed action is not likely to have a significant impact on wetland dependent fauna such as the Southern Bell Frog, Australian Painted Snipe (*Rostratula australis*), Australasian Bittern (*Botaurus poiciloptilus*), Latham's Snipe (*Galinago hardwickii*) or other threatened species of wetlands and floodplains given that: – Construction impacts would be minor and temporary, macrophytes and other understorey vegetation would be allowed to regenerate across the majority of the disturbance footprint and as such a negligible proportion of the wetland habitat available for these species in the locality would be affected in the longer term – Given the small scale and duration of proposed works there is a minor risk of impacts to water quality that is likely to be substantially mitigated through standard environmental management measures – The proposal would not directly or indirectly affect more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and oxbow lakes on the northern floodplain of Billabong Creek at Wanganella – Operation of the proposal would not have an adverse effect on wetland dependent species or their habitats.
Vehicle strike	**Likelihood** Construction of the proposal would generate heavy vehicle movements associated with vegetation and spoil removal, and delivery of construction material and equipment. Light vehicle movements for construction personnel, including contractors, site labour force and specialist supervisory personnel would also be required. The proposal would create additional traffic on the Cobb Highway (a state road with a 100 km/hr speed limit), Conargo Road (a regional road with a 70 km/hr speed limit), Zara Road (local road with a 50 km/hr speed limit) and local farm access tracks. Vehicles travelling to and from the proposal footprint would use several hundred kilometres of sealed road along both fenced and unfenced carriageway widths of up to 7 m within a heavily vegetated landscape. These roads and tracks are already subject to vehicle movements and vehicle strike, however construction would temporarily increase this risk in the study area and surrounds. **Estimated rate of vehicle strike** At Hartwood, it is estimated that there would be up to 51 heavy vehicle and 39 light vehicle movements per day during construction. At Wanganella, 80 heavy vehicle and 51 light vehicle movements are expected per day during construction (GHD 2024d). Traffic generation during operations is expected to be minimal, with 20 truck movements estimated to each of the weirs for the first two years. On average, the operation and maintenance of the proposal would only generate around one inbound and outbound vehicle movement per day. Maintenance activities may span between a couple of days up to approximately a week. The impacts of the proposal on the road network were quantified by adding the traffic generated by the proposed modification works to the expected future traffic volumes on the road network. The Traffic Impact Assessment concluded that the construction and operation of the proposal would have a negligible impact on the adjoining road and transport network (GHD 2024c). The traffic assessment focussed mainly on the capacity of the road network to accommodate additional traffic volumes and did not include any estimation of rates of vehicle strike on native fauna. The assessment indicates that the proposal is expected to have minimal impact on peak hour traffic volumes along the roads within the vicinity of the camps and so it is likely that the proposal would result in a similarly minor increase in the rate of vehicle strike.

Prescribed impact	Likelihood and consequences
	Consequences Access to the proposal footprint would be along a sealed divided carriageway with a lane in each direction and then unsealed access tracks. Access roads may be traversed by native fauna including threatened species. Threatened species such as threatened microbats, forest owls, Bush Stone-curlew and Plains-wanderer are unlikely to experience a significant risk of vehicle strike as vehicle movements will occur predominantly during daylight hours when these species are inactive. Threatened raptors and woodland birds and other diurnal species may be at risk of vehicle strike during the day. The proposal would result in a minor, but tangible increase in vehicle movements and associated risk of vehicle strike for these species. The consequence of vehicle strike on specific threatened fauna is detailed further in Table 8.6 below.

Table 8.6 Residual prescribed impacts – vehicle strikes

Threatened fauna or protected fauna that are part of a TEC that are at risk of vehicle strike (identified in section 6)	SAII entity	Likelihood	Estimated vehicle strike rates	Consequences
Southern Bell Frog	No	Low. While the species is known to occur at Wanganella and Hartwood, its nocturnal nature means that vehicle strike is unlikely, as vehicle movements for construction and operation would generally occur at night.	Vehicle strike rates are likely to be very low, if they occur at all.	Impacts of vehicle strike during construction and operation are unlikely to substantially impact the Southern Bell Frog in the local area.
Raptors	No	Low. On rare occasions raptors would forage on the ground for carrion or small mammals. The likelihood of being subject to vehicle strike as a result of the proposal is low.	Given the location of the proposal in a generally rural area, low density of populations and ecology of the species, vehicle strike rates are likely to be relatively low for the proposal footprint.	Impacts of vehicle strike during construction and operation are unlikely to substantially impact threatened raptors in the local area.
Bush Stone-curlew	No	Low. While the species is known to occur at Wanganella, it was not recorded during surveys. Low density of records in the locality. The likelihood of being subject to vehicle strike as a result of the proposal is low.	Given the location of the proposal in a generally rural area, and low density of records, vehicle strike rates are likely to be relatively low for the proposal footprint.	Impacts of vehicle strike during construction and operation are unlikely to substantially impact the population of the Bush Stone-curlew in the local area.
Plains-wanderer	Yes	Low. Small patches of mapped important habitat occur in the locality, including within the proposal footprint at Hartwood. The core distribution of the species in NSW is north of Billabong Creek (DPE 2016). Occasional individuals may occur in the proposal footprint, however the fragmented nature of preferred habitat present reduces the likelihood of their occurrence.	Given the limited habitat present and likely very low densities of the species, vehicle strike rates are likely to be low for the proposal footprint.	Impacts of vehicle strike during construction and operation are unlikely to substantially impact the Plains-wanderer in the local area.

8.3.1 Potential for significant residual prescribed impacts

Prescribed impacts are difficult to quantify compared to direct, or even indirect, impacts (DPIE 2019b). The consent authority has the discretion to increase the number of biodiversity credits to be retired (or other conservation measures to be undertaken), if the justification is due to environmental, social and economic impacts of the proposed development (see section 7.13(4) BC Act and clause 6.1.2 (b) BC Regulation). Given there is no set method for determining a suitable quantum of credits to offset a prescribed impact, the assessor should clearly document the decision pathway and justification for suggested credit numbers or other compensatory actions in the BDAR. Any biodiversity credits proposed are then additional to the baseline number of biodiversity credits determined by the BAM (DPIE 2019b).

A summary of residual impacts resulting from prescribed impacts is provided in Table 8.7. The potential for significant residual impacts is unlikely.

Table 8.7 Summary of prescribed impacts

Prescribed impact	Comment	Residual impacts
Human-made structures	The proposal would remove some human-made structures that may provide foraging and breeding habitat for certain threatened fauna.	No significant residual impacts are likely.
Non-native vegetation	The proposal would remove areas of non-native vegetation that may provide some foraging and breeding habitat for some threatened fauna.	No significant residual impacts are likely.
Habitat connectivity	The proposal would remove small areas of native vegetation, in particular riparian vegetation associated with the construction of the regulators. Removal of vegetation and construction of regulator infrastructure would only result in a minor increase in the degree of fragmentation between retained areas of habitat for the species. The proposal would not isolate any areas of habitat or sever any connecting links. Threatened biota are expected to continue to be able to move along the riparian corridor. Overall, the proposal is predicted to present an improvement in fish passage (60.7 km and 50.5 km respectively) within the Yanco-Billabong System and general improvements to the hydrological and hydraulic conditions within the proposal study area (Jacobs 2024a, 2024b). Noting that wetland and floodplain communities would also benefit from improved fish passage and hydrological and hydraulic conditions, the proposal would improve aquatic habitat connectivity in the longer term.	No significant residual impacts are likely.
Water bodies, water and hydrological processes	Potential impacts on water quality would occur during construction (around 17 months). These impacts would likely comprise potential increases in sediment load and turbidity over this period. Given the small scale and duration of proposed works there is a minor risk of impacts to water quality that is likely to be substantially mitigated through use of coffer dams and standard environmental management measures on floodplain work areas. Changes to hydrology would occur during operation of the proposal through replacement of existing fixed crest weirs with automatic remote controlled regulated weirs at Hartwood and Wanganella. The proposal would affect hydrological processes through contribution to the regulation of the system in accordance with the Operation Plan (DCCEEW 2023). Operation of the proposal result in minor overall changes to the hydrology of the system, improved delivery of EWRs (Jacobs 2024a) and improved connectivity of aquatic habitat (Jacobs 2024b). Operation of the proposal would not have an adverse effect on wetland dependent species or their habitats.	No significant residual impacts are likely.
Vehicle strike	The proposal would increase the risk of vehicle strike to a small degree.	No significant residual impacts are likely.

8.4 Cumulative impacts

8.4.1 Overview

For an EIS, cumulative impacts can be defined as the successive, incremental, and combined effect of multiple impacts, which may in themselves be minor, but could become significant when considered together. The methodology and proposals considered for the cumulative impact assessment are provided in detail in the EIS.

Cumulative impacts for biodiversity were assessed with reference to the *Cumulative Impact Assessment Guidelines for State Significant Projects* guidelines (DPE 2022d).

In accordance with the guidelines, this cumulative impact assessment has considered relevant future and current projects that could result in a material impact on biodiversity values. Future projects were considered if they were within the vicinity of the proposal, and were:

– related to the proposal
– other State significant development (SSD) and State significant infrastructure (SSI) projects
– projects that are classified as designated development and require an EIS
– projects that require assessment under division 5.1 of the EP&A Act that are likely to significantly affect the environment and require an EIS
– projects that have been declared to be controlled actions under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
– any major greenfield and urban renewal developments that are scheduled for the area (e.g. new areas zoned for urban development).

8.4.2 Scoping of future projects

The proposal forms part of the overall Yanco Creek Modernisation program which involves infrastructure upgrades and new installations to improve water management across the Yanco Creek system. Other projects from this program, currently being developed, are listed in Table 8.8.

A search of the NSW Major Projects website identified three other major projects within the vicinity of the proposal. A summary of these projects has been included in Table 8.8.

Table 8.8 Cumulative impact scoping summary

Future project	Approx. distance to proposal footprint (km)	Nearest proposed regulator	Definition	Project status / Indicative timing / overlap	Potential cumulative impact Yes / No	Impacts on native vegetation	Impacts on relevant threatened ecological communities	Impacts on relevant threatened species
Yanco Creek Modernisation Project Part 1b: Wanganella Swamp Upgrades and construction of a series of structures that would act to raise and control inundation of the swamp to facilitate more successful bird breeding events and other environmental outcomes.	4	Wanganella	Related to the proposal	Construction anticipated to commence in 2025.	Yes	Impacts not yet quantified. Likely to include a small area of native vegetation removal.	Impacts not yet quantified.	Impacts not yet quantified.
Yanco Creek Modernisation Project Part 3: Wilsons Anabranch Upgrade and construction of a structure that would act to facilitate more successful bird breeding events and other environmental outcomes.	21	Hartwood	Related to the proposal	Construction anticipated to commence in mid 2025. Two months to complete.	Yes	Direct impacts to ~0.19 ha of native vegetation	N/A	Slender Darling-pea: 3.53 ha of potential habitat Southern Bell Frog: 0.19 ha of potential habitat
Yanco Creek Modernisation Project Part 4: Forest Creek Return Flows via Piccaninny Creek. Upgrade the existing Piccaninny Creek Block Bank in the connecting channel and install a new regulator so that excess Forest Creek flows can be diverted to Billabong Creek via Piccaninny Creek. A block bank or control structure on Piccaninny Creek upstream of the Forest Creek-Piccaninny Creek connecting channel may also be required.	15	Hartwood	Related to the proposal	Construction anticipated to commence in late 2024. Two months to complete.	Yes	Direct impacts to ~2.08 ha of native vegetation	N/A	Slender Darling-pea: 1.84 ha of potential habitat Southern Bell Frog: 0.35 ha of potential habitat

Future project	Approx. distance to proposal footprint (km)	Nearest proposed regulator	Definition	Project status / Indicative timing / overlap	Potential cumulative impact Yes / No	Impacts on native vegetation	Impacts on relevant threatened ecological communities	Impacts on relevant threatened species
Flow measurement would also be installed.								
Yanco Creek Modernisation Project Part 5b: Cheverells Creek Offtake Remove the existing pipe culvert and construct a new pipe offtake and flow rate control works at the existing Cheverells Creek Offtake location with a Layflat gate regulator, including remote flow control, level and flow monitoring capability.	101	Hartwood	Related to the proposal	Construction anticipated to commence in mid 2025. Take three months to complete.		Direct impacts to ~1.38 ha of native vegetation	N/A	Slender Darling-pea: 0.61 ha of potential habitat Southern Bell Frog: 0.16 ha of potential habitat
Reconnecting River Country Program The program focuses on relaxing or removing some of the constraints or physical barriers impacting the delivery of water for the environment. The program area includes the Murrumbidgee River.	Not known	Not known	Not known	No specific timeline, projects or locations were available at the time of assessment.	N/A	Impacts not yet quantified.	Impacts not yet quantified.	Impacts not yet quantified.
Yanco Delta Wind Farm (SSD-41743746) Construction and operation of a wind farm 10 north-west of Jerilderie in NSW. The proposed wind farm will include approximately 210 turbines, a battery energy storage system, solar panels and associated electrical infrastructure.	39	Hartwood	Project under assessment	Construction of the project is targeted to begin in late-2024 subject to planning approval, with an expected duration of 36 months. Operation is expected to begin in 2025 with an operation life of at least 30 years.	Yes	Direct impacts to ~175 ha of native vegetation	Natural Grasslands of the Murray Valley Plains: ~130 ha	Southern Myotis: 0.20 ha of potential habitat Plains-wanderer: 1.78 ha of mapped important habitat Slender Darling-pea: 3.53 ha of potential habitat

Future project	Approx. distance to proposal footprint (km)	Nearest proposed regulator	Definition	Project status / Indicative timing / overlap	Potential cumulative impact Yes / No	Impacts on native vegetation	Impacts on relevant threatened ecological communities	Impacts on relevant threatened species
Yanco Solar Farm (SSD-9515) Construction and operation of a ground-mounted photovoltaic (PV) solar array generating around 60 megawatts (MW) alternating current (AC).	129	Hartwood	Approved project	Construction phase of the project is expected to begin in 2023 and take approximately 10 months. Facility would be expected to operate for around 30 years.	Yes	Direct impacts to 0.54 ha of native vegetation	N/A	N/A
Bullawah Wind Farm (SSD-50505215) Installation, operation, maintenance and decommissioning of up to 170 wind turbines, Battery Energy Storage System (BESS) facilities, ancillary infrastructure and temporary facilities associated with the construction of the wind farm.	55	Wanganella	Project under assessment	Construction phase of the project is expected to begin in mid to late 2025 and take approximately 24 months.	N/A	Impacts not yet quantified.	Impacts not yet quantified.	Impacts not yet quantified.

8.5 Mitigating residual impacts – management measures and implementation

The proposal will include implementation of measures to mitigate residual impacts, specified in a Construction Environmental Management Plan (CEMP) for the construction phase and an Operational Environmental Management Plan (OEMP) for ongoing operation and maintenance of the regulators. The CEMP and OEMP will provide detailed environmental controls to manage key environmental issues. These plans will be reviewed and updated as necessary throughout the relevant phases of the proposal.

The CEMP and OEMP will include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures for the management of flora and fauna. The mitigation and harm minimisation measures for direct, indirect and prescribed impacts are detailed in Table 8.9 including timing, responsibility and outcomes.

The study area contains local populations of several threatened species as confirmed through targeted surveys and the preparation of this BDAR. Of these species *Swainsona murrayana* and the Southern Bell Frog are notable in that they are, in general, susceptible to direct harm from construction impacts and aspects of their ecology mean that the risk of impact would vary significantly with seasonal conditions.

Swainsona murrayana plants produce winter-spring growth and die back to persistent rootstock after flowering, re-shooting readily after cool-season rains. Abundant quantities of seed can be produced under favourable conditions (Cth. DCCEEW 2024b). September 2023 surveys after two successive years of above-average cool season rains revealed a population of the species at Hartwood but no above-ground plants in the proposal footprint. The extent of above-ground plants in the *Swainsona murrayana* population and the associated risk of impact would depend on the timing of construction and prevailing rainfall conditions in the prior year. A pre-construction assessment of the *Swainsona murrayana* population would be conducted including supplementary survey as appropriate if the construction period coincides with the August to November flowering period for the species (Cth. DCCEEW 2024b).

For Southern Bell Frog populations in the region encompassing the study area, frogs are concentrated in refugia prior to flooding, then disperse across the landscape during flooding / breeding events (Wassens et. al. 2008). Breeding is triggered by flooding of ephemeral waterbodies during spring or summer, and the larval period can be as short as two months (Clemann and Gillespie 2012). The presence of occupied breeding habitat, the abundance and mobility of adult Southern Bell Frogs and the associated risk of impact would depend on the timing of construction and prevailing rainfall conditions. During wet periods the proposal footprint or nearby areas may contain breeding habitat associated with inundated floodplain depressions that may require additional measures to avoid or minimise impacts. A pre-construction assessment of the Southern Bell Frog population would be conducted including supplementary survey as appropriate if the construction period coincides with potential breeding events.

Pre-construction assessment requirements for *Swainsona murrayana* and the Southern Bell Frog are detailed in Table 8.9.

Table 8.9 Summary of proposed mitigation and management measures for residual impacts (direct, indirect and prescribed)

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness
General biodiversity impacts	Flora and fauna management controls will be included within the CEMP. This will include measures, processes, and responsibilities to minimise the potential for biodiversity impacts during construction of the proposal incorporating recommendations below and expanding on specific details where necessary.	Pre-construction/ Proposal ecologist	High
	Flora and fauna management controls will be included within the OEMP. This will include measures, processes, and responsibilities to minimise the potential for biodiversity impacts during operation of the proposal incorporating recommendations below and expanding on specific details where necessary.	Operation/ WaterNSW	High

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness
General	All workers will be provided with an environmental induction prior to starting work on site. This will include information on the biodiversity values of the site, protection measures to be implemented to protect native biota and penalties for breaches.	Construction / Construction contractor and Proposal ecologist	High
Removal of vegetation and habitat resources	Plans will be prepared showing areas to be cleared and areas to be protected, including exclusion zones and protected habitat features in the vicinity of work areas.	Pre-construction / Proposal ecologist	High
	A pre-construction assessment of the local *Swainsona murrayana* population will be conducted including: – consideration of whether the construction period coincides with the August to November flowering period for the species (Cth. DCCEEW 2024b) – consideration of prevailing rainfall conditions in the preceding cool season and assessment of the likely health and extent of the local population – supplementary survey as appropriate to confirm the extent of above-ground plants in the local population – definition and implementation of additional impact and avoidance measures as appropriate potentially including delayed construction activity, adjustment of CAZs, exclusion fencing and/or translocation.	Pre-construction and construction / Proposal ecologist	High
	A pre-construction assessment of the local Southern Bell Frog population will be conducted including: – consideration of whether the construction period coincides with the Spring-Summer breeding and higher adult frog activity period for the species – consideration of prevailing rainfall and river conditions and assessment of the likely presence and extent of potential breeding habitat in ephemeral wetlands – supplementary survey as appropriate to confirm the extent of occupied breeding habitat and/or mobile adult frogs in the local population – definition and implementation of additional impact and avoidance measures as appropriate potentially including delayed construction activity, adjustment of CAZs, exclusion fencing, procedures for dewatering of wetlands and/or translocation.	Pre-construction and construction / Proposal ecologist	High
	Prior to the commencement of any work in or adjoining areas of native vegetation, a survey will be carried out to mark the construction impact boundary. The perimeter of this area would 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 and the transmission of weeds or disease. Fencing and signage will be maintained for the duration of the construction period. Fencing will be designed to allow fauna to exit the site during clearing activities.	Pre-construction and construction / Proposal ecologist	High
Unexpected direct impacts to threatened flora and fauna	An unexpected finds protocol will be prepared to detail measures to be undertaken if threatened flora and fauna not previously recorded on site are detected during clearing or construction activities.	Construction / Proposal ecologist	High

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness
Harm to resident fauna	Protocols for the management of fauna and habitats would be included in the CEMP. These will include (if required): – a procedure for the felling of hollow-bearing trees to prevent or minimise mortality of fauna – salvage of hollows and logs where practicable – management of any trenches or drill sites to prevent fauna from becoming trapped or injured – any additional measures for the management of frog breeding habitat as appropriate to seasonal conditions and the outcomes of pre-construction surveys.	Construction / Construction contractor and Proposal ecologist	High
	Pre-clearing surveys will be undertaken prior to and during construction by a suitably qualified ecologist. The surveys and inspections, and any subsequent relocation of species, will be undertaken in accordance with the CEMP. Specific surveys include: – an initial pre-clearance survey of the proposal footprint, undertaken by a suitably qualified ecologist prior to the commencement of any clearing activities including: • surveys for roosting microbats in any man-made structures to be removed • searches for nests in vegetation to be removed • identification of fauna refuge sites potentially requiring fauna management during removal, including hollow-bearing trees, woody debris as well as human made material such as metal sheets. – a daily pre-clearance fauna survey of the day's work area, undertaken by a suitably qualified ecologist prior to the clearing of native vegetation – monitoring of clearing activities and observation, rescue, treatment and/or relocation of any resident fauna as appropriate. Monitoring of clearing activities would include particular focus on habitat features that may harbour threatened species that are vulnerable to direct harm including during: – felling of habitat trees that may contain roosting threatened birds or microbats – earthworks in or near floodplain depressions that may contain breeding habitat for the Southern Bell Frog – earthworks affecting cracking clay soils or woody debris that may harbour Grey Snakes or Southern Bell Frogs.	Construction / Construction contractor and Proposal ecologist	High
	A post-clearing report will be prepared documenting all animals that are handled, or otherwise managed, within the site. Data to be recorded includes: – date and time of the sighting and details of the observer – species – number of individuals recorded – adult/juvenile – condition of the animal (living/dead/injured/sick) – management action undertaken (e.g. captured, handled, taken to vet)	Construction / Construction contractor and Proposal ecologist	High

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness
	– results of any management actions (e.g. released, placed in a nest box, euthanised, placed with carer). An inventory of hollows and fallen timber salvaged and relocated will be maintained.		
Pathogen spread and establishment	All machinery entering the site will be appropriately washed down and disinfected prior to work on site to prevent the potential spread of weeds and disease in accordance with the NSW best practice Protocols to protect priority biodiversity areas (DPIE 2020c). Protocols to prevent introduction or spread of chytrid fungus will be implemented following the NSW hygiene guidelines for wildlife (DPIE 2020c).	Construction / Contractor	High
Spread of weeds	Declared priority weeds will be managed according to requirements of the NSW *Biosecurity Act*. Soil material and stripped groundcover vegetation with the potential to contain priority weeds will not be removed from the proposal footprint. Soil disturbance would be avoided as much as possible to minimise the potential for spreading weeds.	Construction / Contractor	High
Soil loss hazard – erosion of soils and sediment due to clearing during construction	Erosion and sediment control measures will be established prior to construction in accordance with the principles and guidelines included in Managing Urban Stormwater: Soils and Construction - Volume 1 (Landcom 2004).	Pre-construction, construction / Contractor	High
Reduction in surface water quality due to sedimentation	Erosion and sediment controls throughout the proposal footprint will be inspected and maintained to ensure they are operating effectively.	Construction / Contractor	High
Vehicle strike	Appropriate speeds for all construction and contractor vehicles will be enforced to limit dust generation and minimise risk of fauna mortality through vehicle strike during construction and operation.	Construction, operation / Contractor	Moderate
Light spill – displacement of fauna from habitat adjoining the proposal footprint	Light generated during construction will be managed in general accordance with the requirements in Australian Standard AS 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting. Directional lighting will be used to minimise the effects of light spill outside the CAZ as far as possible.	Construction / Contractor	Moderate
Noise and vibration generation - displacement of fauna from habitat adjoining the proposal footprint	All activities on site are to be undertaken as per the approved CEMP and OEMP, with works confined between the following hours: daytime hours of 7:00 am to 6:00 pm, Monday to Sunday (including public holidays), with the exception of the following activities: – the delivery of materials as requested by the NSW Police Force or other authorities for safety reasons; emergency work to avoid the loss of life or damage to property, or to prevent environmental harm – emergency work to avoid the loss of life, property and/or material harm to the environment – works as approved through the out-of-hours works protocol as approved through the CEMP or OEMP. Additional, specific controls will be included within the CEMP and OEMP and should consider the proposal specific management measures outlined in the Noise and Vibration Impact Assessment (GHD 2023b).	Construction, operation / Construction contractor, WaterNSW	Moderate

Impact	Mitigation measures	Timing / responsibility	Likely effectiveness
Water quality, chemical and fuel impacts on flora and fauna	Specific measures will be incorporated into the CEMP and OEMP to minimise the potential for chemical spills and associated impacts on natural environments adjacent to and downstream of the areas of impact. Spill kits will be made available to construction vehicles and operation/maintenance vehicles. A management protocol for accidental spills will be put in place. Chemicals will be stored in bunded areas.	Construction, operation / Construction contractor, WaterNSW	High

Residual direct impacts require further assessment for SAII (BAM Section 9.1) and to determine a credit requirement (BAM Section 9.2). Residual indirect or prescribed impacts for which no mitigation measures are proposed require an adaptive management strategy (BAM Section 8.5). Other indirect and prescribed impacts that remain after avoid, minimise and mitigate have been applied, may be offset using additional biodiversity credits (above the credit requirement generated by the BAM-C for direct impacts) and/or other conservation measures.

9. Impact summary

9.1 Assessment for serious and irreversible impacts on biodiversity values

Section 6.7 of the BC regulation sets out principles for determining whether an impact on a specific threatened species or ecological community is serious and irreversible. If an impact is likely to contribute significantly to the risk of a threatened species or ecological community becoming extinct, this is deemed serious and irreversible. This likelihood is assessed based on the following four principles:

– The impact will cause a further decline of a species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline.
– The impact will 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.
– The impact is made on the habitat of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very limited geographic distribution.
– The impacted species or ecological community is unlikely to respond to measures to improve its habitat and vegetation integrity, and therefore its members are not replaceable.

A set of criteria have been developed and are included in the *Guidelines to assist a decision-maker to determine a SAII* (DPE, 2023f). Threatened biota that meet the criteria under one or more of the above principles have been identified as SAII entities. Each potential SAII entity has an impact threshold identified which can be used to help determine if a development will result in SAII. The decision-maker must determine whether or not an impact on biodiversity values is likely to be 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 SAII entity to ultimately determine if a proposal would result in a SAII.

One potential SAII entity could be affected by the proposal as outlined in Table 9.1.

None of the other threatened biota of relevance to this assessment are candidate SAII entities.

Table 9.1 Entities at risk of an SAII

Common name	Scientific name	Reason for inclusion in assessment
Plains-wanderer	*Pedionomus torquatus*	Included in current list of entities at risk of an SAII and is likely to be impacted by the proposal

9.1.1 SAII assessment for Plains-wanderer

Table 9.2 Assessment of serious and irreversible impacts for the Plains-wanderer

Criteria	Assessment
(1) the action and measures taken to avoid the direct and indirect impact on the potential entity for a SAII	The proposal has avoided impacts to mapped important areas of Plains-wanderer habitat in the south-east of the Hartwood site by siting access tracks outside this area. The proposal was unable to avoid mapped habitat areas for the species adjacent to Conargo Road where the power supply and access track corridor is proposed.
(2). The assessor must consult the TBDC and/or other sources to report on the current status of the species including:	
Current BC Act status	Listed as a critically endangered species
a. evidence of rapid decline (Principle 1, clause 6.7(2)(a) BC Regulation) presented by an estimate of the: i. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer), or ii. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer) as indicated by: an index of abundance appropriate to the species; decline in geographic distribution and/or habitat quality; exploitation; effect of introduced species, hybridisation, pathogens, pollutants, competitors or parasites	The TBDC identifies that there has been a population reduction of >=80% in ten years or three generations. Analysis of monitoring data collected between 2001 and 2014 indicated that there was an overall decline in numbers of 93% across sites in the Riverina region over this time period (Wilson et al., 2014; DCCEEW 2016).
b. evidence of small population size (Principle 2, clause 6.7(2)(b) BC Regulation) presented by:	The TBDC does not identify this principle as being relevant to this species.
i. an estimate of the species' current population size in NSW, and	Not relevant
ii. an estimate of the decline in the species' population size in NSW in three years or one generation (whichever is longer), and	Not relevant
iii. where such data is available, an estimate of the number of mature individuals in each subpopulation, or the percentage of mature individuals in each subpopulation, or whether the species is likely to undergo extreme fluctuations	Not relevant
c. evidence of limited geographic range for the threatened species (Principle 3, clause 6.7(2)(c) BC Regulation) presented by:	
i. extent of occurrence	The extent of occurrence for the species has declined markedly since European settlement and was estimated to be 930,000 km^2 (Garnett et al., 2011) at the time of writing of the National Recovery Plan. However by 2018, this extent of occurrence had reduced to 526,000 km^2 (National Environmental Science Program Threatened Species Research Hub 2019).
ii. area of occupancy	Garnett et al. (2011) estimated the area of occupancy to be 330 km^2, with a continuing declining trend (DoE 2016). The estimated area of occupancy has not changed since 2016 (National Environmental Science Program Threatened Species Research Hub 2019).

Criteria	Assessment
iii. number of threat-defined locations (geographically or ecologically distinct areas in which a single threatening event may rapidly affect all species occurrences), and	Plains-wanderer populations are threatened by: – small population size – inappropriate habitat management – prolonged drought – wildfire – habitat loss – feral predators – pesticide use. There is no available data pertaining to the location and extent of threat-defined locations, however the Riverina region may be considered a threat defined location as it is a current stronghold for the species.
iv. whether the species' population is likely to undergo extreme fluctuations	The size of the Plains-wanderer population fluctuates greatly in response to seasonal conditions, stocking rate and the time of year (NSW Scientific Committee 2009). Plains-wanderer populations have been shown to recover from population declines associated with drought conditions and localised overgrazing (Baker-Gabb 1990, Maher 1997) (DoE 2016). The population of the species is currently estimated to be between 500-1000 individuals (National Environmental Science Program Threatened Species Research Hub 2019). The following studies show the extreme fluctuation of population numbers for the species: – The Riverina population of Plains-wanderer has been shown to vary by up to 80% from year to year in times of drought Baker-Gabb (1990). – The core population in the NSW Riverina, where highest densities occur, has been estimated as 1000 birds in poor years to 5500 after good years (Baker-Gabb 1998; Garnett & Crowley 2000) – The entire population of the species was estimated to range between 2500 birds to 800 birds dependant on a very wet or dry year following a few good seasons (Bake-Gabb 1998), or between 5500 birds to less than 2000 in years of drought (NPWS 2002).
d. evidence that the species is unlikely to respond to management (Principle 4, clause 6.7(2)(d) BC Regulation) because:	The species is likely to respond to management, if good climatic conditions and suitable habitat for the species is managed to promote recovery of the species. A Paddock for Plains-wanderers initiative has been created by Local Land Services is an initiative for landowners to strategically graze their land to provide refuge during years where understorey cover is too low or high due dry or wet years (NSW DCCEEW 2020).
i. known reproductive characteristics severely limit the ability to increase the existing population on, or occupy new habitat (e.g. species is clonal) on, a biodiversity stewardship site	Plains-wanderers breed in solitary pairs in a territory defended by the larger female, though they can be serially polyandrous. The nest is a hollow or 'scrape' that is scratched into the ground and lined with grass, with nests placed amongst native grasses and herbs, occasionally amongst crops. The male does most of the incubation and is also primarily responsible for attending the young. At this time the female may pair with and lay a clutch for a second male to incubate. Breeding success is often linked to environmental conditions. There may be no breeding during drought years and success can also be very low in years of heavy rainfall. Improving habitat, managing grazing levels, burning regimes and feral predator control is likely to improve habitat values and breeding success at a stewardship site.
ii. the species is reliant on abiotic habitats which cannot be restored or replaced (e.g. karst systems) on a biodiversity stewardship site, or	The species is not reliant on abiotic habitats which cannot be restored.

Criteria	Assessment
iii. life history traits and/or ecology is known but the ability to control key threatening processes at a biodiversity stewardship site is currently negligible (e.g. frogs severely impacted by chytrid fungus).	The species has no life history traits or ecological traits that prevent its recovery. Site occupancy of the species is strongly correlated to having the appropriate density of understorey cover within potential habitat.
3) Where the TBDC indicates data is 'unknown' or 'data deficient' for a species for a criterion listed in Subsection 9.1.2(2.), the assessor must record this in the BDAR or BCAR	The TBDC does not indicate data 'unknown' or 'data deficient for the Plains-wanderer.
4) Impact assessment	The primary 'stronghold' of the species is the Riverina region of south-western NSW (Baker-Gabb., 1990; Bennett, 1983) with the north-central region of Victoria providing a secondary stronghold (DoE 2016). The Plains-wanderer was formerly much more common and widespread but its distribution and population size have declined markedly due to the loss and degradation of sparse, lowland native grasslands, which are its preferred habitat.
a. the impact on the species' population (Principles 1 and 2) presented by:	
i. an estimate of the number of individuals (mature and immature) present in the subpopulation on the subject land (the site may intersect or encompass the subpopulation) and as a percentage of the total NSW population, and	There is no mechanism to accurately estimate the number of Plains-wanderer which may occur within the proposal footprint. Mapped important habitat for the Plains-wanderer in the proposal footprint comprises two small patches of grassland at the Hartwood site. Other small patches occur in the surrounding area, generally characterised by roadside corridors, cropland and also grazing lands. No individuals were recorded during surveys. No important habitat areas under BOAMS have been mapped at the Wanganella site. Solitary Plains-wanderers are known to occupy a home range of ~12ha, with a pair occupying 18ha within the Riverina region (NSW Scientific Committee 2009). Given that 1.96 ha of important Plains-wanderer habitat is present within the proposal footprint, it is likely that one breeding pair may occupy the proposal footprint, which would form a small portion of their home range (if present).
ii. an estimate of the number of individuals (mature and immature) to be impacted by the project and as a percentage of the total NSW population, or	Not relevant.
iii. if the species' unit of measure is area, provide data on the number of individuals on the site, and the estimated number that will be impacted, along with the area of habitat to be impacted by the project	Plains-wanderer were not recorded during field surveys, however the Riverina remains a stronghold for the population, and important habitat areas for the species under BOAMS occur within the proposal footprint. The proposal may impact habitat for up to two Plains-wanderer (breeding pair), assuming they are present within the proposal footprint. This would comprise up to 1.96 ha of native vegetation comprising PCT 44 and PCT 46. However as aforementioned, the abundance and distribution of the species is highly variable and dependant on seasonal conditions.
b. impact on geographic range (Principles 1 and 3) presented by:	
i. the area of the species' geographic range to be impacted by the proposal in hectares, and a percentage of the total AOO, or EOO within NSW	The proposal would remove 1.96 ha of potential habitat for the Plains-wanderer, also mapped as an important habitat area for the species within BOAMs. This equates to 0.006% of the total AOO. Within 20 km of the locality, BOAMS has mapped 191 ha of important habitat for the species; with the proposal potentially impacting only 1% of mapped habitat in the locality.

Criteria	Assessment
ii. the impact on the subpopulation as either: all individuals will be impacted (subpopulation eliminated); OR impact will affect some individuals and habitat; OR impact will affect some habitat, but no individuals of the species will be directly impacted	The proposal would impact 1.96 ha of potential habitat mapped as important habitat areas within BOAMS for the species. The removal of this habitat may impact up to one breeding pair, within a small extent of their home range (if present).
iii. to determine if the persisting subpopulation that is fragmented will remain viable, estimate (based on published and unpublished sources such as scientific publications, technical reports, databases or documented field observations) the habitat area required to support the remaining population, and habitat available within dispersal distance, and distance over which genetic exchange can occur (eg seed dispersal) and pollination distance for the species	The proposal would remove 1.96 ha of potential habitat along Conargo Road, associated road reserves and cleared agricultural land. This would comprise a small portion of the home range of a breeding pair (if present). The potential habitat to be removed, is unlikely to be a critical part of the home range of the species, considering the species was not detected during surveys. The removal of potential habitat within the proposal footprint would force a localised movement (displacement) of up to two individuals to other areas of adjacent suitable habitat. This may include small patches of adjacent important mapped habitat areas mapped within BOAMS to the west of the proposal footprint along Conargo Road. A larger patch of suitable habitat mapped within BOAMS (~57 ha) is also present 1.5 km to the south east of proposed patch of habitat to be removed. The Plains-wanderer has been recorded dispersing up to 125 km between Victoria and the Riverina region in NSW within 11 months (Wanderer 2017; SWIFFT 2024), highlighting that the dispersal distance between habitat proposed for removal in the proposal footprint and adjacent important mapped habitat areas in the locality, comprise a negligible portion of their likely maximum range. This record also highlights that genetic exchanges can occur over large distances of poor quality habitat (ie croplands) and that the proposal as such is unlikely to reduce the genetic viability between Plains-wanderer in the proposal footprint and from adjacent areas of habitat.
iv. to determine changes in threats affecting remaining subpopulations and habitat if the proposed impact proceeds, estimate changes in environmental factors including changes to fire regimes (frequency, severity); hydrology, pollutants; species interactions (increased competition and effects on pollinators or dispersal); fragmentation, increased edge effects, likelihood of disturbance; and disease, pathogens and parasites.	The proposal may increase edge effects such as weed dispersal, which may change the density of local occurrence of mapped habitat within the study area, reducing the suitability of potential habitat . The proposal would not change existing fire regimes (if present), species interactions and disease, pathogen and parasites.

9.2 Offset requirement for impacts under the BC Act

9.2.1 Impacts on native vegetation (ecosystem credits)

Impacts associated with the proposal that require offsetting comprise the removal or modification of up to 16.23 ha of native vegetation and associated threatened species habitat as shown on Figure 9.1 and Figure 9.2.

The data from the fieldwork and desktop assessment was entered into Version 1.4.0.00 of the BAM-Calculator (BAM data last update 14/03/2024 - Version 67) as a ‘Development’ assessment to determine the number and type of biodiversity credits that would be required to offset impacts of the proposal. Version 1.2 ‘wet year’ benchmark data was used reflecting the above average rainfall in the years preceding field surveys as stated in section 2.5.

The credit calculations Parent case ID for the proposal is 00033952. Assessment cases were created as follows:

– Wanganella – 00033952/BAAS23017/23/00044378 Version 1
– Hartwood – 00033952/BAAS23017/23/00044379 Version 1.

The biodiversity credit report is included in Appendix G and identifies the numbers and classes of biodiversity credits required to be retired in accordance with the like-for-like requirements of the offset rules and those that could be retired in accordance with the variation rules. This BDAR has been certified and submitted to the decision-maker within 14 days of the date the BAM-C credit report was finalised.

Ecosystem credit requirements are summarised in Table 9.3 and offset trading groups (OTGs) to ensure 'like for like' provision of biodiversity offsets are summarised in Table 9.4. Each of the ecosystem credit types can be traded with credits:

– In the same offset trading group (OTG) *and,*
– Located in the Murrumbidgee IBRA subregion containing the proposal footprint including the Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain adjoining the proposal footprint *or,*
– The subregions that fall within 100 kilometres of the proposal footprint:
    - Inland Slopes
    - Victorian Riverina
    - Murrumbidgee.

Table 9.3 Impacts that require an offset – ecosystem credits

Vegetation zone	PCT ID - name	TEC	Impact area (ha)	Current VI score	Future VI score	Change in VI score	Biodiversity risk weighting	Number of ecosystem credits required
Hartwood								
7_Moderate	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion	No	0.84	82.7	0	-82.7	1.50	26
10_Moderate	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	No	0.47	74.3	0	-74.3	1.50	13
10_Shrubland	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	No	0.28	43.8	0	-43.8	1.50	5
13_DNG	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	No	1.87	27.3	0	-27.3	1.75	22
13_Moderate	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	No	2.39	64.6	0	-64.6	1.75	68
44_Moderate	44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion	No	0.32	75.9	0	-75.9	2.50	12
46_Moderate	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	No	4.31	85.4	0	-85.4	1.50	138

Vegetation zone	PCT ID - name	TEC	Impact area (ha)	Current VI score	Future VI score	Change in VI score	Biodiversity risk weighting	Number of ecosystem credits required
46_Poor	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	No	0.48	44.4	0	-44.4	1.50	8
Wanganella								
7_Moderate	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion	No	0.61	47.6	0	-47.6	1.50	11
10_Moderate	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	No	0.93	52.7	0	-52.7	1.50	18
13_DNG	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	No	0.89	11.5	0	-11.5	1.75	0
13_Moderate	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	No	0.79	87.6	0	-87.6	1.75	30
46_Moderate	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	No	1.89	89.1	0	-89.1	1.50	63
160_Moderate	160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains	No	0.19	97.3	0	-97.3	1.50	7

Table 9.4 'Like-for-like' ecosystem credits required to offset impacts of the proposal

Vegetation zone	Credit class	Offset trading group (OTG)	Hollow-bearing trees
Hartwood			
7_Moderate	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion	Inland Riverine Forests - < 50% cleared group (including Tier 4 or higher threat status). This includes PCTs: 2, 5, 7, 8, 9, 10, 11, 36, 78, 79, 112, 233, 234, 249, 356, 362, 4088, 4089	Yes
10_Moderate	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Riverine Forests - < 50% cleared group (including Tier 4 or higher threat status). This includes PCTs: 2, 5, 7, 8, 9, 10, 11, 36, 78, 79, 112, 233, 234, 249, 356, 362, 4088, 4089	Yes
10_Shrubland	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Riverine Forests - < 50% cleared group (including Tier 4 or higher threat status). This includes PCTs: 2, 5, 7, 8, 9, 10, 11, 36, 78, 79, 112, 233, 234, 249, 356, 362, 4088, 4089	No
13_DNG	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Floodplain Woodlands - ≥ 50% - < 70% cleared group (including Tier 3 or higher threat status). This includes PCTs: 13, 15, 16, 83, 438, 454, 630	No
13_Moderate	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Floodplain Woodlands - ≥ 50% - < 70% cleared group (including Tier 3 or higher threat status). This includes PCTs: 13, 15, 16, 83, 438, 454, 630	Yes
44_Moderate	44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion	Riverine Plain Grasslands - > 70% - < 90% cleared group (including Tier 2 or higher threat status). This includes PCT: 44	N/A
46_Moderate	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	Riverine Plain Grasslands - < 50% cleared group (including Tier 4 or higher threat status). This includes PCTs: 44, 45, 46, 165, 1203	N/A

Vegetation zone	Credit class	Offset trading group (OTG)	Hollow-bearing trees
46_Poor	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	Riverine Plain Grasslands - < 50% cleared group (including Tier 4 or higher threat status). This includes PCTs: 44, 45, 46, 165, 1203	N/A
Wanganella			
7_Moderate	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion	Inland Riverine Forests - < 50% cleared group (including Tier 4 or higher threat status). This includes PCTs: 2, 5, 7, 8, 9, 10, 11, 36, 78, 79, 112, 233, 234, 249, 356, 362, 4088, 4089	Yes
10_Moderate	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Riverine Forests - < 50% cleared group (including Tier 4 or higher threat status). This includes PCTs: 2, 5, 7, 8, 9, 10, 11, 36, 78, 79, 112, 233, 234, 249, 356, 362, 4088, 4089	Yes
13_DNG	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Floodplain Woodlands - ≥ 50% - < 70% cleared group (including Tier 3 or higher threat status). This includes PCTs: 13, 15, 16, 83, 438, 454, 630	No
13_Moderate	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Inland Floodplain Woodlands - ≥ 50% - < 70% cleared group (including Tier 3 or higher threat status). This includes PCTs: 13, 15, 16, 83, 438, 454, 630	Yes
46_Moderate	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	Riverine Plain Grasslands - < 50% cleared group (including Tier 4 or higher threat status). This includes PCTs: 44, 45, 46, 165, 1203	N/A
160_Moderate	160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains	Inland Floodplain Shrublands - < 50% cleared group (including Tier 4 or higher threat status). This includes PCTs: 17, 24, 25, 115, 160, 161, 240, 241, 247, 261, 271, 375	N/A

9.2.2 Impacts on threatened species and their habitat (species credits)

Table 5.4 identifies the confirmed candidate species credit species requiring assessment in accordance with BAM Subsection 5.2.4, the method used to confirm their presence and the outcome of targeted surveys. Species credits required for impacts as a result of the proposal are identified in Table 9.5.

Each of the other candidate species and species credit matters such as nest trees have been excluded through targeted seasonal survey with reference to the TBDC (NSW DCCEEW 2024a) and relevant guidelines as described in section 2.4. No other species credit matters were recorded or are assumed present within the proposal footprint.

Table 9.5 Impacts that require an offset – species credits

Common name	Scientific name	BC Act status	EPBC Act status	Loss of habitat (ha)	Biodiversity risk weighting	Type	Potential SAII	Number of species credits required
Hartwood								
Southern Bell Frog	*Litoria raniformis*	E	V	5.25	2	Area	No	150
Plains-wanderer	*Pediomomus torquatus*	E	CE	1.96	3	Area	Yes	123
Southern Myotis	*Myotis macropus*	V		3.70	2	Area	No	129
Slender Darling-pea	*Swainsona murrayana*	V	V	2.22	2	Area	No	94
Wanganella								
Little Eagle	*Hieraeetus morphnoides*	V		1.25	1.5	Area	No	30
Southern Bell Frog	*Litoria raniformis*	E	V	3.28	2	Area	No	82
Bush Stone-curlew	*Burhinus grallarius*	E		2.12	2	Area	No	69

Notes: CE – listed as a critically endangered species, E – listed as an endangered species, V – listed as a vulnerable species

9.2.3 Indirect and prescribed impacts

Significant residual indirect and prescribed impacts that remain after measures to avoid, minimise and mitigate have been applied, may require calculation of biodiversity offsets using additional biodiversity credits (above the credit requirement generated by the BAM C for direct impacts) and/or other conservation measures. The process for determining whether there are any significant residual impacts is documented in this BDAR as follows:

– Table 7.2 (Avoidance and minimisation measures for direct, indirect and prescribed impacts) which shows how the potential for impacts to biodiversity values has been substantially avoided.
– Table 8.4 (Summary of residual indirect impacts) and Table 8.5 (Summary of potential prescribed impacts) which presents the minor extent and consequence of potential impacts to biodiversity values.
– Table 8.9 (Summary of proposed mitigation and management measures for residual impacts (direct, indirect and prescribed) which describes how potential residual impacts would be mitigated with generally high confidence of success.

The proposal may result in residual indirect impacts through light spill and noise and vibration generation causing displacement of threatened species and other native fauna from habitat adjoining the proposal footprint. These impacts would mainly occur during construction though there is also a risk of such impacts during risks during operation, noting use of operation and maintenance vehicles and mechanical operation of the regulator. Both construction and operational stages of the proposal would result in residual prescribed impacts through interruption of habitat connectivity, minor changes to surface water flows and a moderate risk of vehicle strike causing harm to threatened fauna species and other native fauna using habitats in the vicinity of the proposal footprint.

Given the limited extent, duration and intensity of impacts and extensive areas of alternative habitat resources in the locality the consequences of these residual impacts are likely to be minor. No biodiversity credits or conservation measures are proposed for these residual impacts.

9.3 Impacts that do not need further assessment under the BC Act

Impacts that do not need further assessment for biodiversity credits are listed in Table 9.6 (as per BAM Section 9.3(1-2).

Table 9.6 Impacts that do not need further assessment for ecosystem credits

Site	Impact	Location within proposal footprint	Justification why no further assessment is required
Hartwood	Removal of 4.04 ha of non-native vegetation.	Refer to Figure 9.1	Impact assessment relating to removal or modification of habitat and calculation of biodiversity offsets is not required for non-native vegetation (other than consideration of prescribed impacts, as described above).
Wanganella	Removal of 0.95 ha of non-native vegetation.	Refer to Figure 9.2	

9.4 Offsets for MNES

Under the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPaC 2012) (the EPBC Act Environmental Offsets Policy) biodiversity offsets are required to compensate for significant residual impacts on MNES. This BDAR includes the identification and assessment of potentially affected MNES, consideration of the potential significance of impacts on MNES pursuant to the *Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (DotE 2013). The outcome of these assessments is that the proposed action is not likely to result in a significant impact to any terrestrial threatened species or communities (Appendix H).

Specific consideration of the approval and offsetting requirements for MNES is only required for controlled actions. This proposal has been referred to the Australian Minister for the Environment (reference number EPBC 2024/09939). The referral decision provided on 17 September 2024 is that the proposal is not a controlled action. No further assessment or approval under the EPBC Act is required. No biodiversity offsets for residual significant impacts on MNES are required under the EPBC Act Environmental Offsets Policy (DSEWPaC 2012).



LEGEND

- Proposal footprint
- Areas not requiring assessment (4.09 ha)
- Impacts requiring offset (10.94 ha)

N

GDA2020 MGA Zone 55

A4 Scale: 1:19,000

0 75 150 225 300

Metres

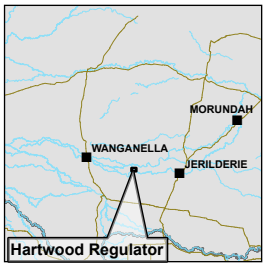


Figure 9.1 Hartwood thresholds for assessment and offsetting impacts

3Rivers

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

Maxar;20/05/2024 4:51 PM rvillalon
\\gldnetfglsd\AUSydney\Projects\21\12537654\GIS\Maps\Deliverables\SDLAM_Yanco\12537654_RFS083_Billabong_BDAR.aprx



Figure 9.2 Wanganella thresholds for assessment and offsetting impacts

Produced by 3Rivers for the SDLAM Program.
3Rivers does not warrant that this document is definitive nor free of errors and does not accept liability for any loss caused or arising from reliance upon information provided herein

9.5 Approach to retiring offsets

The biodiversity offset requirements described in section 9.2 would be secured according to the offset rules established by the *Biodiversity Conservation Regulation 2017* through either:

– purchase of biodiversity credits from existing biodiversity stewardship sites (BSSs) after identifying the required 'like for like' credits in the market through the BOS public registers
– payment to the Biodiversity Conservation Fund (BCF) equivalent to the number and type of credits required
– purchase of biodiversity credits generated by a future Biodiversity Stewardship Agreement (BSA) over a parcel of land identified as a suitable offset for the proposal
– funding an approved biodiversity action.

At this stage of planning for the proposal it is likely that available credits would be sourced from the open market in accordance with the trading rules associated with the BOS with any shortfall met by a payment into the BCF. To support the BCF payment option, NSW DCCEEW would obtain a charge quote from the BCT based on the credit obligation outlined in section 9.2. Payment could be made to retire all or part of the offset obligation through the BCF once NSW DCCEEW receive development approval under Part 5.1 of the EP&A Act along with conditions which include a requirement to retire biodiversity credits.

10. Summary and conclusions

10.1 Introduction

NSW DCCEEW is proposing to replace two existing weirs along Billabong Creek with new regulators (the proposal). The two existing weirs to be demolished are Hartwood Weir and Wanganella Weir. These structures are situated on Billabong Creek within the Yanco Creek system in south-west NSW.

The new regulators would be automated and remotely operated meaning that operators could control the delivery of water more efficiently. The proposal is needed to improve the operator's ability to deliver the right amount of water to the right place at the right time. The new regulators would also feature fishways to support fish movement past the new structures.

GHD has been engaged to prepare a biodiversity development assessment report (BDAR) to accompany the environmental impact statement (EIS) for impacts resulting from the replacement of two existing weirs along Billabong Creek with new regulators. The BDAR:

– describes the existing environment of the study area and assesses the value and conservation significance of native vegetation and habitats in the proposal footprint and the potential for threatened biota including MNES to occur or be affected by the proposal
– provides a description of the proposal, including potential impacts on biodiversity values and measures to avoid or minimise impacts
– assesses the significance of residual impacts on threatened biota and matters of national environmental significance (MNES) under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
– determines the need or otherwise for biodiversity offsets for residual impacts of the proposal in accordance with the Biodiversity Assessment Method (BAM)
– recommends measures to mitigate and manage the impacts of the proposal.

10.2 Existing environment

The proposal footprint at Wanganella occurs adjacent to the Cobb Highway and contains moderate condition riparian woodland along Billabong Creek and native grasslands within the Wanganella Recreation Reserve. The northern bank of Billabong Creek is used by recreational campers, and is routinely subject to human disturbance. Up to 50.63 ha of native vegetation is present in the study area at Wanganella, approximately 5.29 ha occurs in the proposal footprint.

The proposal footprint at Hartwood occurs adjacent to Conargo Road and also contains riparian woodland associated with Billabong Creek. The Hartwood site also contains both native and non-native grasslands and occurs in close proximity to cropped lands. Instream vegetation along sections of Billabong Creek in the Hartwood site is dense in cover. The weir site is not publicly accessible by the public. Up to 80.99 ha of native vegetation is present in the study area at Hartwood, approximately 10.94 ha occurs in the proposal footprint.

10.3 Impacts summary

The proposal would remove up to 16.23 ha of native vegetation across the proposal footprint. Direct impacts on native vegetation as a result of the proposal comprise:

– removal of 1.45 ha of River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion (PCT 7)
– removal of 1.68 ha of River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) (PCT 10)
– removal of 5.93 ha of Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) (PCT 13)

– removal of 0.32 ha of Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion (PCT 44)
– removal of 6.67 ha of Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion (PCT 46)
– removal of 0.19 ha of Nitre Goosefoot shrubland wetland on clays of the inland floodplains (PCT 160).

Direct impacts on candidate species credit species listed under the BAM comprise:

– removal of 1.25 ha of breeding habitat for the Little Eagle (*Hieraaetus morphnoides*) listed as a vulnerable species under the BC Act
– removal of 2.12 ha of occupied habitat for the Bush Stone-curlew (*Burhinus grallarius*) listed as an endangered species under the BC Act
– removal of 8.53 ha of occupied habitat for the Southern Bell Frog (*Litoria raniformis*) listed as a vulnerable species under the BC Act and endangered species under the EPBC Act
– removal of 3.70 ha of occupied habitat for the Southern Myotis (*Myotis macropus*) listed as a vulnerable species under the BC Act
– removal of 1.96 ha of mapped important habitat for the Plains-wanderer (*Pedionomus torquatus*) listed as an endangered species under the BC Act and critically endangered species under the EPBC Act
– removal of 2.22 ha of occupied habitat for Slender Darling-pea (*Swainsona murrayana*) listed as a vulnerable species under the BC Act and EPBC Act.

Additional direct impacts are likely for the following ecosystem credit species recorded within the proposal footprint:

– Dusky Woodswallow (*Artamus cyanopterus cyanopterus*)
– Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*)
– White-bellied Sea-eagle (*Haliaeetus leucogaster*)
– Pink Cockatoo (*Lophochroa leadbeateri*)
– Southern Whiteface (*Aphelocephala leucopsis)*
– Inland Forest Bat (*Vespadelus baverstocki*)
– Little Pied Bat (*Chalinolobus picatus*).

The proposal may result in residual indirect impacts through light spill and noise and vibration generation causing displacement of threatened species and other native fauna from habitat adjoining the proposal footprint. The proposal would result in residual prescribed impacts through the removal or modification of vegetation within habitat corridors, minor changes to surface water flows and a moderate risk of vehicle strike causing harm to threatened fauna species and other native fauna using habitats in the vicinity of the proposal footprint. These residual impacts are likely to be minor in intensity and consequence and so no offsets are proposed.

An assessment of serious and irreversible impacts has been prepared for the Plains-wanderer due to the removal of 1.96 hectares of mapped important habitat for this species.

The study area does not contain important habitat for any migratory species listed under the EPBC Act nor any Critical Habitat for any species as defined under section 207A of the EPBC Act included in the Register of Critical Habitat (DCCEEW 2024c).

Assessments of significance have been prepared for threatened species listed under the EPBC Act that are likely to be impacted by the proposal. The outcome of these assessments is that the proposed action is not likely to result in a significant impact to any terrestrial threatened species or communities listed under the EPBC Act.

10.4 Mitigation

Specific mitigation measures are recommended to minimise likely impacts on biodiversity values. These measures are presented according to the hierarchy of avoidance and mitigation of impacts, and the identification of residual impacts of the proposal that cannot be avoided or mitigated. The proposal will include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures for the management of flora and fauna.

The proposal will include implementation of measures to mitigate residual impacts, specified in a Construction Environmental Management Plan (CEMP). The CEMP will provide detailed environmental controls to manage key environmental issues. The CEMP will be reviewed and updated as necessary throughout the relevant phases of the proposal.

The CEMP will include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures for the management of flora and fauna.

10.5 Offset requirement

A BAM assessment and credit calculations have been performed in accordance with the methodology (DPIE 2020a) and using credit calculator version 1.4.0.00 incorporating version 1.2 'wet year' benchmarks. Offsets are required for residual impacts on native vegetation and threatened species habitat that cannot be avoided or mitigated. The following ecosystem and species credits would need to be retired to offset residual impacts of the proposal on threatened species habitats:

– Hartwood:
  - 26 ecosystem credits for PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland
  - 18 ecosystem credits for PCT 10 River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone
  - 90 ecosystem credits for PCT 13 Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone
  - 12 ecosystem credits for PCT 44 Forb-rich Speargrass - Windmill Grass - White Top grassland
  - 146 ecosystem credits for PCT 46 Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam
  - 150 species credits for the Southern Bell Frog
  - 129 species credits for the Southern Myotis
  - 123 species credits for the Plains-wanderer
  - 94 species credits for the Slender Darling-pea
– Wanganella:
  - 11 ecosystem credits for PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland
  - 18 ecosystem credits for PCT 10 River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone
  - 30 ecosystem credits for PCT 13 Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone
  - 63 ecosystem credits for PCT 46 Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam
  - 7 ecosystem credits for PCT 160 Nitre Goosefoot shrubland wetland on clays of the inland floodplains ecosystem credits
  - 69 species credits for the Bush Stone-curlew
  - 30 species credits for the Little Eagle
  - 82 species credits for the Southern Bell Frog.

11. References

Baker-Gabb DJ (1990). The biology and management of the Plains-wanderer *Pedionomus torquatus* in NSW. NSW NPWS Species Management Report No. 3. NSW National Parks and Wildlife Service, Sydney

Baker-Gabb DJ (1998) Native grasslands and the Plains-wanderer. Birds Australia Conservation Statement no. 1, Supplement to Wingspan 8, 1-8. Accessed at: **https://www.birdsaustralia.com.au/documents/OTHPUB-NativeGrasslands.pdf**

Barrett, T. and Love, J. (2012). Fine-scale modelling of fauna habitat and connectivity values in the ACT region. Report prepared for the Conservation Planning and Research, Environment and Sustainable Development Directorate, ACT Government.

BOM (2023a). New South Wales in 2022: exceptionally wet, cooller than average days. Accessed at: **http://www.bom.gov.au/climate/current/annual/nsw/summary.shtml#:~:text=New%20South%20Wales%20in%202022%3A%20exceptionally%20wet%2C%20cooler%20than%20average,highest%20annual%20totals%20on%20record**.

BOM (2023b) *Weather Station Directory* **Weather Station Directory (bom.gov.au)**

BOM (2023c). *Climate Data Online*. Accessed at: **Climate Data Online - Map search (bom.gov.au)**

BOM (2024) *Groundwater Dependent Ecosystems Atlas*. Accessed at: **GDE Atlas Map: Water Information: Bureau of Meteorology (bom.gov.au)**

Churchill, S. (2008). Australian Bats, Allen and Unwin, Australia.

Clemann, N. & G.R. Gillespie (2012). National Recovery Plan for the Southern Bell Frog *Litoria raniformis*. Department of Sustainability and Environment, Melbourne. Accessed at: **http://www.environment.gov.au/biodiversity/threatened/recovery-plans/national-recovery-plan-southern-bell-frog-litoria-raniformis**

Commonwealth Department of Climate Change, Energy, the Environment and Water (Cth. DCCEEW) (2021) Flow Monitoring Evaluation Research Fridays Spring 2021: Biodiversity in the Basin. Online presentation. Session #3- 5 November 2021. Accessed at: **https://flow-mer.org.au/flow-mer-fridays-series-3/**

Cth. DCCEEW (2022). *Conservation Advice for* Hemiaspis damelii *(grey snake)*. Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: **http://www.environment.gov.au/biodiversity/threatened/species/pubs/1179-conservation-advice-05102022.pdf**.

Cth. DCCEEW (2023a) *Conservation Advice for* Lophochroa leadbeateri leadbeateri *(eastern Major Mitchell's cockatoo), Canberra*. Accessed at: **Conservation advice Lophochroa leadbeateri leadbeateri (eastern Major (environment.gov.au)**

Cth. DCCEEW (2023b)*Conservation Advice for Melanodryas cucullata cucullata (hooded robin (southeastern)), Canberra.* Accessed at: **Conservation advice Melanodryas cucullata cucullata (hooded robin (south-eastern)) (environment.gov.au)**

Cth. DCCEEW (2024a). *Protected Matters Online Search Tool*. Accessed at: **https://www.environment.gov.au/epbc/protected-matters-search-tool**.

Cth. DCCEEW (2024b). *Species profiles and threats database* (SPRAT). Accessed at: **http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl**.

Cth. DCCEEW (2024c). *Register of Critical Habitat*. Accessed at **https://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl**

Commonwealth of Australia (2022) *National Recovery Plan for the Australian Painted Snipe* (Rostratula australis), **national-recovery-plan-australian-painted-snipe-2022.docx (live.com)**

DAWE (2020a). EPBC Act Condition-setting Policy. Department of Agriculture, Water and the Environment. **https://www.environment.gov.au/epbc/publications/condition-setting-policy**

DAWE (2020b). Directory of Important Wetlands in Australia. Accessed at **https://www.environment.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands**

DAWE (2021). National Recovery Plan for the Superb Parrot. Accessed at: **https://www.dcceew.gov.au/sites/default/files/documents/national-recovery-plan-superb-parrot.pdf**

DEC (2006). NSW Recovery Plan for the Large Forest Owls: Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*) and Masked Owl (*Tyto novaehollandiae*) DEC, Sydney. Department of Environment and Conservation. **https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Recovery-plans/large-forest-owls-recovery-plan-060413.pdf**

DECC (2002). Descriptions for NSW (Mitchell) Landscapes Version 2 (2002). Department of Environment and Climate Change, Sydney NSW.

DECC (2006). NSW Recovery Plan for the Large Forest Owls: Powerful Owl (Ninox strenua), Sooty Owl (Tyto tenebricosa) and Masked Owl (Tyto novaehollandiae) DEC, Sydney.

DEE (2017). EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species. **http://www.environment.gov.au/epbc/publications/shorebirds-guidelines**

DEWHA (2008). Approved Conservation Advice for Slender Darling Pea (*Swainsona murrayana*). Accessed at: **https://www.environment.gov.au/biodiversity/threatened/species/pubs/6765-conservation-advice.pdf**

DEWHA (2009). Significant impact guidelines for the vulnerable growling grass frog (*Litoria raniformis*). Accessed at: **https://www.dcceew.gov.au/sites/default/files/documents/significant-impact-guidelines-litoria-raniformis.pdf**

DEWHA (2010a). Survey guidelines for Australia's threatened bats. Guidelines for detecting bats listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. **http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-bats-guidelines-detecting-bats-listed-threatened**

DEWHA (2010b). Survey guidelines for Australia's threatened birds. Guidelines for detecting birds listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. **http://www.environment.gov.au/publications/survey-guidelines-australias-threatened-birds-guidelines-detecting-birds-listed-threatened**

DEWHA (2010c). Survey guidelines for Australia's threatened mammals. Guidelines for detecting mammals listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. **http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-mammals-guidelines-detecting-mammals-listed**

DEWHA (2013). Significant Impact Guidelines 1.1 - Matters of National Environmental Significance. **https://www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/nes-guidelines_1.pdf**

DEWHA (2014). Draft survey guidelines for Australia's threatened orchids. **http://www.environment.gov.au/resource/draft-survey-guidelines-australias-threatened-orchids**

DoE (2016). 'National Recovery Plan for the Plains-wanderer (*Pedionomus torquatus*), Commonwealth of Australia. **https://www.dcceew.gov.au/sites/default/files/documents/national-recovery-plan-plains-wanderer.pdf**

Doerr, VAJ, Doerr, ED and Davies, MJ (2010). Does structural connectivity facilitate dispersal of native species in Australia's fragmented terrestrial landscapes? Systematic Review No 44, Collaboration for Environmental Evidence. http://www.environmentalevidence.org/SR44.html

DPE (2022a). *NSW State Vegetation Type Map – version C1.1*. Accessed at: **NSW State Vegetation Type Map | Dataset | SEED**

DPE (2022b) *Koala Biodiversity Assessment Survey Guide*. Accessed at: **Koala (Phascolarctos cinereus): Biodiversity Assessment Method Survey Guide | NSW Environment and Heritage**

DPE (2022c) *BioNet Plant Community Types Benchmarks data* Accessed at: **BioNet Plant Community Types Benchmarks data | NSW Environment and Heritage**

DPE (2022d) *Title: Cumulative Impact Assessment Guidelines for State Significant Projects*. Accessed at: **Cumulative Impact Assessment Guidelines for State Significant Projects – October 2022 (nsw.gov.au)**

DPE (2023a) NSW BioNet Vegetation Classification Database. Accessed at: **https://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx?ReturnUrl=%2fNSWVCA20PRapp%2fdefault.aspx**

DPE (2023b). BAM - Important Areas viewer. **https://webmap.environment.nsw.gov.au/Html5Viewer291/index.html?viewer=BAM_ImportantAreas**.

DPE (2023c) *New vegetation integrity benchmarks and plant community types*. **Accessed at: New vegetation integrity benchmarks and plant community types | NSW Environment and Heritage**

DPE (2023f). Guidance to assist a decisionmaker to determine a serious and irreversible impact. Accessed at **https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/biodiversity-offsets-scheme/serious-and-irreversible-impacts**

DPIE (2016). **NSW (Mitchell) Landscapes – version 3.1 accessed at: NSW (Mitchell) Landscapes - version 3.1 | Dataset | SEED**

DPIE (2020a). *Surveying threatened plants and their habitats. NSW survey guide for the Biodiversity Assessment Method*. NSW Department of Planning, Industry and Environment.

DPIE (2020b) *NSW Survey Guide for Threatened Frogs. A guide for the survey of threatened frogs and their habitats for the Biodiversity Assessment Method*. NSW Department of Planning, Industry and Environment.

DPIE (2020c) *Guidance for assessors and decision-makers in applying modified benchmarks to assessments of vegetation integrity*. Accessed at: **Guidance for assessors and decision-makers in applying modified benchmarks to assessments of vegetation integrity (nsw.gov.au)**

DPIE (2021) *Species credit' threatened bats and their habitats NSW survey guide for the Biodiversity Assessment Method*. Environment, Energy and Science Department of Planning, Industry and Environment. **'Species credit' threatened bats and their habitats - NSW guide for the Biodiversity Assessment Method**

DSEWPaC (2012). *Environment Protection and Biodiversity Conservation Act 1999 - Environmental Offsets Policy*. Accessed at **https://www.environment.gov.au/system/files/resources/12630bb4-2c10-4c8e-815f-2d7862bf87e7/files/offsets-policy_2.pdf**

Emison, W.B., Beardsell, C.M., Norman, F.I., Loyn, R.H. & Bennett, S. (1987) Atlas of Victorian Birds. Little Eagle, p. 82. Royal Australasian Ornithologists Union and Department of Conservation Forests & Lands, Melbourne.

Forest Creek Working Group (2000). *Draft Management Plan for the Forest Creek System*. Department of Land and Water Conservation.

Garnett ST, Szabo J and Dutson G (2011). The Action Plan for Australian Birds 2010. CSIRO Publishing. Canberra, ACT.

GHD (2024) Billabong Creek Regulators- Traffic Impact Assessment. Report prepared for NSW DCCEEW.

Invasive Plants and Animals Committee (IPAC). (2016). Australian Weeds Strategy 2017 to 2019. Accessed at **https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/pests-diseases-weeds/consultation/aws-final.pdf**

Jacobs (2024a) *Billabong Creek Regulators Hydrology and Surface Water Resources Assessment*. Report prepared for NSW Department of Climate Change, Energy, the Environment and Water, Appendix G to the EIS.

Jacobs (2024b) *Billabong Creek Regulators Surface Water Quality and Aquatic Ecology Assessment.* Report prepared for NSW Department of Climate Change, Energy, the Environment and Water, Appendix K to the EIS.

Johnson, M., Reich, P. and MacNally, R. (2007). Bird assemblages of a fragmented agricultural landscape and the relative importance of vegetation structure and landscape pattern. Wildlife Research 34: 185-193.

Lumsden L, Nelson J, Lindeman M (2008). *Ecological research on the Eastern Long-eared Bat* Nyctophilus timoriensis *(south-eastern form)*. A report to the Mallee Catchment Management Authority. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment. Melbourne, Australia.

Maher P.N. (2022) *Report on waterbirds breeding during the environmental flooding of the Wanganella wetlands in the spring/summer of 2020/2021*. Australian Ornithological Services Pty Ltd

Mathwin R, Wassens S, Gibbs MS, Young J, Qifeng Y, Saltre F and Bradshaw C (2023) *Modeling the effects of water regulation on the population viability of a threatened amphibian*. Ecosphere 14/1. Accessed at: **Modeling the effects of water regulation on the population viability of a threatened amphibian - Mathwin - 2023 - Ecosphere - Wiley Online Library**

Mazerolle, M. J. (2005). Drainage ditches facilitate frog movements in a hostile landscape. *Landscape Ecology* 20, 579–590. doi:10.1007/s10980-004-3977-6

National Environmental Science Program Threatened Species Research Hub (2019) Threatened Species Strategy Year 3 Scorecard – Plains-wanderer. Australian Government, Canberra. Accessed at: **https://www.dcceew.gov.au/sites/default/files/env/pages/4792cfd0-c83c-4bd0-9258-cb99efe22e68/files/plains-wanderer-year-3-scorecard.pdf**

NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW) (2023) *Yanco Creek System operations plan (Draft) September 2023*. Report prepared by NSW DCEEW.

NSW DCCEEW (2024a). *NSW BioNet Wildlife Atlas* **https://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx?ReturnUrl=%2fNSWVCA20PRapp%2fdefault.aspxhttps://www.environment.nsw.gov.au/research/vegetationinformationsystem.htm**

NSW DCCEEW (2024b) *BioNet Atlas Threatened Biodiversity Data Collection Registered User Access* (the TBDC). Accessed at: **BioNet Atlas (nsw.gov.au)**

NSW DCCEEW (2024c) *Threatened biodiversity profile search*. Accessed at: **Threatened biodiversity profile search | NSW Environment, Energy and Science**

NSW DPIE (2020) Saving our species: Plains-wanderer habitat management guide. Accessed at: **https://www.lls.nsw.gov.au/__data/assets/pdf_file/0009/1249047/Plains-wanderer-Habitat-Management-Guide.pdf**

NSW Government (2016) *Plan Map (WSP027_Version 2) Lowbidgee of the Murrumbidgee Regulated River Water Source*. Accessed at: **2016-367_plan_map.pdf (nsw.gov.au)**

NSW Government (2023) *Historical Imagery – Search and Discover*. Accessed at: **Historical Imagery (nsw.gov.au)**

NSW Scientific Committee (2009). Plains-wanderer *Pedionomis torqautus* Review of current information in NSW. Accessed at: **https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Scientific-Committee/sc-plains-wanderer-pedionomus-torquatus-review-report.pdf?la=en&hash=9BD9A3592227D7D7241AE60286066DE9D4C209C4**

NSW Threatened Species Scientific Committee (TSSC) (2023). Blue-winged Parrot final determination. Accessed at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Scientific-Committee/Determinations/2023/blue-winged-parrot-final-determination-VS.pdf?la=en&hash=EDB40A915D96E3EE052263E9EF634FD581816BA9

OEH (2012) Environmental water use in New South Wales, Annual Report 2011-12. Report prepared by the State of NSW and Office of Environment and Heritage.

OEH (2018). A review of koala tree use across NSW. **https://www.environment.nsw.gov.au/research-and-publications/publications-search/a-review-of-koala-tree-use-across-new-south-wales**

SWIFFT 2024 (2024) Threatened Species Profile for the Plains-wanderer. State Wide Integrated Flora and Fauna Teams. Accessed at **https://www.swifft.net.au/cb_pages/sp_plains-wanderer.php**

The Wanderer (2017) Newsletter- First record of a Plains-wanderer moving interstate. Issue 4. Accessed at: **https://trustfornature.org.au/wp-content/uploads/2020/11/Issue_4_The_Wanderer_Winter_2017.pdf**

Threatened Species Scientific Committee (TSSC 2012). *Commonwealth Listing Advice on Natural Grasslands of the Murray Valley Plains*. Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: **http://www.environment.gov.au/biodiversity/threatened/communities/pubs/117-listing-advice.pdf**.

Threatened Species Scientific Committee (2015). *Conservation Advice* Nyctophilus corbeni *south-eastern long-eared bat*. Canberra: Department of the Environment. Available from: **http://www.environment.gov.au/biodiversity/threatened/species/pubs/83395-conservation_advice-01102015.pdf**.

Turner, A., Wassens, S. & McNeil, D. (2020). Yanco Creek and tributaries: Intensive frog surveys of creek and farm habitats 2019-20. Final report for Yanco Creek and Tributaries Advisory Council. Institute of Land Water and Society, Charles Sturt University, Albury.

Walcott, A., Wolfenden, B., Hall, A. & Wassens, S. (2018) Yanco-Billabong Creek Broad-scale Wetland Monitoring Project: Frog communities of the Yanco-Billabong creek system. Final Report prepared for Murray Local Land Services. Institute of Land Water and Society, Charles Sturt University, Albury

Wassens, S., Watts, R., Jansen, A and Roshier, D. (2008). Movement patterns of Southern Bell Frogs (*Litoria raniformis*) in response to flooding. *Wildlife Research.* 35. 50-58. 10.1071/WR07095.

Appendix A

BDAR requirements compliance

Table A.1 below specifies where each component of the BDAR minimum information requirements has been addressed in accordance with BAM Appendix K.

Assessment of compliance with BDAR minimum information requirements:

Table A.1 Assessment of compliance with BDAR minimum information requirements

BAM reference	BAM requirement	Reference(s) in the BDAR
Chapters 2 and 3	**INTRODUCTION**	-
	Introduction to the biodiversity assessment including:	-
	☒ brief description of the proposal	Section 1.1 and 1.3
	☒ identification of subject land boundary, including: ☒ operational footprint ☒ construction footprint indicating clearing associated with temporary/ancillary construction facilities and infrastructure	Section 1.3 and 0
	☒ general description of the subject land	Section 3.2
	☒ sources of information used in the assessment, including reports and spatial data	Section 2.3
	☒ identification and justification for entering the BOS	Section 1.1
	Maps and tables	
	☒ Map of the subject land boundary showing the final proposal footprint, including the construction footprint for any clearing associated with temporary/ancillary construction facilities and infrastructure	Figure 1.2 and Figure 1.3
Sections 3.1 and 3.2, Appendix E	**SITE CONTEXT**	-
	Identification of site context components and landscape features, including:	-
	☒ general description of subject land topographic and hydrological setting, geology and soils	Section 3.1, Table 3.1
	☒ per cent native vegetation cover in the assessment area (as described in BAM Section 3.2)	Section 3.1, Table 3.1
	☒ IBRA bioregions and subregions (as described in BAM Subsection 3.1.3(2.))	Section 3.1, Table 3.1
	☒ rivers and streams classified according to stream order (as described in BAM Subsection 3.1.3(3.) and Appendix E)	Section 3.1, Table 3.1, Section 3.2.1
	☒ wetlands within, adjacent to and downstream of the site (as described in BAM Subsection 3.1.3(3.))	Section 3.2.1
	☒ connectivity of different areas of habitat (as described in BAM Subsection 3.1.3(5–6.))	Section 3.2.2

BAM reference	BAM requirement	Reference(s) in the BDAR
	☒ karst, caves, crevices, cliffs, rocks and other geological features of significance and for vegetation clearing proposals, soil hazard features (as described in BAM Subsections 3.1.3(7.) and 3.1.3(12.))	Section 3.2.3
	☒ areas of outstanding biodiversity value occurring on the subject land and assessment area (as described in BAM Subsection 3.1.3(8–9.))	Section 3.2.4
	☐ any additional landscape features identified in any SEARs for the proposal	N/A
	☒ NSW (Mitchell) landscape on which the subject land occurs	Section 3.2.5
	☒ details of field reconnaissance undertaken to confirm the extent and condition of landscape features and native vegetation cover (as described in Operational Manual Stage 1 Section 2.4)	Section 2.4
	Maps and tables	-
	☒ Site Map ☒ Property boundary ☒ Boundary of subject land ☒ Cadastre of subject land (including labelling of Lot and DP or section plan if relevant) ☒ Landscape features identified in BAM Subsection 3.1.3	Figure 1.2 Figure 1.3
	☒ Location Map ☒ Digital aerial photography at 1:1,000 scale or finer ☒ Boundary of subject land ☒ Assessment area (i.e. the subject land and either 1500 m buffer area or 500 m buffer for linear development) ☒ Landscape features identified in BAM Subsection 3.1.3 ☒ Additional detail (e.g. local government area boundaries) relevant at this scale	Figure 3.1 Figure 3.2
	Landscape features identified in BAM Subsection 3.1.3 and to be shown on the Site Map and/or Location Map include:	-
	☒ IBRA bioregions and subregions ☒ rivers, streams and estuaries ☒ wetlands and important wetlands ☒ connectivity of different areas of habitat ☒ karst, caves, crevices, cliffs, rocks and other geological features of significance and if required, soil hazard features ☒ areas of outstanding biodiversity value occurring on the subject land and assessment area ☒ any additional landscape features identified in any SEARs for the proposal ☒ NSW (Mitchell) landscape on which the subject land occurs	Figure 3.1 Figure 3.2

BAM reference	BAM requirement	Reference(s) in the BDAR
	Data	-
	☒ All report maps as separate jpeg files	Uploaded via BOAMS
	Individual digital shape files of:	-
	☒ subject land boundary	Uploaded via BOAMS
	☒ assessment area (i.e. subject land and 1500 m buffer area) boundary	Uploaded via BOAMS
	☒ cadastral boundary of subject land	Uploaded via BOAMS
	☒ areas of native vegetation cover	Uploaded via BOAMS
	☒ landscape features	Uploaded via BOAMS
Chapter 4, Appendix A and Appendix H	**NATIVE VEGETATION, THREATENED ECOLOGICAL COMMUNITIES AND VEGETATION INTEGRITY**	-
	☒ Identify native vegetation extent within the subject land, including cleared areas and evidence to support differences between mapped vegetation extent and aerial imagery (as described in BAM Section 4.1(1–3.) and Subsection 4.1.1)	Section 4.1
	☒ Provide justification for all parts of the subject land that do not contain native vegetation (as described in BAM Subsection 4.1.2)	Section 4.1, Table 4.1 , Appendix D
	☒ Review of existing information on native vegetation including references to previous vegetation maps of the subject land and assessment area (described in BAM Section 4.1(3.) and Subsection 4.1.1)	Section 4.2.2
	☒ Describe the systematic field-based floristic vegetation survey undertaken in accordance with BAM Section 4.2	Section 2.4.2
	☐ Where relevant, describe the use of more appropriate local data, provide reasons that support the use of more appropriate local data and include the written confirmation from the decision-maker that they support the use of more appropriate local data (as described in BAM Subsection 1.4.2 and Appendix A)	N/A
	For each PCT within the subject land, describe:	–
	☒ PCT name and ID	Section 4.3.3, Table 4.2,
	☒ vegetation class	Section 4.3.3, Table 4.3
	☒ extent (ha) within subject land	Section 4.3.3, Table 4.2, Table 4.3
	☒ evidence used to identify a PCT including any analyses undertaken, references/sources, existing vegetation maps (BAM Section 4.2(1–3.))	Section 4.2.2, Section 4.3.3
	☒ plant species relied upon for identification of the PCT and relative abundance of each species	Section 4.2.2, Appendix D
	☒ if relevant, TEC status including evidence used to determine vegetation is the TEC (BAM Subsection 4.2.2(1–2.))	Section 4.3.3, Section 4.4, Appendix B-2

BAM reference	BAM requirement	Reference(s) in the BDAR
	☒ estimate of per cent cleared value of PCT (BAM Subsection 4.2.1(5.))	Table 4.3
	Describe the vegetation integrity assessment of the subject land, including:	
	☒ identification and mapping of vegetation zones (as described in BAM Subsection 4.3.1)	Section 2.4.2
	☒ description of vegetation zones within the subject land (as described in Operational Manual Stage 1 Table 2 and Subsection 3.3.2)	Section 4.3.3
	☒ area (ha) of each vegetation zone	Table 4.3
	☒ assessment of patch size (as described in BAM Subsection 4.3.2)	Table 4.3, Figure 3.1, Figure 3.2
	☒ survey effort (i.e. number of vegetation integrity survey plots) as described in BAM Subsection 4.3.4(1–2.)	Table 4.3
	☐ use of relevant benchmark data from BioNet Vegetation Classification (as described in BAM Subsection 4.3.3(5.))	Section 4.3.1, Appendix D
	Where use of more appropriate local benchmark data is proposed (as described in BAM Subsection 1.4.2, BAM Subsection 4.3.3(5.) and BAM Appendix A):	
	☐ identify the PCT or vegetation class for which local benchmark data will be applied ☐ identify published sources of local benchmark data (if benchmarks obtained from published sources) ☐ describe methods of local benchmark data collection (if reference plots used to determine local benchmark data)	N/A
	☐ provide justification for use of local data rather than BioNet Vegetation Classification benchmark values	N/A
	☐ provide written confirmation from the decision-maker that they support the use of local benchmark data	N/A
	Maps and tables	
	☒ Map of native vegetation extent within the subject land at scale not greater than 1:10,000 including identification of all areas of native vegetation including areas that are ground cover only, cleared areas (as described in BAM Section 4.1(1–3.)) and all parts of the subject land that do not contain native vegetation (BAM Subsection 4.1.2)	Figure 3.1, Figure 3.2, Figure 4.1, Figure 4.2
	☒ Map of PCTs within the subject land (as described in BAM Section 4.2(1.))	Figure 4.1, Figure 4.2
	☒ Map of vegetation zones within the subject land (as described in BAM Subsection 4.3.1)	Figure 4.1, Figure 4.2
	☒ Map the location of floristic vegetation survey plots and vegetation integrity survey plots relative to PCT boundaries	Figure 4.1, Figure 4.2
	☐ Map of TEC distribution on the subject land and table of TEC listing, status and area (ha)	N/A
	☒ Map of patch size locations for each native vegetation zone and table of patch size areas (as described in BAM Subsection 4.3.2)	Figure 3.1, Figure 3.2, Table 4.3

BAM reference	BAM requirement	Reference(s) in the BDAR
	Table of current vegetation integrity scores for each vegetation zone within the site and including:	-
	☒ composition condition score ☒ structure condition score ☒ function condition score ☒ presence of hollow bearing trees	Table 4.4
	Data	-
	☒ All report maps as separate jpeg files	Uploaded to BOAMS
	☒ Plot field data (MS Excel format)	
	☒ Plot field datasheets	Uploaded to BOAMS
	Digital shape files of:	Uploaded to BOAMS
	☒ PCT boundaries within subject land	Uploaded to BOAMS
	☐ TEC boundaries within subject land	N/A
	☒ vegetation zone boundaries within subject land	Uploaded to BOAMS
	☒ floristic vegetation survey and vegetation integrity plot locations	Uploaded to BOAMS
Chapter 5	**HABITAT SUITABILITY FOR THREATENED SPECIES**	-
	Identify ecosystem credit species likely to occur on the subject land, including:	-
	☒ list of ecosystem credit species derived from the BAM-C (as described in BAM Subsection 5.1.1 and Section 5.2(1.))	Section 5.1.1, Table 5.1, Appendix G
	☒ justification and supporting evidence for exclusion of any ecosystem credit species based on geographic limitations, habitat constraints or vagrancy (as described in BAM Subsections 5.2.1 and 5.2.2)	Table 5.1
	☐ justification for addition of any ecosystem credit species to the list	N/A
	Identify species credit species likely to occur on the subject land, including:	
	☒ list of species credit species derived from the BAM-C (as described in BAM Subsection 5.1.1)	Section 5.1.2, Table 5.2, Appendix G
	☒ justification and supporting evidence for exclusions based on geographic limitations, habitat constraints or vagrancy (as described in BAM Subsections 5.2.1 and 5.2.2)	Table 5.2
	☒ justification and supporting evidence for exclusions based on degraded habitat constraints and/or microhabitats on which the species depends (as described in BAM Subsection 5.2.2)	Section 5.1.2, Table 5.2

BAM reference	BAM requirement	Reference(s) in the BDAR
	☒ justification for addition of any species credit species to the list	N/A
	From the list of candidate species credit species, identify:	-
	☐ species assumed present within the subject land (if relevant) (as described in BAM Subsection 5.2.4(2.a.)) ☒ species present within the subject land on the basis of being identified on an important habitat map for a species (as described in BAM Subsection 5.2.4(2.d.)) ☒ species for which targeted surveys are to be completed to determine species presence (BAM Subsection 5.2.4(2.b.)) ☒ species for which an expert report is to be used to determine species presence (BAM Subsection 5.2.4(2.c.))	Section 5.2, Table 5.4, Table 5.5
	Present the outcomes of species credit species assessments from:	-
	☒ threatened species survey (as described in BAM Section 5.2.4)	Section 5.2, Table 5.3, Table 5.4, Table 5.5
	☐ expert reports (if relevant) including justification for presence of the species and information used to make this determination (as described in BAM Subsection 5.2.4, Section 5.3, Box 3)	N/A
	Where survey has been undertaken include detailed information on:	-
	☒ survey method and effort (as described in BAM Section 5.3)	Section 2.4.3 Section 5.2 Table 5.3
	☒ justification of survey method and effort (e.g. citation of peer-reviewed literature) if approach differs from the department's taxa-specific survey guides or where no relevant guideline has been published	Section 2.4.3
	☒ timing of survey in relation to requirements in the TBDC or the department's taxa-specific survey guides. Where survey was undertaken outside these guides include justification for the timing of surveys	Section 2.4.3, Table 5.3, Table 5.4
	☒ survey personnel and relevant experience	Section 2.8
	☒ describe any limitations to surveys and how these were addressed/overcome	Section 2.5, Section 2.6
	Where an expert report has been used in place of survey (as described in BAM Section 5.3, Box 3), include:	-
	☐ justification of the use of an expert report ☐ identify the expert, provide evidence of their expert credentials and departmental approval of expert status ☐ all requirements of Box 3 have been addressed in the expert report	N/A

BAM reference	BAM requirement	Reference(s) in the BDAR
	Where use of local data is proposed (BAM Subsection 1.4.2):	-
	☐ identify relevant species ☐ identify data to be amended ☐ identify source of information for local data, e.g. published literature, additional survey data, etc. ☐ justify use of local data in preference to VIS Classification or TBDC data	N/A
	☐ provide written confirmation from the decision-maker that they support the use of local data	N/A
	Species polygon completed for species credit species present within the subject land (assumed present or determined on the basis of survey, expert report or important habitat map) ensuring that:	-
	☒ the unit of measure for each species is documented	Table 5.5, Table 9.5
	for species assessed by area:	
	☒ the polygon includes the extent of suitable habitat for the target species within the subject land (as described in BAM Subsection 5.2.5)	Table 5.5, Figure 5.10 to Figure 5.16
	☒ a description of, and evidence-based justification for, the habitat constraints, features or microhabitats used to map the species polygon including reference to information in the TBDC for that species and any buffers applied	Table 5.5
	for species assessed by counts of individuals:	-
	☐ the number of individual plants present on the subject land (as described in BAM Subsection 5.2.5(3.))	N/A
	☐ the method used to derive this number (i.e. threatened species survey or expert report) and evidence-based justification for the approach taken	N/A
	☐ the polygon includes all individuals located on the subject land with a buffer of 30 m around the individuals or groups of individuals on the subject land	N/A
	☐ Identify the biodiversity risk weighting for each species credit species identified as present within the subject land (as described in BAM Section 5.4)	N/A
	Maps and tables	-
	☒ Table showing ecosystem credit species in accordance with BAM Subsection 5.1.1, and identifying:	Table 5.1
	☒ the ecosystem credit species removed from the list	Table 5.1
	☒ the sensitivity to gain class of each species	Table 5.1
	☒ Table detailing species credit species in accordance with BAM Section 5.2 and identifying:	Table 5.2
	☒ the species credit species removed from the list of species because the species is considered vagrant, out of geographic range or the habitat or microhabitat features are not present	Table 5.1

BAM reference	BAM requirement	Reference(s) in the BDAR
	☒ the candidate species credit species not recorded on the subject land as determined by targeted survey, expert report or important habitat map	Table 5.2
	☒ Table detailing species credit species recorded or assumed as present within the subject land, habitat constraints or microhabitats associated with the species, counts of individuals (flora)/extent of suitable habitat (flora and fauna) (as described in BAM Subsection 5.2.6) and biodiversity risk weighting (BAM Section 5.4)	Table 5.4, Table 5.5
	☒ Map indicating the GPS coordinates of all individuals of each species recorded within the subject land and the species polygon for each species (as described in BAM Subsection 5.2.5)	Figure 5.10 to Figure 5.16
	Data	-
	☒ Digital shape files of suitable habitat identified for survey for each candidate species credit species	Uploaded via BOAMS
	☒ Survey locations including GPS coordinates of any plots, transects, grids	Uploaded via BOAMS
	☒ Digital shape files of each species polygon including GPS coordinates of located individuals	Uploaded via BOAMS
	☒ Species polygon map in jpeg format	Uploaded via BOAMS
	☒ Expert reports and any supporting data used to support conclusions of the expert report	Uploaded via BOAMS
	☒ Field datasheets detailing survey information including prevailing conditions, date, time, equipment used, etc.	Uploaded via BOAMS
Chapter 6	**IDENTIFYING PRESCRIBED IMPACTS**	
	Identify potential prescribed biodiversity impacts on threatened entities, including:	
	☒ karst, caves, crevices, cliffs, rocks and other geological features of significance (as described in BAM Subsection 6.1.1) ☒ occurrences of human-made structures and non-native vegetation (as described in BAM Subsection 6.1.2) ☒ corridors or other areas of connectivity linking habitat for threatened entities (as described in BAM Subsection 6.1.3) ☒ waterbodies or any hydrological processes that sustain threatened entities (as described in BAM Subsection 6.1.4)	Table 6.2
	☐ protected animals that may use the proposed wind farm development site as a flyway or migration route (as described in BAM Subsection 6.1.5)	N/A
	☒ where the proposed development may result in vehicle strike on threatened fauna or on animals that are part of a threatened ecological community (as described in BAM Subsection 6.1.6)	Table 6.2
	☒ Identify a list of threatened entities that may be dependent upon or may use habitat features associated with any of the prescribed impacts	Table 6.1
	☒ Describe the importance of habitat features to the species including, where relevant, impacts on life cycle or movement patterns (e.g. Subsection 6.1.3)	Table 6.2, Table 8.5
	Where the proposed development is for a wind farm:	-

BAM reference	BAM requirement	Reference(s) in the BDAR
	☐ identify a candidate list of protected animals that may use the development site as a flyway or migration route, including: resident threatened aerial species, resident raptor species and nomadic and migratory species that are likely to fly over the proposal area (as described in BAM Subsection 6.1.5)	N/A
	☐ provide details of targeted survey for candidate species of wind farm developments undertaken in accordance with BAM Subsection 6.1.5(2–3.)	N/A
	☐ predict the habitual flight paths for nomadic and migratory species likely to fly over the subject land and map the likely habitat for resident threatened aerial and raptor species (BAM Subsection 6.1.5(4.))	N/A
	Where the proposal may result in vehicle strike:	-
	☒ identify a list of threatened fauna or protected fauna species that are part of a TEC and at risk of vehicle strike due to the proposal	Table 6.2, Table 8.5
	Maps and tables	-
	☐ Map showing location of any prescribed impact features (i.e. karst, caves, crevices, cliffs, rocks, human-made structures, etc.) where necessary to assess impact	N/A
	☒ Map showing location of potential vehicle strike locations	Figure 1.2, Figure 1.3
	☐ Maps of habitual flight paths for nomadic and migratory species likely to fly over the site and maps of likely habitat for threatened aerial species resident on the site (for wind farm developments only)	N/A
	Data	-
	☒ Digital shape files of prescribed impact feature locations	Uploaded via BOAMS
	☒ Prescribed impact features map in jpeg format	Uploaded via BOAMS
Chapter 7	**AVOID AND MINIMISE IMPACTS**	-
	Demonstration of efforts to avoid and minimise impacts on biodiversity values (including prescribed impacts) associated with the proposal location in accordance with Chapter 7, including an analysis of alternative:	-
	☐ modes or technologies that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed mode or technology where necessary to assess impacts	N/A
	☐ routes that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed route	N/A
	☒ alternative locations that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed location	Section 7.2.1, 7.2.2
	☒ alternative sites within a property on which the proposal is located that would avoid or minimise impacts on biodiversity values and justification for selecting the proposed site	Section 7.2.1, 7.2.2
	☒ Describe efforts to avoid and minimise impacts (including prescribed impacts) to biodiversity values through proposal design (as described in BAM Sections 7.1 and 7.2)	Section 7.2

BAM reference	BAM requirement	Reference(s) in the BDAR
	☒ Identification of any other site constraints that the proponent has considered in determining the location and design of the proposal (as described in BAM Subsection 7.2.1(3.))	Section 7.2.1
	Maps and tables	-
	☒ Table of measures to be implemented to avoid and minimise the impacts of the proposal, including action, outcome, timing and responsibility	Table 7.1, Table 7.2, Table 8.9
	☐ Maps demonstrating indirect impact zones where applicable	N/A
	Data	-
	Digital shape files of:	-
	☒ alternative and final proposal footprint	Uploaded to BOAMS
	☒ direct and indirect impact zones	Uploaded to BOAMS
	☐ Maps in jpeg format	N/A
Chapter 8, Sections 8.1, Section 8.2, Section 8.3	**IMPACT ASSESSMENT**	
	☒ Determine the impacts on native vegetation and threatened species habitat, including a description of direct impacts of clearing of native vegetation, threatened ecological communities and threatened species habitat (as described in BAM Section 8.1)	Section 8.1, Appendix H
	Assessment of indirect impacts on vegetation and threatened species and their habitat including (as described in BAM Section 8.2):	
	☒ description of the nature, extent, frequency, duration and timing of indirect impacts of the proposal	Table 8.4
	☒ documenting the consequences to vegetation and threatened species and their habitat including evidence-based justifications	Section 8.2, Appendix H
	☒ reporting any limitations or assumptions, etc. made during the assessment, as necessary	Table 8.4
	☒ identification of the threatened entities and their habitat likely to be affected	Chapter Habitat suitability for threatened species5 Appendix H
	Assessment of prescribed biodiversity impacts (as described in BAM Section 8.3) including:	-
	assessment of the nature, extent frequency, duration and timing of impacts on the habitat of threatened species or ecological communities associated with:	-
	☒ karst, caves, crevices, cliffs, rocks and other features of geological significance	Section 8.3
	☒ human-made structures	Section 8.3
	☒ non-native vegetation	Section 8.3

BAM reference	BAM requirement	Reference(s) in the BDAR
	☒ connectivity of different areas of habitat of threatened species that facilitates the movement of those species across their range	Section 8.3
	☒ water quality, waterbodies and hydrological processes that sustain threatened species and threatened ecological communities	Section 8.3
	☐ assessment of the impacts of wind turbine strikes on protected animals	N/A
	☒ assessment of the impacts of vehicle strikes on threatened species of animals or on animals that are part of a TEC	Section 8.3
	☒ evaluate the consequences of prescribed impacts	Table 8.5
	☐ describe impacts that are uncertain	N/A
	☒ document limitations to data, assumptions and predictions	Section 2.7 Section 8.3
	Maps and tables	-
	☒ Table showing change in vegetation integrity score for each vegetation zone as a result of identified impacts	Table 8.3
Chapter 8, Sections 8.4 and 8.5	**AVOID AND MINIMISE IMPACTS**	
	Identification of measures to mitigate or manage impacts in accordance with the recommendations in BAM Sections 8.4 and 8.5 including:	
	☒ techniques, timing, frequency and responsibility ☒ identify measures for which there is risk of failure ☒ evaluate the risk and consequence of any residual impacts	Section 7.2.3 Section 8.5
	☐ document any adaptive management strategy proposed, as required	N/A
	Identification of measures for mitigating impacts related to:	-
	☒ displacement of resident fauna (as described in BAM Subsection 8.4.1(2.)) ☒ indirect impacts on native vegetation and habitat (as described in BAM Subsection 8.4.1(3.)) ☒ mitigating prescribed biodiversity impacts (as described in BAM Subsection 8.4.2)	Section 7.2.3 Section 8.5
	☐ Details of the adaptive management strategy proposed to monitor and respond to impacts on biodiversity values that are uncertain (BAM Section 8.5), as required	N/A
	Maps and tables	
	☐ Table of measures to be implemented before, during and after construction to mitigate and manage impacts of the proposal, including action, outcome, timing and responsibility	Table 8.9

BAM reference	BAM requirement	Reference(s) in the BDAR
Chapter 9	**IMPACT SUMMARY**	-
	Identification and assessment of impacts on TECs and threatened species that are at risk of a serious and irreversible impacts (SAII, in accordance with BAM Section 9.1) including:	-
	☐ addressing all criteria in Subsection 9.1.1 for each TEC listed as at risk of an SAII present on the subject land	N/A
	☐ for each TEC, report the extent of the TEC in NSW	N/A
	☒ addressing all criteria in Subsection 9.1.2 for each threatened species at risk of an SAII present on the subject land	Section 9.1
	☐ for each threatened species, report the population size in NSW	Section 9.1
	☒ documenting assumptions made and/or limitations to information ☒ documenting all sources of data, information, references used or consulted ☐ clearly justifying why any criteria could not be addressed	Section 9.1
	☒ Identification of impacts requiring offset in accordance with BAM Section 9.2	Section 9.2
	☒ Identification of impacts not requiring offset in accordance with BAM Subsection 9.2.1(3.)	Section 9.3
	☒ Identification of areas not requiring assessment in accordance with BAM Section 9.3	Section 9.3
	Maps and tables	-
	☐ Map showing the extent of TECs at risk of an SAII within the subject land	N/A
	☐ Map showing location of threatened species at risk of an SAII within the subject land	Figure 5.11
	Map showing location of:	-
	☐ impacts requiring offset	Figure 9.1, Figure 9.2
	☐ impacts not requiring offset	Figure 9.1, Figure 9.2
	☐ areas not requiring assessment	Figure 9.1, Figure 9.2
	Data	-
	Digital shape files of:	-
	☐ extent of TECs at risk of an SAII within the subject land	
	☒ location of threatened species at risk of an SAII within the subject land	Uploaded to BOAMS
	☒ boundary of impacts requiring offset	Uploaded to BOAMS
	☒ boundary of impacts not requiring offset	Uploaded to BOAMS

BAM reference	BAM requirement	Reference(s) in the BDAR
	☒ boundary of areas not requiring assessment	Uploaded to BOAMS
	☒ Maps in jpeg format	Uploaded to BOAMS
Chapter 10	**IMPACT SUMMARY**	-
	Ecosystem credits and species credits that measure the impact of the development on biodiversity values, including:	-
	☒ future vegetation integrity score for each vegetation zone within the subject land (Equation 25 and Equation 26 in BAM Appendix H) ☒ change in vegetation integrity score (BAM Subsection 8.1.1) ☒ number of required ecosystem credits for the direct impacts of the proposal on each vegetation zone within the subject land (BAM Subsection 10.1.2)	Section 9.2
	☒ biodiversity risk weighting for each	Section 9.2
	☐ number of required species credits for each candidate threatened species that is directly impacted on by the proposal (BAM Subsection 10.1.3)	Section 9.2.2
	Maps and tables	-
	☐ Table of PCTs requiring offset and the number of ecosystem credits required	Table 9.3
	☐ Table of threatened species requiring offset and the number of species credits required	Table 9.5
	Data	-
	☒ Submitted proposal in the BAM Calculator	Uploaded via BOAMS
Chapter 10	**IMPACT SUMMARY**	-
	☒ Description of credit classes for ecosystem credits and species credits at the development or clearing site or land to be biodiversity certified (BAM Section 10.2)	Table 9.4, Appendix G
	☒ BAM credit report in pdf format	Appendix G
	Maps and tables	-
	☒ Table of credit class and matching credit profile	Table 9.4
	Data	-
	☒ BAM credit report in pdf format	Appendix G

Appendix B

Threatened species assessment

B-1 Likelihood of occurrence

Table B.1 Threatened flora species likelihood of occurrence assessment

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Amphibromus fluitans	River Swamp Wallaby-grass	V	V	Species or species habitat may occur within 20km (Cth DCCEEW 2024a)	Species	Historic records in the City of Greater Albury. It has been recorded recently in lagoons beside the Murray River near Cooks Lagoon (Shire of Greater Hume), Mungabarina Reserve, East Albury, at Ettamogah, Thurgoona (Charles Sturt University Campus), near Narranderra, and also further west along the Murray River (near Mathoura) and in Victoria. *Amphibromus fluitans* grows mostly in permanent swamps.	Possible. No records in locality. Study area conditions are generally suitable for this species.	Unlikely, noting the species is not a confirmed candidate species as it is not known from the Murrumbidgee IBRA subregion and it was not detected in multiple rounds of flora surveys.
Austrostipa metatoris		V	V	Species or species habitat may occur within 20km (Cth DCCEEW 2024a)	Species	Most records in the Murray Valley, scattered records also from central NSW including Lake Cargelligo, east of Goolgowi, Condobolin and southwest of Nymadgee. Grows in sandy areas with red to red-brown clay-loam to sandy-loam soils on sandhills, sandridges, undulating plains and flat open mallee country. Associated species include Bimble Box, Gum Coolibah, White Cypress Pine, Belah, Sweet Quandong and Sticky Hop-bush.	Unlikely. Associated species not present and no records within locality.	Unlikely
Austrostipa wakoolica		E	E	Species or species habitat known to occur within 20km (Cth DCCEEW 2024a)	Species	Confined to floodplains of the Murray River tributaries of central and south western NSW, in open woodland on grey, silty clay or sandy loam soils. Habitats include the edges of a lignum swamp with box and mallee; creek banks in grey, silty clay; mallee and lignum sandy-loam flat; open Cypress Pine forest on low sandy range; and a low, rocky rise. Associated species include White Cypress Pine, Grey Box, Bimble Box, Austrostipa eremophila, A. drummondii, Austrodanthonia eriantha and Climbing Saltbush. Flowers from October to December.	Unlikely. Fringe creek bank habitat. No records within locality.	Unlikely

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Brachyscome muelleroides	Mueller Daisy	V	V	Species or species habitat may occur within 20km (Cth DCCEEW 2024a); BAM C	Species	Occurs in the Wagga Wagga, Narranderra, Tocumwal and Walbundrie areas. Grows in damp areas on the margins of claypans in moist grassland with Pycnosorus globosus, Agrostis avenacea and Austrodanthonia duttoniana. Also recorded from the margins of lagoons in mud or water, and in association with Calotis anthemoides.	Possible. No records in locality. Study area conditions are generally suitable for this species.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.
Brachyscome papillosa	Mossgiel Daisy	V	V	Species or species habitat known to occur within 20km (Cth DCCEEW 2024a); BAM C	Species	Endemic to NSW and chiefly occurs within the Riverina Bioregion, from Mossgiel in the north, Murrumbidgee Valley (Yanga) National Park in the south west to Urana in the south east. Sites are scattered across this Bioregion including the Jerilderie area, the Hay Plain (Maude and Oxley) and around Darlington Point. In addition, there are a number of records from the Willandra Lakes World Heritage Area (including Mungo National Park) with a north-western outlier at Byrnedale Station, north of Menindee. The only known site on South Western Slopes is Ganmain Reserve. Recorded primarily in clay soils on Bladder Saltbush (Atriplex vesicaria) and Leafless Bluebush (Maireana aphylla) plains, but also in grassland and in Inland Grey Box (Eucalyptus microcarpa) - Cypress Pine (Callitris spp.) woodland.	Possible. Broadly suitable grassland habitat. No records within locality.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.
Convolvulus tedmoorei	Bindweed	E		BAM C	Species	There are few known records from NSW: two areas on the Murrumbidgee and Darling River floodplains in central-western NSW (from Toganmain Station, Darlington Point, and from a locality 8km north-west of Louth); and two other records from east of Broken Hill on the road to Wilcannia, and from the Menindee Road, Scarsdale. It grows in self-mulching grey clay soils on the floodplains of the Darling and Murrumbidgee Rivers.	Possible. Suitable floodplains present. No records within locality.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Cullen parvum	Small Scurf-pea	E		BAM C	Species	Small populations reported from near Jerilderie, Galong, Young and south-west of Wagga Wagga. Found in grassland, River Red Gum *(Eucalyptus camaldulensis*) Woodland or Box-Gum Woodland, sometimes on grazed land and usually on table drains or adjacent to drainage lines or watercourses, in areas with rainfall of between 450 and 700 mm. Flooding has been suggested as a mechanism for seed dispersal.	Possible. Suitable River Red Gum woodland habitat present	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.
Eucalyptus leucoxylon subsp. *pruinosa*	Yellow Gum	V		BAM C	Species	Restricted to several small areas between Barham and Euston. Remnants occur within State Forests along the Murray River, particularly within Campbells Island and Euston State Forests. Occurs at the bases of sandy rises and on loamy clay flats on the floodplains of the Murray River and its tributaries in the Riverina Bioregion.	Possible. Suitable floodplains present. No records within locality.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.
Lepidium aschersonii	Spiny Peppercress	V	V	Species or species habitat may occur within 20km (Cth DCCEEW 2024a)	Species	Occurring in the marginal central-western slopes and north-western plains regions of NSW. Found on ridges of gilgai clays dominated by *Acacia harpophyll*, *Casuarina cristata*, *Allocasuarina luehmanii* and *Eucalyptus microcarpa*, with the understorey often dominated by introduced plants. Grows as a component of the ground flora, in grey loamy clays. Vegetation structure varies from open to dense, with sparse grassy understorey with introduced plants and occasional heavy litter.	Unlikely. No *Acacia harpophylla* or *Eucalyptus microcarpa* communities present.	Unlikely
Lepidium monoplocoides	Winged Pepper-cress	E	E	Species or species habitat likely to occur within 20km (Cth DCCEEW 2024a); BAM C	Species	Widespread in the semi-arid western plains regions of NSW. Occurs on seasonally moist to waterlogged sites, on heavy fertile soils, with a mean annual rainfall of around 300-500 mm. Highly dependent on seasonal conditions, particularly rainfall. Occurs in periodically flooded and waterlogged habitats and does not tolerate grazing disturbance.	Unlikely. Suitable waterlogged sites, however, grazing present which species does not tolerate.	Unlikely

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Leptorhynchos orientalis	Lanky Buttons	E		BAM C	Species	Recorded from several Hay Plain and southern Riverina localities, including Willanthry east of Hillston, Zara-Wanganella via Hay, McKinley Road SW of Hillston, and "Morundah" navy land west of Buckingbong SF. Associated species include *Eucalyptus populnea* subsp. *bimbil*, *Acacia pendula*, *Eragrostis australasica*, *Lepidium monoplocoides*, *Enchylaena tomentosa*, *Minuria leptophylla*, *Rhodanthe floribunda*, *R. pygmaea* and *Ptilotus spathulatus*.	Possible. Broadly suitable habitat present.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.
Maireana cheelii	Chariot Wheels	V	V	2 records within 20km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20km (Cth DCCEEW 2024a); BAM C	Species	Restricted to the southern Riverina region, mainly between Deniliquin and Hay, and an outlying record east of Wanaaring. Usually found on heavier, grey clay soils with Atriplex vesicaria. Soils include heavy brown to red-brown clay-loams, hard cracking red clay, other heavy texture-contrast soils.	Possible. Records within locality. Suitable clay soils present.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.
Pilularis novae-hollandiae	Austral Pillwort	E		BAM C	Species	Only known extant populations in NSW are at Lake Cowal and Oolambeyan NP, but the species is obscure and may be overlooked elsewhere. Grows in shallow swamps and waterways, often among grasses and sedges. Previous records in Albury-Urana were from table drains beside roads, whereas the only record in the ACT was from a subalpine grassy plain.	Unlikely. Suitable swamp habitat but not known within locality.	Unlikely
Sclerolaena napiformis	Turnip Copperburr	E	E	BAM C	Species	NSW populations are confined to the area between Jerilderie and Moama on travelling stock routes and road reserves. Confined to remnant grassland habitats on clay-loam soils. Grows on level plains in tussock grassland of Austrostipa nodosa and Chloris truncata, in grey cracking clay to red-brown loamy clay.	Possible. Suitable grassland associated with *Chloris truncata* present.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Senecio macrocarpus	Large-fruit Fireweed	V		Species or species habitat may occur within 20km (Cth DCCEEW 2024a)	Species	Occurs in Tablelands east and north of the ACT. Found in woodland, grassland, and sedgeland.	Unlikely. Geographic limitations: the proposal footprint is not 'East and north of ACT'	Unlikely
Solanum karsense	Menindee Nightshade	V	V	BAM C	Species	Endemic to NSW, restricted to the far south-western plains, extending up the Darling River to the Menindee and Wilcannia districts. Mainly restricted to the area between the Darling and Lachlan Rivers. Grows in occasionally flooded depressions with heavy soil, including level river floodplains of grey clay with Black Box and Old Man Saltbush, and open treeless plains with solonized brown soils. Also found on sandy floodplains and ridges and in calcareous soils, red sands, red-brown earths and loamy soils.	Unlikely. Black Box and open plains habitat present. Proposal site located outside the known geographic distribution of this species.	Unlikely, noting the species has been excluded in BAM-C based on geographic restrictions.
Swainsona murrayana	Slender Darling Pea	V	V	1 record within 20km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20km (Cth DCCEEW 2024a); BAM C	Species	Found throughout NSW, recorded in the Jerilderie and Deniliquin areas of the southern riverine plain, the Hay plain as far north as Willandra National Park, near Broken Hill and in various localities between Dubbo and Moree. Grows in a variety of soil and vegetation types including bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with Maireana species. Also found in remnant native grasslands or grassy woodlands that have been intermittently grazed or cultivated.	Present. Species recorded in Hartwood.	Likely

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Swainsona plagiotropis	Red Darling-pea	V	V	Species or species habitat may occur within 20km (Cth DCCEEW 2024a); BAM C	Species	Occurs in the upper Murray Valley, most NSW records from the Jerilderie area, with possible collections from the Louth-Bourke area and disjunct record north of Warren. Grows on flat grassland and in heavy red soil, often on roadsides and especially in table drains. Also recorded from rail reserves, stock routes and areas of lightly grazed unimproved pasture comprising *Austrodanthonia*, *Enteropogon acicularis* and *Austrostipa* grassland communities.	Possible. Suitable grassland habitat and roadside areas present	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.
Swainsona sericea	Silky Swainson-pea	V		1 record within 20km (NSW DCCEEW 2024a); BAM C	Species	Occurs from the Northern Tablelands to the Southern Tablelands and further inland on the slopes and plains. One isolated record from far NW NSW. Found in Natural Temperate Grassland and Snow Gum *Eucalyptus pauciflora* Woodland on the Monaro, in Box-Gum Woodland in the Southern Tablelands and Southwest Slopes and sometimes found in association with cypress pines *Callitris spp*.	Likely. Box-Gum woodland present and species recorded in locality	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.

Notes: V= vulnerable, E= endangered, CE= critically endangered, Ex= currently presumed extinct in NSW, C= listed as migratory under the China-Australia Migratory Bird Agreement (CAMBA), J= listed as migratory under the Japan-Australia Migratory Bird Agreement (JAMBA), K= listed as migratory under the Republic of Korea-Australia Migratory Bird Agreement (KAMBA)
BAM-C = identified as a candidate or predicted threatened species by the BAM-C based on site data and information in the TBDC (DPE 2023a)
See below for definitions of 'Likelihood of occurrence' and 'Likelihood of impact' categories

Table B.2 Threatened fauna species likelihood of occurrence assessment

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Birds								
Botaurus poiciloptilus	Australasian Bittern	E	E	5 records within 20km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a); BAM C	Ecosystem	Widespread but uncommon over south-eastern Australia. Found over most of NSW except for the far north-west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.). Hides during the day amongst dense reeds or rushes and feed mainly at night on frogs, fish, yabbies, spiders, insects and snails. May construct feeding platforms over deeper water from reeds trampled by the bird; platforms are often littered with prey remains.	Likely. Refuge and breeding habitat in Typha along Billabong Creek and particularly in emergent vegetation associated with the Hartwood site. May forage in adjacent mudflats. Known to occur in adjacent Wanganella Swamp.	Likely.
Ardeotis australis	Australian Bustard	E		BAM C	Species	Occurs in inland Australia. In NSW mainly found in the north-west corner, less often in the lower western and central west plains regions, with occasional vagrants east to the western slopes and riverine plain. Breeding confined to the north-west region. Mainly inhabits tussock and hummock grasslands, also occurs in low shrublands and low open grassy woodlands. Breeds on bare ground on low sandy ridges or stony rises in ecotones between grassland and shrubland cover. Travels long distances, presumably in response to habitat and climatic conditions.	Unlikely. No local records. Not recorded despite targeted surveys for this conspicuous species.	Unlikely.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Rostratula australis	Australian Painted Snipe	E	E	2 records within 20 km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a); BAM C	Ecosystem	In NSW many records are from the Murray-Darling Basin including the Paroo wetlands, Lake Cowal, Macquarie Marshes, Fivebough Swamp and more recently, swamps near Balldale and Wanganella. Other important locations with recent records include wetlands on the Hawkesbury River, the Clarence and lower Hunter Valleys. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Forages nocturnally on mud-flats and in shallow water.	Possible. Refuge and breeding habitat in Typha and lignum along Billabong Creek and particularly in emergent vegetation associated with the Hartwood site. May forage in mudflats and adjacent soaked grasslands. Known to occur in adjacent Wanganella Swamp.	Likely.
Ninox connivens	Barking Owl	V		1 record within 20 km (NSW DCCEEW 2024a); BAM C	Species	Found throughout continental Australia except for the central arid regions. Occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains and in some northeast coastal and escarpment forests. Sometimes extends home range into urban areas. Inhabit woodland and open forest, including fragmented remnants and partly cleared farmland. Flexible in its habitat use, hunting can extend in to closed forest and more open areas. Typically roosts in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species.	Possible. Potential foraging habitat in riparian woodland. No breeding habitat present.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.
Falco subniger	Black Falcon	V		4 records within 20 km (NSW DCCEEW 2024a); BAM C	Ecosystem	Widely, but sparsely, distributed in NSW, mostly occurring in inland regions. Occurs in plains, grasslands, foothills, timbered watercourses, wetland environs, crops, and occasionally over towns and cities. Breeding occurs along timbered waterways in in land areas.	Possible. Suitable foraging habitat present along timbered waterways. No occupied or candidate nests recorded.	Possible.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V		4 records within 20 km (NSW DCCEEW 2024a); BAM C	Ecosystem	Widespread in NSW, with records from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. Rarely recorded east of the Great Dividing Range, although regularly observed from the Richmond and Clarence River areas. Recorded at a few scattered sites in the Hunter, Central Coast and Illawarra regions, but very rare in the latter. Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark, White Box, Inland Grey Box, Yellow Box, Blakely's Red Gum and Forest Red Gum. Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks, river sheoaks (nesting habitat) and tea-trees.	Possible. Broadly suitable habitat within grassy riparian woodland. Low number of records in locality.	Possible.
Oxyura australis	Blue-billed Duck	V		BAM C	Ecosystem	Widespread in NSW, but most common in the southern Murray-Darling Basin area. Disperses during the breeding season to deep swamps up to 300 km away, and generally seen in coastal areas only during summer or in drier years. Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation.	Possible, Marginal habitat present within Billabong Creek.	Possible.
Neophema chrysotoma	Blue-winged Parrot	V		6 records within 20 km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a)	Species	During the non-breeding period, from autumn to early spring, birds are recorded in western NSW, with some reaching south-eastern NSW, particularly on the southern migration. Inhabits a range of habitats from coastal, sub-coastal and inland areas, through to semi-arid zones. Tends to favour grasslands and grassy woodlands, often found near wetlands both near the coast and in semi-arid zones. Sometimes seen in altered environments such as airfields, golf-courses and paddocks. Pairs or small parties forage mainly near or on the ground for seeds of a wide range of native and introduced grasses, herbs and shrubs.	Possible. Suitable foraging habitat present along timbered waterways.	Possible.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Grus rubicunda	Brolga	V	E	7 records within 20 km (NSW DCCEEW 2024a); BAM C	Ecosystem	Formerly found across Australia, except for the south-east corner, Tasmania and the south-western third of the country. Very sparse distribution across the southern part of its range. Dependent on wetlands for foraging, especially shallow swamps, but also feed in dry grassland, ploughed paddocks and even desert claypans.	Possible. Suitable foraging habitat present along timbered waterways and adjacent inundated grasslands.	Possible.
Climacteris picumnus victoriae	Brown Treecreeper	V		20 records within 20 km (NSW DCCEEW 2024a); Species or species habitat likely to occur within 20 km (Cth DCCEEW 2024a); BAM C	Ecosystem	The western boundary of the species range runs approximately through Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell. Often found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species. Also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses. Usually not found in woodlands with a dense shrub layer. Fallen timber is an important habitat component for foraging. Also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.	Unlikely. Large numbers of records in locality. Based on distribution, these records are likely to be the western subspecies (subsp. *picumnus picumnus*).	Unlikely.
Burhinus grallarius	Bush Stone-curlew	E		3 records within 20 km (NSW DCCEEW 2024a); BAM C	Species	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. Largely nocturnal, being especially active on moonlit nights and nests on the ground in a scrape or small bare patch.	Present. Recorded 300m to the east of the Wanganella site.	Likely.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Tringa nebularia	Common Greenshank		E, C, J, K	Species or species habitat likely to occur within 20 km (Cth DCCEEW 2024a)	N/A	Common throughout Australia in the summer and recorded in most coastal regions in NSW. Widespread west of the Great Dividing Range, especially between the Lachlan and Murray Rivers and the Darling River drainage basin, including the Macquarie Marshes, and north-west regions. Found both on the coast and inland, in estuaries and mudflats, mangrove swamps and lagoons, and in billabongs, swamps, sewage farms and flooded crops.	Possible. Broadly suitable habitat is present.	Possible.
Calidris ferruginea	Curlew Sandpiper	E	CE, C, J, K	Species or species habitat may occur within 20 km (Cth DCCEEW 2024a)	Species/Ecosystem	Distributed around most of the Australian coastline. Occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. Inland records are probably mainly of birds pausing for a few days during migration. Breeds in Siberia and migrates to Australia for the non-breeding period, arriving in Australia between August and November, and departing between March and mid-April. Generally occupies littoral and estuarine habitats, and is mainly found in intertidal mudflats of sheltered coasts in NSW. Also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes inland. Forages in or at the edge of shallow water, occasionally on exposed algal mats or waterweed, or on banks of beach-cast seagrass or seaweed.	Unlikely. Suitable habitat not present. Study area not part of mapped important habitat areas in BOAMS.	Unlikely

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Stagonopleura guttata	Diamond Firetail	V	V	15 records within 20 km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a); BAM C	Ecosystem	Widely distributed in NSW, with a concentration of records from the Northern, Central and Southern Tablelands, the Northern, Central and South Western Slopes and the North West Plains and Riverina. Not commonly found in coastal districts, though there are records from near Sydney, the Hunter Valley and the Bega Valley. Scattered distribution over the rest of NSW, though is very rare west of the Darling River. Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum Eucalyptus pauciflora Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities, and often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.	Possible. Broadly suitable habitat within grassland and riparian woodland. Moderate number of records in locality.	Possible.
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V		7 records within 20 km (NSW DCCEEW 2024a); BAM C	Ecosystem	Occurs throughout most of New South Wales, but is sparsely scattered in, or largely absent from, much of the upper western region. Most breeding activity occurs on the western slopes of the Great Dividing Range. Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland.	Present. Recorded at the Wanganella site	Likely.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Petroica phoenicea	Flame Robin	V		3 records within 20 km (NSW DCCEEW 2024a); BAM C	Ecosystem	Breeds in upland areas in NSW and moves to the inland slopes and plains in winter. Likely two separate populations in NSW, one in the Northern Tablelands, and another ranging from the Central to Southern Tablelands. Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys.	Possible. Broadly suitable habitat within grassy riparian woodland. Seasonal migrant to the locality.	Possible
Stictonetta naevosa	Freckled Duck	V		BAM C	Ecosystem	Found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. Breeds in large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina. Forced to disperse during extensive inland droughts when wetlands in the Murray River basin provide important habitat. May also occur as far as coastal NSW and Victoria during such times. Prefers permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds.	Possible. Potential foraging and refuge habitat in Typha reedbeds.	Possible.
Pachycephala inornata	Gilbert's Whistler	V		BAM C	Ecosystem	Extends from the central NSW mallee (Yathong, Nombinnie and Round Hill NRs), south and east through the Cocoparra Range to Pomingalama Reserve (near Wagga Wagga) then north through the South West Slopes east as far as Cowra and Burrendong Dam, to the Goonoo reserves (with scattered records as far north as Pilliga). Occurs in a range of habitats with a dense shrub layer. Widely recorded in mallee shrublands, but also occurs in box-ironbark woodlands, Cypress Pine and Belah woodlands and River Red Gum forests (along the Murray, Edwards and Wakool Rivers).	Possible, Marginal habitat present along River Red Gum Forests. No local records.	Possible.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Falco hypoleucos	Grey Falcon	E	V	Species or species habitat likely to occur within 20 km (Cth DCCEEW 2024a); BAM C	Ecosystem	Sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range. Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey.	Possible. Suitable wooded watercourse habitat present. No occupied or candidate nests observed.	Possible.
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V		182 records within 20 km (NSW DCCEEW 2024a); BAM C	Ecosystem	Occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. Also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. Inhabits open Box-Gum Woodlands on the slopes, Box-Cypress-pine and open Box Woodlands on alluvial plains and woodlands on fertile soils in coastal regions.	Present. Recorded within grassy riparian woodland at the Wanganella site. Fallen timber present in study area.	Likely.
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	E	E	3 records within 20 km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a); BAM C	Ecosystem	Found from Brisbane to Adelaide and throughout much of inland NSW, with the exception of the extreme north-west, where it is replaced by subspecies *picata*. Prefers lightly wooded country, usually open eucalypt woodland, Acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.	Possible. Broadly suitable habitat within grassy riparian woodland.	Possible.
Gallinago hardwickii	Latham's Snipe		V, J, R	Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a)	N/A	Non-breeding migrant to the south east of Australia. Breeds in Japan and on the east Asian mainland. Seen in small groups or singly in freshwater wetlands on or near the coast, generally among dense cover. Found in any vegetation around wetlands, in sedges, grasses, lignum, reeds and rushes and also in saltmarsh and creek edges on migration. Also uses crops and pasture.	Possible. Suitable habitat present where Typha provides dense cover.	Possible.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Hieraaetus morphnoides	Little Eagle	V		15 records within 20 km (NSW DCCEEW 2024a); BAM C	Species/Ecosystem	Found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. Occurs as a single population throughout NSW. Occupies open eucalypt forest, woodland or open woodland. Also found in Sheoak or Acacia woodlands and riparian woodlands of inland NSW. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.	Present. Potential foraging habitat present. Stick nests recorded at Wanganella site along with observations of individuals.	Likely
Anseranas semipalmata	Magpie Goose	V		BAM C	Ecosystem	Still relatively common in the Australian northern tropics, but had disappeared from south-east Australia by 1920 due to drainage and overgrazing of reed swamps used for breeding. Since the 1980s there have been an increasing number of records in central and northern NSW. Vagrants can follow food sources to south-eastern NSW. Inhabits shallow wetlands containing dense rushes or sedges, and nearby dry land used for grazing. Feeds on grasses, bulbs and rhizomes and roosts in tall vegetation within wetland areas. Breeding occurs predominately in monsoonal areas and is unlikely in SE NSW. Nests are formed in trees over deep water.	Possible. No local records. Potential foraging habitat present.	Possible.
Lophochroa leadbeateri	Major Mitchell's Cockatoo	V		4 records within 20 km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a); BAM C	Species/Ecosystem	Occurs in arid and semi-arid NSW, regularly as far east as Bourke and Griffith and occasionally further east as vagrants. Inhabits a range of treed and treeless inland habitats within easy reach of water. Nests in tree hollows. Feeds mostly on the ground, especially on the seeds of native and exotic melons and on the seeds of species of saltbush, wattles and cypress pines.	Present. One individual recorded foraging at Wanganella Weir	Likely (foraging habitat only)

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Tyto novaehollandiae	Masked Owl	V		1 record within 20 km (NSW DCCEEW 2024a); BAM C	Species	Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. Lives in dry eucalypt forests and woodlands from sea level to 1100 m and often hunts along the edges of forests, including roadsides. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	Possible. Potential foraging habitat in riparian woodland. No breeding habitat present.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.
Grantiella picta	Painted Honeyeater	V	V	8 records within 20 km (NSW DCCEEW 2024a). Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a); BAM C	Ecosystem	Nomadic species occurring at low densities throughout its range. Most commonly found on the inland slopes of the Great Dividing Range in NSW, where almost all breeding occurs. More likely to be found in the north of its distribution in winter. Inhabits Boree/ Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) and Box-Gum Woodlands and Box-Ironbark Forests. Specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.	Possible. Mistletoe habitat present in broader locality.	Possible.
Certhionyx variegatus	Pied Honeyeater	V		1 record within 20 km (NSW DCCEEW 2024a); BAM C	Ecosystem	Widespread throughout acacia, mallee and spinifex scrubs of arid and semi-arid Australia. Occasionally occurs further east, on the slopes and plains and the Hunter Valley, typically during periods of drought. Inhabits wattle shrub, primarily Mulga (*Acacia aneura*), mallee, spinifex and eucalypt woodlands, usually when shrubs are flowering; feeds on nectar, predominantly from various species of emu-bushes (*Eremophila* spp.); also from mistletoes and various other shrubs (e.g. *Grevillea* spp.). Highly nomadic, following the erratic flowering of shrubs; can be locally common at times.	Possible. Nomadic migrant that may visit the proposal footprint on a transient basis. Broadly suitable foraging woodland habitat present.	Possible.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Pedionomus torquatus	Plains-wanderer	E	CE	51 records within 20 km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a); BAM C	Species/Ecosystem	Most records from an area of the western Riverina bounded by Hay and Narrandera on the Murrumbidgee River in the north, the Cobb Highway in the west, the Billabong Creek in the south, and Urana in the east. Lives in semi-arid, lowland native grasslands that typically occur on hard red-brown soils. Habitat structure appears to play a more important role than plant species composition. Preferred habitat of the Plains-wanderer typically comprises 50% bare ground, 10% fallen litter, and 40% herbs, forbs and grasses.	Assumed present. Suitable lowland grassland present. Large numbers recorded within the NSW Riverina region. Mapped important habitat areas identified in BOAMS are present.	Likely.
Anthochaera phrygia	Regent Honeyeater	CE	CE	Foraging, feeding or related behaviour may occur within 20 km (Cth DCCEEW 2024a); BAM C	Species/Ecosystem	Mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. Very patchy distribution in NSW, mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests. Inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, White Box and Swamp Mahogany. Flowering of associated species such as Thin-leaved Stringybark *Eucalyptus eugenioides* and other Stringybark species, and Broad-leaved Ironbark *E. fibrosa* can also contribute important nectar flows at times. Nectar and fruit from the mistletoes *Amyema miquelii*, *A. pendula* and *A. cambagei* are also utilised.	Unlikely. Habitat constraints: no areas mapped on the important habitat map from BOAMS occur within or adjacent to the proposal footprint.	Unlikely.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Polytelis anthopeplus monarchoides	Regent Parrot	E	V	BAM C	Species/Ecosystem	Occurs along the Murray River downstream of Tooleybuc (though there are few records between Mildura and the South Australian border), the Wakool River downstream of Kyalite, and the Murrumbidgee River immediately upstream from the junction with the Murray River and adjoining areas of mallee. Nests within River Red Gum forests along the Murray, Wakool and lower Murrumbidgee Rivers, and possibly the Darling River downstream of Pooncarie. Typical nest trees are large, mature healthy trees with many spouts (though dead trees are used) and are usually located close to a watercourse. Its main foraging habitat is mallee woodlands, also occurs in riverine forests and woodlands. Mallee woodland within 20 kilometres of nesting sites is critical foraging habitat for breeding birds.	Unlikely. Geographic limitations: the proposal footprint is not 'within 10 km of the junction of the Murray River' according to the BAM C.	Unlikely.
Petroica boodang	Scarlet Robin	V		3 records within 20 km (NSW DCCEEW 2024a); BAM C	Ecosystem	Occurs from the coast to the inland slopes in NSW. Disperses to the lower valleys and plains of the tablelands and slopes after breeding. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter. Found in dry eucalypt forests and woodlands with usually open and grassy understorey with few scattered shrubs. Lives in both mature and regrowth vegetation and occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Abundant logs and fallen timber are important components of its habitat.	Possible. Broadly suitable habitat within grassy riparian woodland. Seasonal migrant to the locality.	Possible.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Calidris acuminata	Sharp-tailed Sandpiper		E, C, J, K	Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a)	N/A	Most of the population migrates to Australia during non-breeding season, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage. Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation.	Possible. Known from the locality. Suitable foraging habitat present in waterlogged area where muddy edges and Typha is present. Study area not part of mapped important habitat areas in BOAMS.	Possible.
Aphelocephala leucopsis	Southern Whiteface	V	V	30 records within 20 km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a)	Ecosystem	Occur across most of mainland Australia south of the tropics, from the north-eastern edge of the Western Australian wheatbelt, east to the Great Dividing Range. Lives in a wide range of open woodlands and shrublands where there is an understorey of grasses or shrubs, or both. These areas are usually in habitats dominated by acacias or eucalypts on ranges, foothills and lowlands, and plains. Forages almost exclusively on the ground, favouring habitat with low tree densities and an herbaceous understorey litter cover.	Present. Recorded at Wanganella site.	Likely.
Circus assimilis	Spotted Harrier	V		12 records within 20 km (NSW DCCEEW 2024a); BAM C	Ecosystem	Occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges. Individuals disperse widely in NSW and comprise a single population. Occurs in grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. Found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	Possible. Broadly suitable habitat within grassland and riparian woodland. Moderate number of records in locality.	Possible.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Lophoictinia isura	Square-tailed Kite	V		8 records within 20 km (NSW DCCEEW 2024a); BAM C	Species/Ecosystem	Ranges along coastal and subcoastal areas from south-western to northern Australia. Scattered records throughout NSW indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. Summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March. Found in a variety of timbered habitats including dry woodlands and open forests and shows a particular preference for timbered watercourses. Observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland in arid north-western NSW.	Possible. Broadly suitable habitat within grassland and riparian woodland. Moderate number of records in locality. Suitably-sized stick nests observed at Wanganella were associated with the Little Eagle.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.
Polytelis swainsonii	Superb Parrot	V	V	105 records within 20 km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a); BAM C	Species/Ecosystem	Found throughout eastern inland NSW. On the South-western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. The other main breeding sites are in the Riverina along the corridors of the Murray, Edward and Murrumbidgee Rivers where birds are present all year round. Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest.	Possible. Potential foraging and breeding habitat within River Red Gum Forest. Hollows of suitable size throughout proposal footprint.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Lathamus discolor	Swift Parrot	E	CE	1 record within 20 km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a); BAM C	Species/Ecosystem	Migrates from Tasmania to south-eastern Australia in the autumn and winter months. Mostly occurs on the coast and south west slopes in NSW. Occurs on the mainland in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany Eucalyptus robusta, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Forest Red Gum *E. tereticornis*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*.	Unlikely. Favoured food trees are absent. Not recorded within 20 km. Habitat constraints: no areas mapped on the important habitat map occur within or adjacent to the proposal area.	Unlikely, no suitable habitat present and species has been excluded in BAM-C based on important habitat maps
Daphoenositta chrysoptera	Varied Sittella	V		5 records within 20 km (NSW DCCEEW 2024a); BAM C	Ecosystem	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The species inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	Possible. Broadly suitable habitat within grassy riparian woodland.	Possible.
Haliaeetus leucogaster	White-bellied Sea-Eagle	V		1 record within 20 km (NSW DCCEEW 2024a); BAM C	Species/Ecosystem	Widespread along the NSW coast, and along all major inland rivers and waterways. Habitats characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. Occurs at sites near the sea, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest). Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat.	Possible. Potential foraging habitat present. No very large stick nests recorded.	Unlikely, noting the species was not recorded despite targeted seasonal survey in accordance with the BAM.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Epthianura albifrons	White-fronted Chat	V		14 records within 20 km (NSW DCCEEW 2024a); BAM C	Ecosystem	Found mostly in temperate to arid climates and very rarely sub-tropical areas. Occurs mostly in the southern half of NSW, in damp open habitats along the coast, and near waterways in the western part of the state. Along the coastline, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas. Typically usually found foraging on bare or grassy ground in wetland areas, singly or in pairs.	Possible. Broadly suitable habitat within flooded grassland. Moderate number of records in locality.	Possible.
Hirundapus caudacutus	White-throated Needletail	V	V, C, J, R	Species or species habitat may occur within 20 km (Cth DCCEEW 2024a); BAM C	Ecosystem	Migrates to eastern Australia from October to April. Almost exclusively aerial and most often seen before storms, low pressure troughs and approaching cold fronts and occasionally bushfire. Occurs over most types of habitat, but mostly recorded above wooded areas, including open forest and rainforest. May also fly between trees or in clearings, below the canopy. Recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows.	Possible. Broadly suitable habitat is present.	Possible.
Frogs								
Litoria raniformis	Growling Grass Frog	E	V	Species or species habitat likely to occur within 20 km Cth DCCEEW 2024a); BAM C	Species	Currently known to exist only in isolated populations in the Coleambally Irrigation Area, the Lowbidgee floodplain and around Lake Victoria. A few yet unconfirmed records have also been made in the Murray Irrigation Area in recent years. Usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. Also found in irrigated rice crops, particularly where there is no available natural habitat. Breeding occurs during the warmer months and is triggered by flooding or a significant rise in water levels. The species has been known to breed anytime from early spring through to late summer/early autumn	Present. Recorded at Wanganella site over two survey rounds. Call recorded at the Hartwood site (Forest Creek block bank). Refuge and breeding habitat in periodically flooded depressions throughout the Billabong Creek system.	Likely

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Crinia sloanei	Sloane's Froglet	V	E	Species or species habitat may occur within 20 km (Cth DCCEEW 2024a)	Species	Most records are from the Darling Riverine Plains, NSW South Western Slopes and Riverina bioregions. It has not been recorded recently in the northern part of its range and has only been recorded infrequently in the southern part of its range in NSW. Typically associated with periodically inundated areas in grassland, woodland and disturbed habitats.	Unlikely. Marginal refuge and breeding habitat in inundated grasslands. No local records. All recent records in NSW are from the Albury area.	Unlikely.
Mammals								
Nyctophilus corbeni	Corben's Long-eared Bat	V	V	Species or species habitat may occur within 20 km (Cth DCCEEW 2024a)	Ecosystem	Found throughout the Murray-Darling Basin and the Pilliga Scrub region. Inhabits a variety of vegetation types, including mallee, bulloke *Allocasuarina leuhmanni* and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. Roosts in tree hollows, crevices, and under loose bark.	Possible. May roost in hollow-bearing tree. Broadly suitable foraging habitat in riparian forest.	Possible.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Species or species habitat may occur within 20 km (Cth DCCEEW 2024a)	Species/Ecosystem	Generally found within 200 km of the eastern coast of Australia, from Rockhampton in Queensland to Adelaide in South Australia. May be found in unusual locations in times of natural resource shortage. Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.	Unlikely. Not recorded in locality or Riverina bioregion.	Unlikely.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Vespadelus baverstocki	Inland Forest Bat	V		BAM C	Ecosystem	The distribution of this species, particularly in NSW, is very poorly known due to its difficulty in identification. It is believed to occur generally in areas with annual rainfall less than 400 millimetres. The Inland Forest Bat roosts in tree hollows and abandoned buildings. It is known to roost in very small hollows in stunted trees only a few metres high. The habitat requirements of this species are poorly known but it has been recorded from a variety of woodland formations, including Mallee, Mulga and River Red Gum. Most records are from drier woodland habitats with riparian areas inhabited by the Little Forest Bat.	Present. Probable (Pr) calls from Anabat detector at Wanganella site in riparian vegetation	Likely.
Phascolarctos cinereus	Koala	E	E	Species or species habitat likely to occur within 20 km (Cth DCCEEW 2024a); BAM C	Species	Found on the central and north coasts, southern highlands, southern and northern tablelands, Blue Mountains, southern coastal forests of NSW, with some smaller populations on the plains west of the Great Dividing Range. Inhabits eucalypt woodlands and forests, and feeds on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but will select preferred browse species in any one area.	Possible. Preferred River Red Gum food trees present in study area. Not recorded despite targeted survey and no local records.	Possible.
Chalinolobus picatus	Little Pied Bat	V		BAM C	Ecosystem	Found in inland Queensland and NSW (including Western Plains and slopes) extending slightly into South Australia and Victoria. Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress pine forest and mallee and Bimbil box woodlands. The species is known to roost in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings.	Present. Probable (Pr) calls from Anabat detector at Wanganella site in riparian vegetation	Likely.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Myotis macropus	Southern Myotis	V		BAM C	Species	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.	Present. Probable (Pr) calls from Anabat detector at two locations at Hartwood site in riparian vegetation	Likely.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		BAM C	Ecosystem	Wide-ranging species found across northern and eastern Australia. Rare visitor of south-western NSW in late summer and autumn. Scattered records of this species across the New England Tablelands and North West Slopes. Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. It forages in most habitats across its very wide range, with and without trees.	Possible. Broadly suitable foraging and roosting habitat present.	Possible.
Reptiles								
Hemiaspis damelii	Grey Snake	E	E	Species or species habitat likely to occur within 20 km (Cth DCCEEW 2024a)	N/A	Occurs as separate subpopulations, predominantly associated with the lower reaches of major westerly flowing rivers, including the Gwydir, Namoi, Castlereagh, Macquarie, Lachlan and Murrumbidgee River systems. Key attributes of the habitat of the species are the floodplains and ephemeral wetlands which provide breeding habitat for the frog species that are its main prey, the presence of the frog species themselves, and the heavy clay soils which provide cracks and crevices that the species uses in its hunting strategy and for shelter.	Possible. Cracking soils may provide potential foraging and shelter habitat	Possible.

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Credit class	Description	Likelihood of occurrence	Likelihood of impact
Aprasia parapulchella	Pink-tailed Worm-lizard	V	V	Species or species habitat may occur within 20 km (Cth DCCEEW 2024a)	Species	Only known from the Central and Southern Tablelands, and the South Western Slopes. There is a concentration of populations in the Canberra/Queanbeyan Region. Other populations have been recorded near Cooma, Yass, Bathurst, Albury and West Wyalong. This species is also found in the Australian Capital Territory. Inhabit sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by Kangaroo Grass (*Themeda australis*). Sites are typically well-drained, with rocky outcrops or scattered, partially-buried rocks. Commonly found beneath small, partially-embedded rocks and appear to spend considerable time in burrows below these rocks; the burrows have been constructed by and are often still inhabited by small black ants and termites.	Unlikely. No suitable habitat present. Habitat constraint - not within 50m of rocky areas	Unlikely.

Notes: V= vulnerable, E= endangered, CE= critically endangered, Ex= currently presumed extinct in NSW, C= listed as migratory under the China-Australia Migratory Bird Agreement (CAMBA), J= listed as migratory under the Japan-Australia Migratory Bird Agreement (JAMBA), K= listed as migratory under the Republic of Korea-Australia Migratory Bird Agreement (KAMBA)
BAM-C = identified as a candidate or predicted threatened species by the BAM-C based on site data and information in the TBDC (DPE 2023a)
See below for definitions of 'Likelihood of occurrence' and 'Likelihood of impact' categories

Table B.3 Migratory species likelihood of occurrence assessment

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Description	Likelihood of occurrence	Likelihood of impact
Actitis hypoleucos	Common Sandpiper		C, J, K	Species or species habitat may occur within 20 km (Cth DCCEEW 2024a)	Does not breed in Australia. When in Australia it is found on all coastlines and in inland areas, but is concentrated in the north and west with important areas in WA, the NT and Qld. Utilises a wide range of coastal and inland wetlands with varying salinity levels.	Unlikely. Suitable habitat not present. Not recorded in locality.	Unlikely
Apus pacificus	Fork-tailed Swift		C, J, K	Species or species habitat likely to occur within 20 km (Cth DCCEEW 2024a)	Almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher. Many records occur east of the Great Divide, however, a few populations have been found west of the Great Divide. Mostly occur over inland plains but sometimes above foothills or in coastal areas. Mostly found over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. Also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. Sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines. Also found over settled areas, including towns, urban areas and cities.	Possible. Broadly suitable habitat is present.	Unlikely, species is almost exclusively aerial.
Calidris acuminata	Sharp-tailed Sandpiper		C, J , K	1 record within 20 km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a)	Spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage. In Australasia, prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. Breeds in northern Siberia.	Possible. Known from the locality. Suitable foraging habiat present in waterlogged area where muddy edges and Typha. Spp is present.	Possible

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Description	Likelihood of occurrence	Likelihood of impact
Calidris ferruginea	Curlew Sandpiper	E	CE, C, J, K	Species or species habitat may occur within 20 km (Cth DCCEEW 2024a)	Distributed around most of the Australian coastline. Occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. Inland records are probably mainly of birds pausing for a few days during migration. Breeds in Siberia and migrates to Australia for the non-breeding period, arriving in Australia between August and November, and departing between March and mid-April. Generally occupies littoral and estuarine habitats, and is mainly found in intertidal mudflats of sheltered coasts in NSW. Also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes inland. Forages in or at the edge of shallow water, occasionally on exposed algal mats or waterweed, or on banks of beach-cast seagrass or seaweed.	Unlikely. Suitable habitat not present. Important habitat not mapped over study area for this migratory shorebird.	Unlikely
Calidris melanotos	Pectoral Sandpiper		J, K	Species or species habitat likely to occur within 20 km (Cth DCCEEW 2024a)	Widespread but scattered records across NSW, east of the divide and in the Riverina and Lower Western regions. Breeds in the northern hemisphere. In Australasia, prefers shallow fresh to saline wetlands and is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. Usually in coastal or near-coastal habitats, and prefers wetlands with open mudflats and low emergent or fringing vegetation such as grass or samphire.	Possible. Suitable habitat present where mudflat habitat is exposed. Scattered records in the Riverina region.	Possible
Gallinago hardwickii	Latham's Snipe		J, K	2 records wihtin 20 km (NSW DCCEEW 2024a); Species or species habitat known to occur within 20 km (Cth DCCEEW 2024a)	Non-breeding migrant to the south east of Australia. Breeds in Japan and on the east Asian mainland. Seen in small groups or singly in freshwater wetlands on or near the coast, generally among dense cover. Found in any vegetation around wetlands, in sedges, grasses, lignum, reeds and rushes and also in saltmarsh and creek edges on migration. Also uses crops and pasture.	Possible. Suitable habitat present where Typha. Spp provide dense cover.	Possible

Scientific name	Common name	BC Act Status	EPBC Act Status	Records	Description	Likelihood of occurrence	Likelihood of impact
Hirundapus caudacutus	White-throated Needletail		V	Species or species habitat may occur within 20 km (Cth DCCEEW 2024a)	Migrates to eastern Australia from October to April. Almost exclusively aerial and most often seen before storms, low pressure troughs and approaching cold fronts and occasionally bushfire. Occurs over most types of habitat, but mostly recorded above wooded areas, including open forest and rainforest. May also fly between trees or in clearings, below the canopy. Recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows.	Possible. Broadly suitable habitat is present.	Unlikely, species is almost exclusively aerial.
Motacilla flava	Yellow Wagtail		C, J, K	Species or species habitat may occur within 20 km (Cth DCCEEW 2024a)	Occurs 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. Breeds in temperate Europe and Asia.	Unlikely Broadly suitable habitat present, however not previously recorded within the Riverina bioregion.	Unlikely
Myiagra cyanoleuca	Satin Flycatcher			Species or species habitat may occur within 20 km (Cth DCCEEW 2024a)	Found along the east coast of Australia from far northern Queensland to Tasmania. Uncommonly seen species, especially in the far south of its range, where it is a summer breeding migrant. Inhabits heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests.	Unlikely. Suitable habitat not present.	Unlikely
Tringa nebularia	Common Greenshank		C, J, K	Species or species habitat likely to occur within 20 km (Cth DCCEEW 2024a)	Common throughout Australia in the summer. In NSW, the species has been recorded in most coastal regions. It is widespread west of the Great Dividing Range, especially between the Lachlan and Murray Rivers and the Darling River drainage basin, including the Macquarie Marshes, and north-west regions. Found both on the coast and inland, in estuaries and mudflats, mangrove swamps and lagoons, and in billabongs, swamps, sewage farms and flooded crops.	Possible. Broadly suitable habitat is present.	Possible

Notes: V= vulnerable, E= endangered, CE= critically endangered, Ex= currently presumed extinct in NSW, C= listed as migratory under the China-Australia Migratory Bird Agreement (CAMBA), J= listed as migratory under the Japan-Australia Migratory Bird Agreement (JAMBA), K= listed as migratory under the Republic of Korea-Australia Migratory Bird Agreement (KAMBA)
BAM-C = identified as a candidate or predicted threatened species by the BAM-C based on site data and information in the TBDC (DPE 2023a)
See below for definitions of 'Likelihood of occurrence' and 'Likelihood of impact' categories

Table B.4 Threatened species likelihood of occurrence categories

Likelihood	Definition
Present	Threatened species, population or community was recorded in the proposal footprint during surveys.
Likely	The proposal footprint is within the known area of occupancy of the species, population or community and suitable habitat occurs within the proposal footprint. Likely to be dependent on identified suitable habitat (ie for breeding or important life cycle periods such as winter flowering resources), and is known or likely to maintain resident populations in the proposal footprint. Also includes fauna species known or likely to visit the proposal footprint during regular seasonal movements or migration, or threatened flora that could potentially regenerate from the soil seed bank or become established from nearby populations.
Possible	The proposal footprint is within the known area of occupancy of the species, population or community but only marginal suitable habitat recorded as in a modified or degraded state. Fauna species are unlikely to maintain sedentary populations, however, may seasonally use resources within the proposal footprint opportunistically or during migration. The species is unlikely to be dependent (ie for breeding or important life cycle periods such as winter flowering resources) on habitat within the proposal footprint.
Unlikely	The proposal footprint is within the known area of occupancy of the species, population or community but there is no suitable habitat present. The species is dependent on specific vegetation types, habitat features or resources and its presence can be generally discounted based on the absence of these attributes from the proposal footprint. Fauna species may be an occasional visitor on a vagrant, short term or opportunistic basis.
Nil	The proposal footprint is outside the known area of occupancy of the species, population or community and there is no suitable habitat present. The species is dependent on specific vegetation types, habitat features or resources and its presence can be readily discounted based on the absence of these attributes from the proposal footprint. Given the distance of the proposal footprint from any known populations there is no chance of the species occurring even on a vagrant, short term or opportunistic basis.

Table B.5 Threatened species likelihood of impact categories

Likelihood	Definition
Likely	Species recorded and/or known from the locality and/or; suitable habitat occurs within the proposal footprint. These species are likely to occur in the proposal footprint and the proposal may result in direct or indirect impacts on these species, including through the removal of habitat resources that may be relied upon by local populations of these species.
Possible	Species known or predicted to occur within the locality and low quality potentially suitable habitat occurs within the proposal footprint. These species may occur in the proposal footprint on a transitory, seasonal or opportunistic basis. The proposal may result in negligible direct or indirect impacts on these species, but would not remove any habitat resources that are relied upon by local populations of these species for their ongoing survival in the locality.
Unlikely	The proposal footprint is outside of the biota's known distribution and/or; suitable habitat not present within the proposal footprint.
Nil	The proposal would not result in any direct or indirect impacts on these species or their habitats. Threatened ecological communities not identified in the proposal footprint.

B-2 Natural Grasslands of the Murray Valley Plains assessment

Table B.6 ***Assessment of PCT 44 vegetation zones against the Natural Grasslands of the Murray Valley Plains (EPBC Act CEEC) diagnostic characteristics and condition thresholds (TSSC 2012)***

Step 1: use key diagnostic characteristics to identify if the ecological community is present:		
Key diagnostic characteristics	**Answer**	**Justification**
Is the community based in the Riverina Bioregion?	Yes	'The community' that is the subject of this assessment is Hartwood vegetation zone 6, PCT 44_Moderate. The community is located within the Murrumbidgee Subregion within the Riverina Bioregion, close to the northern limit of the CEEC.
Does the community occur on a landscape of flat alluvial lowland plains with heavy-textured grey, brown and red clays?	Yes	The community occurs on low lying floodplains associated with Billabong Creek and Forest Creek at an elevation of approximately 90 m above sea level.
Is the community dominated by a range of perennial grasses and/or forbs or co-dominated by small shrubs from the following genera? – *Grasses: Rytidosperma, Austrostipa, Chloris, Enteropogon* – *Forbs / herbs: Arthropodium, Bulbine, Calotis, Chrysocephalum, Leptorhynchos, Minuria, Ptilotus, Rhodanthe, Sida, Swainsona* – *Shrubs: Atriplex and Maireana.*	Yes	The community is dominated by grass species with a lesser abundance of forbs and chenopod shrubs from the following genera: *Rytidosperma*, *Chloris*, *Enteropogon*, *Chrysocephalum* and *Sclerolaena*.
Are trees and large shrubs (>1 m tall) generally absent to sparse, amounting to less than 10% projective foliage cover?	Yes	Tree species, including *Eucalyptus camadulensis* and *E. largiflorens* occur directly adjacent to the grassland patch but not within it. Some shrubs occur including *Sclerolaena muricata* and *Chenopodium nitraceum* but at an estimated cover of less than 10%.
Does the community contain as many or more of the species in: – *Table 1 (A) Species more frequent in the Natural Grasslands of the Murray Valley Plains ecological community in NSW; than in* – *Table 1 (B) Species more frequent in grassland vegetation not considered to be the ecological community in NSW*	Yes (Plot K1 only)	Plot K1 (patch within proposal footprint) contained more Table 1 (A) species than Table 1 (B) species. Plot 10 (patch in study area, outside the proposal footprint) only contained Table 1 (B) species.
Is there reliable evidence (e.g. historical records, photographs) that a patch was once a woodland or shrubland with >10% cover (of trees, shrubs >1m) ? If so, then the patch is not considered to be part of the ecological community	No	Historical Google Earth aerial imagery from 1984 to present shows the patch has not previously been a shrubland of woodland during this time period.
Conclusion of step 1	-	Hartwood vegetation zone 6, PCT 44_Moderate meets the key diagnostic characteristics of the CEEC.

Step 2: Determine condition of the ecological community:		
Condition thresholds	**Answer**	**Justification**
Is the percentage cover of native vascular plants (annual and perennial) in the patch is greater than the percentage cover of perennial exotic species ? AND	No	Plot K1 only contains 28.7 % cover of native vascular plants.
Category A. For patches with high diversity or that are relatively undisturbed: – *A1. 15 or more native vascular plant species are present in the patch. AND* – *A2. The patch contains one or more indicator species in Table 2, characteristic of sites that are relatively undisturbed (e.g. have little to no history of cultivation) AND* – *A3. The size of the grassland patch is at least 0.04 ha or more in size (i.e. at least 400 m2 or a 20m x 20m square or equivalent area in any shape)* – *OR*	N/A	End of assessment.
Category B. For larger patches that have good ground layer diversity, do not meet the high diversity or lack of disturbance criteria in Category A, but still retain sufficient elements of their natural diversity: – *B1. 10 or more native vascular plant species are present in the patch AND* – *B2. The size of the grassland patch is at least 1 ha or more in size (i.e. at least 10 000 m2 or a 100m x 100m square or equivalent area in any shape*	-	-
Conclusion of step 2		Hartwood vegetation zone 6, PCT 44_Moderate, does not meet the condition thresholds for the CEEC due to the patch containing a higher percentage cover (33.6%) of perennial exotic species.
Additional considerations pertaining to the decision criteria in the above table. A patch is defined as a discrete and continuous area of the ecological community. However, a patch may include small-scale disturbances, such as tracks or breaks (including exposed soil, leaf and other plant litter, cryptogams) or small-scale variations in vegetation that do not significantly alter its overall functionality (for instance the movement of wildlife or dispersal of plant propagules). Minimum patch size for the Natural Grasslands of the Murray Valley Plains was determined by analysis of known patch sizes across the ecological community (see section 9. Criterion 2). The ecological community now occurs in a highly fragmented state and patches are generally small in size, with most being less than 100 ha in area. Consequently, impacts to patches of the ecological community that are 0.04 ha in size and of high diversity are likely to be significant.		

Table B.7 ***Assessment of PCT 46 vegetation zones against the Natural Grasslands of the Murray Valley Plains (EPBC Act CEEC) diagnostic characteristics and condition thresholds (TSSC 2012)***

Step 1: use key diagnostic characteristics to identify if the ecological community is present:		
Key diagnostic characteristics	**Answer**	**Justification**
Is the community based in the Riverina Bioregion?	Yes	'The community' that is the subject of this assessment is the following PCT 46 vegetation zones within the proposal footprint and similar vegetation in adjoining parts of the study area: – Hartwood vegetation zone 7 (PCT 46_Moderate) – Hartwood vegetation zone 8 (PCT 46_Poor) – Wanganella vegetation zone 5 PCT 46_Moderate) The community is located within the Murrumbidgee Subregion of the Riverina Bioregion, close to the northern limit of the CEEC.
Does the community occur on a landscape of flat alluvial lowland plains with heavy-textured grey, brown and red clays?	Yes	The community occurs on low lying floodplains associated with Billabong Creek and Forest Creek at an elevation of approximately 90 m above sea level.
Is the community dominated by a range of perennial grasses and/or forbs or co-dominated by small shrubs from the following genera? – *Grasses: Rytidosperma, Austrostipa, Chloris, Enteropogon* – *Forbs / herbs: Arthropodium, Bulbine, Calotis, Chrysocephalum, Leptorhynchos, Minuria, Ptilotus, Rhodanthe, Sida, Swainsona* – *Shrubs: Atriplex and Maireana.*	Yes	The community is dominated by grass species with a lesser abundance of forbs and chenopod shrubs from the following genera: *Rytidosperma*, *Chloris*, *Enteropogon*, *Chrysocephalum* and *Sclerolaena*.
Are trees and large shrubs (>1 m tall) generally absent to sparse, amounting to less than 10% projective foliage cover?	Yes	Tree species, including *Eucalyptus camadulensis* and *E. largiflorens* occur directly adjacent to the grassland patch but not within. Some shrubs occur including *Sclerolaena muricata* and *Chenopodium nitraceum* but at an estimated cover of less than 10%.
Does the community contain as many or more of the species in: – *Table 1 (A) Species more frequent in the Natural Grasslands of the Murray Valley Plains ecological community in NSW; than in* – *Table 1 (B) Species more frequent in grassland vegetation not considered to be the ecological community in NSW*	No	Hartwood: Plot F16, 11, J8 and JR_8 all contained more Table 1 (B) species than Table 1 (A) species. Wanganella Plot 3 and F5 both contained all contained more Table 1 (B) species than Table 1 (A) species.
Is there reliable evidence (e.g. historical records, photographs) that a patch was once a woodland or shrubland with >10% cover (of trees, shrubs >1m) ? If so, then the patch is not considered to be part of the ecological community	N/A	End of assessment.
Conclusion of step 1		Due to the patches containing more Table 1 (B) species than Table 1 (A) species, the PCT 46 vegetation zones within the proposal footprint and adjoining parts of the study area do not meet the key diagnostic characteristics of the CEEC. Therefore, the CEEC is not present in PCT 46 vegetation zones.

Step 2: Determine condition of the ecological community:		**Not applicable due to all PCT 46 vegetation zones not meeting the key diagnostic characteristics of the CEEC**
Condition thresholds		
Is the percentage cover of native vascular plants (annual and perennial) in the patch is greater than the percentage cover of perennial exotic species ? AND	-	-
Category A. For patches with high diversity or that are relatively undisturbed: – *A1. 15 or more native vascular plant species are present in the patch. AND* – *A2. The patch contains one or more indicator species in Table 2, characteristic of sites that are relatively undisturbed (e.g. have little to no history of cultivation) AND* – *A3. The size of the grassland patch is at least 0.04 ha or more in size (i.e. at least 400 m^2 or a 20m x 20m square or equivalent area in any shape)* – *OR*	-	-
Category B. For larger patches that have good ground layer diversity, do not meet the high diversity or lack of disturbance criteria in Category A, but still retain sufficient elements of their natural diversity: – *B1. 10 or more native vascular plant species are present in the patch AND* – *B2. The size of the grassland patch is at least 1 ha or more in size (i.e. at least 10 000 m^2 or a 100m x 100m square or equivalent area in any shape*	-	-
Conclusion of step 2	-	-
Additional considerations pertaining to the decision criteria in the above table. A patch is defined as a discrete and continuous area of the ecological community. However, a patch may include small-scale disturbances, such as tracks or breaks (including exposed soil, leaf and other plant litter, cryptogams) or small-scale variations in vegetation that do not significantly alter its overall functionality (for instance the movement of wildlife or dispersal of plant propagules). Minimum patch size for the Natural Grasslands of the Murray Valley Plains was determined by analysis of known patch sizes across the ecological community (see section 9. Criterion 2). The ecological community now occurs in a highly fragmented state and patches are generally small in size, with most being less than 100 ha in area. Consequently, impacts to patches of the ecological community that are 0.04 ha in size and of high diversity are likely to be significant.		

Table B.8 ***Assessment of PCT 13 derived native grassland against the Natural Grasslands of the Murray Valley Plains (EPBC Act CEEC) diagnostic characteristics and condition thresholds (TSSC 2012)***

Step 1: use key diagnostic characteristics to identify if the ecological community is present:		
Key diagnostic characteristics	**Answer**	**Justification**
Is the community based in the Riverina Bioregion?	Yes	'The community' that is the subject of this assessment is the following PCT 13 vegetation zones within the proposal footprint and similar vegetation in adjoining parts of the study area: – Hartwood vegetation zone 4 (PCT 13_DNG) – Wanganella vegetation zone 4 (PCT 13_DNG) The community is located within the Murrumbidgee Subregion within the Riverina Bioregion, close to the northern limit of the CEEC.
Does the community occur on a landscape of flat alluvial lowland plains with heavy-textured grey, brown and red clays?	Yes	The community occurs on low lying floodplains associated with Billabong Creek and Forest Creek at an elevation of approximately 90 m above sea level.
Is the community dominated by a range of perennial grasses and/or forbs or co-dominated by small shrubs from the following genera? – *Grasses: Rytidosperma, Austrostipa, Chloris, Enteropogon* – *Forbs / herbs: Arthropodium, Bulbine, Calotis, Chrysocephalum, Leptorhynchos, Minuria, Ptilotus, Rhodanthe, Sida, Swainsona* – *Shrubs: Atriplex and Maireana.*	Yes	The community is dominated by grass species with a lesser abundance of forbs and chenopod shrubs from the following genera: *Rytidosperma*, *Chloris*, *Enteropogon*, *Chrysocephalum* and *Sclerolaena*.
Are trees and large shrubs (>1 m tall) generally absent to sparse, amounting to less than 10% projective foliage cover?	Yes	Tree species, including *Eucalyptus camadulensis* and *E. largiflorens* occur directly adjacent to the grassland patch but not within. Some shrubs occur including *Sclerolaena muricata* and *Chenopodium nitraceum* but at an estimated cover of less than 10%.
Does the community contain as many or more of the species in: – *Table 1 (A) Species more frequent in the Natural Grasslands of the Murray Valley Plains ecological community in NSW; than in* – *Table 1 (B) Species more frequent in grassland vegetation not considered to be the ecological community in NSW*		Hartwood: Plot JR_1, JR_2, JR_7, JR_9, 12 all contained more Table 1 (B) species than Table 1 (A) species. Wanganella Plot JR_3 and JR_4 both contained all contained more Table 1 (B) species than Table 1 (A) species.
Is there reliable evidence (e.g. historical records, photographs) that a patch was once a woodland or shrubland with >10% cover (of trees, shrubs >1m) ? If so, then the patch is not considered to be part of the ecological community	N/A	End of assessment.
Conclusion of step 1	-	Due to the patches containing more Table 1 (B) species than Table 1 (A) species, the PCT 13 DNG vegetation zones within the proposal footprint and adjoining parts of the study area do not meet the key diagnostic characteristics of the CEEC. Therefore, the CEEC is not present in PCT 13 DNG vegetation zones.

Step 2: Determine condition of the ecological community:		**Not applicable due to all PCT 13 DNG vegetation zones not meeting the key diagnostic characteristics of the CEEC**
Condition thresholds		
Is the percentage cover of native vascular plants (annual and perennial) in the patch is greater than the percentage cover of perennial exotic species ? AND	-	-
Category A. For patches with high diversity or that are relatively undisturbed: – *A1. 15 or more native vascular plant species are present in the patch. AND* – *A2. The patch contains one or more indicator species in Table 2, characteristic of sites that are relatively undisturbed (e.g. have little to no history of cultivation) AND* – *A3. The size of the grassland patch is at least 0.04 ha or more in size (i.e. at least 400 m^2 or a 20m x 20m square or equivalent area in any shape)* – *OR*	-	-
Category B. For larger patches that have good ground layer diversity, do not meet the high diversity or lack of disturbance criteria in Category A, but still retain sufficient elements of their natural diversity: – *B1. 10 or more native vascular plant species are present in the patch AND* – *B2. The size of the grassland patch is at least 1 ha or more in size (i.e. at least 10 000 m^2 or a 100m x 100m square or equivalent area in any shape*	-	-
Conclusion of step 2		-
Additional considerations pertaining to the decision criteria in the above table. A patch is defined as a discrete and continuous area of the ecological community. However, a patch may include small-scale disturbances, such as tracks or breaks (including exposed soil, leaf and other plant litter, cryptogams) or small-scale variations in vegetation that do not significantly alter its overall functionality (for instance the movement of wildlife or dispersal of plant propagules). Minimum patch size for the Natural Grasslands of the Murray Valley Plains was determined by analysis of known patch sizes across the ecological community (see section 9. Criterion 2). The ecological community now occurs in a highly fragmented state and patches are generally small in size, with most being less than 100 ha in area. Consequently, impacts to patches of the ecological community that are 0.04 ha in size and of high diversity are likely to be significant.		

Appendix C

Species recorded in the study area

Table C.1 Fauna species recorded in the study area

Family	Common Name	Scientific Name	NSW Status	EPBC Status	Exotic
Frogs					
Hylidae	Peron's Tree Frog	*Litoria peronii*			
Hylidae	Southern Bell Frog	*Litoria raniformis*	E	V	
Myobatrachidae	Common Eastern Froglet	*Crinia signifera*			
Myobatrachidae	Eastern Banjo Frog	*Limnodynastes dumerilii*			
Myobatrachidae	Eastern Sign-bearing Froglet	*Crinia parinsignifera*			
Myobatrachidae	Long-thumbed Frog	*Limnodynastes fletcheri*			
Myobatrachidae	Spotted Grass Frog	*Limnodynastes tasmaniensis*			
Birds					
Acanthizidae	Buff-rumped Thornbill	*Acanthiza reguloides*			
Acanthizidae	Chestnut-rumped Thornbill	*Acanthiza uropygialis*			
Acanthizidae	Southern Whiteface	*Aphelocephala leucopsis*			
Acanthizidae	Weebill	*Smicrornis brevirostris*			
Acanthizidae	Western Gerygone	*Gerygone fusca*			
Acanthizidae	Yellow Thornbill	*Acanthiza nana*			
Accipitridae	Black Kite	*Milvus migrans*			
Accipitridae	Black-shouldered Kite	*Elanus axillaris*			
Accipitridae	Brown Goshawk	*Accipiter fasciatus*			
Accipitridae	Collared Sparrowhawk	*Accipiter cirrocephalus*			
Accipitridae	Little Eagle	*Hieraaetus morphnoides*	V		
Accipitridae	Whistling Kite	*Haliastur sphenurus*			
Accipitridae	White-bellied Sea-eagle	*Haliaeetus leucogaster*	V		
Acrocephalidae	Australian Reed-Warbler	*Acrocephalus australis*			
Aegothelidae	Australian Owlet-nightjar	*Aegotheles cristatus*			
Alcedinidae	Laughing Kookaburra	*Dacelo novaeguineae*			
Alcedinidae	Sacred Kingfisher	*Todiramphus sanctus*			
Anatidae	Australian Wood Duck	*Chenonetta jubata*			
Anatidae	Black Swan	*Cygnus atratus*			
Anatidae	Grey Teal	*Anas gracilis*			
Anatidae	Hardhead	*Aythya australis*			
Anatidae	Pacific Black Duck	*Anas superciliosa*			
Anatidae	Plumed Whistling-Duck	*Dendrocygna eytoni*			
Anhingidae	Australasian Darter	*Anhinga novaehollandiae*			
Ardeidae	Nankeen Night Heron	*Nycticorax caledonicus*			
Ardeidae	Unidentified Egret	*Ardea/Egretta sp.*			
Ardeidae	White-faced Heron	*Egretta novaehollandiae*			
Ardeidae	White-necked Heron	*Ardea pacifica*			
Artamidae	Australian Magpie	*Cracticus tibicen*			
Artamidae	Dusky Woodswallow	*Artamus cyanopterus cyanopterus*	V		

Family	Common Name	Scientific Name	NSW Status	EPBC Status	Exotic
Artamidae	Masked Woodswallow	*Artamus personatus*			
Artamidae	Pied Butcherbird	*Cracticus nigrogularis*			
Artamidae	Pied Currawong	*Strepera graculina*			
Artamidae	White-breasted Woodswallow	*Artamus leucorynchus*			
Cacatuidae	Galah	*Eolophus roseicapillus*			
Cacatuidae	Major Mitchell's Cockatoo	*Lophochroa leadbeateri*	V	E	
Cacatuidae	Sulphur-crested Cockatoo	*Cacatua galerita*			
Campephagidae	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*			
Climacteridae	Brown Treecreeper	*Climacteris picumnus picumnus*			
Columbidae	Common Bronzewing	*Phaps chalcoptera*			
Columbidae	Crested Pigeon	*Ocyphaps lophotes*			
Columbidae	Peaceful Dove	*Geopelia striata*			
Corcoracidae	White-winged Chough	*Corcorax melanorhamphos*			
Corvidae	Australian Raven	*Corvus coronoides*			
Corvidae	Little Raven	*Corvus mellori*			
Cuculidae	Pallid Cuckoo	*Cacomantis pallidus*			
Estrildidae	Red-browed Finch	*Neochmia temporalis*			
Falconidae	Brown Falcon	*Falco berigora*			
Falconidae	Nankeen Kestrel	*Falco cenchroides*			
Hirundinidae	Tree Martin	*Petrochelidon nigricans*			
Hirundinidae	welcome swallow	*Hirundo neoxena*			
Maluridae	Superb Fairy-wren	*Malurus cyaneus*			
Maluridae	Variegated Fairy-wren	*Malurus lamberti*			
Megaluridae	Brown Songlark	*Cincloramphus cruralis*			
Megaluridae	Rufous Songlark	*Cincloramphus mathewsi*			
Meliphagidae	Blue-faced Honeyeater	*Entomyzon cyanotis*			
Meliphagidae	Brown-headed Honeyeater	*Melithreptus brevirostris*			
Meliphagidae	Little Friarbird	*Philemon citreogularis*			
Meliphagidae	Noisy Miner	*Manorina melanocephala*			
Meliphagidae	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*			
Meliphagidae	Striped Honeyeater	*Plectorhyncha lanceolata*			
Meliphagidae	White-naped Honeyeater	*Melithreptus lunatus*			
Meliphagidae	White-plumed Honeyeater	*Ptilotula penicillatus*			
Meropidae	Rainbow Bee-eater	*Merops ornatus*			
Monarchidae	Magpie-lark	*Grallina cyanoleuca*			
Monarchidae	Restless Flycatcher	*Myiagra inquieta*			
Motacillidae	Australian Pipit	*Anthus novaeseelandiae*			
Nectariniidae	Mistletoebird	*Dicaeum hirundinaceum*			
Pachycephalidae	Grey Shrike-thrush	*Colluricincla harmonica*			
Pachycephalidae	Rufous Whistler	*Pachycephala rufiventris*			
Pardalotidae	Spotted Pardalote	*Pardalotus punctatus*			

Family	Common Name	Scientific Name	NSW Status	EPBC Status	Exotic
Pardalotidae	Striated Pardalote	*Pardalotus striatus*			
Phalacrocoracidae	Little Pied Cormorant	*Microcarbo melanoleucos*			
Phasianidae	Stubble Quail	*Coturnix pectoralis*			
Podargidae	Tawny Frogmouth	*Podargus strigoides*			
Podicipedidae	Australasian Grebe	*Tachybaptus novaehollandiae*			
Pomatostomidae	Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	V		
Pomatostomidae	White-browed Babbler	*Pomatostomus superciliosus*			
Psittacidae	Yellow Rosella	*Platycercus elegans flaveolus*			
Psittacidae	Blue Bonnet	*Northiella haematogaster*			
Psittacidae	Crimson Rosella	*Platycercus elegans*			
Psittacidae	Eastern Rosella	*Platycercus eximius*			
Psittacidae	Red-rumped Parrot	*Psephotus haematonotus*			
Rallidae	Dusky Moorhen	*Gallinula tenebrosa*			
Rallidae	Eurasian Coot	*Fulica atra*			
Rallidae	Purple Swamphen	*Porphyrio porphyrio*			
Rhipiduridae	Grey Fantail	*Rhipidura albiscapa*			
Rhipiduridae	Willie Wagtail	*Rhipidura leucophrys*			
Strigidae	Southern Boobook	*Ninox novaeseelandiae*			
Threskiornithidae	Australian White Ibis	*Threskiornis molucca*			
Threskiornithidae	Straw-necked Ibis	*Threskiornis spinicollis*			
Threskiornithidae	Yellow-billed Spoonbill	*Platalea flavipes*			
Timaliidae	Silvereye	*Zosterops lateralis*			
Turnicidae	Unidentified Button-quail	*Turnix sp.*			
Tytonidae	Eastern Barn Owl	*Tyto javanica*			
Mammals					
Canidae	Fox	*Vulpes vulpes*			*
Dasyuridae	Yellow-footed Antechinus	*Antechinus flavipes*			
Leporidae	Brown Hare	*Lepus capensis*			*
Leporidae	Rabbit	*Oryctolagus cuniculus*			*
Macropodidae	Eastern Grey Kangaroo	*Macropus giganteus*			
Macropodidae	Swamp Wallaby	*Wallabia bicolor*			
Molossidae	White-striped Freetail-bat	*Tadarida australis*			
Muridae	Water-Rat	*Hydromys chrysogaster*			
Phalangeridae	Common Brushtail Possum	*Trichosurus vulpecula*			
Reptiles					
Elapidae	Eastern Brown Snake	*Pseudonaja textilis*			
Scincidae	Snake-eyed Skink	*Cryptoblepharus sp.*			
Scincidae	South-eastern Morethia Skink	*Morethia boulengeri*			

Key: E – endangered, V - vulnerable

Table C.2 Flora species list - Hartwood vegetation zone 1

Family	Scientific Name	Common Name	Growth Form	1 C	1 A
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed	FG	1	50
Asteraceae	*Centipeda cunninghamii*	Common Sneezeweed	FG	20	50
Asteraceae	*Cirsium vulgare*	Spear Thistle	EX	0.1	5
Asteraceae	*Pseudognaphalium luteoalbum*	Jersey Cudweed	FG	0.1	2
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	EX	0.1	10
Asteraceae	*Xanthium spinosum*	Bathurst Burr	HT	0.1	10
Boraginaceae	*Heliotropium europaeum*		EX	0.1	1
Brassicaceae	*Sisymbrium irio*	London Rocket	EX	0.1	1
Chenopodiaceae	*Atriplex suberecta*		FG	0.1	2
Chenopodiaceae	*Chenopodium murale*	Nettle-leaf Goosefoot	EX	0.1	5
Chenopodiaceae	*Chenopodium nitrariaceum*	Nitre Goosefoot	SG	0.1	1
Chenopodiaceae	*Dysphania pumilio*	Small Crumbweed	FG	2	100
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	FG	3	200
Chenopodiaceae	*Sclerolaena muricata*	Black Rolypoly	SG	0.1	20
Cucurbitaceae	*Cucumis myriocarpus*		EX	0.5	10
Fabaceae (Faboideae)	*Medicago spp.*	A Medic	EX	0.1	15
Fabaceae (Mimosoideae)	*Acacia stenophylla*	River Cooba	TG	3	20
Malvaceae	*Sida corrugata*	Corrugated Sida	FG	0.1	1
Myrtaceae	*Eucalyptus camaldulensis*	River Red Gum	TG	30	3
Myrtaceae	*Eucalyptus largiflorens*	Black Box	TG	25	10
Oxalidaceae	*Oxalis perennans*		FG	0.1	5
Phyllanthaceae	*Phyllanthus* sp.		EX	0.1	30
Poaceae	*Paspalidium jubiflorum*	Warrego Grass	GG	35	500
Polygonaceae	*Polygonum plebeium*	Small Knotweed	FG	0.1	5
Polygonaceae	*Rumex brownii*	Swamp Dock	FG	0.1	10
Solanaceae	*Physalis lanceifolia*		EX	0.1	2

Family	Scientific Name	Common Name	Growth Form	1 C	1 A
Solanaceae	*Solanum nigrum*	Black-berry Nightshade	EX	0.2	20
Verbenaceae	*Phyla canescens*	Lippia	HT	0.1	5
Verbenaceae	*Verbena supina*	Trailing Verbena	EX	0.1	5

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.3 Flora species list -Hartwood vegetation zone 2

Family	Scientific Name	Common Name	Growth Form	9 C	9 A	JR13 C	JR13 A
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed	FG			0.2	30
Asteraceae	*Calotis scapigera*	Tufted Burr-daisy	FG	0.3	30		
Asteraceae	*Cirsium vulgare*	Spear Thistle	EX			4	60
Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane	EX			0.1	10
Asteraceae	*Lactuca serriola*	Prickly Lettuce	EX			0.1	30
Asteraceae	*Sonchus asper*	Prickly Sowthistle	EX			0.1	8
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	EX	0.1	3		
Asteraceae	*Xanthium spinosum*	Bathurst Burr	HT	0.1	1		
Asteraceae	*Xanthium strumarium*		HT			0.1	7
Boraginaceae	*Heliotropium europaeum*		EX	0.1	2		
Brassicaceae	*Ssymbrium sp.*					0.2	20
Chenopodiaceae	*Chenopodium nitrariaceum*	Nitre Goosefoot	SG	1	1	0.1	30
Chenopodiaceae	*Dysphania pumilio*	Small Crumbweed	FG	0.1	1		
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	FG	1	30	2	80
Chenopodiaceae	*Maireana decalvans*	Black Cotton Bush	SG	0.1	1		
Chenopodiaceae	*Sclerolaena muricata*	Black Rolypoly	SG	0.1	1	0.2	50
Cucurbitaceae	*Cucumis myriocarpus*		EX	0.1	1		
Cyperaceae	*Cyperus exaltatus*		GG	0.5	10		
Euphorbiaceae	*Chamaesyce drummondii*	Caustic Weed	FG	0.5	50		
Euphorbiaceae	*Euphorbia drummondii*		FG			0.2	100

Family	Scientific Name	Common Name	Growth Form	9 C	9 A	JR13 C	JR13 A
Fabaceae (Mimosoideae)	*Acacia salicina*	Cooba	TG	3	10		
Fabaceae (Mimosoideae)	*Acacia stenophylla*	River Cooba	TG			0.2	3
Goodeniaceae	*Goodenia glauca*	Pale Goodenia	FG	0.1	20		
Haloragaceae	*Haloragis glauca*		FG	1	50		
Juncaceae	*Juncus remotiflorus*		GG	0.2	10		
Lobeliaceae	*Lobelia concolor*	Poison Pratia	FG	0.1	1		
Malvaceae	*Sida corrugata*	Corrugated Sida	FG	0.5	20		
Malvaceae	*Sida trichopoda*	High Sida	FG	0.1	1		
Myrtaceae	*Eucalyptus camaldulensis*	River Red Gum	TG	15	2	60	15
Myrtaceae	*Eucalyptus largiflorens*	Black Box	TG	10	4	15	3
Nyctaginaceae	*Boerhavia dominii*	Tarvine	FG	0.5	30		
Poaceae	*Austrostipa nodosa*	A Speargrass	GG			0.3	0.2
Poaceae	*Enteropogon acicularis*	Curly Windmill Grass	GG	0.2	10		
Poaceae	*Lolium perenne*	Perennial Ryegrass	EX			1	150
Poaceae	*Paspalidium jubiflorum*	Warrego Grass	GG	0.5	20	40	100
Poaceae	*Paspalum distichum*	Water Couch	GG	0.2	5		
Poaceae	*Sporobolus mitchellii*	Rat's Tail Couch	GG	3	50		
Poaceae	*Walwhalleya proluta*		GG	0.1	2		
Polygonaceae	*Rumex brownii*	Swamp Dock	FG	0.1	2	0.1	10
Solanaceae	*Solanum esuriale*	Quena	FG	0.2	10		
Solanaceae	*Solanum nigrum*	Black-berry Nightshade	EX			0.1	30
Verbenaceae	*Phyla canescens*	Lippia	HT	25	200	5	200

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.4 Flora species list – Hartwood vegetation zone 3

Family	Scientific Name	Common Name	Growth Form	JR12 C	JR12 A
Amaranthaceae	*Alternanthera denticulata*	*Lesser Joyweed*	*FG*	*0.2*	*50*
Asteraceae	*Conyza bonariensis*	*Flaxleaf Fleabane*	*EX*	*0.1*	*25*
Boraginaceae	*Echium plantagineum*	*Patterson's Curse*	*EX*	*0.2*	*50*
Chenopodiaceae	*Chenopodium nitrariaceum*	*Nitre Goosefoot*	*SG*	*20*	*19*
Chenopodiaceae	*Einadia nutans*	*Climbing Saltbush*	*FG*	*1*	*80*
Chenopodiaceae	*Sclerolaena muricata*	*Black Rolypoly*	*SG*	*8*	*150*
Euphorbiaceae	*Euphorbia drummondii*	*-*	*FG*	*0.1*	*20*
Goodeniaceae	*Goodenia fascicularis*	*Mallee Goodenia*	*FG*	*0.1*	*2*
Juncaceae	*Juncus amabilis*	*-*	*GG*	*0.1*	*1*
Marsileaceae	*Marsilea drummondii*	*Common Nardoo*	*EG*	*4*	*20*
Myrtaceae	*Eucalyptus largiflorens*	*Black Box*	*TG*	*0.1*	*1*
Poaceae	*Anthosachne scabra*	*Wheatgrass*	*GG*	*0.1*	*10*
Poaceae	*Austrostipa scabra*	*Speargrass*	*GG*	*0.1*	*2*
Poaceae	*Lolium perenne*	*Perennial Ryegrass*	*EX*	*0.1*	*10*
Poaceae	*Paspalidium jubiflorum*	*Warrego Grass*	*GG*	*50*	*400*
Poaceae	*Rytidosperma setaceum*	*Small-flowered Wallaby-grass*	*GG*	*0.1*	*20*
Verbenaceae	*Phyla canescens*	*Lippia*	*HT*	*18*	*60*

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.5 Flora species list – Hartwood vegetation zone 4

Family	Scientific Name	Common Name	Growth Form	12 C	12 A	JR1 C	JR1 A	JR2 C	JR2 A	JR7 C	JR7 A	JR9 C	JR9 A
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed	FG					0.1	2				
Amaranthaceae	*Alternanthera spp.*	Joyweed	FG	1	2								
Asteraceae	*Centipeda minima*		FG			0.4	300						
Asteraceae	*Cirsium vulgare*	Spear Thistle	EX							0.1	1	0.1	1
Asteraceae	*Eclipta platyglossa*	Yellow Twin-heads	FG	3	50								
Asteraceae	*euchiton sphaericus*	Star Cudweed	FG	0.1	2								
Asteraceae	*Lactuca serriola*	Prickly Lettuce	EX	0.1	2								
Asteraceae	*Rhodanthe corymbiflora*	Small White Sunray	FG			0.1	40	0.1	20	0.2	70		
Asteraceae	*Sonchus asper*	Prickly Sowthistle	EX			0.1	8	0.1	3	0.2	30	0.1	10
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	EX	0.1	5								
Asteraceae	*Vittadinia cuneata*	A Fuzzweed	FG	1	15							0.1	2
Asteraceae	*Xanthium occidentale*	Noogoora Burr	HT							0.4	4	0.3	3
Asteraceae	*Xanthium spinosum*	Bathurst Burr	HT	1	30								
Boraginaceae	*Echium plantagineum*	Patterson's Curse	EX							0.3	30	0.1	1
Boraginaceae	*Echium vulgare*	Viper's Bugloss	EX			1	50	0.2	10				
Boraginaceae	*Heliotropium spp.*	A Heliotrope	EX	0.1	1								
Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush	SG	5	20					8	50	5	50
Chenopodiaceae	*Chenopodium nitrariaceum*	Nitre Goosefoot	SG	0.5	1								
Chenopodiaceae	*Maireana spp.*	Cotton Bush, Bluebush, Fissure-weed	SG			0.2	80	0.2	100				
Chenopodiaceae	*Salsola australis*	-	SG	2	50								
Chenopodiaceae	*Sclerolaena divaricata*	Tangled Copperburr	SG							2	10	1	15
Chenopodiaceae	*Sclerolaena muricata*	Black Rolypoly	SG	20	100	0.2	2			8	15	6	80
Convolvulaceae	*Dichondra repens*	Kidney Weed	FG	0.2	10								

Family	Scientific Name	Common Name	Growth Form	12 C	12 A	JR1 C	JR1 A	JR2 C	JR2 A	JR7 C	JR7 A	JR9 C	JR9 A
Crassulaceae	*Crassula spp.*	Stonecrop	EX					0.2	1000				
Cucurbitaceae	*Cucumis myriocarpus*	-	EX	1	10								
Cucurbitaceae	*Cucumis myriocarpus subsp. leptodermis*	Paddy Melon	EX							0.1	40	0.1	8
Cyperaceae	*Eleocharis acuta*	-	GG			10	1000						
Euphorbiaceae	*Chamaesyce drummondii*	Caustic Weed	FG	0.1	2								
Euphorbiaceae	*Euphorbia drummondii*	-	FG			0.1	5	0.1	3			0.1	15
Fabaceae (Faboideae)	*Medicago spp.*	A Medic	EX	0.1	1			3	600	1	500		
Fabaceae (Faboideae)	*Trifolium spp.*	A Clover	EX									5	100
Geraniaceae	*Erodium cicutarium*	Common Crowfoot	EX					0.1	2				
Iridaceae	*Moraea setifolia*	Thread Iris	EX					0.1	80				
Juncaceae	*Juncus flavidus*	-	GG	0.1	3								
Malvaceae	*Sida cunninghamii*	Ridge Sida	FG					0.1	7				
Marsileaceae	*Marsilea drummondii*	Common Nardoo	EG			25	1000	5	400				
Myrtaceae	*Eucalyptus largiflorens*	Black Box	TG					0.1	1				
Oxalidaceae	*Oxalis perennans*	-	FG	0.1	5							0.2	40
Poaceae	*Avena fatua*	Wild Oats	EX	0.1	5	0.1	18	0.1	15	1	50	0.2	20
Poaceae	*Bromus diandrus*	Great Brome	HT							4	250		
Poaceae	*Cenchrus clandestinus*	Kikuyu Grass	EX	10	7								
Poaceae	*Chloris truncata*	Windmill Grass	GG	0.2	10			1	60	3	40	0.4	30
Poaceae	*Enteropogon acicularis*	Curly Windmill Grass	GG	3	30								
Poaceae	*Hordeum leporinum*	Barley Grass	EX							75	1000	70	1000
Poaceae	*Hordeum spp.*	A Barley Grass	EX	0.1	5								
Poaceae	*Lolium perenne*	Perennial Ryegrass	EX			80	1000	50	1000	90	1000	80	1000
Poaceae	*Panicum effusum*	Hairy Panic	GG			15	150	0.2	30	25	150		

Family	Scientific Name	Common Name	Growth Form	12 C	12 A	JR1 C	JR1 A	JR2 C	JR2 A	JR7 C	JR7 A	JR9 C	JR9 A
Poaceae	*Phalaris Paradoxa*	Paradoxa Grass	EX			0.1	20						
Poaceae	*Poaceae sp.*		GG	0.1	1								
Poaceae	*Rytidosperma setaceum*	Small-flowered Wallaby-grass	GG	5	10								
Poaceae	*Walwhalleya proluta*		GG	1	20								
Polygonaceae	*Duma florulenta*	Lignum	SG			5	6						
Polygonaceae	*Polygonum aviculare*	Wireweed	EX	1	10								
Polygonaceae	*Rumex brownii*	Swamp Dock	FG	0.1	3								
Solanaceae	*Solanum esuriale*	Quena	FG	0.5	20								
Solanaceae	*Solanum nigrum*	Black-berry Nightshade	EX	0.2	1								
Verbenaceae	*Phyla nodiflora*	Carpet Weed	HT			40	600	20	500				

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.6 Flora species list – Hartwood vegetation zone 5

Family	Scientific Name	Common Name	Growth Form	F14 C	F14 A	F15 C	F15 A
Asteraceae	*Calotis scapigera*	Tufted Burr-daisy	FG	1	200		
Asteraceae	*Lactuca serriola*	Prickly Lettuce	EX			0.1	3
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	EX	0.1	4		
Asteraceae	*Vittadinia cuneata*	A Fuzzweed	FG	0.1	1		
Boraginaceae	*Echium plantagineum*	Patterson's Curse	EX			0.1	5
Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush	SG	0.5	5		
Chenopodiaceae	*Chenopodium nitrariaceum*	Nitre Goosefoot	SG			0.1	1
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	FG	1	50	1	50
Chenopodiaceae	*Maireana decalvans*	Black Cotton Bush	SG	0.1	2		
Chenopodiaceae	*Salsola australis*	-	SG	0.5	20		
Chenopodiaceae	*Sclerolaena muricata*	Black Rolypoly	SG	0.5	20		
Chenopodiaceae	*Sclerolaena stelligera*	Star Copperburr	SG	0.1	2		

Family	Scientific Name	Common Name	Growth Form	F14 C	F14 A	F15 C	F15 A
Convolvulaceae	*Convolvulus erubescens*	Pink Bindweed	OG			0.1	2
Fabaceae (Mimosoideae)	*Acacia stenophylla*	River Cooba	TG	0.5	20		
Haloragaceae	*Haloragis aspera*	Rough Raspwort	FG			0.5	100
Lamiaceae	*Marrubium vulgare*	White Horehound	EX	0.1	10	3	100
Lamiaceae	*Teucrium racemosum*	Grey Germander	FG	0.1	10	0.1	1
Malvaceae	*Sida trichopoda*	High Sida	FG	0.1	1	0.1	2
Myrtaceae	*Eucalyptus largiflorens*	Black Box	TG	15	2	8	2
Nyctaginaceae	*Boerhavia dominii*	Tarvine	FG	0.1	5	0.1	3
Poaceae	*Austrostipa aristiglumis*	Plains Grass	GG			2	100
Poaceae	*Austrostipa scabra*	Speargrass	GG	10	300	2	100
Poaceae	*Avena fatua*	Wild Oats	EX	1	100	20	1000
Poaceae	*Bromus diandrus*	Great Brome	HT			20	1000
Poaceae	*Enteropogon acicularis*	Curly Windmill Grass	GG	1	50	1	50
Poaceae	*Lolium rigidum*	Wimmera Ryegrass	EX	40	1000		
Poaceae	*Paspalidium jubiflorum*	Warrego Grass	GG	10	200	15	250
Poaceae	*Poaceae spp.*	-	GG			10	1000
Poaceae	*Rytidosperma setaceum*	Small-flowered Wallaby-grass	GG			10	400
Poaceae	*Sporobolus caroli*	Fairy Grass	GG			0.1	5
Polygonaceae	*Duma florulenta*	Lignum	SG	6	10	1	1
Polygonaceae	*Rumex brownii*	Swamp Dock	FG			0.1	2
Solanaceae	*Solanum esuriale*	Quena	FG	0.1	1		
Verbenaceae	*Phyla canescens*	Lippia	HT	1	200		

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.7 Flora species list – Hartwood vegetation zone 6

Family	Scientific Name	Common Name	Growth Form	10 C	10 A	K1 C	K1 A
Asteraceae	Calotis scabiosifolia	Rough Burr-daisy	FG			0.1	20
Asteraceae	Chrysocephalum apiculatum	Common Everlasting	FG			0.1	3
Asteraceae	Cotula bipinnata	Ferny Cotula	EX			0.2	100
Asteraceae	Hyalosperma semisterile		FG	3	200		
Asteraceae	Leiocarpa panaetioides	Wooly Buttons	FG			0.2	25
Asteraceae	Leucochrysum molle	Hoary Sunray	FG			1	2000
Asteraceae	Rhodanthe corymbiflora	Small White Sunray	FG			0.1	10
Asteraceae	Sonchus oleraceus	Common Sowthistle	EX			0.1	1
Asteraceae	Vittadinia cuneata	A Fuzzweed	FG	2	30	0.1	7
Chenopodiaceae	Atriplex semibaccata	Creeping Saltbush	SG	1	10	0.1	1
Chenopodiaceae	Atriplex sp.	A Saltbush	SG			0.1	1
Chenopodiaceae	Chenopodiaceae sp.	Goosefoot, Crumbweed	FG			0.1	1
Chenopodiaceae	Enchylaena tomentosa	Ruby Saltbush	SG			0.1	20
Chenopodiaceae	Maireana decalvans	Black Cotton Bush	SG	0.5	20		
Chenopodiaceae	Maireana spp.	Cotton Bush, Bluebush, Fissure-weed	SG	3	200		
Chenopodiaceae	Salsola australis		SG			0.1	20
Chenopodiaceae	Salsola tragus	Buckbush,Soft Rolpoly, Saltwort	SG	0.5	30		
Chenopodiaceae	Sclerolaena muricata var muria	Black Rolypoly	SG			0.1	5
Chenopodiaceae	Sclerolaena stelligera	Star Copperburr	SG	0.1	2		
Crassulaceae	Crassula decumbens	Spreading Stonecrop	FG			0.1	2000
Crassulaceae	Crassula tetramera		FG			0.1	500
Euphorbiaceae	Chamaesyce drummondii	Caustic Weed	FG			0.1	5
Fabaceae (Faboideae)	Medicago polymorpha	Burr Medic	EX			0.2	200
Fabaceae (Faboideae)	Medicago truncatula	Barrel Medic	EX			15	2000
Fabaceae (Mimosoideae)	Acacia stenophylla	River Cooba	TG	0.1	1		

Family	Scientific Name	Common Name	Growth Form	10 C	10 A	K1 C	K1 A
Goodeniaceae	Goodenia pusilliflora		FG			0.1	300
Goodeniaceae	Goodenia spp.		FG	0.1	5		
Iridaceae	Romulea sp.	0	EX			0.1	200
Iridaceae	Romulea spp.		EX	0.1	20		
Malvaceae	Sida trichopoda	High Sida	FG	0.2	10		
Poaceae	Aria sp.	A Hairgrass	EX			3	2000
Poaceae	Austrostipa scabra	Speargrass	GG	5	50	1	10
Poaceae	Avena fatua	Wild Oats	EX	0.1	2		
Poaceae	Chloris truncata	Windmill Grass	GG	15	2	5	300
Poaceae	Enteropogon acicularis	Curly Windmill Grass	GG	8	150	5	200
Poaceae	Hordeum sp.	A Barley Grass	EX			0.1	1
Poaceae	Lolium sp.	A Ryegrass	EX			15	10000
Poaceae	Panicum spp.	Panicum	GG	1	20		
Poaceae	Rytidosperma setaceum	Small-flowered Wallaby-grass	GG	10	500	15	1000
Poaceae	Sporobolus caroli	Fairy Grass	GG	15	250		
Poaceae	Walwhalleya proluta		GG	20	500		
Polygonaceae	Duma horrida subsp. Horrida		SG	1	2		
Rutaceae	Leionema sp.		SG	0.2	2		
Solanaceae	Solanum esuriale	Quena	FG	0.1	1		

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.8 Flora species list – Hartwood vegetation zone 7

Family	Scientific Name	Common Name	Growth Form	11 C	11 A	F16 C	F16 A	J8 C	J8 A
Amaranthaceae	*Ptilotus spp.*		FG			0.1	1		
Asteraceae		White asteracea sp.						0.2	200
Asteraceae	*Brachyscome multifida*	Cut-leaved Daisy	FG					0.2	500
Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting	FG					0.4	200
Asteraceae	*Chrysocephalum spp.*		FG					0.2	500
Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane	EX	0.1	3				
Asteraceae	*Leiocarpa panaetioides*	Wooly Buttons	FG	0.1	1	0.1	4		
Asteraceae	*Leiocarpa semicalva subsp. semicalva*		FG					0.2	20
Asteraceae	*Sonchus asper*	Prickly Sowthistle	EX			0.1	6		
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	EX	0.1	5				
Asteraceae	*Vittadinia cuneata*	A Fuzzweed	FG	0.1	2	0.1	2	0.1	100
Boraginaceae	*Echium plantagineum*	Patterson's Curse	EX	0.1	1			0.1	40
Chenopodiaceae	*Atriplex leptocarpa*	Slender-fruit Saltbush	SG	0.2	1				
Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush	SG	2	20	0.5	10	0.1	20
Chenopodiaceae	*Chenopodium spp.*	Goosefoot, Crumbweed	EX					0.1	2
Chenopodiaceae	*Dissocarpus paradoxus*	Cannonball Burr	SG					0.1	10
Chenopodiaceae	*Enchylaena tomentosa*	Ruby Saltbush	SG					0.1	50
Chenopodiaceae	*Maireana aphylla*	Cotton Bush	SG					0.1	2
Chenopodiaceae	*Maireana coronata*	Crown Fissure-weed	SG	0.1	1				
Chenopodiaceae	*Maireana decalvans*	Black Cotton Bush	SG	1	40	0.3	50	0.1	5
Chenopodiaceae	*Maireana sclerolaenoides*		SG	0.1	1				
Chenopodiaceae	*Salsola australis*		SG	0.1	5	0.5	20	0.2	70
Chenopodiaceae	*Sclerolaena muricata*	Black Rolypoly	SG	0.1	1	0.2	30		

Family	Scientific Name	Common Name	Growth Form	11 C	11 A	F16 C	F16 A	J8 C	J8 A
Chenopodiaceae	*Sclerolaena stelligera*	Star Copperburr	SG	0.1	1	0.2	40		
Convolvulaceae	*Convolvulus spp.*	A Bindweed	EX	0.1	1				
Euphorbiaceae	*Chamaesyce drummondii*	Caustic Weed	FG	0.1	10	0.1	1		
Euphorbiaceae	*Euphorbia drummondii*		FG					0.1	50
Fabaceae (Faboideae)	*Trifolium subterraneum*	Subterranean Clover	EX					8	1500
Iridaceae	*Romulea rosea*		EX					0.2	1000
Juncaceae	*Juncus flavidus*		GG	0.1	2				
Malvaceae	*Sida corrugata*	Corrugated Sida	FG					0.1	20
Malvaceae	*Sida fibulifera*	Pin Sida	FG	0.5	10				
Malvaceae	*Sida filiformis*		FG	0.1	1				
Malvaceae	*Sida trichopoda*	High Sida	FG			0.1	1		
Nyctaginaceae	*Boerhavia dominii*	Tarvine	FG					0.1	70
Oxalidaceae	*Oxalis perennans*		FG	0.1	10				
Poaceae	*Aira spp.*	A Hairgrass	EX					0.2	50
Poaceae	*Austrostipa scabra*	Speargrass	GG			5	200	0.1	50
Poaceae	*Austrostipa spp.*	A Speargrass	GG	3	100				
Poaceae	*Avena fatua*	Wild Oats	EX	0.1	10				
Poaceae	*Bothriochloa macra*	Red Grass	GG	15	100				
Poaceae	*Chloris truncata*	Windmill Grass	GG	1	20	20	1000	20	300
Poaceae	*Chloris virgata*	Feathertop Rhodes Grass	EX	2	10				
Poaceae	*Enteropogon acicularis*	Curly Windmill Grass	GG	50	300	40	1000	10	100
Poaceae	*Eriochloa pseudoacrotricha*	Early Spring Grass	GG	2	50				
Poaceae	*Lolium rigidum*	Wimmera Ryegrass	EX					10	1000
Poaceae	*Panicum decompositum*	Native Millet	GG			20	1000		
Poaceae	*Panicum spp.*	Panicum	GG					1	100

Family	Scientific Name	Common Name	Growth Form	11 C	11 A	F16 C	F16 A	J8 C	J8 A
Poaceae	*Paspalum dilatatum*	Paspalum	HT	5	100				
Poaceae	*Poa annua*	Winter Grass	EX					2	200
Poaceae	*Rytidosperma setaceum*	Small-flowered Wallaby-grass	GG	5	100				
Poaceae	*Rytidosperma spp.*		GG			5	200	0.5	20
Poaceae	*Sporobolus caroli*	Fairy Grass	GG	5	200	5	200		
Poaceae	*Walwhalleya proluta*		GG	5	50				
Polygonaceae	*Rumex crispus*	Curled Dock	EX	2	30				
Rubiaceae	*Asperula conferta*	Common Woodruff	FG					0.1	50
Solanaceae	*Solanum esuriale*	Quena	FG	1	50	0.1	1	0.1	50

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.9 Flora species list – Hartwood vegetation zone 8

Family	Scientific Name	Common Name	Growth Form	JR8 C	JR8 A
Asteraceae	*Pseudognaphalium luteoalbum*	Jersey Cudweed	FG	0.1	1
Asteraceae	*Sonchus asper*	Prickly Sowthistle	EX	0.1	5
Brassicaceae	*Rorippa palustris*	Yellow Cress	EX	0.3	5
Euphorbiaceae	*Euphorbia drummondii*		FG	0.1	3
Fabaceae (Faboideae)	*Medicago spp.*	A Medic	EX	0.5	100
Oxalidaceae	*Oxalis perennans*		FG	0.2	40
Poaceae	*Austrostipa scabra*	Speargrass	GG	2	40
Poaceae	*Avena fatua*	Wild Oats	EX	40	500
Poaceae	*Chloris truncata*	Windmill Grass	GG	0.4	40
Poaceae	*Hordeum leporinum*	Barley Grass	EX	10	200
Poaceae	*Lolium perenne*	Perennial Ryegrass	EX	3	800
Poaceae	*Panicum effusum*	Hairy Panic	GG	90	800
Solanaceae	*Solanum nigrum*	Black-berry Nightshade	EX	0.1	1

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.19 Flora species list – Wanganella vegetation zone 1

Family	Scientific Name	Common Name	Growth Form	F8	F8
Asteraceae	*Calotis scapigera*	Tufted Burr-daisy	FG	0.1	15
Asteraceae	*Cirsium vulgare*	Spear Thistle	EX	0.1	1
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	EX	0.1	2
Brassicaceae	*Lepidium spp.*	A Peppercress	EX	0.5	100
Campanulaceae	*Wahlenbergia gracilenta*	Annual Bluebell	FG	0.1	8
Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush	SG	0.1	1
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	FG	6	100
Chenopodiaceae	*Enchylaena tomentosa*	Ruby Saltbush	SG	0.2	10
Chenopodiaceae	*Rhagodia spinescens*	Thorny Saltbush	SG	0.2	8
Fabaceae (Mimosoideae)	*Acacia stenophylla*	River Cooba	TG	0.1	4
Malvaceae	*Sida trichopoda*	High Sida	FG	0.1	3
Myrtaceae	*Eucalyptus camaldulensis*	Eucalyptus camaldulensis population in the Hunter catchment	TG	40	12
Myrtaceae	*Eucalyptus largiflorens*	Black Box	TG	2	3
Oxalidaceae	*Oxalis perennans*		FG	0.1	3
Poaceae	*Bromus spp.*	A Brome	GG	2	200
Poaceae	*Sporobolus caroli*	Fairy Grass	GG	1	50
Polygonaceae	*Rumex brownii*	Swamp Dock	FG	0.1	3

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.10 Flora species list – Wanganella vegetation zone 2

Family	Scientific Name	Common Name	Growth Form	F6 C	F6 A	JR5 C	JR5 A
	Unidentified Forb					5	150
Asteraceae	*Centipeda minima subsp. minima*	spreading sneezeweed	FG			20	1000
Asteraceae	*Conyza spp.*	A Fleabane	EX			0.3	50
Asteraceae	*Lactuca serriola*	Prickly Lettuce	EX	0.1	1		
Asteraceae	*Pseudognaphalium luteoalbum*	Jersey Cudweed	FG			7	500
Asteraceae	*Sonchus asper*	Prickly Sowthistle	EX			0.4	80
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	EX	0.1	1		
Asteraceae	*Vittadinia cuneata*	A Fuzzweed	FG	0.1	2		
Brassicaceae	*Lepidium africanum*	Common Peppercress	EX			0.1	1
Brassicaceae	*Lepidium spp.*	A Peppercress	EX	0.1	1		
Brassicaceae	*Rorippa palustris*	Yellow Cress	EX			0.1	1
Campanulaceae	*Wahlenbergia spp.*	Bluebell	FG	0.1	1		
Chenopodiaceae	*Chenopodium album*	Fat Hen	EX			0.2	10
Chenopodiaceae	*Chenopodium nitrariaceum*	Nitre Goosefoot	SG	1	4		
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	FG	0.2	20	6	250
Chenopodiaceae	*Enchylaena tomentosa*	Ruby Saltbush	SG	1	10		
Chenopodiaceae	*Rhagodia spinescens*	Thorny Saltbush	SG	2	25		
Chenopodiaceae	*Sclerolaena muricata*	Black Rolypoly	SG			7	50
Chenopodiaceae	*Sclerolaena sp. A*		Unknown			0.1	5
Fabaceae (Faboideae)	*Medicago spp.*	A Medic	EX			4	1000
Fabaceae (Mimosoideae)	*Acacia salicina*	Cooba	TG	10	30		
Iridaceae	*Romulea rosea var. australis*		EX			0.1	80
Lamiaceae	*Teucrium racemosum*	Grey Germander	FG	0.2	30		
Myrtaceae	*Eucalyptus camaldulensis*	River Red Gum	TG	10	2	8	2
Myrtaceae	*Eucalyptus largiflorens*	Black Box	TG	15	3	15	11
Nyctaginaceae	*Boerhavia dominii*	Tarvine	FG	0.1	2		

Family	Scientific Name	Common Name	Growth Form	F6 C	F6 A	JR5 C	JR5 A
Oxalidaceae	*Oxalis perennans*		FG	0.1	5	0.1	20
Poaceae	*Austrostipa nodosa*	A Speargrass	GG			0.1	1
Poaceae	*Austrostipa scabra*	Speargrass	GG	0.1	10		
Poaceae	*Avena fatua*	Wild Oats	EX	0.5	20		
Poaceae	*Bromus diandrus*	Great Brome	HT	30	1000		
Poaceae	*Enteropogon acicularis*	Curly Windmill Grass	GG	2	100		
Poaceae	*Hordeum leporinum*	Barley Grass	EX	2	100		
Poaceae	*Lolium perenne*	Perennial Ryegrass	EX			0.1	3
Poaceae	*Paspalidium jubiflorum*	Warrego Grass	GG	0.5	20		
Poaceae	*Paspalidium spp.*		GG	1	100		
Poaceae	*Rytidosperma setaceum*	Small-flowered Wallaby-grass	GG	0.2	20		
Polygonaceae	*Duma florulenta*	Lignum	SG	0.2	2		
Polygonaceae	*Persicaria maculosa*	Redshank	EX			0.3	8
Polygonaceae	*Polygonum aviculare*	Wireweed	EX	0.1	1		
Polygonaceae	*Rumex brownii*	Swamp Dock	FG	0.1	2		
Polygonaceae	*Rumex spp.*	Dock	FG			1	30
Portulacaceae	*Portulaca oleracea*	Pigweed	FG			0.2	20
Scrophulariaceae	*Glossostigma spp.*		FG			0.5	50
Solanaceae	*Solanum nigrum*	Black-berry Nightshade	EX			0.2	10
Verbenaceae	*Verbena africana*		EX			6	400
Verbenaceae	*Verbena supina*	Trailing Verbena	EX			5	600

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.11 Flora species list – Wanganella vegetation zone 3

Family	Scientific Name	Common Name	Growth Form	F7 C	F7 A	JR6 C	JR6 A
Aizoaceae	*Mesembryanthemum crystallinum*	Common Ice Plant	EX			5	400
Aizoaceae	*Tetragonia tetragonioides*	New Zealand Spinach	FG			85	800
Asteraceae	*Arctotheca calendula*	Capeweed	EX			0.1	20
Asteraceae	*Calotis Cuneifolia*	Purple Burr-Daisy	FG			0.3	15
Asteraceae	*Cirsium vulgare*	Spear Thistle	EX			0.1	1
Asteraceae	*Hypochaeris glabra*	Smooth Catsear	EX			0.1	2
Asteraceae	*Pseudognaphalium luteoalbum*	Jersey Cudweed	FG			2	100
Asteraceae	*Rhodanthe corymbiflora*	Small White Sunray	FG			0.1	10
Asteraceae	*Sonchus asper*	Prickly Sowthistle	EX			0.2	25
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	EX	0.1	1		
Boraginaceae	*Echium plantagineum*	Patterson's Curse	EX			0.2	20
Brassicaceae	*Lepidium africanum*	Common Peppercress	EX	0.1	1		
Brassicaceae	*Sisymbrium spp.*		EX			10	150
Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush	SG	0.2	5	5	200
Chenopodiaceae	*Chenopodium nitrariaceum*	Nitre Goosefoot	SG	6	15	12	60
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	FG	0.1	5	7	200
Chenopodiaceae	*Enchylaena tomentosa*	Ruby Saltbush	SG	5	40		
Chenopodiaceae	*Maireana decalvans*	Black Cotton Bush	SG	0.1	2		
Chenopodiaceae	*Maireana spp.*	Cotton Bush, Bluebush, Fissure-weed	SG			0.1	3
Chenopodiaceae	*Rhagodia spinescens*	Thorny Saltbush	SG	10	30		
Chenopodiaceae	*Salsola australis*		SG	0.1	2		
Chenopodiaceae	*Sclerolaena divaricata*	Tangled Copperburr	SG	0.1	1	4	120
Chenopodiaceae	*Sclerolaena muricata*	Black Rolypoly	SG	0.1	1	0.3	5
Chenopodiaceae	*Sclerolaena stelligera*	Star Copperburr	SG	0.1	1		
Crassulaceae	*Crassula spp.*	Stonecrop	EX			1	1000
Cucurbitaceae	*Citrullus amarus*		EX			2	80

Family	Scientific Name	Common Name	Growth Form	F7 C	F7 A	JR6 C	JR6 A
Cucurbitaceae	*Cucumis myriocarpus subsp. leptodermis*	Paddy Melon	EX			1	60
Fabaceae (Faboideae)	*Medicago spp.*	A Medic	EX			0.3	300
Fabaceae (Mimosoideae)	*Acacia salicina*	Cooba	TG	0.1	1		
Malvaceae	*Malva parviflora*	Small-flowered Mallow	EX			0.1	15
Malvaceae	*Sida trichopoda*	High Sida	FG	0.1	3		
Myrtaceae	*Eucalyptus camaldulensis*	River Red Gum	TG	30	1		
Myrtaceae	*Eucalyptus largiflorens*	Black Box	TG			45	4
Nyctaginaceae	*Boerhavia dominii*	Tarvine	FG	0.1	5		
Oxalidaceae	*Oxalis perennans*		FG			0.1	40
Oxalidaceae	*Oxalis spp.*		FG	0.1	2		
Poaceae	*Aira spp.*	A Hairgrass	EX			0.1	20
Poaceae	*Austrostipa nodosa*	A Speargrass	GG			0.1	2
Poaceae	*Austrostipa scabra*	Speargrass	GG	5	200		
Poaceae	*Bromus diandrus*	Great Brome	HT			0.1	5
Poaceae	*Bromus molliformis*	Soft Brome	EX	2	100		
Poaceae	*bromus rubens*	Red Brome	EX			3	200
Poaceae	*Enteropogon acicularis*	Curly Windmill Grass	GG	0.5	30		
Poaceae	*Hordeum leporinum*	Barley Grass	EX	2	100	20	800
Poaceae	*Lolium perenne*	Perennial Ryegrass	EX			0.3	100
Poaceae	*Rytidosperma setaceum*	Small-flowered Wallaby-grass	GG	5	200		
Poaceae	*Vulpia spp.*	Rat's-tail Fescue	EX	0.2	20		
Polygonaceae	*Duma florulenta*	Lignum	SG	0.5	1		
Polygonaceae	*Persicaria maculosa*	Redshank	EX			5	350
Solanaceae	*Solanum esuriale*	Quena	FG	0.1	5		
Solanaceae	*Solanum nigrum*	Black-berry Nightshade	EX			0.8	35

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.12 Flora species list – Wanganella vegetation zone 4

Family	Scientific Name	Common Name	Growth Form	JR3 C	JR3 A	JR4 C	JR4 A
Aizoaceae	*Tetragonia tetragonioides*	New Zealand Spinach	FG			0.1	1
Amaranthaceae	*Ptilotus spathulatus f. spathulatus*	Pussy-tails	FG	0.1	20		
Asteraceae	*Arctotheca calendula*	Capeweed	EX	0.1	30	0.2	50
Asteraceae	*Calotis Cuneifolia*	Purple Burr-Daisy	FG			1	30
Asteraceae	*Craspedia globosa*		FG	0.1	2	0.1	1
Asteraceae	*Rhodanthe corymbiflora*	Small White Sunray	FG	0.1	7	0.1	30
Asteraceae	*rhodanthe diffusa subsp. Leucactina*		FG	0.1	10		
Asteraceae	*Vittadinia cuneata*	A Fuzzweed	FG	7	300	4	100
Asteraceae	*xerochrysum bracteatum*	Golden Everlasting	FG	0.1	2		
Boraginaceae	*Echium plantagineum*	Patterson's Curse	EX			0.1	3
Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush	SG	1	20	0.1	10
Chenopodiaceae	*Maireana brevifolia*		SG			0.1	1
Chenopodiaceae	*Maireana spp.*	Cotton Bush, Bluebush, Fissure-weed	SG			10	1000
Chenopodiaceae	*Rhagodia spinescens*	Thorny Saltbush	SG	2	5		
Chenopodiaceae	*Sclerolaena diacantha*	Grey Copperburr	SG	0.5	100	0.1	5
Chenopodiaceae	*Sclerolaena muricata*	Black Rolypoly	SG	4	100	12	60
Chenopodiaceae	*Sclerolaena spp.*	Copperburr, Poverty-bush	SG			0.1	1
Crassulaceae	*Crassula colorata*	Dense Stonecrop	FG	0.2	500		
Fabaceae (Faboideae)	*Medicago spp.*	A Medic	EX	3	1000	0.3	300
Fabaceae (Faboideae)	*Trifolium arvense*	Haresfoot Clover	EX			1	300
Iridaceae	*Moraea setifolia*	Thread Iris	EX	0.1	150		
Malvaceae	*Sida cunninghamii*	Ridge Sida	FG	0.1	5	0.1	2
Oxalidaceae	*Oxalis perennans*		FG	0.1	10		
Poaceae	*Austrostipa nodosa*	A Speargrass	GG	50	700	60	700
Poaceae	*Avena fatua*	Wild Oats	EX			0.1	10

Family	Scientific Name	Common Name	Growth Form	JR3 C	JR3 A	JR4 C	JR4 A
Poaceae	*bromus rubens*	Red Brome	EX	5	700	0.1	50
Poaceae	*Chloris truncata*	Windmill Grass	GG	6	200	7	250
Poaceae	*Hordeum leporinum*	Barley Grass	EX	0.2	30	10	400
Poaceae	*Lolium perenne*	Perennial Ryegrass	EX	0.4	100		
Poaceae	*Panicum spp.*	Panicum	GG			0.1	1
Poaceae	*rytidosperma auriculatum*	Lobed Wallaby Grass	GG	5	600	10	350
Poaceae	*Rytidosperma caespitosum*	Ringed Wallaby Grass	GG	0.5	50	0.5	100
Poaceae	*Rytidosperma setaceum*	Small-flowered Wallaby-grass	GG			1	150
Poaceae	*vulpia myuros*	Rat's Tail Fescue	EX	0.1	400	8	1000

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.13 Flora species list – Wanganella vegetation zone 5

Family	Scientific Name	Common Name	Growth Form	3 C	3 A	F5 C	F5 A
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed	FG	0.1	5		
Asteraceae	*Cirsium vulgare*	Spear Thistle	EX			0.1	1
Asteraceae	*Sonchus asper*	Prickly Sowthistle	EX	0.1	50		
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	EX	0.5	50		
Asteraceae	*Vittadinia cuneata*	A Fuzzweed	FG			0.1	1
Boraginaceae	*Heliotropium europaeum*		EX	0.1	1	0.2	10
Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush	SG	1	20	0.1	1
Chenopodiaceae	*Chenopodium nitrariaceum*	Nitre Goosefoot	SG			0.1	1
Chenopodiaceae	*Enchylaena tomentosa*	Ruby Saltbush	SG	0.5	25		
Chenopodiaceae	*Maireana aphylla*	Cotton Bush	SG			0.1	1
Chenopodiaceae	*Maireana decalvans*	Black Cotton Bush	SG	0.1	1	1	30
Chenopodiaceae	*Maireana spp.*	Cotton Bush, Bluebush, Fissure-weed	SG			0.1	5
Chenopodiaceae	*Rhagodia spinescens*	Thorny Saltbush	SG	0.2	1	0.1	1
Chenopodiaceae	*Salsola australis*		SG			0.1	2
Chenopodiaceae	*Sclerolaena divaricata*	Tangled Copperburr	SG			0.1	4

Family	Scientific Name	Common Name	Growth Form	3 C	3 A	F5 C	F5 A
Chenopodiaceae	*Sclerolaena muricata var. muricata*	Black Rolypoly	SG	0.1	1		
Chenopodiaceae	*Sclerolaena muricata var. semiglabra*	Black Rolypoly	SG	1	30		
Chenopodiaceae	*Sclerolaena stelligera*	Star Copperburr	SG	0.1	3		
Convolvulaceae	*Convolvulus erubescens*	Pink Bindweed	OG			0.1	1
Cucurbitaceae	*Cucumis myriocarpus*		EX	0.1	5		
Cyperaceae	*Eleocharis obicis*	Spike-Rush	GG	0.1	2		
Euphorbiaceae	*Chamaesyce drummondii*	Caustic Weed	FG	1	200	0.2	30
Euphorbiaceae	*Chamaesyce spp.*		FG			0.1	10
Euphorbiaceae	*Euphorbia planiticola*	Plains Spurge	FG	0.1	1		
Fabaceae (Faboideae)	*Medicago minima*	Woolly Burr Medic	EX	0.1	1		
Fabaceae (Faboideae)	*Medicago spp.*	A Medic	EX			0.1	20
Fabaceae (Faboideae)	*Trifolium spp.*	A Clover	EX			0.1	1
Goodeniaceae	*Goodenia glauca*	Pale Goodenia	FG	0.1	10		
Iridaceae	*Romulea rosea var. australis*		EX			0.1	10
Juncaceae	*Juncus flavidus*		GG	0.2	10		
Lobeliaceae	*Lobelia spp.*		FG	0.1	10		
Malvaceae	*Sida corrugata*	Corrugated Sida	FG			0.1	1
Malvaceae	*Sida spp.*		EX	0.1	1		
Malvaceae	*Sida trichopoda*	High Sida	FG	0.1	15	2	200
Nyctaginaceae	*Boerhavia dominii*	Tarvine	FG	0.2	10	0.2	20
Oxalidaceae	*Oxalis perennans*		FG	0.1	10	0.1	3
Poaceae	*Austrostipa scabra*	Speargrass	GG	0.5	10	20	500
Poaceae	*Austrostipa spp.*	A Speargrass	GG			2	100
Poaceae	*Avena fatua*	Wild Oats	EX	0.5	10	1	50
Poaceae	*Chloris truncata*	Windmill Grass	GG	0.1	20		
Poaceae	*Enteropogon acicularis*	Curly Windmill Grass	GG	80	500	30	600

Family	Scientific Name	Common Name	Growth Form	3 C	3 A	F5 C	F5 A
Poaceae	*Eriochloa pseudoacrotricha*	Early Spring Grass	GG	0.1	4		
Poaceae	*Hordeum leporinum*	Barley Grass	EX			10	400
Poaceae	*Lolium rigidum*	Wimmera Ryegrass	EX			5	200
Poaceae	*Rytidosperma caespitosum*	Ringed Wallaby Grass	GG	0.1	2		
Poaceae	*Rytidosperma setaceum*	Small-flowered Wallaby-grass	GG	2	100	2	50
Poaceae	*Rytidosperma spp.*		GG			0.5	30
Poaceae	*Sporobolus caroli*	Fairy Grass	GG	0.1	10	2	100
Poaceae	*Walwhalleya proluta*		GG	5	100		
Polygonaceae	*Polygonum aviculare*	Wireweed	EX	0.3	30	0.1	2
Solanaceae	*Solanum esuriale*	Quena	FG	1	50	0.1	2

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Table C.14 Flora species list – Wanganella vegetation zone 6

Family	Scientific Name	Common Name	Growth Form	2 C	2 A
Amaranthaceae	*Alternanthera denticulata*	Lesser Joyweed	FG	0.1	5
Asteraceae	*Centipeda minima*		FG	0.1	5
Asteraceae	*Sonchus oleraceus*	Common Sowthistle	EX	0.1	3
Boraginaceae	*Echium plantagineum*	Patterson's Curse	EX	0.1	2
Boraginaceae	*Heliotropium europaeum*		EX	0.1	1
Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush	SG	0.1	5
Chenopodiaceae	*Chenopodium nitrariaceum*	Nitre Goosefoot	SG	20	15
Chenopodiaceae	*Dysphania pumilio*	Small Crumbweed	FG	0.1	1
Chenopodiaceae	*Einadia nutans*	Climbing Saltbush	FG	0.1	2
Chenopodiaceae	*Enchylaena tomentosa*	Ruby Saltbush	SG	0.5	20
Chenopodiaceae	*Maireana decalvans*	Black Cotton Bush	SG	0.2	10
Chenopodiaceae	*Sclerolaena muricata*	Black Rolypoly	SG	1	10
Chenopodiaceae	*Sclerolaena muricata var. muricata*	Black Rolypoly	SG	0.5	20
Chenopodiaceae	*Sclerolaena stelligera*	Star Copperburr	SG	0.1	1

Family	Scientific Name	Common Name	Growth Form	2 C	2 A
Cucurbitaceae	*Cucumis myriocarpus*		EX	0.1	1
Euphorbiaceae	*Chamaesyce drummondii*	Caustic Weed	FG	0.3	100
Euphorbiaceae	*Euphorbia planiticola*	Plains Spurge	FG	0.1	5
Fabaceae (Faboideae)	*Medicago polymorpha*	Burr Medic	EX	0.1	5
Fabaceae (Faboideae)	*Trifolium spp.*	A Clover	EX	0.1	10
Fabaceae (Mimosoideae)	*Acacia salicina*	Cooba	TG	0.1	1
Goodeniaceae	*Goodenia glauca*	Pale Goodenia	FG	0.2	50
Malvaceae	*Sida corrugata*	Corrugated Sida	FG	0.1	1
Malvaceae	*Sida filiformis*		FG	0.3	10
Malvaceae	*Sida trichopoda*	High Sida	FG	0.5	20
Nyctaginaceae	*Boerhavia dominii*	Tarvine	FG	3	100
Oxalidaceae	*Oxalis perennans*		FG	0.1	20
Poaceae	*Austrostipa scabra*	Speargrass	GG	1	30
Poaceae	*Chloris truncata*	Windmill Grass	GG	0.1	2
Poaceae	*Enteropogon acicularis*	Curly Windmill Grass	GG	20	200
Poaceae	*Walwhalleya proluta*		GG	1	10
Polygonaceae	*Polygonum aviculare*	Wireweed	EX	0.5	15
Portulacaceae	*Portulaca oleracea*	Pigweed	FG	0.1	2
Solanaceae	*Solanum esuriale*	Quena	FG	5	200

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines), C=Cover, A=Abundance.

Appendix D

Vegetation integrity plot data

Table D.1 Hartwood vegetation integrity plots – Composition and structure data

Veg zone	PCT	Condition	Plot	Composition (number of species)							Structure (% cover)					
				TG	SG	GG	FG	EG	OG	Total	TG	SG	GG	FG	EG	OG
	7		**Benchmark**	**2**	**2**	**6**	**11**	**0**	**0**	**21**	**15**	**0**	**60**	**11**	**0**	**0**
1	7	Moderate	1	3	2	1	10	0	0	16	58	0.2	35	26.6	0	0
	10		**Benchmark**	**2**	**2**	**6**	**11**	**0**	**0**	**21**	**15**	**0**	**60**	**11**	**0**	**0**
2	10	Moderate	9	3	3	7	12	0	0	25	28	1.2	4.7	4.5	0	0
2	10	Moderate	JR_13	3	2	2	4	0	0	11	75.2	0.3	40.3	2.5	0	0
3	10	Shrubland	JR_12	1	2	5	4	1	0	13	0.1	28	50.4	1.4	4	0
	13		**Benchmark**	**2**	**8**	**3**	**11**	**0**	**0**	**24**	**14**	**18**	**4**	**11**	**0**	**0**
4	**13**	DNG	JR_1	0	3	2	3	1	0	9	0	5.4	25	0.6	25	0
4	**13**	DNG	JR_2	1	1	2	4	1	0	9	0.1	0.2	1.2	0.4	5	0
4	**13**	DNG	JR_7	0	3	2	1	0	0	6	0	18	28	0.2	0	0
4	**13**	DNG	JR_9	0	3	1	3	0	0	7	0	12	0.4	0.4	0	0
4	**13**	DNG	12	0	4	5	9	0	0	18	0	27.5	9.3	6.1	0	0
5	**13**	Moderate	F14	2	6	3	7	0	0	18	15.5	7.7	21	2.5	0	0
5	**13**	Moderate	F15	1	2	7	6	0	1	17	8	1.1	40.1	1.9	0	0.1
	44		**Benchmark**	**0**	**4**	**6**	**12**	**0**	**1**	**23**	**0**	**4**	**90**	**11**	**0**	**0**
6	44	Moderate	10	1	7	8	5	0	0	20	0.1	6.3	74	5.4	0	0
6	44	Moderate	K1	0	5	4	11	0	0	20	0	0.5	26	2.2	0	0
	46		**Benchmark**	**0**	**4**	**6**	**12**	**0**	**1**	**23**	**0**	**4**	**90**	**11**	**0**	**0**
7	46	Moderate	F16	0	5	6	6	0	0	17	0	0	92.4	0.4	0	0
7	46	Moderate	11	0	9	9	7	0	0	25	0	1.2	95	0.6	0	0
7	46	Moderate	J8	0	6	5	11	0	0	22	0	0.7	31.6	1.8	0	0
8	46	Poor	JR_8	0	0	3	3	0	0	6	0	0	92.4	0.4	0	0

Notes: TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines).

Table D.2 Hartwood vegetation integrity plots - Function and location data

Veg zone	PCT	Condition	Plot	Large trees	Hollow trees	Litter cover (%)	Fallen logs (m)	Tree DBH 5-10 (cm)	Tree DBH 10-20 (cm)	Tree DBH 20-30 (cm)	Tree DBH 30-50 (cm)	Tree DBH 50-80 (cm)	Tree regen	HTE cover (total)	Zone	Easting	Northing	Bearing
	7	**Benchmark**		**4**		**80**	**92**											
1	7	Moderate	1	5	3	62	3	1	1	1	1	1	1	0.2	55	344341	6091273	280
	10	**Benchmark**		**4**		**80**	**92**											
2	10	Moderate	9	7	5	60	5	0	0	0	1	0	0	25.1	55	344970	6089394	320
2	10	Moderate	JR_13	3	1	96.6	131.5	1	1	1	1	1	1	5.1	55	342671	6089561	232
3	10	Shrubland	JR_12	0	0	40	23	1	0	1	0	0	0	18	55	342664	6089476	19
	13	**Benchmark**		**2**		**40**	**39**											
3	13	DNG	JR_1	0	0	4.4	0	0	0	0	0	0	0	40	55	344309	6091104	209
3	13	DNG	JR_2	0	0	8.2	0	0	0	0	0	0	0	20	55	344282	6091192	284
3	13	DNG	JR_7	0	0	26	0	0	0	0	0	0	0	4.4	55	344826	3910677	290
3	13	DNG	JR_9	0	0	47	0	0	0	0	0	0	0	0.3	55	344945	3910649	185
3	13	DNG	12	0	0	14.5	0	0	0	0	0	0	0	0	55	324676	6091564	243
4	13	Moderate	F14	3	2	48	51.5	1	0	0	0	1	1	1	55	343775	3908891	93
4	13	Moderate	F15	3	3	37	48.5	0	1	1	0	0	1	20	55	342730	3910112	177
	44	**Benchmark**		**0**		**35**	**0**											
5	44	Moderate	10	0	0	62	0	0	0	0	0	0	0	0	55	345021	6089144	200
5	44	Moderate	K1	0	0	8	0	0	0	0	0	0	0	0	55	343901	6090470	93
	46	**Benchmark**		**0**		**35**	**0**											
6	46	Moderate	F16	0	0	0	0	0	0	0	0	0	0	0	55	344077	6090825	308
6	46	Moderate	11	0	0	50	0	0	0	0	0	0	0	5	55	342986	6090233	100
6	46	Moderate	J8	0	0	0	0	0	0	0	0	0	0	0	55	344157	6090790	344
7	46	Low	JR_8	0	0	10	0	0	0	0	0	0	0	0	55	344042	3908959	133

Notes: Function data is not required in BAM-Calculations for PCT 44, 46 or 160 but is presented to inform a general description of the site.
For Tree regen and Tree stem size classes 1 = present, 0 = absent. HTE = High Threat Exotic.

Table D.3 Wanganella vegetation integrity plots-- Composition and structure data

Veg zone	PCT	Condition	Plot	Composition (number of species)							Structure (% cover)					
				TG	SG	GG	FG	EG	OG	Total	TG	SG	GG	FG	EG	OG
	7		**Benchmark**	**2**	**2**	**6**	**11**	**0**	**0**	**21**	**15**	**0**	**60**	**11**	**0**	**0**
1	7	Moderate	F8	3	3	2	6	0	0	14	42.1	0.5	3	6.5	0	0
	10		**Benchmark**	**2**	**2**	**6**	**11**	**0**	**0**	**21**	**15**	**0**	**60**	**11**	**0**	**0**
2	10	Moderate	F6	3	4	5	7	0	0	19	35	4.2	3.8	0.9	0	0
2	10	Moderate	JR_5	2	2	1	8	0	0	13	23	7.1	0.1	39.8	0	0
	13		**Benchmark**	**2**	**8**	**3**	**9**	**0**	**0**	**22**	**15**	**18**	**2**	**8**	**0**	**0**
3	13	DNG	JR_3	0	4	4	9	0	0	17	0	7.5	61.5	7.9	0	0
3	13	DNG	JR_4	0	6	6	6	0	0	18	0	22.4	78.6	5.4	0	0
4	13	Moderate	F7	2	10	3	5	0	0	20	30.1	22.2	10.5	0.5	0	0
4	13	Moderate	JR_6	1	5	1	6	0	0	13	45	21.4	0.1	94.5	0	0
	46		**Benchmark**	**0**	**4**	**6**	**12**	**0**	**1**	**23**	**0**	**4**	**90**	**11**	**0**	**0**
5	46	Moderate	3	0	7	10	9	0	0	26	0	3	88.2	2.8	0	0
5	46	Moderate	F5	0	8	6	8	0	1	23	0	1.7	56.5	2.9	0	0.1
	160		**Benchmark**	**0**	**6**	**3**	**9**	**1**	**0**	**19**	**0**	**21**	**11**	**7**	**0**	**0**
6	160	Moderate	2	1	7	4	14	0	0	26	0.1	22.4	22.1	10.1	0	0

Notes: Benchmark data are Version 1.2 wet year benchmarks. Function data is not required in BAM-Calculations for PCT 131 or PCT 143 but is presented to inform a general description of the site.
TG=Tree growth form group; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other (palms, cycads and vines).

Table D.4 Wanganella vegetation integrity plots – Function and location data

Veg zone	PCT	Condition	Plot	Large trees	Hollow trees	Litter cover (%)	Fallen logs (m)	Tree DBH 5-10 (cm)	Tree DBH 10-20 (cm)	Tree DBH 20-30 (cm)	Tree DBH 30-50 (cm)	Tree DBH 50-80 (cm)	Tree regen	HTE cover (total)	Zone	Easting	Northing	Bearing
	7	**Benchmark**		**4**		**80**	**92**											
1	7	Moderate	F8	7	0	97	1	1	1	1	1	0	0	0	55	300439	6100643	65
	10	**Benchmark**		**4**		**80**	**92**											
2	10	Moderate	F6	4	0	68	9	1	1	1	1	1	1	30	55	300443	6100568	248
2	10	Moderate	JR_5	0	0	10.8	6.5	1	1	1	0	1	1	0	55	300688	3898612	312
	13	**Benchmark**		**2**		**40**	**39**											
3	13	DNG	JR_3	0	0	1.1	0	0	0	0	0	0	0	0	55	300571	3898605	61
3	13	DNG	JR_4	0	0	7.8	0	0	0	0	0	0	0	0	55	300573	3898884	75
4	13	Moderate	F7	2	1	60	4	0	1	1	1	0	0	0	55	300345	6100513	41
4	13	Moderate	JR_6	1	11	33	45	1	1	11	1	1	1	0.1	55	300521	3898588	250
	46	**Benchmark**		**0**		**35**	**0**											
5	46	Moderate	3	0	0	28	0	0	0	0	0	0	0	0	55	301000	6100665	60
5	46	Moderate	F5	0	0	1.8	0	0	0	0	0	0	0	0	55	300442	6100526	232
	160	**Benchmark**		**0**		**30**	**65**											
6	160	Moderate	2	0	0	26	0	1	0	0	0	0	0	0	55	300321	6100537	200

Notes: Function data is not required in BAM-Calculations for PCT 44, 46 or 160 but is presented to inform a general description of the site.
For Tree regen and Tree stem size classes 1 = present, 0 = absent. HTE = High Threat Exotic.

Appendix E

Microbat call analysis results

E-1 Analysis method

Bat calls were recorded during field surveys using Anabat Express Zero Crossing detectors (Titley Scientific).

The zero crossing analysis file (zca file) recorded using the detector was converted to .zc sequence files using Anabat Insight (version 2.0.6-2, Titley Scientific) for analysis and in order to add metadata (e.g. species label etc). During the conversion process maximum file length was set to 10 seconds and a filter was applied to identify bat sequences and remove noise files. Noise files were moved to a separate folder for later checking.

The *Bat calls of NSW: Region based guide to the echolocation calls of microchiropteran bats* (Pennay et al. 2004) was used to assist call analysis. Call identification was also assisted by consulting distribution information for potential species (Pennay et al 2011; Churchill 2008; Van Dyck et al. 2013, ABS 2022) and records from BioNet (November 2022). No reference calls were collected during the survey.

A call (pass) was defined as a sequence of three or more consecutive pulses of similar frequency and shape. Calls with less than three defined consecutive pulses of similar frequency and shape were not unambiguously identified to a species but were used as part of the activity count for the survey area. Due to variability in the quality of calls and the difficulty in distinguishing some species the identification of each call was assigned a confidence rating (see Mills *et al.* 1996 & Duffy *et al.* 2000 for similar process) as summarised in Table E.1. A conservative approach was taken when analysing calls due to the absence of reference calls from the study area, high level of variability within a bat call and overlap in call characteristics between some species.

Species nomenclature follows Armstrong, K.N., Reardon, T.B., and Jackson, S.M. (2020). A current taxonomic list of Australian Chiroptera. Australasian Bat Society. Version 2020-06-09.

Table E.1 Confidence ratings applied to calls

Identification	Description
D – Definite	Species identification not in doubt.
PR – Probable	Call most likely to represent a particular species, but there exists a low probability of confusion with species of similar call type or call lacks sufficient detail.
SG – Species Group	Call made by one of two or more species. Call characteristics overlap making it too difficult to distinguish between species for e.g. *Chalinolobus gouldii /Ozimops sp.* *Nyctophilus sp.* The calls of *Nyctophilus geoffroyi / gouldi/ corbeni* cannot be distinguished during the analysis process and are therefore lumped together. *Nyctophilus sp/Myotis macropus.* The calls of these species can be easily confused during the analysis process and are therefore often lumped together.

E-2 Analysis results

September 2022

Approximately 15,566 .zc files were generated from 10 nights of Anabat Express recordings in September 2022. Nine species were positively (Definite) identified of the 14 or so species that are known to occur from the locality of the study area. As many as three other species may also have been recorded, but poor data quality and/or interspecific call similarities precluded reliable identification of additional species.

No threatened bat species were definitively identified as a result of the call analysis during this survey rounds.

Table E.2 presents a summary of the species recorded for each site for the survey period as a result of the bat call analysis.

Table E.2 Summary of number of calls for each species and species group during September 2022 at Wanganella and Hartwood sites

Species	NOC2/SN428781 2022-09-19 (Hartwood)	NOC2/SN428781 2022-09-20 (Wanganella)	NOC3 - /SN528637 2022-09-19 (Hartwood)	NOC3 - Hartwood Block bank/SN528637 2022-09-20 (Hartwood)	SOC3/SN542859 2022-09-19 (Wanganella)	SOC3/SN542859 2022-09-20 (Wanganella)	SOC3/SN542859 2022-09-21 (Wanganella)	Wagga/SN409366 2022-09-19 (Wanganella)	Wagga/SN409366 2022-09-20 (Forest Anabranch)	Wagga/SN409366 2022-09-21 (Forest Anabranch)
Austronomus australis						D			D	D
Chalinolobus gouldii	D	D	D		D	D	D	D	D	D
Chalinolobus morio			D					D	D	D
Ozimops planiceps		D			D	D		D	PR	D
Ozimops ridei					D			D		
Scotorepens balstoni		D						D	D	
Scotorepens greyii						D				
Vespadelus vulturnus			D		D	D		PR	D	D
Vespadelus regulus			PR		D	PR		D	D	
Nyctophilus geoffroyi/gouldi			SG		SG	SG	SG		SG	
C. gouldii/ S. balstoni		SG	SG		SG	SG	SG	SG	SG	SG
C. gouldii/ O. planiceps/ridei	SG	SG	SG		SG	SG	SG	SG	SG	SG
C. morio /V. regulus			SG		SG			SG	SG	SG
O. planiceps/ridei					SG	SG	SG		SG	SG
V. darlingtoni/vulturnus			SG							
V. vulturnus/C. morio		SG	SG		SG	SG		SG	SG	SG
Number of species	1	3	3	0#	5	5	1	6	6	5
Approximate survey effort (hrs:mins)	11	11	6.5	11	11	11	3.5	11	11	11

January 2024

Anabat Express detectors were placed at four locations for five consecutive nights from 18/1/24 – 23/1/24. Table E.13 presents a summary of the species recorded for each site for the January 2024 survey period as a result of the bat call analysis.

Ten species were positively (Definite) identified of the 16 or so species that are known to occur from the locality of the study area. Three *Biodiversity Conservation Act 2016* species (all vulnerable) were recorded as Probable (PR) including the:

– *Myotis macropus* (10 + files from two locations at Hartwood). Files considered displayed 10 or more consecutive pulses. Some files within the sequence displayed average initial slope of greater than 400 octaves per second (OPS) and average pulse interval of less than 75 milliseconds (ms). Some pulses also displayed central kink in slope but poor data quality (e.g. short pulses) and/or interspecific call similarities (e.g. *Nyctophilus* sp) precluded confident identification. However, given the location of the bat detectors (e.g. next to or over water) and few definitive Nyctophilus calls recorded during the survey, it is most likely that these calls and a portion of calls attributed to the species group Nyctophilus sp./Myotis Macropus are *Myotis macropus*.
– *Chalinolobus picatus* (2 files) from one location at Wanganella – both files contained few pulses however demonstrated possible alternation characteristics of this species. The short sequence precluded confident identification.
– *Vespadelus baverstocki* (10 + files) from one location at Wanganella). Most files displayed average characteristic frequency of 43-44 kHz but poor data quality and/or interspecific call similarities (e.g. *V. vulturnus*) precluded confident identification.

Of the 48,324 files recorded approximately 80% contained bat files of some description. Remaining files contained anthropogenic and/or insect noise. As many as three other species may also have been recorded, but poor data quality and/or interspecific call similarities precluded reliable identification of additional species.

Table E.3 Summary of number of calls for each species and species group during January 2024 at Wanganella sites

Species	SN409366 2024-01-18 Wanganella	SN409366 2024-01-19 Wanganella	SN409366 2024-01-20 Wanganella	SN409366 2024-01-21 Wanganella	SN409366 2024-01-22 Wanganella	SN429859 2024-01-18 Wanganella	SN429859 2024-01-19 Wanganella	SN429859 2024-01-20 Wanganella	SN429859 2024-01-21 Wanganella	SN429859 2024-01-22 Wanganella
Austronomus australis	D	D	D	-	D	D	D	D	D	D
Chalinolobus gouldii	D	D	D	D	D	D	D	D	D	D
Chalinolobus morio	D	D	D	D	D	D	D	D	D	D
Chalinolobus picatus	-	-	-	-	-	-	-	PR	-	-
Ozimops planiceps	D	D	D	D	D	D	D	D	D	D
Ozimops ridei	D	D	D	D	D					
Scotorepens balstoni	D	D	D	D	D	D	PR	D	D	PR
Scotorepens greyii	D	D	PR	-	-	D	D	D		
Vespadelus baverstocki	-	-	-	-	-	-	PR	-	PR	PR
Vespadelus vulturnus	D	D	D	D	D	D	D	D	D	D
Vespadelus regulus		PR	D	D	-	D	D	PR	-	-
C. gouldii/ S. balstoni	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG
C. gouldii/ O. planiceps/ridei	SG	SG	SG	SG	SG					
C. morio /V. regulus	SG	-	SG	SG	-	SG	SG	SG	-	SG
O. planiceps/ridei	SG	SG	-	-	-	SG	SG	SG	SG	SG
V. baverstocki/V. vulturnus						SG	SG	-	SG	SG
V. vulturnus/C. morio	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG
Number of files	2833	3364	2846	2700	1991	1702	1896	2010	1546	1354
Number of species per night	8	8	8	7	7	8	8	8	7	5
Approximate survey effort (hrs:mins)	10	10	10	10	10	10	10	10	10	10

Table E.4 Summary of number of calls for each species and species group during January 2024 at Hartwood

Species	SN528637 2024-01-18 Hartwood	SN528637 2024-01-19 Hartwood	SN528637 2024-01-20 Hartwood	SN528637 2024-01-21 Hartwood	SN528637 2024-01-22 Hartwood	SN507312 2024-01-18 Hartwood	SN507312 2024-01-19 Hartwood	SN507312 2024-01-20 Hartwood	SN507312 2024-01-21 Hartwood	SN507312 2024-01-22 Hartwood
Austronomus australis	D	-	D	D	D	D	-	D	-	-
Chalinolobus gouldii	D	D	D	D	D	D	D	D	D	D
Chalinolobus morio	D	D	D	D	D	D	D	D	D	D
Myotis macropus vu	PR	PR	-	-	PR	PR	PR	PR	PR	PR
Ozimops planiceps	D	D	D	D	D	D	D	D	-	D
Scotorepens balstoni	D	D	D	D	D	D	D	D	D	D
Scotorepens greyii	D	D	D	D	D	D	D	D	D	D
Vespadelus vulturnus	D	D	D	D	D	D	D	D	D	D
Vespadelus regulus	D	D	D	D	D	D	D	D	D	D
Nyctophilus geoffroyi/gouldi	D	D	D	D	D	-	D	-	D	-
A.australis/Saccolaimus flaviventris	SG	-	SG	SG	SG	SG	-	SG	-	-
C. gouldii/ S. balstoni	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG
C. gouldii/ O. planiceps/ridei	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG
C. morio /V. regulus	-	-	-	-	SG	SG	SG	SG	SG	SG
O. planiceps/ridei	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG
S. balstoni/S. greyii	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG
V. baverstocki/V. vulturnus	SG	SG	-	-	-					
Number of files										
Number of species per night	9	8	9	9	9	7	8	7	8	7
Approximate survey effort (hrs:mins)	10	10	10	10	10	10	10	10	10	10

E-3 References

Australasian Bat Society 2022 - BatMap. http://ausbats.org.au/batmap. Accessed January 2024

BioNet- NSW Government, Department of Environment and Heritage (2022) BioNet – the website for the Atlas of NSW wildlife. http://www.bionet.nsw.gov.au/

Churchill, S 2008. Australian Bats, Allen and Unwin, Australia.

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

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

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

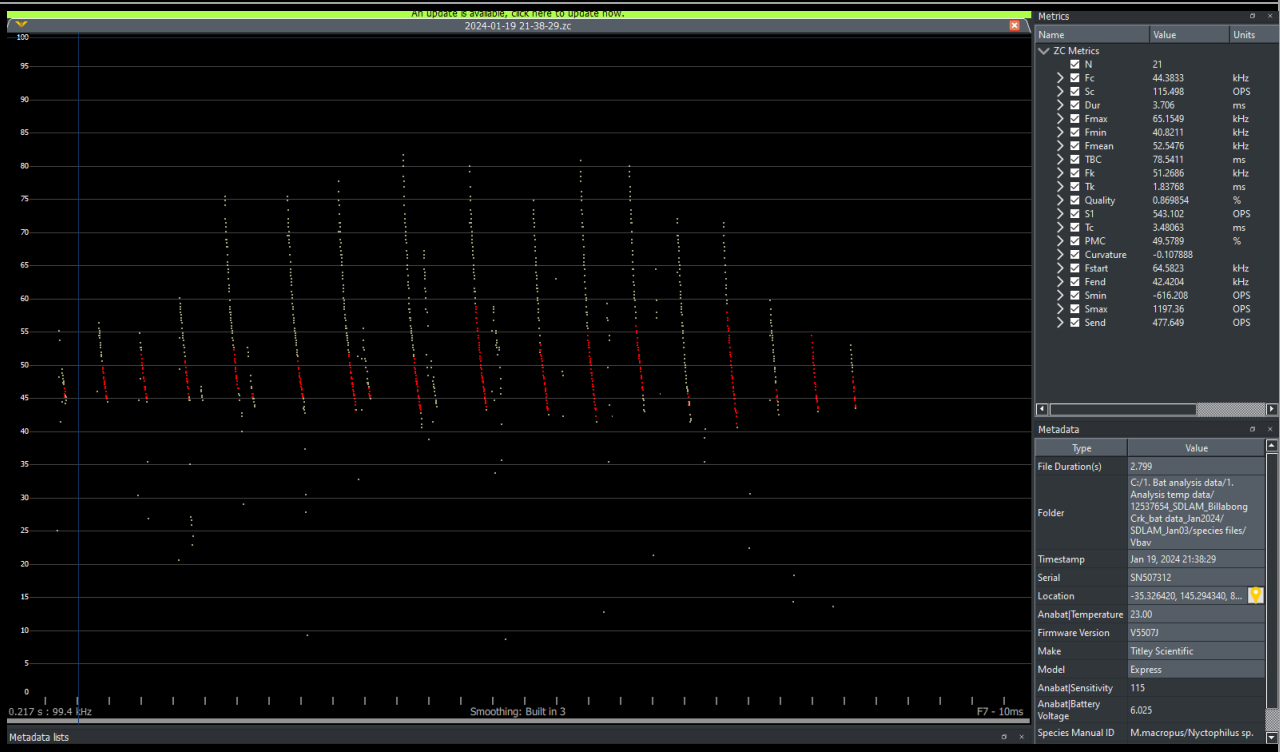
Pennay, M, Law, B, Reinhold, L 2004. Bat calls of New South Wales: Region based guide to the echolocation calls of Microchiropteran bats, NSW Department of Environment and Climate Change, Hurstville.

Reardon, T. B., McKenzie, N. L., Cooper, S. J. B., Appleton., B., Carthew, S. and Adams, M 2014 A molecular and morphological investigation of species boundaries and phylogenetic relationships in Australian free-tailed bats Mormopterus (Chiroptera : Molossidae). *Australian Journal of Zoology* 62: 109-136.

Van Dyke. S, Gynther. I, and Baker. A. 2013. Field Companion To The Mammals of Australia. New Holland Publishers.

Attachment 1 – Example spectrogram calls from site for threatened species. Calls presented in F7, compressed mode

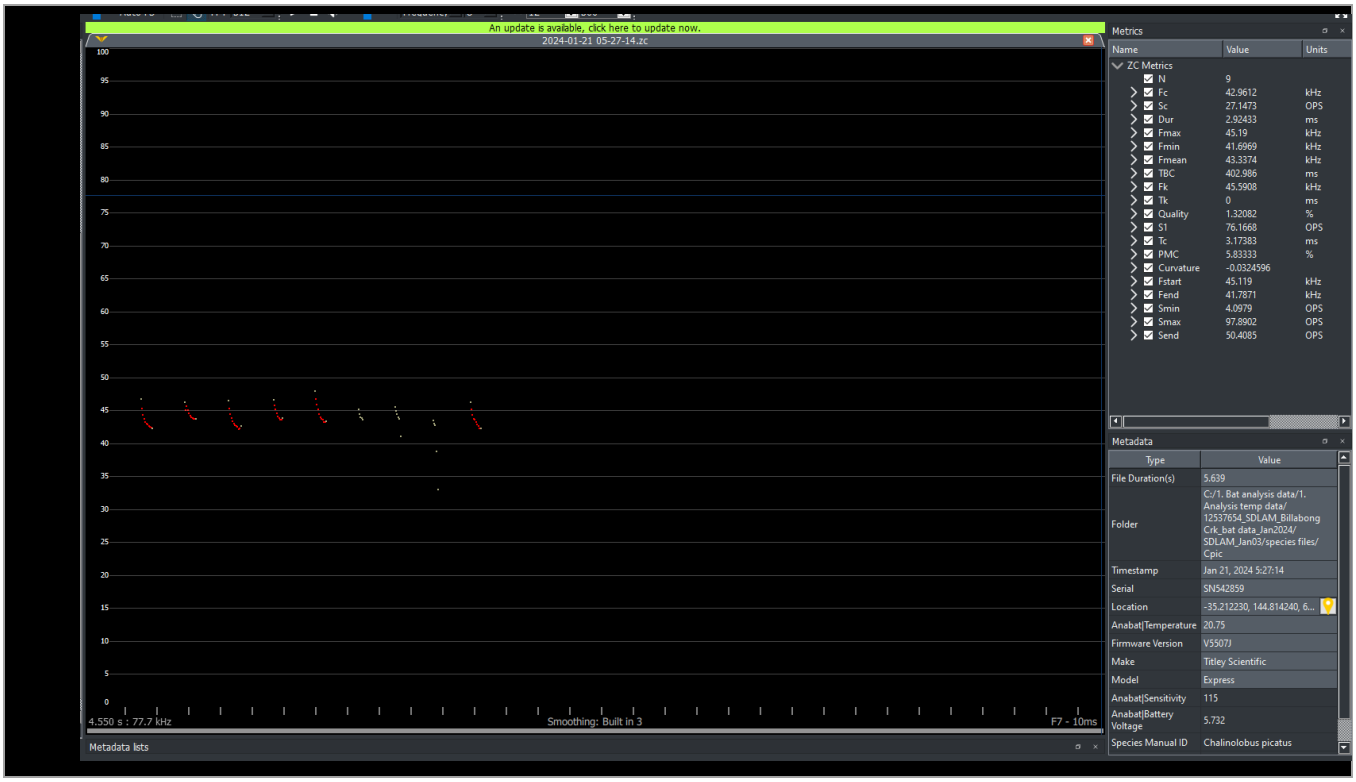
Myotis macropus – probable



Vespadelus baverstocki - probable



Chalinolobus picatus - probable


An update is available, click here to update now.
2024-01-21 05-27-14.zc
4.550 s : 77.7 kHz
Smoothing: Built in 3
F7 - 10ms
Metadata lists
Metrics
Name
Value
Units
ZC Metrics
N 9
Fc 42.9612 kHz
Sc 27.1473 OPS
Dur 2.92433 ms
Fmax 45.19 kHz
Fmin 41.6969 kHz
Fmean 43.3374 kHz
TBC 402.986 ms
Fk 45.5908 kHz
Tk 0 ms
Quality 1.32082 %
S1 76.1668 OPS
Tc 3.17383 ms
PMC 5.83333 %
Curvature -0.0324596
Fstart 45.119 kHz
Fend 41.7871 kHz
Smin 4.0979 OPS
Smax 97.8902 OPS
Send 50.4085 OPS
Metadata
Type
Value
File Duration(s) 5.639
Folder C:/1. Bat analysis data/1. Analysis temp data/12537654_SDLAM_Billabong Crk_bat data_Jan2024/SDLAM_Jan03/species files/Cpic
Timestamp Jan 21, 2024 5:27:14
Serial SN542859
Location -35.212230, 144.814240, 6...
Anabat|Temperature 20.75
Firmware Version V5507J
Make Titley Scientific
Model Express
Anabat|Sensitivity 115
Anabat|Battery Voltage 5.732
Species Manual ID Chalinolobus picatus

E-4 Qualifications of bat call analysis specialist

Craig Grabham

Senior Ecologist



Qualifications B. App. Science (Parks, Recreation and Heritage) 1998 (Honours) 2004 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)

Relevance to project. Craig is a Project Manager and Senior Ecologist with GHD's Natural Resource Team in Victoria. He has over 22 years' experience in conducting ecological survey and assessment within Australia. He is currently undertaking targeted surveys for the threatened Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara form)and Ghost Bat (*Macroderma gigas*).

Key experience areas

Bat survey and assessment experience

Craig has completed microchiropteran bat surveys and assessments in various states and territories of Australia including the NT (WA, NSW, QLD, Vic, Tasmania) using a variety of methods including: radio-tracking, harp trapping; light tagging; cave occupancy sheeting; habitat surveys (e.g. cave assessments); roost surveillance/roost counts (using infrared and thermal video cameras); bat call (echolocation) survey (using SongMeter and Anabat detectors); and bat call analysis. Craig has also completed bat inventory surveys for National Parks, Nature Reserves, catchment management areas and private land conservation projects.

Bat call analysis and reporting

To date Craig has completed echolocation (ultrasonic) analysis and reporting for over 160 GHD projects from WA, NSW, NT, QLD and Vic. Calls collected during field surveys from Anabat or Song Meter devices are analysed primarily using Anabat Insight or Kaleidoscope software. Craig has experience with a variety of analysis methods/programs including manual identification (comparison of sonograms and call characteristics with reference material) and automated analysis (e.g. using recognisers/classifiers in Songscope/ Kaleidoscope or filters within Anabat Insight).

Bat Management Plans

Craig has designed and implement management plans for a variety of bridge removal and refurbishment projects with roosting bats in Victoria and NSW. He has also assisted with the peer review of bat management plans for bridges, wind farms, mines and building demolition. The key aim of most plans is to help proponents design and implement a humane program of management, usually by a process of gradual exclusion and/or the retention and monitoring of bat roosts. Plans use strategies from guidelines produced by the Australasian Bat Society and Bat Conservation International.

BHP Jimblebar | WA (Pilbara).

Ghost Bat surveys, proposed mine expansion (2019 - 2020). Craig has undertaken targeted surveys for the Ghost Bat and assisted with the survey design, analysis and reporting of other surveys for BHP including full spectrum (FS) ultrasonic call survey and analysis (ongoing).

FMG/FMG Iron Bridge | WA (Pilbara). *Pilbara Leaf-nosed Bat, North Star Mine (2014-2020)*. Craig has been undertaking targeted surveys since 2014 to inform the EPA conditions for approval for its North Star Mine Operations. The scope of works currently includes:

- Full spectrum (FS) ultrasonic call survey and analysis at over 60 locations
- Development of a Survey Plan and standard operating procedures for the methods and techniques to survey the Pilbara Leaf-nosed Bat including handling trapping and release protocols; roost surveillance; cave occupation determination and radio tracking methods and procedures
- Structural and habitat assessments of a known roosts to determine 1. geological characteristics and stability of roost habitat 2. characterisation of the internal architecture of the roosting habitat (e.g. internal dimensions and microhabitat characteristics) 3. classification of roost habitats according to conservation guidelines
- Regional surveys to assist with the location additional roost locations and habitat extent
- Roost occupancy determination surveys using the non-invasive sheeting method described (Survey guidelines for Australia's threatened bats DEWHA 2010) in conjunction with ultrasonic surveys and infrared camera surveillance
- Radio-tracking of Pilbara Leaf-nosed Bat using digitally encoded nanotags, automated receiver base-station array and handheld receiver units (2017 and 2019).

FMG/FMG Iron Bridge | WA (Pilbara). *Pilbara Leaf-nosed Bat and Ghost Bat surveys, Proposed Glacier Valley/South Star area (2018-2019)*. Craig has been undertaking baseline and targeted surveys for both species to inform the proposed North Star Mine expansion processions including:

- FS ultrasonic call survey and analysis for both species
- Habitat assessment and modelling including cave habitat searches to assist with determining habitat suitability and occupations, and classification of roost habitats according to conservation guidelines

- Regional surveys to assist with the location of other habitat/ roost sites using helicopter
- Roost occupancy determination surveys using the non-invasive sheeting method.

Targeted bat surveys Balickera Tunnel | Hunter Water, NSW (Newcastle region). Craig assisted with ultrasonic activity and emergence surveys (using Infrared cameras) for the three threatened bat species that occupy the tunnel (*Myotis macropus, Miniopterus schreibersii* and *Miniopterus australis*). Craig has also assisted with the surveys using an innovative drone watercraft capable of recording video imagery of the tunnel ceiling to identify the roosting locations for various bat species.

Parks Victoria | Cumberland River, Vic.
Use of an existing cave – Bent-wing Bat. Craig completed a survey of a foreshore cave using infrared camera and ultrasonic recorders to determine the presence of threatened bent-wing bats (*Miniopterus orianae bassanii / Miniopterus schreibersii oceanensis*). Methods include roost exit counts using infrared camera and handheld ultrasonic detectors and nightly surveys using FS ultrasonic detectors (2018).

Volunteer position | King Lake NP, Vic.
Use of an abandoned mine adits – Eastern Bent-wing Bat. Craig assisted with the study of this species use of several abandoned mines in the King Lake area. Methods include roost exit counts, harp trapping and bat call survey and analysis (2011 - 2012).

Murray Wildlife | Hay, NSW
Bat survey and analysis of tank sites (dams). Bat surveys were completed to determine the usage of tank sites within grazing land by micro bats for the Hay Landcare Group. The overall aim of the project was to determine how important these artificial water sources are for native wildlife within this agricultural landscape (2012).

NSW RTA | Murray River, NSW/Vic
Cobram-Barooga historic bridge partial demolition. Targeted surveys (harp trapping, bat call survey and analysis, roost searches) was completed for the threatened Large-footed Myotis and other micro bat species to determine the impacts of the partial bridge demolition. A Bat Management Plan was developed to avoid or minimise impacts upon the bat species within the bridge. Monitoring of bats was undertaken during demolition and post demolition phases (2009 – 2010).

Lower Murray Darling CMA | Lower Murray-Darling, NSW
Survey of ground-dwelling vertebrate fauna and microchiropteran bats at pre-determined sites. Harp trapping, Anabat and reference call collection were completed at six sites. Anabat analysis was completed for 25 locations within the project area (2008).

QLD Rail | Byerwen, QLD
Targeted survey - threatened Little Pied Bat Including harp trapping, bat call surveys, roost search and cave habitat assessments to determine the impacts of the proposed 450 ha quarry (2008).

DMR | Hermidale region, NSW
Anabat surveys and analysis of 12 derelict mine shafts.. Craig assisted with the development of the management plan and provided recommendations regarding the closure of shafts (2006).

NSW RTA | Gundagai, NSW
Prince Alfred Bridge, (initial assessment and post refurbishment monitoring). Targeted surveys (harp trapping, bat call survey and analysis, roost searches) were completed to determine the impacts of the bridge refurbishment to micro bats. A Bat Management Plan was developed to minimise impacts upon the bat species within the bridge. Monitoring of bats was undertaken during refurbishment and post refurbishment phases (2005 - 2006).

NPWS | Kosciusko National Park, NSW
Micro bat use of abandoned mine adits. Anabat surveys and analysis was completed of Kings Mine, Ravine River Adit, and Ravine Mine Adit for the South West Slopes Division of the NSW National Parks and Wildlife Service. Craig provided recommendations regarding the ongoing use of the mine adits by bats (2004).

Other relevant experience
Honours (2003 - 2004) Title: '*Bats in fragmented rural landscapes - the use of remnant and revegetated habitats*'. Craig investigated the use of six main habitat types (30 sites) by microchiropteran bats across a fragmented rural landscape including the value of native revegetation to bats.
Contact details: T: 03 52731869 M: 0428884821
E: **craig.grabham@ghd.com**

Appendix F

Audiomoth Report

F-1 Introduction

GHD placed four passive acoustic monitoring (PAM) devices (AudioMoths) for between 6-8 nights each to record calls for the threatened Growling Grass Frog (*Litoria raniformis*) and Australasian Bittern (*Botaurus poiciloptilus*) at two areas (Wanganella Weir and Hartwood Weir) along the Billabong Creek during March 2023.

F-2 Analysis methods

The following section provides a description for the collation and classification of calls using .wav files recorded by AudioMoth units. The aim of the Kaleidoscope Pro (version 5.5.0, Wildlife Acoustics) basic cluster analysis process is to identify signals representing the target species of interest (in this case the Growling Grass Frog and Australasian Bittern from the four AudioMoth units over the course of the survey period.

A total of 1203 .wav files were recorded for all sites combined for the entire survey period. The following sections provide a step-by-step description for the classification of animal vocalisations using .wav files recorded by AudioMoth units.

Step 1 – Download of audio data post field surveys

Audio data (.wav files) recorded by each AudioMoth unit were downloaded to a computer and then to a portable hard drive for backup. A hierarchical folder system was used to store and catalogue the data using a unique numbering system that could later be applied to the different sites (site number/name). This allowed for accurate and consistent presentation of data throughout the analysis.

Step 2 – Basic cluster analysis

Using the signal parameters and cluster analysis functions in Kaleidoscope Pro the raw .wav files were processed for signals of interest (e.g. within the acoustic range of the target species). Prior to applying the settings, target species vocalisations were examined from the following sources to better determine the parameters to be applied for the basic cluster analysis process:

Australasian Bittern:

– Xeno-canto - https://xeno-canto.org/species/Botaurus-poiciloptilus
– Birdlife Australia - **https://birdlife.org.au/bird-profiles/australasian-bittern/**
– eBird - **https://ebird.org/species/ausbit1?siteLanguage=en_AU**

Growling Grass Frog:

– FrogID - **https://www.frogid.net.au/frogs/litoria-raniformis**
– Frogs of Australia - **https://frogs.org.au/frogs/species/Litoria/raniformis/**
– Michael A. Ford (1989) Vocalisations of the green frogs *Litoria aurea* and *Litoria raniformis*, including species-specific male calls, New Zealand Journal of Zoology, 16:1, 17-23, DOI: 10.1080/03014223.1989.10423700

Analysis of all recordings was undertaken and compared with the designated settings under the signal parameters function. Once a signal has passed these parameters (the specified criteria), it is considered to be a detected signal and is passed to the cluster analysis (CA) module. The CA module analyses detected signals for similar patterns based on the designated settings under the CA parameters function. Based on these parameters, the process designates each detected signal as part of a cluster. Clusters are initially named, starting with cluster 000, cluster 001, cluster 002 and so on. The largest number of similar detected signals are assigned to cluster 000, the next largest to cluster 001, and so on. Subsequent clusters are ordered to be most similar to those that come before. Table F.1 shows the applied settings.

Table F.1 Settings

Parameter	Australasian Bittern	Growling Grass Frog
Minimum and Maximum Frequency Range (Hz)	0-3000	100-8000
Minimum and maximum length of detection (seconds)	0.3-10	0.3-10
Maximum inter-syllabe gap (seconds)	1	1

Cluster analysis

- Maximum distance from cluster centre to include outputs in cluster.csv: 2 (to ensure no signals of interest were ignored)
- FFT Window: 10.67 ms (to allow for a greater resolution of frequency aiming to better define low frequency sounds)
- Maximum states: 12 (mid range recommended default)
- Maximum distance to cluster centre for building clusters: 0.5 recommended default
- Maximum clusters: 100

Step 3 – Manual review and labelling of clusters

Signals of interest were identified as a result of the basic cluster analysis process. A signal of interest may have contained a single syllable or a single call (vocalisation consisting of multiple consecutive syllables) from a single species, or may have contained syllables or calls from multiple species. The following process was applied to review and label each of the designated clusters:

- The top 100 detections (based on analysis of the *Top1 distance output* number for each cluster) was manually review by viewing the spectrogram window in KP and for some files the audio was listened to using the playback function.
- Files were then labelled according to the target species or other species or other sound (e.g. car, human).
- This process was completed for each cluster.
- Additional analysis of vocalisations for 1-2 hrs following sunset each night was undertaken each night as this is considered the peak calling period for each species.

F-3 Analysis results

At least 12 species were recorded using PAM (all sites, all night combined) during the survey including the Growling Grass Frog. The Growling Grass Frog was recorded calling from one site (Hartwood weir - G19) for one night (1/3/2023) at 10:30 pm for approximately 40-50 seconds (see Figure F.1).

Growling Grass frog vocalisations were also recorded from the Wanganella Weir site - G30 on the night of the 1/03/2023, however upon review the calls were determined to have originated from call playback survey for the species undertaken by GHD field ecologists on the night in question. The recording and detection of call playback vocalisations is useful as it somewhat validates that the use of the AudioMoth for this species at that site.

The Australasian Bittern was not detected during the analysis process, however it is possible that species called very infrequently (e.g. few calls), thus there was insufficient data for the generation of a cluster or clusters recognising this species vocalisation.

Diurnal bird species were also recorded at each site however the focus of the analysis was the target species and nocturnal fauna and diurnal birds were not counted.

Overall, the recording quality was good, however insect noise was regularly detected at all sites for all nights, and light-moderate intermittent rain and wind were also detected at some sites on the 1, 3 and 5-8 March 2023. The Growling Grass was recorded at Hartwood weir G19 (1/3/2023) during a night with light-moderate background noise, therefore it is reasonable to assume that despite the background noise on other nights this species would have been detected providing it was within a reasonable distance of the AudioMoth unit. However it is possible background noise events like rain/wind may mask the call of the Australasian Bittern.

Table F.2 Wanganella Weir survey results – G30

Species	1/03/2023	2/03/2023	3/03/2023	4/03/2023	5/03/2023	6/03/2023	7/03/2023
Barn Owl	Y	Y	-	-	-	-	-
Boobook	-	Y	Y	Y	Y	Y	-
Brushtail Possum	-	Y	-	-		Y	-
Cormorant (Pied or Great)	Y	Y	Y	Y	Y	Y	-
Diurnal bird	Y	Y	Y	Y	Y	Y	Y
Domestic dog	Y	Y	Y	Y	Y	Y	-
Fox					Y	Y	-
Grey Teal	Y	Y	Y	Y	Y	Y	-
Growling Grass Frog	Call Playback (G30)	-	-	-	-	-	-
Wood Duck	Y	Y	Y	Y	Y	Y	-
Pacific Black Duck	Y	Y	Y	Y	Y	Y	
Tawny Frogmouth	-	-	-	-	Y	-	-
White Ibis	Y	Y	Y	Y	Y	Y	-
White-faced Heron	Y	Y	Y	Y	Y	Y	-

Table F.3 Hartwood weir – site G19

Species	1/03/2023	2/03/2023	3/03/2023	4/03/2023	5/03/2023	6/03/2023	7/03/2023	8/03/2023	9/03/2023
Southern Boobook	-	-	-	-	-	-	Y	-	-
Brushtail Possum	-	-	-	-	-	-		Y	-
Cormorant (Pied or Great)	-	Y	Y	-	-	Y	Y	Y	-
Diurnal bird	Y	Y	Y	Y	Y	Y	Y	Y	Y
Dog domestic	-	-	-	-	-	-	Y	-	-
Grey Teal	-	Y	Y	-	-	Y	Y	Y	-
Growling Grass Frog	Y	-	-	-	-	-	-	-	-
Wood Duck	-	Y	Y	-	-	Y	Y	Y	-
Other waterbird (not identified)	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pacific Black Duck	-	Y	Y	-	-	Y	Y	Y	-
White Ibis	-	Y	Y	-	-	Y	Y	Y	-
White-faced Heron	-	Y	Y	-	-	Y	Y	Y	-

Table F.4 Hartwood weir – site G21

Species	1/03/2023	3/03/2023	4/03/2023	5/03/2023	6/03/2023	7/03/2023	8/03/2023	9/03/2023
Barn Owl	-	-	-	-	Y	-	-	-
Southern Boobook	-	-	Y	-	Y	Y	-	-
Brushtail Possum	-	-	Y	-	-	-	-	-
Cormorant (Pied or Great)	Y		Y	Y	Y	Y	Y	Y
Diurnal bird	Y	Y	Y	Y	Y	Y	Y	Y
Dog domestic	-	-	-	Y	-	-	-	-
Fox	-	-	-	-	-	-	Y	-
Grey Teal	Y	-	Y	Y	Y	Y	Y	Y
Wood Duck	Y	-	Y	Y	Y	Y	Y	Y
Other waterbird (not identified)	Y	Y	Y	Y	Y	Y	Y	Y
Owlet Nightjar	Y	-	Y	Y	Y	Y	Y	-
Pacific Black Duck	Y	-	Y	Y	Y	Y	Y	Y
White Ibis	Y	-	Y	Y	Y	Y	Y	Y
White-faced Heron	Y	-	Y	Y	Y	Y	Y	Y

Table F.5 Hartwood weir – site G26

Species	1/03/2023	2/03/2023	3/03/2023	4/03/2023	5/03/2023	6/03/2023
Brushtail Possum	-	-	Y	-	-	-
Cat	-	-	-	-	Y	-
Cormorant (Pied or Great)	-	Y	-	-	Y	Y
Diurnal bird	Y	Y	Y	Y	Y	Y
Dog domestic	-	-	-	-	Y	-
Fox	-	Y	-	-	-	-
Grey Teal	-	Y	-	-	Y	Y
Wood Duck	-	Y	-	-	Y	Y
Other waterbird (not identified)	Y	Y	Y	Y	Y	Y
Pacific Black Duck	-	Y	-	-	Y	Y
White Ibis	-	Y	-	-	Y	Y
White-faced Heron	-	Y	-	-	Y	Y

Spectrogram example of Growling Grass Frog Calls (Kaleidoscope Pro).

G19 1/3/24- 22:30. Top spectrogram = file with call (yellow box) at correct time scale. Bottom spectrogram = call at within yellow box from top spectrogram at expanded time scale.

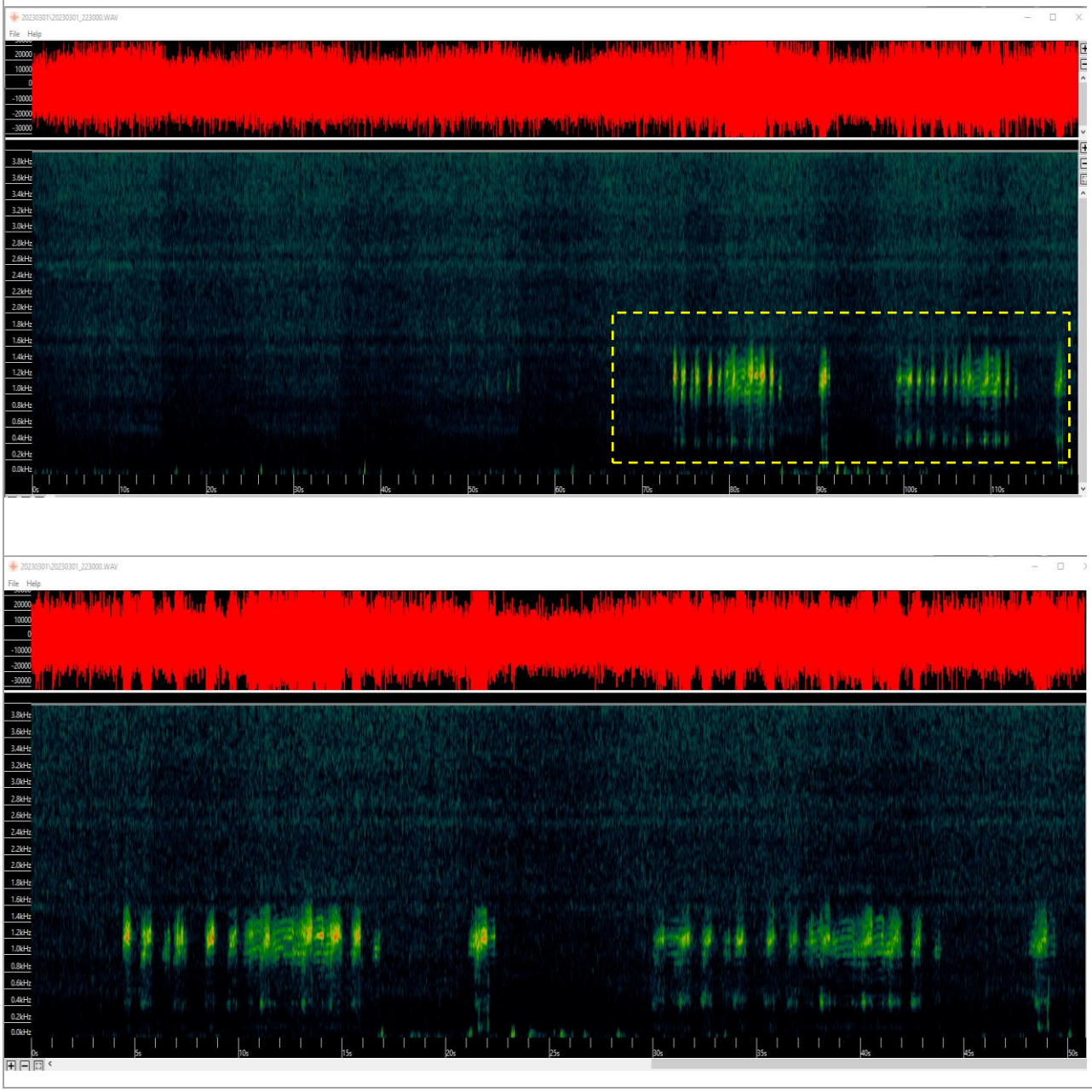


Figure F.1 Example spectrogram calls from site for threatened species

Appendix G

BAM Calculator Reports

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00033952/BAAS23017/23/00044379

Proposal Name
Billabong Creek EIS - Hartwood Regulator upgrade

BAM data last updated *
14/03/2024

Assessor Name
Kirsten Crosby

Assessor Number
BAAS17011

BAM Data version *
67

Proponent Names
Lara Hess

Report Created
11/10/2024

BAM Case Status
Finalised

Assessment Revision
3

Assessment Type
Major Projects

Date Finalised
11/10/2024

* 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
Pedionomus torquatus / Plains-wanderer

Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

PCT
7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion

Predicted Threatened Species Not On Site

Name
No Changes

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

BAM Biodiversity Credit Report (Like for like)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion	Not a TEC	0.8	26	0	26
10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Not a TEC	0.8	13	5	18
13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Not a TEC	4.3	68	22	90
44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion	Not a TEC	0.3	0	12	12
46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	Not a TEC	4.8	0	146	146

7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region

	Inland Riverine Forests This includes PCT's: 2, 5, 7, 8, 9, 10, 11, 36, 78, 79, 112, 233, 234, 249, 356, 362, 4088, 4089	Inland Riverine Forests <50%	7_Moderate	Yes	26	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Inland Riverine Forests This includes PCT's: 2, 5, 7, 8, 9, 10, 11, 36, 78, 79, 112, 233, 234, 249, 356, 362, 4088, 4089	Inland Riverine Forests <50%	10_Moderate	Yes	13	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Inland Riverine Forests This includes PCT's: 2, 5, 7, 8, 9, 10, 11, 36, 78, 79, 112, 233, 234, 249, 356, 362, 4088, 4089	Inland Riverine Forests <50%	10_Shrubland	No	5	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Inland Floodplain Woodlands This includes PCT's: 13, 15, 16, 83, 438, 454, 630	Inland Floodplain Woodlands >=50% and <70%	13_DNG	No	22	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Inland Floodplain Woodlands This includes PCT's: 13, 15, 16, 83, 438, 454, 630	Inland Floodplain Woodlands >=50% and <70%	13_Moderate	Yes	68	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Riverine Plain Grasslands This includes PCT's: 44	Riverine Plain Grasslands >=70% and <90%	44_Moderate	No	12	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion	
46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	**Like-for-like credit retirement options**

Class	Trading group	Zone	HBT	Credits	IBRA region
Riverine Plain Grasslands This includes PCT's: 44, 45, 46, 165, 1203	Riverine Plain Grasslands <50%	46_Moderate	No	138	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Riverine Plain Grasslands This includes PCT's: 44, 45, 46, 165, 1203	Riverine Plain Grasslands <50%	46_Poor	No	8	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Litoria raniformis / Southern Bell Frog	**7_Moderate, 10_Moderate, 13_Moderate, 13_DNG**	5.3	150.00
Myotis macropus / Southern Myotis	**7_Moderate, 10_Moderate, 13_Moderate**	3.7	129.00
Pedionomus torquatus / Plains-wanderer	**44_Moderate, 46_Poor, 46_Moderate**	2.0	123.00
Swainsona murrayana / Slender Darling Pea	**44_Moderate, 46_Moderate**	2.2	94.00

Credit Retirement Options

Like-for-like credit retirement options

Litoria raniformis / Southern Bell Frog	Spp	IBRA subregion
	Litoria raniformis / Southern Bell Frog	Any in NSW
Myotis macropus / Southern Myotis	Spp	IBRA subregion
	Myotis macropus / Southern Myotis	Any in NSW
Pedionomus torquatus / Plains-wanderer	Spp	IBRA subregion
	Pedionomus torquatus / Plains-wanderer	Any in NSW

Swainsona murrayana / Slender Darling Pea	Spp	IBRA subregion
	Swainsona murrayana / Slender Darling Pea	Any in NSW

BAM Predicted Species Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00033952/BAAS23017/23/00044379	Billabong Creek EIS - Hartwood Regulator upgrade	14/03/2024
Assessor Name	**Report Created**	**BAM Data version ***
Kirsten Crosby	11/10/2024	67
Assessor Number	**Assessment Type**	**BAM Case Status**
BAAS17011	Major Projects	Finalised
Assessment Revision		**Date Finalised**
3		11/10/2024

* 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.

Threatened species reliably predicted to utilise the site. No surveys are required for these species. Ecosystem credits apply to these species.

Common Name	Scientific Name	Vegetation Types(s)
Australasian Bittern	Botaurus poiciloptilus	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Australian Painted Snipe	Rostratula australis	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Black Falcon	Falco subniger	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

Black Falcon	Falco subniger	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Black-chinned Honeyeater (eastern subspecies)	Melithreptus gularis gularis	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
Brolga	Grus rubicunda	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Diamond Firetail	Stagonopleura guttata	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Dusky Woodswallow	Artamus cyanopterus cyanopterus	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

Dusky Woodswallow	Artamus cyanopterus cyanopterus	44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Flame Robin	Petroica phoenicea	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
Freckled Duck	Stictonetta naevosa	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Gilbert's Whistler	Pachycephala inornata	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Grey Falcon	Falco hypoleucos	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Grey-crowned Babbler (eastern subspecies)	Pomatostomus temporalis temporalis	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Inland Forest Bat	Vespadelus baverstocki	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

Little Eagle	Hieraaetus morphnoides	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Little Pied Bat	Chalinolobus picatus	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Painted Honeyeater	Grantiella picta	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Pied Honeyeater	Certhionyx variegatus	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Pink Cockatoo	Lophochroa leadbeateri	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

Pink Cockatoo	Lophochroa leadbeateri	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Plains-wanderer	Pedionomus torquatus	44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Regent Honeyeater	Anthochaera phrygia	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
Regent Parrot (eastern subspecies)	Polytelis anthopeplus monarchoides	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Scarlet Robin	Petroica boodang	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
South-eastern Hooded Robin	Melanodryas cucullata cucullata	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Spotted Harrier	Circus assimilis	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Square-tailed Kite	Lophoictinia isura	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion

Square-tailed Kite	Lophoictinia isura	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Superb Parrot	Polytelis swainsonii	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Swift Parrot	Lathamus discolor	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Varied Sittella	Daphoenositta chrysoptera	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
White-bellied Sea-Eagle	Haliaeetus leucogaster	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

White-bellied Sea-Eagle	Haliaeetus leucogaster	44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
White-fronted Chat	Epthianura albifrons	44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
White-throated Needletail	Hirundapus caudacutus	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		44-Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

Threatened species Manually Added

None added

Threatened species assessed as not within the vegetation zone(s) for the PCT(s)

Refer to BAR for detailed justification

Common Name	Scientific Name	Justification in the BAM-C

BAM Candidate Species Report

Proposal Details

Assessment Id 00033952/BAAS23017/23/00044379	Proposal Name Billabong Creek EIS - Hartwood Regulator upgrade	BAM data last updated * 14/03/2024
Assessor Name Kirsten Crosby	Report Created 11/10/2024	BAM Data version * 67
Assessor Number BAAS17011	Assessment Type Major Projects	BAM Case Status Finalised
Assessment Revision 3	Date Finalised 11/10/2024	

* 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.

List of Species Requiring Survey

Name	Presence	Survey Months
Ardeotis australis Australian Bustard	No (surveyed)	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Brachyscome muelleroides Claypan Daisy	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Brachyscome papillosa Mossgiel Daisy	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?

Burhinus grallarius Bush Stone-curlew	No (surveyed)	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Convolvulus tedmoorei Bindweed	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Cullen parvum Small Scurf-pea	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Eucalyptus leucoxylon subsp. pruinosa Yellow Gum	No (surveyed)	☐ Jan ☑ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Haliaeetus leucogaster White-bellied Sea-Eagle	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☑ Survey month outside the specified months?
Hieraaetus morphnoides Little Eagle	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?

Lepidium monoplocoides Winged Peppercress	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Leptorhynchos orientalis Lanky Buttons	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Litoria raniformis Southern Bell Frog	Yes (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?
Lophochroa leadbeateri Pink Cockatoo	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Lophoictinia isura Square-tailed Kite	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Maireana cheelii Chariot Wheels	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?

Myotis macropus Southern Myotis	Yes (surveyed) *Survey months are outside of the months specified in Bionet.	☑ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?
Ninox connivens Barking Owl	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?
Pedionomus torquatus Plains-wanderer	Yes (assumed present)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Phascolarctos cinereus Koala	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Pilularia novae-hollandiae Austral Pillwort	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Polytelis swainsonii Superb Parrot	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?

Sclerolaena napiformis Turnip Copperburr	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Swainsona murrayana Slender Darling Pea	Yes (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Swainsona plagiotropis Red Darling Pea	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Swainsona sericea Silky Swainson-pea	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Tyto novaehollandiae Masked Owl	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?

Threatened species Manually Added

None added

Threatened species assessed as not on site

Refer to BAR for detailed justification

BAM Candidate Species Report

Common name	Scientific name	Justification in the BAM-C
Menindee Nightshade	Solanum karsense	Refer to BAR
Regent Honeyeater	Anthochaera phrygia	Habitat constraints
Regent Parrot (eastern subspecies)	Polytelis anthopeplus monarchoides	Refer to BAR
Swift Parrot	Lathamus discolor	Habitat constraints

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00033952/BAAS23017/23/00044378

Proposal Name
Billabong Creek EIS - Wanganella Regulator upgrade

BAM data last updated *
14/03/2024

Assessor Name
Kirsten Crosby

Assessor Number
BAAS17011

BAM Data version *
67

Proponent Names
Lara Hess

Report Created
11/10/2024

BAM Case Status
Finalised

Assessment Revision
2

Assessment Type
Major Projects

Date Finalised
11/10/2024

* 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

PCT
7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains

Predicted Threatened Species Not On Site

Name
Polytelis anthopeplus monarchoides / Regent Parrot (eastern subspecies)

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

BAM Biodiversity Credit Report (Like for like)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion	Not a TEC	0.6	11	0	11
10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Not a TEC	0.9	18	0	18
13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	Not a TEC	1.7	30	0	30
46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion	Not a TEC	1.9	0	63	63
160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains	Not a TEC	0.2	0	7	7

7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region

	Inland Riverine Forests This includes PCT's: 2, 5, 7, 8, 9, 10, 11, 36, 78, 79, 112, 233, 234, 249, 356, 362, 4088, 4089	Inland Riverine Forests <50%	7_Moderate	Yes	11	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Inland Riverine Forests This includes PCT's: 2, 5, 7, 8, 9, 10, 11, 36, 78, 79, 112, 233, 234, 249, 356, 362, 4088, 4089	Inland Riverine Forests <50%	10_Moderate	Yes	18	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region
Inland Floodplain Woodlands This includes PCT's: 13, 15, 16, 83, 438, 454, 630	Inland Floodplain Woodlands >=50% and <70%	13_Moderate	Yes	30	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Inland Floodplain Woodlands This includes PCT's: 13, 15, 16, 83, 438, 454, 630	Inland Floodplain Woodlands >=50% and <70%	13_DNG	No	0	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region
Riverine Plain Grasslands This includes PCT's: 44, 45, 46, 165, 1203	Riverine Plain Grasslands <50%	46_Moderate	No	63	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region

	Inland Floodplain Shrublands This includes PCT's: 17, 24, 25, 115, 160, 161, 240, 241, 247, 261, 271, 375	Inland Floodplain Shrublands <50%	160_Moderate	No	7	Murrumbidgee, Darling Depression, Lachlan, Lachlan Plains, Lower Slopes, Murray Fans, Robinvale Plains and South Olary Plain. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Burhinus grallarius / Bush Stone-curlew	**7_Moderate, 10_Moderate, 13_Moderate**	2.1	69.00
Hieraaetus morphnoides / Little Eagle	**7_Moderate, 10_Moderate, 13_Moderate, 46_Moderate, 160_Moderate**	1.3	30.00
Litoria raniformis / Southern Bell Frog	**7_Moderate, 10_Moderate, 13_Moderate, 13_DNG, 160_Moderate**	3.3	82.00

Credit Retirement Options

Like-for-like credit retirement options

Burhinus grallarius / Bush Stone-curlew	Spp	IBRA subregion
	Burhinus grallarius / Bush Stone-curlew	Any in NSW
Hieraaetus morphnoides / Little Eagle	Spp	IBRA subregion
	Hieraaetus morphnoides / Little Eagle	Any in NSW
Litoria raniformis / Southern Bell Frog	Spp	IBRA subregion
	Litoria raniformis / Southern Bell Frog	Any in NSW

BAM Predicted Species Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00033952/BAAS23017/23/00044378	Billabong Creek EIS - Wanganella Regulator upgrade	14/03/2024
Assessor Name	**Report Created**	**BAM Data version ***
Kirsten Crosby	11/10/2024	67
Assessor Number	**Assessment Type**	**BAM Case Status**
BAAS17011	Major Projects	Finalised
Assessment Revision		**Date Finalised**
2		11/10/2024

* 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.

Threatened species reliably predicted to utilise the site. No surveys are required for these species. Ecosystem credits apply to these species.

Common Name	Scientific Name	Vegetation Types(s)
Australasian Bittern	Botaurus poiciloptilus	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Australian Painted Snipe	Rostratula australis	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Black Falcon	Falco subniger	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion

Black Falcon	Falco subniger	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Black-chinned Honeyeater (eastern subspecies)	Melithreptus gularis gularis	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
Blue-billed Duck	Oxyura australis	160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Brolga	Grus rubicunda	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Diamond Firetail	Stagonopleura guttata	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Dusky Woodswallow	Artamus cyanopterus cyanopterus	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion

Dusky Woodswallow	Artamus cyanopterus cyanopterus	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Flame Robin	Petroica phoenicea	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
Freckled Duck	Stictonetta naevosa	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Gilbert's Whistler	Pachycephala inornata	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Grey Falcon	Falco hypoleucos	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains

Grey-crowned Babbler (eastern subspecies)	Pomatostomus temporalis temporalis	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Inland Forest Bat	Vespadelus baverstocki	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Little Eagle	Hieraaetus morphnoides	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Little Pied Bat	Chalinolobus picatus	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Magpie Goose	Anseranas semipalmata	160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Painted Honeyeater	Grantiella picta	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

Painted Honeyeater	Grantiella picta	13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Pied Honeyeater	Certhionyx variegatus	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Pink Cockatoo	Lophochroa leadbeateri	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Plains-wanderer	Pedionomus torquatus	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Regent Honeyeater	Anthochaera phrygia	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
Scarlet Robin	Petroica boodang	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
South-eastern Hooded Robin	Melanodryas cucullata cucullata	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Spotted Harrier	Circus assimilis	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

Spotted Harrier	Circus assimilis	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Square-tailed Kite	Lophoictinia isura	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Superb Parrot	Polytelis swainsonii	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
Swift Parrot	Lathamus discolor	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
Varied Sittella	Daphoenositta chrysoptera	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

White-bellied Sea-Eagle	Haliaeetus leucogaster	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
White-fronted Chat	Epthianura albifrons	46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
White-throated Needletail	Hirundapus caudacutus	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		46-Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains
Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	7-River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland mainly in the Riverina Bioregion
		10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		160-Nitre Goosefoot shrubland wetland on clays of the inland floodplains

BAM Predicted Species Report

Threatened species Manually Added

None added

Threatened species assessed as not within the vegetation zone(s) for the PCT(s)

Common Name	Scientific Name	Plant Community Type(s)
Regent Parrot (eastern subspecies)	Polytelis anthopeplus monarchoides	10-River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)
		13-Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion)

Threatened species assessed as not within the vegetation zone(s) for the PCT(s)

Refer to BAR for detailed justification

Common Name	Scientific Name	Justification in the BAM-C
Regent Parrot (eastern subspecies)	Polytelis anthopeplus monarchoides	Refer to BAR

BAM Candidate Species Report

Proposal Details

Assessment Id 00033952/BAAS23017/23/00044378	Proposal Name Billabong Creek EIS - Wanganella Regulator upgrade	BAM data last updated * 14/03/2024
Assessor Name Kirsten Crosby	Report Created 11/10/2024	BAM Data version * 67
Assessor Number BAAS17011	Assessment Type Major Projects	BAM Case Status Finalised
Assessment Revision 2	Date Finalised 11/10/2024	

* 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.

List of Species Requiring Survey

Name	Presence	Survey Months
Ardeotis australis Australian Bustard	No (surveyed)	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Brachyscome muelleroides Claypan Daisy	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Brachyscome papillosa Mossgiel Daisy	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?

Burhinus grallarius Bush Stone-curlew	Yes (assumed present)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Convolvulus tedmoorei Bindweed	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Cullen parvum Small Scurf-pea	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Eucalyptus leucoxylon subsp. pruinosa Yellow Gum	No (surveyed)	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Haliaeetus leucogaster White-bellied Sea-Eagle	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Hieraaetus morphnoides Little Eagle	Yes (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?

Lepidium monoplocoides Winged Peppercress	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Leptorhynchos orientalis Lanky Buttons	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Litoria raniformis Southern Bell Frog	Yes (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?
Lophochroa leadbeateri Pink Cockatoo	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?
Lophoictinia isura Square-tailed Kite	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?
Maireana cheelii Chariot Wheels	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?

Myotis macropus Southern Myotis	No (surveyed) *Survey months are outside of the months specified in Bionet.	☑ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?
Ninox connivens Barking Owl	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?
Phascolarctos cinereus Koala	No (surveyed)	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Pilularia novae-hollandiae Austral Pillwort	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?
Polytelis swainsonii Superb Parrot	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?
Sclerolaena napiformis Turnip Copperburr	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☑ Dec ☐ Survey month outside the specified months?

Swainsona murrayana Slender Darling Pea	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Swainsona plagiotropis Red Darling Pea	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Swainsona sericea Silky Swainson-pea	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☐ Survey month outside the specified months?
Tyto novaehollandiae Masked Owl	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☑ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☑ Aug ☑ Sep ☐ Oct ☐ Nov ☐ Dec ☑ Survey month outside the specified months?

Threatened species Manually Added

None added

Threatened species assessed as not on site

Refer to BAR for detailed justification

Common name	Scientific name	Justification in the BAM-C
Menindee Nightshade	Solanum karsense	Refer to BAR
Plains-wanderer	Pedionomus torquatus	Habitat constraints
Regent Honeyeater	Anthochaera phrygia	Habitat constraints
Regent Parrot (eastern subspecies)	Polytelis anthopeplus monarchoides	Refer to BAR

Swift Parrot	Lathamus discolor	Habitat constraints

Appendix H

EPBC Act Assessments of Significance

H-1 Vulnerable bird species of semi-arid shrubland and woodland

This section presents the assessment of significance pursuant to the *Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (MNES Guidelines 1.1) (DotE 2013) for the 'vulnerable bird species of semi-arid shrubland and woodland': Southern Whiteface (*Aphelocephala leucopsis*); Superb Parrot (*Polytelis swainsonii*); Grey Falcon (*Falco hypoleucos*); Painted Honeyeater (*Grantiella picta*); Blue-winged Parrot (*Neophema chrysotoma*); and Diamond Firetail (*Stagonopleura guttata*).

H-1-1 Southern Whiteface

Distribution

The Southern Whiteface (*Aphelocephala leucopsis*) occurs across most of mainland Australia south of the tropics, from the north-eastern edge of the Western Australian wheatbelt, east to the Great Dividing Range (DCCEEW 2023b).

Habitat requirements

The Southern Whiteface inhabits a wide range of open woodlands and shrublands where there is an understorey of grasses or shrubs, or both, generally in areas dominated by acacias or eucalypts on ranges, foothills and lowlands, and plains (DCCEEW 2023b, Higgins & Peter 2002). It forages almost exclusively on the ground, favouring habitat with low tree densities and an herbaceous understorey litter cover (DCCEEW 2023b). When breeding, the Southern Whiteface mainly utilises hollows and crevices, but will nest in low bushes (DCCEEW 2023b, Higgins & Peter 2002).

Habitat in the study area

The species was recorded foraging at Wanganella. There is foraging habitat for the Southern Whiteface throughout the proposal footprint associated with PCT 10 River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone and PCT 13 Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone according to the TBDC (NSW DCCEEW 2024b) and potentially also PCT 7 River Red Gum riparian tall open forest. The species was observed foraging in River Red Gum and Black Box woodland on multiple occasions during field surveys. Southern Whiteface may also nest in denser patches of small trees and shrubs in the proposal footprint but would be more likely to breed in larger trees with hollows and crevices (DCCEEW 2024b) in PCT 7 River Red Gum riparian tall open forest. No evidence of breeding was noted despite diurnal bird surveys and nest tree censuses conducted over multiple seasons.

No important populations of the Southern Whiteface are noted in the conservation advice for the species (DCCEEW 2023b) and no critical habitat has been identified (DCCEEW 2023c). According to the MNES significant impact guidelines 1.1 (DotE 2013) an 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: key source populations either for breeding or dispersal; populations that are necessary for maintaining genetic diversity; and/or populations that are near the limit of the species range. The Southern Whiteface individuals recorded at Wanganella are likely to form part of a viable local population that extends through this reach of the Billabong Creek system and the broader floodplain that could interact with other populations. In this context the proposal footprint may contain source populations necessary for breeding, dispersal or for maintaining genetic diversity. Therefore for the purposes of this assessment it is assumed that the proposal would affect an important population of the species .

H-1-2 Superb Parrot

Distribution

The Superb Parrot is mainly found in NSW and northern Victoria, where it occurs on the inland slopes of the Great Divide and on adjacent plains, especially along the major river-systems (DEE 2019b).

Habitat requirements

The breeding range of the Superb Parrot is divided into three main areas: the first, along the Murray and Edward Rivers; the second, along the Murrumbidgee River; and the third, in a triangle bounded by Molong, Yass and Young (DCCEEW 2024b). Superb Parrots breed in either River Red Gum forests and woodlands or box woodlands (Webster 1998).

At least part of the population of the Superb Parrot undertakes regular seasonal movements, vacating the breeding area after the conclusion of the breeding season, and then returning in spring, while others remain in the breeding areas throughout the year. In central NSW, movements are said to occur when eucalypts flower, and when food becomes scarce due to drought and birds seek alternative sources of food (Higgins 1999).

The species seasonally occurs in non-breeding foraging habitat in Box-Cypress Pine (*Callitris* spp.) and Weeping Myall (*Acacia pendula*) woodlands. The Superb Parrot feeds mainly on the ground, on the seeds of grasses as well as cereal crops and spilt grain. They also eat the seed-pods of many understorey species of wattles, and flowers and fruits of eucalypts, berries of mistletoe and lerps (NSW DCCEEW 2024b).

Habitat in the study area

There is foraging habitat for the Superb Parrot throughout the proposal footprint associated with PCT 10 River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone, PCT 13 Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone and PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest. The species is known to nest in hollows within tall Eucalypts, however, no evidence of breeding or foraging was noted despite diurnal bird surveys and nest tree censuses conducted over multiple seasons.

The recovery plan for the species maps the Wanganella site as species likely to occur and is in close proximity to known breeding sites. No areas mapped as ‘breeding likely to occur’ are located in the study area, however, there are scattered records of birds breeding outside these mapped areas (DAWE 2021). Superb Parrots that may occur at the study area would form part of a viable local population that extends through this reach of the Billabong Creek system, including breeding habitat in River Red Gum forest up and downstream. In this context the proposal footprint may help support source populations necessary for breeding, dispersal or for maintaining genetic diversity. Therefore, for the purposes of this assessment it is assumed that the proposal would affect an important population of the species pursuant to the MNES significant impact guidelines 1.1 (DotE 2013).

H-1-3 Grey Falcon

Distribution

The Grey Falcon is sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range (DCCEEW 2023b). It generally occurs west of the Darling River, and most reports of ‘Grey Falcons’ on the tablelands and coast of NSW are almost certainly Grey Goshawks (NSW Scientific Committee 2009). The species is mainly found where annual rainfall is less than 500 mm, except when wet years are followed by drought, when the species might become marginally more widespread, although it is essentially confined to the arid and semi-arid zones (DCCEEW 2023b).

Habitat requirements

Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey. The species frequents timbered lowland plains, particularly acacia shrublands that are crossed by tree-lined water courses (DCCEEW 2023b).

Habitat in the study area

There is potential habitat for the Grey Falcon throughout the proposal footprint associated with PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland, PCT 10 River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone, PCT 13 Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone, PCT 44 Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion, PCT 46 Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion and PCT 160 Nitre Goosefoot shrubland wetland on clays of the inland floodplains. Raptor species with similar life histories were observed at the study area as well as abundant populations of potential prey species. The species is known to nest in tall trees within timbered watercourses and may potentially breed in PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland, PCT 10 River Red Gum - Black Box woodland wetland and PCT 13 – Black Box - Lignum woodland wetland in the proposal footprint and broader study area, although given the location of the proposal east of the Darling River and in southern Australia, breeding is considered unlikely. No evidence of breeding was noted despite diurnal bird surveys and nest tree censuses conducted over multiple seasons.

The species consists of a single population with a total size estimated to be <1000 mature birds occurring at low densities across its range (DCCEEW 2023b). As such, any individuals that occurred in the proposal footprint would form part of an important population. No critical habitat for the species has been identified (DCCEEW 2023c).

H-1-4 Painted Honeyeater

Distribution

The Painted Honeyeater (*Grantiella picta)* is nomadic and occurs at low densities throughout its range. The greatest concentrations of individuals and almost all breeding occurs on the inland slopes of the Great Dividing Range in New South Wales, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution (CTH DCCEEW 2024B).

Habitat requirements

The Painted Honeyeater inhabits dry open woodland and forests, particularly Boree/ Weeping Myall (*Acacia pendula*), Brigalow (*A. harpophylla*) and Box-Gum Woodlands and Box-Ironbark Forests. It is a specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias, with a preference for the mistletoes of the genus *Amyema*. Insects and nectar from mistletoe or eucalypts are occasionally eaten (DCCEEW 2023b). It may also be found along rivers, on plains with scattered trees and on farmland with remnant vegetation. It has been seen in urban parks and gardens where large eucalypts are available (DCCEEW 2023b).

The Painted Honeyeater nests from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches. It breeds in loose colonies, forming pair bonds for the duration of the breeding season. In some areas, the same nest or tree may be re-used over several years (DCCEEW 2023b).

Habitat in the study area

There is potential habitat for the Painted Honeyeater throughout the proposal footprint associated with PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland, PCT 10 River Red Gum - Black Box woodland wetland and PCT 13 Black Box - Lignum woodland wetland, including foraging resources associated with mistletoe species.

There are eight records of the species within the locality. No evidence of breeding was noted despite diurnal bird surveys and nest tree censuses conducted over multiple seasons.

The Painted Honeyeater is nomadic and occurs at low densities throughout its range. Considering its dispersive habits, the species is considered to comprise a single population (Garnett *et al.* 2011). As such, any individuals that occurred in the proposal footprint would form part of an important population. No critical habitat for the species has been identified (DCCEEW 2023c).

H-1-5 Blue-winged Parrot

Distribution

The Blue-winged Parrot can occur across northern Victoria, eastern South Australia, south-western Queensland and western NSW during the non-breading period (NSW TSSC, 2023). The species breeds in Tasmania, coastal south-eastern South Australia and southern Victoria during spring and summer (NSW TSSC 2023). The species is a partial migrant. Variable numbers of birds migrate across Bass Strait in winter, and during the non-breeding period birds can be recorded into south-western Queensland and south-east NSW (Higgins 1999).

Habitat requirements

The Blue-winged Parrot inhabits eucalypt forests and woodlands during the breeding period and utilise hollows in living or dead trees (NSW TSSC 2023). During the non-breeding period the Blue-winged Parrot are known to occupy grassy woodlands and semi-arid chenopod shrublands and grasslands often near wetlands (NSW TSSC, 2023). Pairs or small parties forage mainly near or on the ground for seeds of a wide range of native and introduced grasses, herbs and shrubs.

Habitat in the study area

There is potential non-breeding habitat for the Blue-winged Parrot throughout the proposal footprint associated with PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland, PCT 10 River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone, PCT 13 Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone, PCT 44 Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion and PCT 46 Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain.

There are six records of the species within the locality.

No important populations of the Blue-winged Parrot are noted in the final determination for the species (NSW TSSC 2023) and no critical habitat has been identified (DCCEEW 2024c). According to the MNES significant impact guidelines 1.1 (DotE 2013) an ‘important population’ is a population that is necessary for a species’ long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: key source populations either for breeding or dispersal; populations that are necessary for maintaining genetic diversity; and/or populations that are near the limit of the species range.

Given the partially migratory nature of the species, individuals that may occur in the proposal footprint are likely to be transient visitors, and therefore an important population is not considered to be present.

H-1-6 Diamond Firetail

Distribution

The Diamond Firetail (*Stagonopleura guttata*) has a scattered distribution over NSW and is not commonly found on the east coast. The species has concentrated records within Northern, Central and Southern Tablelands, the Northern, Central and South Western Slopes and the North West Plains and Riverina (DPE 2023b).

Habitat requirements

The Diamond Firetail broadly occurs in grassy eucalypt woodland including in open forest, mallee, Natural Temperate Grassland, and in secondary grasslands as well as riparian and lightly wooded farmland areas. The Diamond Firetail is a ground-feeder, foraging on grass and herbaceous seeds, leaves and also insects. Nests are built in a shrubby understorey. The species also roosts in dense shrubs (DPE 2023b).

Habitat in the study area

There is potential habitat for the Diamond Firetail in grassland derived from PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland, PCT 10 River Red Gum - Black Box woodland wetland, PCT 13 Black Box - Lignum woodland wetland, PCT 44 Forb-rich Speargrass - Windmill Grass - White Top grassland, PCT 46 Curly Windmill Grass - speargrass - wallaby grass grassland, and PCT 160 Nitre Goosefoot shrubland wetland. There is potential roosting or nesting habitat in proposal footprint, as areas within PCT 7, PCT 10, PCT 13 and PCT 160 mentioned above contain scattered areas of dense shrubs.

There are 15 records of the species within the locality (DPE 2023a).

A local population of the species would comprise part of an important population if present at the proposal footprint. The species has not been recorded despite multiple rounds of diurnal bird surveys and so there is no direct evidence that the proposal footprint supports an important population. No critical habitat for the species has been identified (DCCEEW 2023c).

EPBC Act Assessment of Significance
Vulnerable bird species of semi-arid shrubland and woodland

According to the DotE (2013) 'significant impact criteria', 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

As described above, other than the Blue-winged Parrot, each of the populations of these vulnerable bird species of semi-arid shrubland and woodland that could occur at the proposal footprint would comprise an important population as defined in the MNES Guidelines 1.1 (DotE 2013).

The factors that could potentially lead to a long-term decrease in the size of a population of these vulnerable bird species include direct harm, loss of foraging habitat affecting an ecologically significant proportion of local populations or loss of important breeding habitat.

The proposal would result in direct impacts to native vegetation and associated threatened species habitat through:

– clearing of 5.29 ha of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure
– clearing of 10.94 ha of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure.

The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works.

The Southern Whiteface was the only vulnerable species recorded in the proposal footprint, however no evidence of breeding was noted. The remaining vulnerable bird species of semi-arid shrubland and woodland were not recorded in the proposal footprint but are known to occur in similar habitats in the region and may occur in the proposal footprint on occasion.

The proposal would remove or modify a total of 16.23 ha of native vegetation in varying condition across the Hartwood and Wanganella proposal footprint, all of which provides foraging and potential breeding habitat for these semi-arid shrubland and woodland species. Clearing of vegetation may, in general, directly harm resident fauna. Most resident birds could easily evade harm once construction activity begins at the proposal footprint. The proposal would include fauna management protocols including pre-clearing surveys and salvage and treatment of any resident fauna. This would partially mitigate impacts on the local populations of these species if any less mobile nesting individuals or their young are in the proposal footprint during vegetation clearing works. There is no direct evidence of these species breeding in the proposal footprint despite targeted surveys over multiple seasons. Given the limited extent and duration of the proposed works the proposal is unlikely to directly harm a significant proportion of the populations of these bird species, if any.

Noise and vibration, light, vehicle movement and other human activities during the operation of the proposal has the potential to disturb individuals, if nesting in areas adjacent to the proposal footprint and may result in individuals foraging elsewhere. These indirect impacts resulting from the proposal would be temporary in nature and would only last about 18 months during construction of the proposal. Operation of the new regulators would not result in the generation of any additional noise or light. Vegetation management measures recommended for the proposal would help to avoid direct impacts and minimise indirect impacts on habitat adjoining the proposal footprint. Extensive areas of comparable foraging and nesting habitat are present in surrounding areas and so the temporary displacement of fauna over short distances would have a minor consequence. The likely magnitude of edge effects or other indirect effects would not be sufficient to tangibly affect the life cycle of these threatened species.

Operation of the proposal would have a minor impact on the hydrology of the Billabong Creek system in the context of the current degree of regulation. The effects of the proposal would be limited to in stream habitats and lower, more frequently inundated parts of the floodplain. No adverse operational impacts on populations of these species are likely to occur.

The proposal is therefore unlikely to adversely affect the lifecycle of these vulnerable bird species such that an important population would decline in size.

EPBC Act Assessment of Significance
Vulnerable bird species of semi-arid shrubland and woodland

Reduce the area of occupancy of an important population

The proposal would reduce the overall area of occupancy of these species by reducing the extent of potential habitat. The proposal would remove or modify up to 16.23 ha of native vegetation that is habitat for these vulnerable bird species, all of which have areas of occupancy of many thousands of square kilometres. This maximum disturbance footprint is conservative and the majority would only be subject to partial or temporary impacts, noting:

– Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate.
– Vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate.
– Operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. The proposal would create a small-scale gap in habitat comparable to existing gaps in the landscape that could be easily passed over or through by populations of these species. The maximum gap in habitat created would be around 200 m and would only be during the construction of the proposal. The habitat to be removed or modified comprises a small proportion of that available in the project area and locality which includes many thousands of hectares of similar wetland and riparian vegetation in the Billabong Creek and Forest Creek corridors.

Given the small scale and duration of proposed works there is a minor risk of additional indirect impacts that is likely to be substantially mitigated through standard environmental management measures. Noise, dust and human activity may affect the quality or occupation of habitat adjoining the proposal footprint during construction and periods when the site is occupied.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would be restricted to in stream habitat and lower floodplain environments with low commence to flow levels and would not inundate any flood-sensitive terrestrial vegetation or otherwise reduce the extent of habitat for these species.

Given the extent of habitat in the locality, populations of these species would persist in the local area and region. Therefore, despite removing or modifying a small area of habitat the proposal would not reduce the overall area of occupancy of these species.

Fragment an existing important population into two or more populations

These species may travel through the proposal footprint on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the connectivity provided by the proposal footprint to support their continued use of the local area. The proposal would include removal of native vegetation cover and erection of structures in up to 16.23 ha of land, with impacts spread across two sites located around 45 km apart. Construction of the regulators and associated infrastructure would reduce connectivity through the proposal footprint by decreasing shelter by removing native vegetation and creating physical barriers. Removal of native vegetation cover and operation of the proposal would reduce connectivity within:

– an irregularly shaped area interrupting east-west habitat connectivity about 150 m wide, and north-south connectivity around 200 m wide at the Hartwood regulator CAZ
– irregularly shaped areas interrupting east-west and north-south habitat connectivity about 0.4 ha in size at the Forest Creek block bank CAZ at Hartwood
– an area interrupting east-west habitat connectivity up to 80 m wide at the Wanganella flood bypass channel
– an irregularly shaped area interrupting east-west habitat connectivity of about 146 m wide, and in the north-south connectivity around 130 m at the Wanganella regulator
– 5 m wide access track corridors
– up to 20 m wide power supply corridors.

These maximum disturbance areas are conservative and the majority would only be subject to partial or temporary impacts, noting:

– Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate.
– Vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate.
– Construction-only access tracks are generally aligned with existing tracks and/or through treeless areas and so upgrade for the proposal would require minimal vegetation removal.
– Operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

Human occupation may also deter these bird species from moving through the local area during construction. Construction would take approximately 18 months but would be paused during high flow periods.

EPBC Act Assessment of Significance Vulnerable bird species of semi-arid shrubland and woodland
Habitat connectivity would be maintained around the proposal footprint through extensive areas of similar Black Box, River Red Gum woodland and chenopod shrubland. The proposal would not isolate any areas of habitat or sever any connecting links. The proposal does not include the erection of any large or hazardous structures that would increase the risk or energy cost of movement of any threatened or migratory fauna. Removal of vegetation and construction of infrastructure would only result in a minor increase in the degree of fragmentation between retained areas of habitat for these species and would not result in the isolation of any habitat. The proposal would create a small-scale gap in habitat that could be easily passed over or through by these mobile bird species. Given the extent of habitat in the locality, populations of these species would persist in the local area and region. Therefore, despite removing or modifying a small area of habitat within fauna movement corridors the proposal would not fragment an important population of these bird species into two or more populations.
Adversely affect habitat critical to the survival of a species
No Critical Habitat for vulnerable bird species of semi-arid shrubland and woodland as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat (DCCEEW 2024c). Habitat critical to the survival of the Southern Whiteface includes areas of: relatively undisturbed open woodlands and shrublands with an understorey of grasses or shrubs, or both; habitat with low tree densities and an herbaceous understory litter cover which provides essential foraging habitat; and living and dead trees with hollows and crevices which are essential for roosting and nesting (DCCEEW 2024b). No evidence of breeding was noted despite diurnal bird surveys and nest tree censuses conducted over multiple seasons. The proposal would remove or modify up to 6.03 ha of woodland and forest habitat with potential nest sites and a further 10.21 ha of treeless foraging habitat that may be habitat critical to the survival of the Southern Whiteface. This is a minor proportion of the extent of similar critical habitat on the Billabong Creek floodplain and with eucalypt forest and woodland in the broader region. Habitat critical to the survival of the Superb Parrot comprises all potential breeding and foraging habitat within the species' known area of occupancy (DAWE 2021). The proposal would remove 16.23 ha of native vegetation that may be foraging habitat critical to the survival of the Superb Parrot. This is a small proportion of the extent of similar critical habitat in the locality and region, which includes high cover of similar semi-arid woodland and shrubland. No evidence of breeding was noted despite diurnal bird surveys and nest tree censuses conducted over multiple seasons. Habitat critical to the survival of the Grey Falcon would comprise suitable nesting habitat such as tree-lined watercourses through areas of suitable foraging habitat. The species may hunt in any vegetation or open space that contains prey species and so foraging habitat with particular characteristics is unlikely to be critical to the survival of the species. The proposal would remove trees in riparian corridors which may form essential habitat for roosting and nesting, however no evidence of breeding was noted despite diurnal bird surveys and nest tree censuses conducted over multiple seasons. There are five key biodiversity areas nominated for the Painted Honeyeater all of which are several hundred kilometres northeast of the proposal footprint (CTH DCCEEW 2024B). According to the recovery plan for the species, foraging habitat critical to the survival of the Painted Honeyeater includes all preferred foraging species within known and likely foraging habitat particularly mistletoes of the genus *Amyema* growing on forest and woodland eucalypts and acacias (CTH DCCEEW 2024B). The proposal would remove or modify a maximum of just 6.03 ha of woodland and forest containing mistletoe that may be habitat critical to the survival of the Painted Honeyeater. The remaining 10.21 ha of treeless native vegetation to be removed does not contain mistletoe resources for the species. This is a small proportion of the extent of similar critical habitat in the locality and region. According to the conservation advice for the species, habitat critical to the survival of the Diamond Firetail includes areas of Eucalypt, Acacia or Casuarina woodlands, open forests and other lightly timbered habitats; with low tree density, few large logs, and little litter cover but high grass cover for foraging, roosting and breeding (DCCEEW 2024b). The proposal would remove or modify a maximum of 16.23 ha of forest, woodland, shrubland and grassland in the vicinity of Eucalypt woodland that may be habitat critical to the survival of the Diamond Firetail. This is a minor proportion of the extent of similar critical habitat in the locality and region. The proposal would remove or modify up to 16.23 ha of native vegetation that may be foraging habitat critical to the survival of the Blue-winged Parrot. This is a minor proportion of the extent of similar critical habitat in the locality and region. The proposal footprint is located several hundred kilometres from the region in which this species breeds. These potential residual direct impacts to critical habitat comprise a conservative upper limit noting that the majority of the proposal footprint would be subject to partial and/or temporary vegetation removal. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would be restricted to in stream habitat and lower floodplain environments with low commence to flow levels and would not inundate any flood-sensitive terrestrial vegetation or otherwise adversely affect habitat critical to the survival of these species. Overall, the proposal would have a minor adverse effect on habitat that is critical to the survival of these species.

EPBC Act Assessment of Significance
Vulnerable bird species of semi-arid shrubland and woodland

Disrupt the breeding cycle of an important population

The proposal would remove or modify 16.23 ha of native vegetation that comprises potential habitat for these species in varying condition and quality. Removal of vegetation may disrupt the breeding cycle of these species by reducing foraging resources available or displacing or harming nesting birds. The proposal would not affect any identified nesting habitat. A breeding population of these species may be present in the wider locality given the large tracts of vegetation nearby. There is no direct evidence of these species breeding in the study area or proposal footprint despite targeted surveys over multiple seasons.

Clearing of vegetation may, in general, directly harm resident fauna. The proposal would remove vegetation in up to 16.23 ha of land, with much of this total area open space or low vegetation that would not comprise nesting habitat for these bird species. The proposal would include fauna management protocols including pre-clearing surveys and salvage and treatment of any less mobile nesting individuals or their young that are in the proposal footprint during vegetation clearing works, which is unlikely given the limited extent and duration of vegetation removal. The proposal would not directly harm or otherwise interrupt the breeding cycle of a significant proportion of the populations of these bird species, if any. In addition, the loss of habitat spread across two separate locations would not affect the ability of these species to move between their foraging and breeding areas.

Indirect impacts such as generation of additional noise and light would occur for approximately 18 months during the construction period. Extensive areas of comparable foraging and nesting habitat are present in surrounding areas and so the temporary displacement of fauna over short distances would have a minor consequence.

The proposal is therefore unlikely to substantially disrupt the breeding cycle of an important population of these vulnerable bird species.

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

The proposal would remove or modify 16.23 ha of native vegetation that comprises potential habitat for these species in varying condition and quality. The proposal would result in direct impacts to native vegetation and associated habitat for these species through:

– clearing of 5.29 ha of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure.
– clearing of 10.94 ha of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure.

These potential residual direct impacts to habitat comprise a conservative upper limit noting that the majority of the proposal footprint would be subject to partial and/or temporary vegetation removal.

The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. Habitat connectivity would be retained around the impact area through extensive areas of similar River Red Gum, Black Box woodland, chenopod shrubland and native grasslands. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of movement of these bird species.

The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would be restricted to in stream habitat and lower floodplain environments with low commence to flow levels and would not inundate any flood-sensitive terrestrial vegetation or otherwise adversely affect habitat for these species.

The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Given this minor quantum of impact and the presence of alternative habitat resources the proposal is unlikely to have an adverse effect on habitat for these species to the extent that they would be likely to decline.

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

Disturbance associated with vegetation clearing and vehicle traffic during construction or use of the regulator may, in general, increase the potential for the spread, introduction and establishment of weed and pest species.

Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting weed propagules. Environmental inductions, visual barriers and/or exclusion fencing will be used to exclude personnel and vehicles from habitat outside the proposal footprint.

To further mitigate the risk of pathogens being brought onto and/or spread through the proposal footprint all vehicles, plant and equipment will be cleaned down (wash/blow down) and certified weed free prior to initial entry to site; all vehicles, plant and equipment will strictly adhere to the approved roads, tracks, easements and work areas to minimise contact with vegetation.

EPBC Act Assessment of Significance Vulnerable bird species of semi-arid shrubland and woodland
Introduce disease that may cause the species to decline, or
As described for invasive species above, the proposal may, in general, increase the potential for the spread, introduction and establishment of diseases and pathogens. The proposal does not include any higher risk activities such as transport of biological material. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting disease. To further mitigate the risk of pathogens being brought onto and/or spread through the proposal footprint, all vehicles, plant and equipment will be cleaned and inspected. Personnel, vehicles and equipment will be restricted to work areas to minimise contact with sensitive habitat.
Interfere substantially with the recovery of the species
The proposal would interfere with the recovery of these species by removing or modifying habitat, which is noted as a key threat for each species (DCCEEW 2024b). As described above, the proposal would remove or modify a maximum of 16.23 ha of habitat for these species at the proposal footprint. The only confirmed populations of these species at the proposal footprint is the Southern Whiteface, and much of the habitat is marginal in terms of vegetation structure, species composition or general condition. The potential residual direct impacts to habitat comprise a conservative upper limit. The proposal footprint does not contain any confirmed breeding habitat or habitat features that would comprise an important connecting link between any other areas of habitat. These species occupy the proposal footprint on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the habitat at the proposal footprint. The reduction in extent of habitat would be negligible. The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Given this minor quantum of impact and the presence of alternative habitat resources the proposal would not interfere substantially with the recovery of these species.
Conclusion of assessment of significance
Based on consideration of the above criteria, the proposal is unlikely to have a significant effect on an important population of these vulnerable bird species, given: – That with exception of the Southern Whiteface, survey effort to date has not identified these species within the project area suggesting these species would most likely occur as transient individuals (if at all), rather than as resident populations. – The limited extent of native vegetation to be removed or modified in comparison to the extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system and adjoining floodplains. – The limited quality of habitat to be removed or modified, noting that no nest trees have been identified despite seasonally appropriate surveys. – The proposal is unlikely to have an adverse effect on the size or breeding cycle of an important population of these species. – The proposal will only result in a minor increase in the degree of fragmentation between retained areas of habitat for these mobile species and will not result in any isolation of habitat. – Habitat within the proposal footprint is unlikely to be important to the recovery and long-term survival of these species.

H-2 Endangered and critically endangered bird species of semi-arid grassland, shrubland and woodland:

This section presents the assessment of significance pursuant to the MNES Guidelines 1.1 (DotE 2013) for the 'endangered and critically endangered bird species of semi-arid grassland, shrubland and woodland': Pink Cockatoo (*Lophochroa leadbeateri*); Hooded Robin (*Melanodryas cucullata cucullata*); and Plains-wanderer (*Pedionomus torquatus*).

H-2-1 Pink Cockatoo

Distribution

The Pink Cockatoo is listed as an endangered species under the EPBC Act. The species occurs in arid and semi-arid NSW, regularly as far east as Bourke and Griffith and occasionally further east as vagrants (DPE 2023a).

Habitat requirements

The species inhabits a range of treed and treeless inland habitats within easy reach of water. The species nests in tree hollows in eucalypts or cypress pines. Unlike other threatened cockatoos, Pink Cockatoos do not like nesting close to other breeding pairs, with nesting hollows well-spaced between pairs (Commonwealth DCCEEW 2024).

The Pink Cockatoo feeds mostly on the ground, especially on the seeds of native and exotic melons and on the seeds of species of saltbush, wattles and cypress pines (DPE 2023a).

Habitat in the study area

There is potential foraging habitat for the Pink Cockatoo throughout the proposal footprint associated with PCT 10 River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone, PCT 13 Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone and PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest. One individual was observed foraging at the Wanganella site. There is potential breeding habitat for the species in the adjacent tall River Red Gums including a number of candidate nest trees with suitable hollows. No evidence of breeding was noted despite completion of diurnal bird surveys and nest tree census within the nominated survey window specified in the TBDC (DPE 2023a).

H-2-2 Hooded Robin

Distribution

The Hooded Robin (southeastern) (*Melanodryas cucullata cucullata*) (hereafter Hooded Robin) is listed as an endangered species under the EPBC Act. The species occurs from Brisbane to Adelaide and throughout much of inland NSW, with the exception of the extreme north-west, where it is replaced by subspecies picata. The Hooded Robin is rarely found on the coast (DPE 2023a).

Habitat requirements

The Hooded Robin requires structurally diverse habitats within open eucalypt woodland in lightly wooded country. Habitats include a mixture of mature and immature eucalypts and structurally complex vegetation with shrubs and groundcover present. Stumps or fallen timber are used as perches for hunting prey. The species requires tree forks or crevices where it will lay eggs in a cup nest between July and November (DPE 2023b).

Habitat in the study area

There is potential habitat for the Hooded Robin in associated with PCT 10 River Red Gum - Black Box woodland wetland of the semi-arid (warm) climatic zone, PCT 13 Black Box - Lignum woodland wetland of the inner floodplains in the semi-arid (warm) climate zone and PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest as well as adjoining areas of floodplain grassland and chenopod shrubland.

H-2-3 Plains-wanderer

Distribution

The Plains-wanderer is listed as a critically endangered species under the EPBC Act. The species occurs in arid and semi-arid grasslands throughout NSW, with the majority of records within the western Riverina region bounded by Hay and Narrandera and Billabong Creek in the South (Commonwealth DCCEEW 2024).

Habitat requirements

The Plains Wanderer is associated with low, open native grasslands with specific structural and to a lesser extent species composition characteristics (DoE 2016). The Plains-wanderer favours sparse, treeless, species-rich, lowland native grasslands with approximately 50% bare ground, 40% herbs and grasses and 10% fallen litter. It's favoured feed species include native grasses (*Austrostipa, Sporobolus, Panicum and Eragrostis*) as well was chenopods (*Atriplex, Maireana, Chenopodium and Sclerolaena*) (Commonwealth DCCEEW 2024).

Habitat in the study area

Billabong Creek marks the southern limit of the species' core range in this region of NSW (DoE 2016). There are patches of mapped important habitat (DPE 2023d) in the project area at Hartwood including 1.96 ha of native grassland within the access track and power supply alignments. The species is presumed to present at Hartwood because of the important habitat mapped in the proposal footprint and surrounding area. The species was not recorded despite targeted surveys. It should be noted that important habitat is mapped at the regional scale based on primary habitat mapping completed in 2001 for NPWS using aerial photo interpretation (API) mapping of the extent and location of native grassland habitat suitable for the species in the NSW Riverina (DPE 2023d). This mapping does not coincide with better quality habitat at the project area and overlaps with non-native vegetation such as the Conargo Road carriageway.

The proposal footprint contains up to 9.27 ha of potential Plains-wanderer habitat in PCT 44 – Forb-rich Speargrass - Windmill Grass - White Top grassland of the Riverina Bioregion and PCT 46 – Curly Windmill Grass - speargrass - wallaby grass grassland on alluvial clay and loam on the Hay Plain, Riverina Bioregion. The majority of this potential habitat would have low value for the species noting high perennial native grass cover, high exotic plant cover, proximity to treed vegetation which the species is known to avoid (DoE 2016) and proximity to Conargo Road and the Cobb Highway.

EPBC Act Assessment of Significance Endangered and critically endangered bird species of semi-arid grassland, shrubland and woodland
According to the DotE (2013) 'significant impact criteria', an action is likely to have a significant impact on a critically endangered or 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 factors that could potentially lead to a long-term decrease in the size of a population of these endangered bird species include direct harm, loss of foraging habitat affecting an ecologically significant proportion of local populations or loss of important breeding habitat. The proposal would result in direct impacts to native vegetation and associated habitat for these species through: – clearing of 5.29 ha of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure. – clearing of 10.94 ha of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure. The proposal would remove or modify 16.23 ha of native vegetation in varying condition, much of which provides potential foraging and breeding habitat for these species. The proposal would require trimming or removal of some potential nest trees with hollows of a suitable size or location for nesting of the Pink Cockatoo and tree forks and crevices suitable for nesting of Hooded Robins. The Plains-wanderer nests in native grassland and forbs, or rarely amongst crops. Clearing of vegetation may, in general, directly harm resident fauna. Most resident birds could easily evade harm once construction activity begins at the proposal footprint. The proposal would include fauna management protocols including pre-clearing surveys and salvage and treatment of any resident fauna. This would partially mitigate impacts on the local populations of these species if any less mobile nesting individuals or their young are in the proposal footprint during vegetation clearing works. There is no direct evidence of these species breeding in the proposal footprint despite targeted surveys over multiple seasons. Given the limited extent and duration of the proposed works the proposal is unlikely to directly harm a significant proportion of the populations of these bird species, if any.

EPBC Act Assessment of Significance
Endangered and critically endangered bird species of semi-arid grassland, shrubland and woodland

The proposed action would result in a minor impact on habitat connectivity comprising:

– creation or maintenance of permanent gaps in understorey vegetation up to 5 m wide along access tracks and at the regulators
– creation of partial gaps in vegetation cover and/or displacement of fauna from construction activity zones up to 200 m across, for a period of up to 18 months
– reduction in vegetation cover where trees have been removed or trimmed or groundcover has been disturbed until natural regeneration occurs.

Given the maintenance of the riparian corridor around the disturbance footprint for the life of the proposal, and the degree of fragmentation of floodplain habitat in the locality, this is unlikely to isolate any areas of habitat or substantially affect any populations of threatened species.

The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. The likely magnitude of edge effects or other indirect effects would not be sufficient to tangibly affect the life cycle of these threatened species.

Noise and vibration, light, vehicle movement and other human activities during the operation of the proposal have the potential to displace individuals from foraging habitat. Extensive areas of comparable habitat are present in surrounding areas and so the temporary displacement of fauna over short distances would have a minor consequence.

Operation of the proposal would have a minor impact on the hydrology of the Billabong Creek system in the context of the current degree of regulation. The effects of the proposal would be limited to in stream habitats and lower, more frequently inundated parts of the floodplain. No adverse operational impacts on populations of these species are likely to occur.

The proposal is therefore unlikely to adversely affect the lifecycle of these bird species such that a population would decline in size.

Reduce the area of occupancy of the species

The proposal would remove or modify up to 16.23 ha of native vegetation that is potential habitat for these bird species, which have areas of occupancy of hundreds to thousands of square kilometres. This maximum disturbance footprint is conservative and the majority would only be subject to partial or temporary impacts, noting:

– Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate.
– Vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate.
– Operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. The proposal would create a small-scale gap in habitat comparable to existing gaps in the landscape that could be easily passed over or through by populations of these species. The maximum gap in habitat created would be around 200 m and would only be during the construction of the proposal. The habitat to be removed or modified comprises a small proportion of that available in the project area and locality which includes many thousands of hectares of similar wetland and riparian vegetation in the Billabong Creek and Forest Creek corridors.

Given the small scale and duration of proposed works there is a minor risk of additional indirect impacts that is likely to be substantially mitigated through standard environmental management measures. Noise, dust and human activity may affect the quality or occupation of habitat adjoining the proposal footprint during construction and periods when the site is occupied.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would be restricted to in stream habitat and lower floodplain environments with low commence to flow levels and would not inundate any flood-sensitive terrestrial vegetation or otherwise reduce the extent of habitat for these species.

Given the extent of habitat in the locality, populations of these species would persist in the local area and region. Therefore, despite removing or modifying a small area of habitat the proposal would not reduce the overall area of occupancy of these species.

EPBC Act Assessment of Significance
Endangered and critically endangered bird species of semi-arid grassland, shrubland and woodland

Fragment an existing population into two or more populations

These species may travel through the proposal footprint on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the connectivity provided by the proposal footprint to support their continued use of the local area. The proposal would include removal of native vegetation cover and erection of structures in up to 16.23 ha of land, with impacts spread across two sites located around 45 km apart. Construction of the regulators and associated infrastructure would reduce connectivity through the proposal footprint by decreasing shelter by removing native vegetation and creating physical barriers. Removal of native vegetation cover and operation of the proposal would reduce connectivity within:

– an irregularly shaped area interrupting east-west habitat connectivity about 150 m wide, and north-south connectivity around 200 m wide at the Hartwood regulator CAZ
– irregularly shaped areas interrupting east-west and north-south habitat connectivity about 0.4 ha in size at the Forest Creek block bank CAZ at Hartwood
– an area interrupting east-west habitat connectivity up to 80 m wide at the Wanganella flood bypass channel
– an irregularly shaped area interrupting east-west habitat connectivity of about 146 m wide, and in the north-south connectivity around 130 m at the Wanganella regulator
– 5 m wide access track corridors
– up to 20 m wide power supply corridors.

These maximum disturbance areas are conservative and the majority would only be subject to partial or temporary impacts, noting:

– Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate.
– Vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate.
– Construction-only access tracks are generally aligned with existing tracks and/or through treeless areas and so upgrade for the proposal would require minimal vegetation removal.
– Operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

Human occupation may also deter these bird species from moving through the local area during construction. Construction would take approximately 18 months but would be paused during high flow periods.

Habitat connectivity would be maintained around the proposal footprint through extensive areas of similar Black Box, River Red Gum woodland and chenopod shrubland. The proposal would not isolate any areas of habitat or sever any connecting links. The proposal does not include the erection of any large or hazardous structures that would increase the risk or energy cost of movement of any threatened or migratory fauna. Removal of vegetation and construction of infrastructure would only result in a minor increase in the degree of fragmentation between retained areas of habitat for these species and would not result in the isolation of any habitat. The proposal would create a small-scale gap in habitat that could be easily passed over or through by these mobile bird species. Given the extent of habitat in the locality, populations of these species would persist in the local area and region. Therefore, despite removing or modifying a small area of habitat within fauna movement corridors the proposal would not fragment an important population of these bird species into two or more populations.

Adversely affect habitat critical to the survival of a species

No Critical Habitat for these endangered and critically endangered bird species of semi-arid grassland, shrubland and woodland as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat (DCCEEW 2024b).

Habitat critical to the survival of the Pink Cockatoo consist of arid and semi-arid woodlands dominated by mulga, mallee and box eucalypts, containing suitable attributes such as large mature trees with suitable hollows along with movement corridors for dispersal across the landscape (Cth. DCCEEW 2023a). The proposal would remove or modify up to 6.03 ha of woodland and forest habitat with potential nest sites and a further 10.21 ha of treeless foraging habitat that may be habitat critical to the survival of the Pink Cockatoo. Much of this habitat would be marginal noting that habitat is located on a floodplain and is distinct from the drier woodland favoured by the species (DCCEEW 2023b). This is a negligible proportion of the extent of similar critical habitat on the Billabong Creek floodplain and higher quality habitat associated with semi-arid woodland in the broader region.

Habitat critical to the survival of Plains-wanderer consist of native vegetation in any regions where the species is likely to occur (DoE 2016). Billabong Creek marks the southern limit of the species' core range in this region of NSW (DoE 2016). The proposed action would remove or modify up to 9.27 ha of native grassland comprising habitat critical for the survival of the species. The majority of this potential habitat would have low value for the species noting high perennial native grass cover, high exotic plant cover, proximity to treed vegetation which the species is known to avoid (DoE 2016) and proximity to Conargo Road and the Cobb Highway. Impacts would be minor and temporary: other than operational access tracks and the immediate vicinity of power poles, grassland vegetation would be left undisturbed or would be allowed to regenerate. The proposal would affect a very small proportion of the extent of similar habitat in the locality and region.

EPBC Act Assessment of Significance Endangered and critically endangered bird species of semi-arid grassland, shrubland and woodland
According to the conservation advice for the species habitat critical to the survival of the Hooded Robin includes dry eucalypt and acacia woodlands and shrublands remnants with an open understorey, some grassy areas and a complex ground layer, often in or near clearings or open areas; structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses; standing dead or live trees and tree stumps which are essential for nesting, roosting and foraging; and moderately deep to deep soils, rocks and fallen timber which provides essential foraging habitat (Cth. DCCEEW 2023b). The proposal would remove or modify up to 6.03 ha of woodland and forest habitat with potential nest sites and a further 10.21 ha of treeless foraging habitat that may be habitat critical to the survival of the Hooded Robin. Much of this habitat would be marginal noting: the treed habitat is located on a floodplain and is distinct from the drier woodland favoured by the species (Cth. DCCEEW 2023b); the treeless habitat has low structural complexity, no trees and minimal woody debris. This is a negligible proportion of the extent of similar critical habitat on the Billabong Creek floodplain and higher quality habitat associated with semi-arid woodland in the broader region. These potential residual direct impacts to critical habitat comprise a conservative upper limit noting that the majority of the proposal footprint would be subject to partial and/or temporary vegetation removal. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would be restricted to in stream habitat and lower floodplain environments with low commence to flow levels and would not inundate any flood-sensitive terrestrial vegetation or otherwise adversely affect habitat critical to the survival of these species. Overall, the proposal would have a minor adverse effect on habitat that is critical to the survival of these species.
Disrupt the breeding cycle of a population
The proposal would remove or modify 16.23 ha of native vegetation that comprises potential habitat for these species in varying condition and quality. Removal of vegetation may disrupt the breeding cycle of these species by reducing foraging resources available or displacing or harming nesting birds. The proposal would not affect any identified nesting habitat. A breeding population of these species may present in the wider locality given the large tracts of vegetation nearby. There is no direct evidence of these species breeding in the study area or proposal footprint despite targeted surveys over multiple seasons. Clearing of vegetation may, in general, directly harm resident fauna. The proposal would remove vegetation in up to 16.23 ha of land, with much of this total area open space or low vegetation that would not comprise nesting habitat for these bird species. The proposal would include fauna management protocols including pre-clearing surveys and salvage and treatment of any less mobile nesting individuals or their young that are in the proposal footprint during vegetation clearing works, which is unlikely given the limited extent and duration of vegetation removal. The proposal would not directly harm or otherwise interrupt the breeding cycle of a significant proportion of the populations of these bird species, if any. Indirect impacts such as generation of additional noise and light would occur for approximately 18 months during the construction period. Extensive areas of comparable foraging and nesting habitat are present in surrounding areas and so the temporary displacement of fauna over short distances would have a minor consequence. The proposal is therefore unlikely to substantially disrupt the breeding cycle of these bird species.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove or modify 16.23 ha of native vegetation that comprises potential habitat for these species in varying condition and quality. The proposal would result in direct impacts to native vegetation and associated habitat for these species through: – clearing of 5.29 ha of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure – clearing of 10.94 ha of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure. These potential residual direct impacts to habitat comprise a conservative upper limit noting that the majority of the proposal footprint would be subject to partial and/or temporary vegetation removal. The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. Habitat connectivity would be retained around the impact area through extensive areas of similar River Red Gum, Black Box woodland, chenopod shrubland and native grasslands. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of movement of these bird species. The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would be restricted to in stream habitat and lower floodplain environments with low commence to flow levels and would not inundate any flood-sensitive terrestrial vegetation or otherwise adversely affect habitat for these species.

EPBC Act Assessment of Significance Endangered and critically endangered bird species of semi-arid grassland, shrubland and woodland
The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Given this minor quantum of impact and the presence of alternative habitat resources the proposal is unlikely to have an adverse effect on habitat for these species to the extent that they would be likely to decline.
Result in invasive species that are harmful to a species becoming established in the species' habitat
Disturbance associated with vegetation clearing and vehicle traffic during construction or use of the regulator may, in general, increase the potential for the spread, introduction and establishment of weed and pest species. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting weed propagules. Environmental inductions, visual barriers and/or exclusion fencing will be used to exclude personnel and vehicles from habitat outside the proposal footprint. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned down (wash/blow down) and certified weed free prior to initial entry to site; all vehicles, plant and equipment will strictly adhere to the approved roads, tracks, easements and work areas to minimise contact with vegetation.
Introduce disease that may cause the species to decline, or
As described for invasive species above, the proposal may, in general, increase the potential for the spread, introduction and establishment of diseases and pathogens. The proposal does not include any higher risk activities such as transport of biological material. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting disease. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned and inspected. Personnel, vehicles and equipment will be restricted to work areas to minimise contact with sensitive habitat.
Interfere with the recovery of the species
The proposal would interfere with the recovery of these species by directly removing or modifying habitat, which is noted as a key threat for each species (DCCEEW 2024b). As described above, the proposal would remove or modify a maximum of 16.23 ha of habitat for these species at the proposal footprint. The only confirmed populations of these species at the proposal footprint is the Pink Cockatoo, and much of the habitat is marginal in terms of vegetation structure, species composition or general condition. These species may occupy the proposal footprint on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the habitat at the site. The site does not contain any confirmed breeding habitat, or any habitat features that suggest that it would be important to the recovery of the species. The proposal would make a minor contribution to habitat fragmentation but not sever an important connecting link or isolate any areas of habitat. The proposal would have a minor adverse impact on habitat critical to the survival of these species in the context of extensive areas of such habitat in the locality and surrounding region. The reduction in extent of habitat would be minor. The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Given this minor quantum of impact and the presence of alternative habitat resources the proposal would not interfere substantially with the recovery of these species.
Conclusion of assessment of significance
The project is not likely to have a significant impact on these endangered or critically endangered bird species given: – The limited extent of native vegetation to be removed in comparison to the extensive areas of alternative habitat in the locality. – The limited quality of habitat to be removed, noting that the proposal footprint does not contain any candidate nest trees for the Pink Cockatoo the very minor impacts to known Plains-wanderer habitat. – The proposal is unlikely to have an adverse effect on the size or breeding cycle of a population of these species. – The proposal will only result in a minor increase in the degree of fragmentation between retained areas of habitat for these species and will not result in any isolation of habitat. – The proposal footprint is unlikely to be important to the recovery of the species.

H-3 Vulnerable wetland bird species

This section presents the assessment of significance for the 'vulnerable wetland bird species': Sharp-tailed Sandpiper (*Calidris acuminata*) and Latham's Snipe (*Gallinago hardwickii*). These waders are also listed as migratory species under the EPBC Act and several international migratory bird agreements.

H-3-1 Sharp-tailed Sandpiper

Distribution

The Sharp-tailed Sandpiper spends the non-breeding season in Australia and occurs mostly to the south-east. The species is widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage (CTH DCCEEW 2024B).

Habitat requirements

The Sharp-tailed Sandpiper occupies muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline salt lakes inland. They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. They tend to occupy coastal mudflats mainly after ephemeral terrestrial wetlands have dried out, moving back during the wet season (CTH DCCEEW 2024B).

Habitat in the study area

The Sharp-tailed Sandpiper was not recorded during field surveys for the project.

The study area includes foraging habitat for this species in a small portion of the riparian and floodplain vegetation with suitable foraging substrate in mud exposed by shallow water. This would include shallow wetlands around the oxbow lake at Wanganella and shallow water upstream of the block bank at Hartwood. The extent of potential habitat would increase during occasional inundation of the broader floodplain to include inundated depressions in forest, woodland, chenopod shrubland and grassland where suitable vegetation cover is present. The proposal footprint does not comprise important habitat for the species as identified in MNES Guidelines 1.1 (DotE 2013). NSW Important Habitat Mapping (DPE 2023b) maps areas that support bird numbers exceeding the international and national significance thresholds and does not include any areas within or near the proposal footprint. During most seasons the proposal footprint would contain a small area of marginal habitat and would not frequently support large numbers of the species, if at all. For the purposes of this assessment, it is assumed that any individuals of the species that could occur at the proposal footprint would be part of the collectively important population of the species that migrates to southern Australia.

H-3-2 Latham's Snipe

Distribution

Latham's Snipe is a non-breeding visitor to south-eastern Australia and can occur west of the Great Dividing Range in NSW (Barret et al 2003).

Habitat requirements

Latham's Snipe occurs in permanent and ephemeral wetlands up to 2000 m above sea-level. They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity (CTH DCCEEW 2024B).

Habitat in the study area

Latham's Snipe was not recorded during field surveys for the project. The species has been recorded ~2 kilometres from the proposal footprint at Wanganella Swamp (NSW DCCEEW 2024a, Maher 2021).

The study area includes foraging habitat for this species in a small portion of the riparian and floodplain vegetation with suitable foraging substrate in mud exposed by shallow water. This would include shallow wetlands around the oxbow lake at Wanganella and shallow water upstream of the block bank at Hartwood. The extent of potential habitat would increase during occasional inundation of the broader floodplain to include inundated depressions in forest, woodland, chenopod shrubland and grassland where suitable vegetation cover is present. The proposal footprint does not comprise important habitat for the species as identified in MNES Guidelines 1.1 (DotE 2013) or MNES Guideline 3.21 (DEE 2017), which defines important habitat for this species as habitat that supports 18 or more individuals. NSW Important Habitat Mapping (DPE 2023b) maps areas that support bird numbers exceeding the international and national significance thresholds and does not include any areas within or near the proposal footprint. During most seasons the proposal footprint would contain a small area of marginal habitat and would not frequently support large numbers of the species, if at all. For the purposes of this assessment, it is assumed that any individuals of the species that could occur at the proposal footprint would be part of the collectively important population of the species that migrates to southern Australia.

EPBC Act Assessment of Significance
Vulnerable wetland bird species

According to the DotE (2013) 'significant impact criteria', 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

As described above, each of the populations of these vulnerable wetland bird species that could occur at the proposal footprint would comprise an important population as defined in the MNES Guidelines 1.1 (DotE 2013) or 3.21 (DEE 2017). The factors that could potentially lead to a long-term decrease in the size of these non-breeding migrant populations include direct harm, loss of foraging habitat affecting an ecologically significant proportion of local populations or significant interruption of migratory pathways. These species will forage in freshwater and saline habitats in both coastal and inland locations and will forage or rest in broadly suitable habitat when moving between areas of important habitat. The study area contains potential habitat for these migratory bird species including:

– high-quality foraging habitat in shallow wetlands and adjoining mudflats associated with frequently flooded oxbow lagoons on the northern floodplain of Billabong Creek at Wanganella and Forest Creek upstream of the block bank at Hartwood
– moderate quality, but infrequently inundated wetland habitat such as small, vegetated depressions in River Red Gum and Black Box woodland, Nitre Goosefoot shrubland and native grasslands on the outer floodplain of Billabong Creek
– marginal habitat associated with the deep, steep sided and permanent water bodies of Forest Creek and Billabong Creek.

There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system.

The proposed action would remove or modify potential habitat for these migratory species through:

– removal or modification of up to 10.94 ha of native vegetation at Hartwood for construction of the regulator, upgraded Forest Creek block bank, power supply and access tracks and associated infrastructure
– removal or modification of up to 5.29 ha of native vegetation at Wanganella for construction of the regulator, flood bypass channel, power supply and access tracks and associated infrastructure.

The proposed action would result in a minor impact on habitat connectivity comprising:

– creation or maintenance of permanent gaps in understorey vegetation up to 5 m wide along access tracks and at the regulators
– creation of partial gaps in vegetation cover and/or displacement of fauna from construction activity zones up to 200 m across, for a period of up to 1 months
– reduction in vegetation cover where trees have been removed or trimmed or groundcover has been disturbed until natural regeneration occurs.

The proposed action would not directly or indirectly affect more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and the oxbow lakes on the northern floodplain of Billabong Creek at Wanganella.

Given the small scale and duration of proposed works there is a minor risk of additional indirect impacts that is likely to be substantially mitigated through standard environmental management measures.

The disturbance of habitat for construction and periodic use of the project area by vehicles during operation is largely consistent with the current uses of the project area for agriculture, recreation and water management. The proposal would result in removal or modification of up to 16.23 ha of native vegetation and associated habitat for migratory wetland species. Much of the conservative disturbance footprint contains only marginal habitat that would be used infrequently, if at all, and would only be subject to partial or temporary impacts. Clearing of vegetation may, in general, directly harm resident fauna. Most resident birds could easily evade harm once construction activity begins at the proposal footprint. The proposal would include fauna management protocols including pre-clearing surveys and salvage and treatment of any resident fauna. Given the limited extent and duration of the proposed works the proposal is unlikely to directly harm a significant proportion of the populations of these migratory bird species, if any.

EPBC Act Assessment of Significance
Vulnerable wetland bird species

Noise and vibration, light, vehicle movement and other human activities during the operation of the proposal has the potential to disturb individuals in areas adjacent to the proposal footprint and may result in individuals foraging elsewhere. These indirect impacts resulting from the proposal would be temporary in nature and would only last about 18 months during construction of the proposal. Operation of the new regulators would not result in the generation of any additional noise or light. Vegetation management measures recommended for the proposal would help to avoid direct impacts and minimise indirect impacts on habitat adjoining the proposal footprint. Extensive areas of comparable or superior foraging habitat are present in surrounding areas and so the temporary displacement of fauna over short distances would have a minor consequence. The likely magnitude of edge effects or other indirect effects would not be sufficient to tangibly affect the life cycle of these species.

Operation of the proposal would have a minor impact on the hydrology of the Billabong Creek system in the context of the current degree of regulation. These hydrological changes are not likely to adversely affect wetland habitat for these species (Cardno 2024a, 2024b).

The proposal is therefore unlikely to adversely affect the lifecycle of these vulnerable bird species such that an important population would decline in size.

Reduce the area of occupancy of an important population

The proposal would reduce the overall area of occupancy of these species by reducing the extent of potential habitat. The proposal would remove or modify up to 16.23 ha of native vegetation that is potential habitat for these vulnerable bird species, both of which have areas of occupancy of many thousands of square kilometres. This maximum disturbance footprint is conservative and the majority would only be subject to partial or temporary impacts, noting:

- Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate.
- Vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate.
- Operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.
- The proposal footprint contains only small areas of moderate quality wetland habitat such as small, vegetated depressions in River Red Gum and Black Box woodland and macrophyte beds on the deep, steep sided and permanent water bodies of Forest Creek and Billabong Creek.

There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system. The proposal would not directly or indirectly affect more extensive and better-quality wetland habitat such as Wanganella Swamp and oxbow lakes on the northern floodplain of Billabong Creek at Wanganella that would be important in supporting periodic use of the local area by these migratory species.

The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. The proposal would create a small-scale gap in habitat that could be easily passed over or through by these mobile bird species during the construction of the proposal.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would not reduce the extent or quality of of habitat for these species.

Given the extent of habitat in the locality, populations of these species would persist in the local area and region. Therefore, despite removing or modifying a small area of marginal habitat the proposal would not reduce the overall area of occupancy of these species.

Fragment an existing important population into two or more populations

These species may travel through the proposal footprint on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the connectivity provided by the proposal footprint to support their continued use of the local area. The proposal would include removal of native vegetation cover and erection of structures in up to 16.23 ha of land, with impacts spread across two sites located around 45 km apart. Construction of the regulators and associated infrastructure would reduce connectivity through the proposal footprint by decreasing shelter by removing native vegetation and creating physical barriers. Removal of native vegetation cover and operation of the proposal would reduce connectivity within:

- an irregularly shaped area interrupting east-west habitat connectivity about 150 m wide, and north-south connectivity around 200 m wide at the Hartwood regulator CAZ
- irregularly shaped areas interrupting east-west and north-south habitat connectivity about 0.4 ha in size at the Forest Creek block bank CAZ at Hartwood
- an area interrupting east-west habitat connectivity up to 80 m wide at the Wanganella flood bypass channel
- an irregularly shaped area interrupting east-west habitat connectivity of about 146 m wide, and in the north-south connectivity around 130 m at the Wanganella regulator
- 5 m wide access track corridors
- up to 20 m wide power supply corridors.

EPBC Act Assessment of Significance
Vulnerable wetland bird species

These maximum disturbance areas are conservative and the majority would only be subject to partial or temporary impacts, noting:

– Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate.
– Vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate.
– Construction-only access tracks are generally aligned with existing tracks and/or through treeless areas and so upgrade for the proposal would require minimal vegetation removal.
– Operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

Human occupation may also deter these bird species from moving through the local area during construction. Construction would take approximately 18 months but would be paused during high flow periods.

Habitat connectivity would be maintained around the proposal footprint through extensive areas of similar Black Box, River Red Gum woodland, grassland and chenopod shrubland. The proposal would not isolate any areas of habitat or sever any connecting links. The proposal does not include the erection of any large or hazardous structures that would increase the risk or energy cost of movement of these migratory species. The proposal would create a small-scale gap in habitat that could be easily passed over or through by these migratory bird species. Therefore, despite removing or modifying a small area of habitat within fauna movement corridors the proposal would not fragment an important population of these bird species into two or more populations.

Adversely affect habitat critical to the survival of a species

No Critical Habitat for these vulnerable wetland bird species as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat (DCCEEW 2024b).

Habitat critical to the survival of the Sharp-tailed Sandpiper and Latham's Snipe is defined as areas that are necessary: for activities such as foraging, breeding, roosting, or dispersal; for the long-term maintenance of the species (including the maintenance of food species, such as macrobenthos); to maintain genetic diversity and long-term evolutionary development; or for the re-introduction of populations or recovery of the species. This extends to both high quality vegetated wetland or mudflat foraging habitat as well as periodically inundated grasslands or shrublands that may be used less frequently (DCCEEW 2024b).

The proposal would remove or modify up to 16.23 ha of native vegetation that may be critical foraging habitat that contributes to the maintenance of populations of these vulnerable bird species. This would comprise a minor adverse effect on habitat that is critical to the survival of these species given:

– The disturbance footprint contains only small areas of moderate quality wetland habitat such as small, vegetated depressions in River Red Gum and Black Box woodland and macrophyte beds on the deep, steep sided and permanent water bodies of Forest Creek and Billabong Creek. There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system.
– The proposed action would not directly or indirectly affect more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and oxbow lakes on the northern floodplain of Billabong Creek at Wanganella.
– Construction impacts would be minor and temporary, macrophytes and other understorey vegetation would be allowed to regenerate across the majority of the disturbance footprint and as such a negligible proportion of the wetland habitat available for these species in the locality would be removed or fragmented in the longer term.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. These hydrological changes are not likely to adversely affect wetland habitat for these species (Cardno 2024a, 2024b).

Disrupt the breeding cycle of an important population

As described above, each of the populations of these vulnerable wetland bird species that could occur at the proposal footprint would comprise an important population, composed of non-breeding migrants. Factors that could disrupt the breeding cycle of these populations include direct harm or loss of foraging habitat affecting an ecologically significant proportion of a population or significant interruption of migratory pathways.

Noting the limited extent and duration of the proposed works, and quality of habitat in the direct disturbance area, the proposal is unlikely to directly harm a significant proportion of the populations of these wetland bird species, if any. The proposal would remove or modify a small area of potential foraging habitat that may be used intermittently. There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system. The proposed action would not directly or indirectly affect more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and the oxbow lakes on the northern floodplain of Billabong Creek at Wanganella. The proposal would result in a minor reduction in the extent and/or quality of foraging habitat and would have a negligible effect on the ability of non-breeding migrants to maintain condition and then to travel to breeding habitat.

Given the small scale and duration of proposed works there is a minor risk of additional indirect impacts that is likely to be substantially mitigated through standard environmental management measures.

EPBC Act Assessment of Significance Vulnerable wetland bird species
The disturbance of habitat for construction and periodic use of the project area by vehicles during operation is largely consistent with the current uses of the study area for agriculture, recreation and water management. This is unlikely to affect these wetland bird species continued use of the area. The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. Habitat connectivity would be retained around the impact area through extensive areas of similar River Red Gum, Black Box woodland, chenopod shrubland and native grasslands. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of movement of these bird species. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. These hydrological changes are not likely to adversely affect wetland habitat for these species (Cardno 2024a, 2024b). The proposal is therefore unlikely to disrupt the breeding cycle of these bird species.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove or modify 16.23 ha of native vegetation that comprises potential habitat for these species in varying condition and quality. The proposal would result in direct impacts to native vegetation and associated habitat for these species through: – clearing of 5.29 ha of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure – clearing of 10.94 ha of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure. Construction within and adjacent to the Billabong Creek riparian corridor would remove or modify potential foraging and movement habitat for these wetland specialists. Construction of access roads and powerlines would affect marginal and infrequently used habitat for these species on higher parts of the floodplain. Construction of the new regulators may result in some clearing or disturbance of instream vegetation including macrophyte beds. These potential residual direct impacts to habitat comprise a conservative upper limit noting that the majority of the proposal footprint is marginal habitat that would be used infrequently if at all by these wetland birds and would be subject to partial and/or temporary vegetation removal. There are extensive areas of equivalent or higher quality wetland habitat in the local area including: – known foraging habitat for the Latham's Snipe and Sharp-tailed Sandpaper associated with shallow water and flats at Wanganella Swamp (Maher 2021) – oxbow lagoons with extensive areas of shallow, periodically inundated wetland vegetation that would comprise better value foraging habitat than the deep, steep-sided, permanent water bodies of Billabong Creek and Forest Creek – smaller patches of macrophyte beds and floodplain depressions equivalent to those in the disturbance footprint throughout the riparian corridor of the Billabong Creek system. The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. Habitat connectivity would be retained around the impact area through extensive areas of similar River Red Gum, Black Box woodland, chenopod shrubland and native grasslands. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of movement of these bird species. The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. These hydrological changes are not likely to adversely affect wetland habitat for these species (Cardno 2024a, 2024b). Given this minor quantum of impact and the presence of alternative, higher quality habitat resources the proposal is unlikely to have an adverse effect on habitat for these species to the extent that they would be likely to decline.
Result in invasive species that are harmful to a species becoming established in the species' habitat
Disturbance associated with vegetation clearing and vehicle traffic during construction or use of the regulator may, in general, increase the potential for the spread, introduction and establishment of weed and pest species. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting weed propagules. Environmental inductions, visual barriers and/or exclusion fencing will be used to exclude personnel and vehicles from habitat outside the proposal footprint. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned down (wash/blow down) and certified weed free prior to initial entry to site; all vehicles, plant and equipment will strictly adhere to the approved roads, tracks, easements and work areas to minimise contact with vegetation.

EPBC Act Assessment of Significance Vulnerable wetland bird species
Introduce disease that may cause the species to decline, or
As described for invasive species above, the proposal may, in general, increase the potential for the spread, introduction and establishment of diseases and pathogens. The proposal does not include any higher risk activities such as transport of biological material. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting disease. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned and inspected. Personnel, vehicles and equipment will be restricted to work areas to minimise contact with sensitive habitat.
Interfere with the recovery of the species
The proposal would interfere with the recovery of these species by directly removing or modifying habitat, which is noted as a key threat for each species (DCCEEW 2024b). As described above, the proposal would remove or modify a maximum of 16.23 ha of habitat for these species at the proposal footprint. These species have not been recorded at the proposal footprint and much of the habitat to be affected is marginal in terms of vegetation structure, species composition or general condition. These species may occupy the proposal footprint on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the habitat at the site. The site does not contain any confirmed breeding habitat, or any habitat features that suggest that it would be important to the recovery of these species. The proposal would make a minor contribution to habitat fragmentation but would not sever an important connecting link or isolate any areas of habitat. The proposal would have a minor adverse impact on habitat critical to the survival of these species in the context of extensive areas of such habitat in the locality and surrounding region. The reduction in extent of habitat would be minor. The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Given this minor quantum of impact and the presence of alternative habitat resources the proposal would not interfere substantially with the recovery of these species.
Conclusion of assessment of significance
The project is not likely to have a significant impact on these endangered bird species given: – The limited extent and quality of native vegetation to be removed in comparison to the extensive areas of extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system. – The proposed action would not directly or indirectly affect more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and oxbow lakes on the northern floodplain of Billabong Creek at Wanganella. – The proposal is unlikely to have an adverse effect on the size or breeding cycle of a population of these species. – The proposal will only result in a minor increase in the degree of fragmentation between retained areas of habitat for these species and will not result in any isolation of habitat. – Construction impacts would be minor and temporary, macrophytes and other understorey vegetation would be allowed to regenerate across the majority of the disturbance footprint and as such a negligible proportion of the wetland habitat available for these species in the locality would be removed or fragmented in the longer term. – Operation of the proposal would not have an adverse effect on wetland dependent species or their habitats.

H-4 Endangered wetland bird species

This section presents the assessment of significance for the 'endangered wetland bird species': Australasian Bittern (*Botaurus poiciloptilus*); Australian Painted Snipe (*Rostratula australis*); and Common Greenshank (*Tringa nebularia*).

H-4-1 Australasian Bittern

Distribution

The Australasian Bittern occurs from south-east Queensland to south-east South Australia, Tasmania and south-west Western Australia (Cth DCCEEW 2024b).

Habitat requirements

This species favours freshwater wetlands (and rarely estuarine habitats) vegetated with tall, dense vegetation dominated by sedges, rushes and/or reeds (flora species from the genera *Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, Bolboschoenus* and *Gahnia*) on muddy/peaty substrates. The Australasian Bittern forages in still water of 30 centimetres maximum depth at the edges of pools or waterways, or platforms/mats of vegetation over deep water (Cth DCCEEW 2024b).

Knowledge of the breeding habitats is poor, however data indicates that the species breeds in relatively deep, densely vegetated freshwater swamps and pools. The species builds nests in deep cover over shallow water (Cth DCCEEW 2024b). Large numbers of bitterns may breed in rice crops of the New South Wales' Riverina each year (Bitterns in Rice Project 2018).

Habitat in the study area

The Australasian Bittern was not recorded during field surveys for the project. The species has been recorded ~2 kilometres from the proposal footprint at Wanganella Swamp (NSW DCCEEW 2024a, Maher 2021). The study area includes foraging habitat and potential breeding habitat for this species in a small portion of riparian and floodplain vegetation with suitable shelter and foraging substrate. This would include shallow, densely vegetated wetlands around the oxbow lakes at Wanganella and occasional macrophyte beds on the banks of Billabong Creek and Forest Creek. The extent of potential habitat would increase during occasional inundation of the broader floodplain to include inundated depressions in forest, woodland, chenopod shrubland and grassland where suitable vegetation cover is present.

During most seasons the proposal footprint would contain a small area of marginal habitat and would not frequently support large numbers of the species, if at all.

H-4-2 Australian Painted Snipe

Distribution

The Australian Painted Snipe has been recorded at wetlands in all states of Australia and is most common in eastern Australia (Cth DCCEEW 2024b).

Habitat requirements

The Australian Painted Snipe is a wading bird inhabiting shallow, terrestrial, freshwater (occasionally brackish) wetlands in all states of Australia. These wetlands include temporary and permanent lakes, swamps, clay pans, inundated/waterlogged grasslands or saltmarsh, dams, rice crops, sewage dams and bore drains (Cth DCCEEW 2024b).

This species is migratory, breeding in southern Australia from August to February (Cth DCCEEW 2024b). Australian Painted Snipe breeding habitat requirements may be quite specific: shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby. Nest records are all, or nearly all, from or near small islands in freshwater wetlands, provided that these islands are a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover (Rogers et al. 2005).

Habitat in the study area

The Australian Painted Snipe was not recorded during field surveys for the project. The species has been recorded ~2 kilometres from the proposal footprint at Wanganella Swamp (NSW DCCEEW 2024a, Maher 2021). The study area includes foraging habitat and potential breeding habitat for this species in a small portion of the riparian and floodplain vegetation with suitable shelter and foraging substrate. This would include shallow wetlands around the oxbow lakes at Wanganella and shallow water upstream of the block bank at Hartwood. The extent of potential habitat would increase during occasional inundation of the broader floodplain to include inundated depressions in forest, woodland, chenopod shrubland and grassland where suitable vegetation cover is present.

During most seasons the proposal footprint would contain a small area of marginal habitat and would not frequently support large numbers of the species, if at all.

H-4-3 Common Greenshank

Distribution

The Common Greenshank does not breed in Australia; however, the species occurs in all types of wetlands and has the widest distribution of any shorebird in Australia. In New South Wales, the species has been recorded in most coastal regions. It is widespread west of the Great Dividing Range, especially between the Lachlan and Murray Rivers and the Darling River drainage basin, including the Macquarie Marshes, and north-west regions (Cth. DCCEEW 2024B).

Habitat requirements

The Common Greenshank is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. The species uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and salt flats. It will also use artificial wetlands, including sewage farms and saltworks dams, inundated rice crops and bores. The edges of the wetlands used are generally of mud or clay, occasionally of sand, and may be bare or with emergent or fringing vegetation, including short sedges and saltmarsh, mangroves, thickets of rushes, and dead or live trees.

The species is known to forage at edges of wetlands, in soft mud on mudflats, in channels, or in shallows around the edges of water often among pneumatophores of mangroves or other sparse, emergent or fringing vegetation, such as sedges or saltmarsh (Cth. DCCEEW 2024b).

Habitat in the study area

The Common Greenshank was not recorded during field surveys for the project. The species has been recorded ~2 kilometres from the proposal footprint at Wanganella Swamp (NSW DCCEEW 2024a, Maher 2021). The study area includes foraging habitat for this species in a small portion of the riparian and floodplain vegetation with suitable foraging substrate in mud exposed by shallow water. This would include shallow wetlands around the oxbow lakes at Wanganella and shallow water upstream in the vicinity of the block bank at Hartwood. The extent of potential habitat would increase during occasional inundation of the broader floodplain to include inundated depressions in forest, woodland, chenopod shrubland and grassland where suitable vegetation cover is present.

The proposal footprint does not comprise important habitat for the species as identified in MNES Guidelines 1.1 (DotE 2013) or MNES Guideline 3.21 (DEE 2017). NSW Important Habitat Mapping (DPE 2023b) maps areas that support bird numbers exceeding the international and national significance thresholds and does not include any areas within or near the proposal footprint. During most seasons the proposal footprint would contain a small area of marginal habitat and would not frequently support large numbers of the species, if at all. For the purposes of this assessment, it is assumed that any individuals of the species that could occur at the proposal footprint would be part of the collectively important population of the species that migrates to southern Australia.

EPBC Act Assessment of Significance
Endangered wetland birds

According to the DotE (2013) 'significant impact criteria', an action is likely to have a significant impact on a critically endangered or 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 factors that could potentially lead to a long-term decrease in the size of populations of these endangered wetland bird species include direct harm, loss of foraging habitat affecting an ecologically significant proportion of local populations, loss of breeding habitat or significant interruption of migratory pathways. These species will forage in freshwater and saline habitats in both coastal and inland locations and will forage or rest in broadly suitable habitat when moving between areas of important habitat. The study area contains potential habitat for these wetland bird species including:

– high-quality foraging habitat in shallow wetlands and adjoining mudflats associated with frequently flooded oxbow lagoons on the northern floodplain of Billabong Creek at Wanganella and Forest Creek upstream of the block bank at Hartwood
– moderate quality, but infrequently inundated wetland habitat such as small, vegetated depressions in River Red Gum and Black Box woodland, Nitre Goosefoot shrubland and native grasslands on the outer floodplain of Billabong Creek
– marginal habitat associated with the deep, steep sided and permanent water bodies of Forest Creek and Billabong Creek.

There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system.

The proposed action would remove or modify potential habitat for these migratory species through:

– removal or modification of up to 10.94 ha of native vegetation at Hartwood for construction of the regulator, upgraded Forest Creek block bank, power supply and access tracks and associated infrastructure
– removal or modification of up to 5.29 ha of native vegetation at Wanganella for construction of the regulator, flood bypass channel, power supply and access tracks and associated infrastructure.

The proposed action would result in a minor impact on habitat connectivity comprising:

– creation or maintenance of permanent gaps in understorey vegetation up to 5 m wide along access tracks and at the regulators
– creation of partial gaps in vegetation cover and/or displacement of fauna from construction activity zones up to 200 m across, for a period of up to 18 months
– reduction in vegetation cover where trees have been removed or trimmed or groundcover has been disturbed until natural regeneration occurs.

The proposed action would not directly or indirectly affect more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and the oxbow lakes on the northern floodplain of Billabong Creek at Wanganella.

Given the small scale and duration of proposed works there is a minor risk of additional indirect impacts that is likely to be substantially mitigated through standard environmental management measures.

The disturbance of habitat for construction and periodic use of the project area by vehicles during operation is largely consistent with the current uses of the project area for agriculture, recreation and water management. The proposal would result in removal or modification of up to 16.23 ha of native vegetation and associated habitat for these wetland bird species. Much of the conservative disturbance footprint contains only marginal habitat that would be used infrequently, if at all, and would only be subject to partial or temporary impacts. Clearing of vegetation may, in general, directly harm resident fauna. Most resident birds could easily evade harm once construction activity begins at the proposal footprint. The proposal would include fauna management protocols including pre-clearing surveys and salvage and treatment of any resident fauna. Given the limited extent of wetland vegetation in the impact area the proposal is highly unlikely to affect any occupied breeding habitat for the Australasian Bittern or Australian Painted Snipe. Noting the limited extent and duration of the proposed works the proposal is unlikely to directly harm a significant proportion of the populations of these wetland bird species, if any.

Noise and vibration, light, vehicle movement and other human activities during the operation of the proposal has the potential to disturb individuals, if nesting in areas adjacent to the proposal footprint and may result in individuals foraging elsewhere. These indirect impacts resulting from the proposal would be temporary in nature and would only last about 18 months during construction of the proposal. Operation of the new regulators would not result in the generation of any additional noise or light. Vegetation management measures recommended for the proposal would help to avoid direct impacts and minimise indirect impacts on habitat adjoining the proposal footprint. Extensive areas of comparable or superior foraging habitat are present in surrounding areas and so the temporary displacement of fauna over short distances would have a minor consequence. The likely magnitude of edge effects or other indirect effects would not be sufficient to tangibly affect the life cycle of these species.

Operation of the proposal would have a minor impact on the hydrology of the Billabong Creek system in the context of the current degree of regulation. These hydrological changes are not likely to adversely affect wetland habitat for these species (Cardno 2024a, 2024b).

The proposal is therefore unlikely to adversely affect the lifecycle of these wetland bird species such that a population would decline in size.

EPBC Act Assessment of Significance
Endangered wetland birds

Reduce the area of occupancy of the species

The proposal would reduce the overall area of occupancy of these species by reducing the extent of potential habitat. The proposal would remove or modify up to 16.23 ha of native vegetation that is potential habitat for these vulnerable bird species, all of which have areas of occupancy of many thousands of square kilometres. This maximum disturbance footprint is conservative and the majority would only be subject to partial or temporary impacts, noting:

– Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate.
– Vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate.
– Operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.
– The proposal footprint contains only small areas of moderate quality wetland habitat such as small, vegetated depressions in River Red Gum and Black Box woodland and macrophyte beds on the deep, steep sided and permanent water bodies of Forest Creek and Billabong Creek.

There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system. The proposal would not directly or indirectly affect more extensive and better-quality wetland habitat such as Wanganella Swamp and oxbow lakes on the northern floodplain of Billabong Creek at Wanganella that would be important in supporting periodic use of the local area by these migratory species.

The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. The proposal would create a small-scale gap in habitat that could be easily passed over or through by these mobile bird species during the construction of the proposal.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would not reduce the extent or quality of of habitat for these species.

Given the extent of habitat in the locality, populations of these species would persist in the local area and region. Therefore, despite removing or modifying a small area of marginal habitat the proposal would not reduce the overall area of occupancy of these species.

Fragment an existing population into two or more populations

These species may travel through the proposal footprint on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the connectivity provided by the proposal footprint to support their continued use of the local area. The proposal would include removal of native vegetation cover and erection of structures in up to 16.23 ha of land, with impacts spread across two sites located around 45 km apart. Construction of the regulators and associated infrastructure would reduce connectivity through the proposal footprint by decreasing shelter by removing native vegetation and creating physical barriers. Removal of native vegetation cover and operation of the proposal would reduce connectivity within:

– an irregularly shaped area interrupting east-west habitat connectivity about 150 m wide, and north-south connectivity around 200 m wide at the Hartwood regulator CAZ
– irregularly shaped areas interrupting east-west and north-south habitat connectivity about 0.4 ha in size at the Forest Creek block bank CAZ at Hartwood
– an area interrupting east-west habitat connectivity up to 80 m wide at the Wanganella flood bypass channel
– an irregularly shaped area interrupting east-west habitat connectivity of about 146 m wide, and in the north-south connectivity around 130 m at the Wanganella regulator
– 5 m wide access track corridors
– up to 20 m wide power supply corridors.

These maximum disturbance areas are conservative and the majority would only be subject to partial or temporary impacts, noting:

– Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate.
– Vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate.
– Construction-only access tracks are generally aligned with existing tracks and/or through treeless areas and so upgrade for the proposal would require minimal vegetation removal.
– Operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

Human occupation may also deter these bird species from moving through the local area during construction. Construction would take approximately 18 months but would be paused during high flow periods.

EPBC Act Assessment of Significance Endangered wetland birds
Habitat connectivity would be maintained around the proposal footprint through extensive areas of similar Black Box, River Red Gum woodland, grassland and chenopod shrubland. The proposal would not isolate any areas of habitat or sever any connecting links. The proposal does not include the erection of any large or hazardous structures that would increase the risk or energy cost of movement of these mobile species. The proposal would create a small-scale gap in habitat that could be easily passed over or through by these bird species. Therefore, despite removing or modifying a small area of habitat within fauna movement corridors the proposal would not fragment a population of these bird species into two or more populations.
Adversely affect habitat critical to the survival of a species
No Critical Habitat for these endangered wetland bird species as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat (DCCEEW 2024c). Habitat critical to the survival of the Australasian Bittern includes all natural habitat (including constructed wetlands with suitable habitat) in which the Australasian Bittern is known or likely to occur (DCCEEW 2024b). Habitat critical to the survival of the Australian Painted Snipe is broadly defined and includes any natural wetland habitat where the species is known or likely to occur; and any location outside the above area that may be periodically occupied by the species when wetland conditions are favourable (Commonwealth of Australia 2022). Habitat critical to the survival of the Common Greenshank is defined as areas that are necessary: for activities such as foraging, breeding, roosting, or dispersal; for the long-term maintenance of the species (including the maintenance of food species, such as macrobenthos); to maintain genetic diversity and long-term evolutionary development; or for the re-introduction of populations or recovery of the species. This extends to feeding and roosting habitat in freshwater and estuarine wetlands as well as flooded grasslands (DCCEEW 2024b). The proposal would remove or modify up to 16.23 ha of native vegetation that may be critical habitat that contributes to the maintenance of populations of these wetland bird species. The proposal would remove or modify up to 16.23 ha of native vegetation that may be critical foraging habitat that contributes to the maintenance of populations of these vulnerable bird species. This would comprise a minor adverse effect on habitat that is critical to the survival of these species given: – The disturbance footprint contains only small areas of moderate quality wetland habitat such as small, vegetated depressions in River Red Gum and Black Box woodland and macrophyte beds on the deep, steep sided and permanent water bodies of Forest Creek and Billabong Creek. There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system. – The proposed action would not directly or indirectly affect more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and oxbow lakes on the northern floodplain of Billabong Creek at Wanganella. – Construction impacts would be minor and temporary, macrophytes and other understorey vegetation would be allowed to regenerate across the majority of the disturbance footprint and as such a negligible proportion of the wetland habitat available for these species in the locality would be removed or fragmented in the longer term. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. These hydrological changes are not likely to adversely affect wetland habitat for these species (Cardno 2024a, 2024b).
Disrupt the breeding cycle of a population
The population of the Common Greenshank that could occur at the proposal footprint would be composed of non-breeding migrants. Given the limited extent of wetland vegetation in the impact area the proposal is highly unlikely to affect any occupied breeding habitat for the Australasian Bittern or Australian Painted Snipe. Factors that could disrupt the breeding cycle of these populations include direct harm or loss of foraging habitat affecting an ecologically significant proportion of a population or significant interruption of migratory pathways. Noting the limited extent and duration of the proposed works, and quality of habitat in the direct disturbance area, the proposal is unlikely to directly harm a significant proportion of the populations of these wetland bird species, if any. The proposal would remove or modify a small area of potential foraging habitat that may be used intermittently. There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system. The proposed action would not directly or indirectly affect more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and the oxbow lakes on the northern floodplain of Billabong Creek at Wanganella. The proposal would result in a minor reduction in the extent and/or quality of foraging habitat and would have a negligible effect on the ability of non-breeding migrants to maintain condition and then to travel to breeding habitat. Given the small scale and duration of proposed works there is a minor risk of additional indirect impacts that is likely to be substantially mitigated through standard environmental management measures. The disturbance of habitat for construction and periodic use of the project area by vehicles during operation is largely consistent with the current uses of the study area for agriculture, recreation and water management. This is unlikely to affect these wetland bird species continued use of the area.

EPBC Act Assessment of Significance Endangered wetland birds
The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. Habitat connectivity would be retained around the impact area through extensive areas of similar River Red Gum, Black Box woodland, chenopod shrubland and native grasslands. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of movement of these bird species. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. These hydrological changes are not likely to adversely affect wetland habitat for these species (Cardno 2024a, 2024b). The proposal is therefore unlikely to disrupt the breeding cycle of these bird species.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove or modify 16.23 ha of native vegetation that comprises potential habitat for these species in varying condition and quality. The proposal would result in direct impacts to native vegetation and associated habitat for these species through: – clearing of 5.29 ha of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure. – clearing of 10.94 ha of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure. Construction within and adjacent to the Billabong Creek riparian corridor would remove or modify potential foraging and movement habitat for these wetland specialists. Construction of access roads and powerlines would affect marginal and infrequently used habitat for these species on higher parts of the floodplain. Construction of the new regulators may result in some clearing or disturbance of instream vegetation including macrophyte beds. These potential residual direct impacts to habitat comprise a conservative upper limit noting that the majority of the proposal footprint is marginal habitat that would be used infrequently if at all by these wetland birds and would be subject to partial and/or temporary vegetation removal. There are extensive areas of equivalent or higher quality wetland habitat in the local area including: – suitable breeding habitat for the Australasian Bittern and Australian Painted Snipe associated with extensive macrophyte beds at Wanganella Swamp (Maher 2021) – known foraging habitat for the Common Greenshank associated with shallow water and flats at Wanganella Swamp (Maher 2021) – oxbow lagoons with extensive areas of shallow, periodically inundated wetland vegetation that would comprise better value foraging habitat than the deep, steep-sided, permanent water bodies of Billabong Creek and Forest Creek – smaller patches of macrophyte beds and floodplain depressions equivalent to those in the disturbance footprint throughout the riparian corridor of the Billabong Creek system. The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. Habitat connectivity would be retained around the impact area through extensive areas of similar River Red Gum, Black Box woodland, chenopod shrubland and native grasslands. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of movement of these bird species. The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. These hydrological changes are not likely to adversely affect wetland habitat for these species (Cardno 2024a, 2024b). Given this minor quantum of impact and the presence of alternative, higher quality habitat resources the proposal is unlikely to have an adverse effect on habitat for these species to the extent that they would be likely to decline.
Result in invasive species that are harmful to a species becoming established in the species' habitat
Disturbance associated with vegetation clearing and vehicle traffic during construction or use of the regulator may, in general, increase the potential for the spread, introduction and establishment of weed and pest species. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting weed propagules. Environmental inductions, visual barriers and/or exclusion fencing will be used to exclude personnel and vehicles from habitat outside the proposal footprint. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned down (wash/blow down) and certified weed free prior to initial entry to site; all vehicles, plant and equipment will strictly adhere to the approved roads, tracks, easements and work areas to minimise contact with vegetation.

EPBC Act Assessment of Significance Endangered wetland birds
Introduce disease that may cause the species to decline, or
As described for invasive species above, the proposal may, in general, increase the potential for the spread, introduction and establishment of diseases and pathogens. The proposal does not include any higher risk activities such as transport of biological material. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting disease. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned and inspected. Personnel, vehicles and equipment will be restricted to work areas to minimise contact with sensitive habitat.
Interfere with the recovery of the species
The proposal would interfere with the recovery of these species by removing or modifying habitat, which is noted as a key threat for each species (DCCEEW 2024b). As described above, the proposal would remove or modify a maximum of 16.23 ha of habitat for these species at the proposal footprint. There are no confirmed populations of these species at the proposal footprint and much of the potential habitat is marginal in terms of vegetation structure, species composition or general condition. These species may occupy the proposal footprint on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the habitat at the site. The site does not contain any confirmed breeding habitat, or any habitat features that suggest that it would be important to the recovery of the species. The proposal would make a minor contribution to habitat fragmentation but not sever an important connecting link or isolate any areas of habitat. The proposal would have a minor adverse impact on habitat critical to the survival of these species in the context of extensive areas of such habitat in the locality and surrounding region. The reduction in extent of habitat would be minor. The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Given this minor quantum of impact and the presence of alternative habitat resources the proposal would not interfere substantially with the recovery of these species.
Conclusion of assessment of significance
The project is not likely to have a significant impact on these endangered bird species given: – The limited extent of native vegetation to be removed in comparison to the extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system. – The proposed action would not directly or indirectly affect more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and oxbow lakes on the northern floodplain of Billabong Creek at Wanganella. – The limited quality of habitat to be removed, noting that the proposal footprint does not contain any known or potential breeding habitat. – The proposal is unlikely to have an adverse effect on the size or breeding cycle of a population of these species. – The proposal will only result in a minor increase in the degree of fragmentation between retained areas of habitat for these species and will not result in any isolation of habitat. – Construction impacts would be minor and temporary, macrophytes and other understorey vegetation would be allowed to regenerate across the majority of the disturbance footprint and as such a negligible proportion of the wetland habitat available for these species in the locality would be removed or fragmented in the longer term. – Operation of the proposal would not have an adverse effect on wetland dependent species or their habitats.

H-5 Migratory shorebirds of semi-arid wetlands and grasslands

This section presents the assessment of significance for 'migratory shorebirds of semi-arid wetlands and grasslands': Sharp-tailed Sandpiper (*Calidris acuminata*), Pectoral Sandpiper (*Calidris melanotos*), Common Greenshank (*Tringa nebularia*) and Latham's Snipe (*Gallinago hardwickii*). Latham's Snipe and the Sharp-tailed Sandpiper are also listed as a vulnerable species under the EPBC Act and information about the species' distribution and ecology is provided in appendix section H-3 above. The Common Greenshank is also listed as an endangered species under the EPBC Act and information about the species' distribution and ecology is provided in appendix section H-4 above.

H-5-1 Pectoral Sandpiper

Distribution

The Pectoral Sandpiper is listed as a migratory bird species under the JAMBA and ROKAMBA. The Pectoral Sandpiper migrates from its breeding grounds in Russia and North America, to Australia and other areas of Australasia where it is transient. In NSW, the species can occur in the lower western and Riverina regions although the species is widespread. The project area provides suitable habitat for the species at shallow wetlands, particularly where grass fringes water (where they are known to forage). The project is very unlikely to lead to a long-term decrease in the size of a population of this species, reduce the area of occupancy of this species, or fragment an existing population. The operational levels may have a small indirect impact as they could possibly increase the floodplain wetland area (Cth DCCEEW 2024b).

Records of the Pectoral Sandpiper are widespread but scattered including coastal records from Casino and Ballina, south to Ulladulla. West of the Great Divide, the species is widespread in the Riverina and Lower Western regions (Cth DCCEEW 2024b).

Habitat requirements

The Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. The species has also been recorded in swamp overgrown with lignum. They forage in shallow water or soft mud at the edge of wetlands (Cth DCCEEW 2024b).

Habitat in the study area

The Pectoral Sandpiper was not recorded during field surveys for the project. The study area includes potential foraging habitat for this species in a small portion of the riparian and floodplain vegetation with suitable foraging substrate in mud exposed by shallow water. This would include shallow wetlands around the oxbow lakes at Wanganella and shallow water upstream in the vicinity of the block bank at Hartwood. The extent of potential habitat would increase during occasional inundation of the broader floodplain to include inundated depressions in forest, woodland, chenopod shrubland and grassland where suitable vegetation cover is present.

The proposal footprint does not comprise important habitat for the species as identified in MNES Guidelines 1.1 (DotE 2013) or MNES Guideline 3.21 (DEE 2017). NSW Important Habitat Mapping (DPE 2023b) maps areas that support bird numbers exceeding the international and national significance thresholds and does not include any areas within or near the proposal footprint. During most seasons the proposal footprint would contain a small area of marginal habitat and would not frequently support large numbers of the species, if at all.

EPBC Act of Significance Migratory shorebirds of semi-arid wetlands and grasslands
According to the DotE (2013) 'significant impact criteria', An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will: **Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species**
The proposal footprint does not comprise important habitat for these species as identified in MNES Guidelines 1.1 (DotE 2013) or MNES Guideline 3.21 (DEE 2017). NSW Important Habitat Mapping (DPE 2023b) maps areas that support bird numbers exceeding the international and national significance thresholds and does not include any areas within or near the proposal footprint. During most seasons the proposal footprint would contain a small area of marginal habitat and would not frequently support large numbers of these species, if any at all. The proposal would remove or modify 16.23 ha of native vegetation that comprises potential habitat for these species in varying condition and quality. The proposal would result in direct impacts to native vegetation and associated habitat for these species through: – clearing of 5.29 ha of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure. – clearing of 10.94 ha of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure. Construction within and adjacent to the Billabong Creek riparian corridor would remove or modify potential foraging and movement habitat for these wetland specialists. Construction of access roads and powerlines would affect marginal and infrequently used habitat for these species on higher parts of the floodplain. Construction of the new regulators may result in some clearing or disturbance of instream vegetation including shallow water over mudflats. These potential residual direct impacts to habitat comprise a conservative upper limit noting that the majority of the proposal footprint is marginal habitat that would be used infrequently if at all by these wetland birds and would be subject to partial and/or temporary vegetation removal. There are extensive areas of equivalent or higher quality wetland habitat in the local area including: – known foraging habitat for the Common Greenshank associated with shallow water and flats at Wanganella Swamp (Maher 2021) – oxbow lagoons with extensive areas of shallow, periodically inundated wetland vegetation that would comprise better value foraging habitat than the deep, steep-sided, permanent water bodies of Billabong Creek and Forest Creek – smaller patches of shallow water on the margins of drainage lines and in floodplain depressions equivalent to those in the disturbance footprint throughout the riparian corridor of the Billabong Creek system. The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. Impacts would be spread across two sites located around 45 km apart. Habitat connectivity would be retained around the impact area through extensive areas of similar River Red Gum, Black Box woodland, chenopod shrubland and native grasslands. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of migration of these bird species. The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. These hydrological changes are not likely to adversely affect wetland habitat for these species (Cardno 2024a, 2024b). Given this minor quantum of impact and the presence of alternative, higher quality habitat resources in the local area and region, the proposal is unlikely to have an adverse effect on habitat for these species to the extent that they would be likely to decline.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or
As described above the proposal footprint does not comprise important habitat for the species as identified in MNES Guidelines 1.1 (DotE 2013) or MNES Guideline 3.21 (DEE 2017) or based on NSW Important Habitat Mapping (DPE 2023b). Disturbance associated with vegetation clearing and vehicle traffic during construction or use of the regulator may, in general, increase the potential for the spread, introduction and establishment of weed and pest species. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting weed propagules. Environmental inductions, visual barriers and/or exclusion fencing will be used to exclude personnel and vehicles from habitat outside the proposal footprint. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned down (wash/blow down) and certified weed free prior to initial entry to site; all vehicles, plant and equipment will strictly adhere to the approved roads, tracks, easements and work areas to minimise contact with vegetation

EPBC Act of Significance Migratory shorebirds of semi-arid wetlands and grasslands
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.
The populations of the Sharp-tailed Sandpiper, Pectoral Sandpiper and Common Greenshank that could occur at the proposal footprint would be composed of non-breeding migrants. Factors that could disrupt the breeding cycle of these populations include direct harm or loss of foraging habitat affecting an ecologically significant proportion of a population or significant interruption of migratory pathways. Noting the limited extent and duration of the proposed works, and quality of habitat in the direct disturbance area, the proposal is unlikely to directly harm a significant proportion of the populations of these wetland bird species, if any. The proposal would remove or modify a small area of potential foraging habitat that may be used intermittently. There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system. The proposed action would not directly or indirectly affect more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and the oxbow lakes on the northern floodplain of Billabong Creek at Wanganella. The proposal would result in a minor reduction in the extent and/or quality of foraging habitat and would have a negligible effect on the ability of non-breeding migrants to maintain condition and then to travel to breeding habitat. Given the small scale and duration of proposed works there is a minor risk of additional indirect impacts that is likely to be substantially mitigated through standard environmental management measures. The disturbance of habitat for construction and periodic use of the project area by vehicles during operation is largely consistent with the current uses of the study area for agriculture, recreation and water management. This is unlikely to affect these wetland bird species continued use of the area. The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. Impacts would be spread across two sites located around 45 km apart. Habitat connectivity would be retained around the impact area through extensive areas of similar River Red Gum, Black Box woodland, chenopod shrubland and native grasslands. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of movement of these bird species. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. These hydrological changes are not likely to adversely affect wetland habitat for these species (Cardno 2024a, 2024b). The proposal is therefore unlikely to disrupt the breeding cycle of these bird species.
Conclusion of assessment of significance
The project is not likely to have a significant impact on these migratory wetland bird species given: – The limited extent of native vegetation to be removed in comparison to the extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system. – The proposed action would not directly or indirectly affect the more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and oxbow lakes on the northern floodplain of Billabong Creek at Wanganella. – The limited quality of habitat to be removed, noting that the proposal footprint does not contain any recognised any important habitat. – The proposal is unlikely to have an adverse effect on the size or breeding cycle of a population of these species. – The proposal will only result in a minor increase in the degree of fragmentation between retained areas of habitat for these species and will not result in any isolation of habitat. – Construction impacts would be minor and temporary, understorey vegetation would be allowed to regenerate across the majority of the disturbance footprint and as such a negligible proportion of the wetland habitat available for these species in the locality would be removed or fragmented in the longer term. – Operation of the proposal would not have an adverse effect on wetland dependent species or their habitats.

H-6 Southern Bell Frog (*Litoria raniformis*)

Distribution

The Southern Bell Frog is distributed along the Murray and Murrumbidgee rivers and their tributaries, the southern slopes of the Monaro district and the central southern tablelands as far north as Tarana, near Bathurst (Cth DCCEEW 2024b).

Habitat requirements

The species inhabits permanent and ephemeral swamps and billabongs along floodplains and river valleys and is associated with Black Box, Nitre Goosefoot and River Red Gum wetland communities. Emergent and aquatic vegetation such as Common Reed (*Phragmites australis)* is important for breeding habitat. Coarse woody debris also forms important habitat on the edges of swamps and billabongs for shelter outside of the breeding season (Cth DCCEEW 2024b).

Habitat in the study area

Southern Bell Frogs were recorded by GHD ecologists on the banks of Billabong Creek and associated oxbow lagoons in the vicinity of the Wanganella Weir in February, March and September 2023. The species was also detected by call on an Audiomoth recording device in the vicinity of the Forest Creek block bank in March 2023 and observed downstream on the banks of Billabong Creek and associated oxbow lagoons in the vicinity of Caroonboon Weir in February 2023.

There is suitable breeding and foraging habitat for the Southern Bell Frog across much of the Wanganella and Hartwood sites. This includes within: PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland, PCT 10 River Red Gum - Black Box woodland wetland and PCT 13 Black Box - Lignum woodland wetland according to the TBDC (NSW DCCEEW 2024b); PCT 160 Nitre Goosefoot shrubland wetland by direct observation; and potentially also PCT 44 and PCT 46 floodplain grasslands during wet periods.

Southern Bell Frog species polygons have been mapped according to the BAM and align with aquatic habitats linked directly to records and a buffer, incorporating the PCTs with which the species is associated, of 200 metres radius from the top of bank. Species polygons include minimum 50-metre-wide corridors of native and non-native vegetated areas linking the available waterbodies (DPIE 2020b). Species polygons have been mapped in the proposal footprint as shown on Figure 5.10 including 5.25 ha of breeding, shelter and travelling habitat at Hartwood and 3.28 ha at Wanganella. The quantum of impact to the species may include additional areas of potential habitat as described above.

For Southern Bell Frog populations in the region encompassing the study area, frogs are concentrated in refugia prior to flooding, then disperse across the landscape during flooding / breeding events (Wassens et. al. 2008). Breeding is triggered by flooding of ephemeral waterbodies during spring or summer, and the larval period can be as short as two months (Clemann and Gillespie 2012). The presence of occupied breeding habitat, the abundance and mobility of adult Southern Bell Frogs and the associated risk of impact would depend on the timing of construction and prevailing rainfall conditions. During wet periods the proposal footprint or nearby areas may contain breeding habitat associated with inundated floodplain depressions that may require additional measures to avoid or minimise impacts. A pre-construction assessment of the Southern Bell Frog population would be conducted including supplementary survey as appropriate if the construction period coincides with potential breeding events as detailed in Table 8.9. If this assessment reveals occupied Southern Bell Frog breeding habitat at the study area, then further impact mitigation may be appropriate.

Any viable population of this species is considered to be an important population. A viable population is one which is not isolated from other populations or water bodies, such that it has the opportunity to interact with other nearby populations or has the ability to establish new populations when water bodies fill and become available (DEWHA 2009). The number and distribution of records of the Southern Bell Frog between Hartwood and Caroonboon suggests that there is a viable local population that extends through this reach of the Billabong Creek system and that could interact with other populations and/or expand when waterbodies fill on the broader floodplain. Therefore, the proposal would affect an important population of the species.

No critical habitat for the species has been identified (DEWHA 2009, Clemann and Gillespie 2012).

EPBC Act Assessment of Significance Southern Bell Frog (*Litoria raniformis*)
According to the DotE (2013) 'significant impact criteria', 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**
As described above, the population of Southern Bell Frog recorded in the proposal footprint and study area would comprise an important population for this species. The factors that could potentially lead to a long-term decrease in the size of an important population of this species include direct harm, loss of habitat affecting a significant proportion of an important local population, loss of important breeding habitat, isolation of a population or introduction of disease. The proposal would result in direct impacts to native vegetation and associated habitat for this species through removal or modification of: – 3.28 ha of core habitat within Southern Bell Frog species polygons at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure – 5.25 ha within species polygons at Hartwood for construction of the regulator, power supply and associated infrastructure. The total quantum of impact to the species may include removal or modification of additional areas of potential habitat that is in non-associated PCTs and/or farther from waterbodies as described above. The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. Clearing of vegetation and vehicle traffic may, in general, directly harm resident Southern Bell Frogs. The proposal would remove or modify a total of 16.23 ha of native vegetation including aquatic, frequently inundated wetlands and rarely inundated terrestrial vegetation. The proposal would include fauna management protocols including pre-construction Southern Bell Frog population assessment, pre-clearing surveys and salvage and treatment of any resident fauna. This would partially mitigate impacts on the local populations of the species if present in the proposal footprint during vegetation clearing works. Noise and vibration, light, vehicle movement and other human activities during the construction of the proposal has the potential to disturb individuals in areas adjacent to the proposal footprint and may result in individuals dispersing elsewhere to forage, breed and shelter. These indirect impacts resulting from the proposal would be temporary in nature and would only last about 18 months during construction of the proposal. Operation of the new regulators would not result in the generation of any additional noise or light. Vegetation management measures recommended for the proposal would help to avoid direct impacts and minimise indirect impacts on habitat adjoining the proposal footprint. Extensive areas of comparable foraging, breeding and shelter habitat are present in surrounding areas and so the temporary displacement of this species over short distances would have a minor consequence. The likely magnitude of edge effects or other indirect effects would not be sufficient to tangibly affect the life cycle of the species. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. These hydrological changes are not likely to adversely affect wetland habitat for the species (Cardno 2024a, 2024b). As discussed under the relevant criteria below, the proposal is unlikely to introduce or exacerbate the severity of a disease such that an important population would decline. The proposal is therefore considered unlikely to adversely affect the lifecycle of the Southern Fell Frog such that an important population would decline in size.
Reduce the area of occupancy of an important population
The proposal would reduce the overall area of occupancy of the species by reducing the extent of potential habitat. The proposal would remove or modify up to 8.53 ha of core habitat within Southern Bell Frog species polygons within a total a total of 16.23 ha of native vegetation that is potential habitat for the Southern Bell Frog, which has an area of occupancy of many thousands of square kilometres. This maximum disturbance footprint is conservative, and the majority would only be subject to partial or temporary impacts, noting: – other than the regulator structures and their immediate vicinity, understorey vegetation would be allowed to regenerate – vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate – operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes – the proposal footprint contains only small areas of moderate quality wetland habitat such as small, vegetated depressions in River Red Gum and Black Box woodland and macrophyte beds on the deep, steep sided and permanent water bodies of Forest Creek and Billabong Creek.

EPBC Act Assessment of Significance
Southern Bell Frog (*Litoria raniformis*)

There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system. The proposal would not directly or indirectly affect more extensive and better-quality breeding habitat such as Wanganella Swamp and oxbow lakes on the northern floodplain of Billabong Creek at Wanganella.

The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat.

Noise, dust and human activity may affect the quality or occupation of habitat adjoining the proposal footprint during the 18-month construction period. The proposal would create a small-scale gap in habitat; however habitat connectivity would be maintained between the adjacent areas of suitable aquatic and terrestrial habitat in the study area and broader locality.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would not reduce the extent or quality of Southern Bell Frog habitat.

Given the extent of quality habitat in the surrounding locality and small area of habitat to be removed, the small reduction in the area of occupancy of an important population of Southern Bell Frog would have a minor impact and the species would continue to persist in the local area and surrounding region.

Fragment an existing important population into two or more populations

The recorded population may travel through the proposal footprint on occasion as an extension of their use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the connectivity provided by the proposal footprint to support their continued use of the local area. The proposal would include removal of native vegetation cover and erection of structures in up to 16.23 ha of land containing potential habitat for the species, of which 8.53 ha is suitable vegetation within 200 m of waterbodies that is more likely to be important as a movement corridor. Construction of the regulators and associated infrastructure would reduce connectivity throughout the proposal footprint by decreasing vegetation cover, removing shelter sites on trees or woody debris and creating physical barriers.

Removal of native vegetation cover and operation of the proposal would reduce connectivity within:

– an irregularly shaped area interrupting east-west habitat connectivity about 150 m wide, and north-south connectivity around 200 m wide at the Hartwood regulator CAZ
– irregularly shaped areas interrupting east-west and north-south habitat connectivity about 0.4 ha in size at the Forest Creek block bank CAZ at Hartwood
– an area interrupting east-west habitat connectivity up to 80 m wide at the Wanganella flood bypass channel
– an irregularly shaped area interrupting east-west habitat connectivity of about 146 m wide, and in the north-south connectivity around 130 m at the Wanganella regulator
– 5 m wide access track corridors
– up to 20 m wide power supply corridors.

These maximum disturbance areas are conservative and the majority would only be subject to partial or temporary impacts, noting:

– Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate.
– Vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate.
– Construction-only access tracks are generally aligned with existing tracks and/or through treeless areas and so upgrade for the proposal would require minimal vegetation removal.
– Operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

Human occupation may also deter the species from dispersing through the study area during construction. Construction will take approximately 18 months but would be paused during high flow periods.

Removal of vegetation and construction of regulator infrastructure would only result in a minor increase in the degree of fragmentation between retained areas of habitat for the species and would not result in the isolation of any habitat. Impacts would be spread across two sites located around 45 km apart. Habitat connectivity would be maintained in the proposal footprint and adjacent areas through extensive areas of similar Black Box, River Red Gum woodland and chenopod shrubland. The proposal would not isolate any areas of habitat or sever any connecting links. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of movement of the species. Given the extent of habitat in the study area and surrounding locality, the important population of the species would persist in the study area and locality. Therefore, despite removing or modifying a small area of habitat the proposal would not fragment an important population of the Southern Bell Frog into two or more populations.

EPBC Act Assessment of Significance
Southern Bell Frog (*Litoria raniformis*)

Adversely affect habitat critical to the survival of a species

No Critical Habitat for the Southern Bell Frog as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat (DCCEEW 2024c). According to the conservation advice for the species important habitat for the species includes Black Box and River Red Gum woodlands, chenopod shrubland and flood lands (DCCEEW 2024b). Critical features of these habitat types appear to be that they are large, continuous areas containing both permanent and ephemeral waterbodies that undergo regular flooding and are surrounded by areas containing suitable refugia in the form of ground debris, vegetation cover and cracking soils (Clemann and Gillespie 2012).

The proposal would remove or modify up to 16.23 ha of land containing potential habitat for the species, of which 8.53 ha is suitable vegetation within 200 m of waterbodies that is more likely to be habitat critical to the survival of the Southern Bell Frog. This is a very small proportion of the extent of similar critical habitat in the surrounding study area and locality. This would comprise a minor adverse effect on habitat that is critical to the survival of this species given:

– The disturbance footprint contains only small areas of wetland habitat such as small, vegetated depressions in River Red Gum and Black Box woodland and macrophyte beds on the deep, steep sided and permanent water bodies of Forest Creek and Billabong Creek. There are extensive areas of connected, alternative habitat with similar value throughout the Billabong Creek system.
– The proposed action would not directly or indirectly affect more extensive and better-quality wetland habitat in the local area such as Wanganella Swamp and oxbow lakes on the northern floodplain of Billabong Creek at Wanganella.
– Construction impacts would be minor and temporary, macrophytes and other understorey vegetation would be allowed to regenerate across the majority of the disturbance footprint and as such a negligible proportion of the wetland habitat available for the species in the locality would be removed or fragmented in the longer term.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. These hydrological changes are not likely to adversely affect habitat critical to the survival of the species (Cardno 2024a, 2024b).

Disrupt the breeding cycle of an important population

The Southern Bell Frog relies on permanent or seasonally flooded water bodies for breeding. Breeding occurs during the warmer months (September to April) and is triggered by flooding or a significant rise in water levels. Tadpoles have an aquatic period which can vary between two and 15 months. Outside the breeding season animals disperse away from the water and take shelter beneath ground debris such as fallen timber and bark, rocks, grass clumps and in deep soil cracks (DEWHA 2009).

The proposal would remove or modify up to 16.23 ha of land containing potential habitat for the species, of which 8.53 ha is suitable vegetation within 200 m of waterbodies that may contain breeding habitat and/or connect areas of breeding habitat during wet periods. The proposal may disrupt the breeding cycle of the species by reducing foraging resources and disrupting breeding sites when tadpoles are present, noting construction is expected to take 18 months which would coincide the breeding season of this species. Areas of potential breeding habitat are present in the proposal footprint including in the vicinity of the Forest Creek block bank at Hartwood and flood bypass channel at Wanganella. A pre-construction Southern Bell Frog population assessment will be completed. Pre-clearing surveys would be undertaken prior to construction (subject to appropriate seasonal conditions and flooding) to confirm the presence or absence of a breeding population of the Southern Bell Frog at the study area and within the proposal footprint. Additional impact and avoidance measures would be implemented as appropriate potentially including delayed construction activity, adjustment of CAZs, exclusion fencing, procedures for dewatering of wetlands and/or translocation. If pre-clearing surveys confirm tadpoles are present in the proposal footprint, construction within the area containing a breeding population may need to be deferred until the population have metamorphosed into frogs and are able to disperse from the breeding habitat.

With the implementation of the pre-construction assessment and adoption of appropriate impact minimisation measures, the proposal is considered unlikely to substantially disrupt the breeding cycle of the Southern Bell Frog.

If the construction period coincides with a period without extensive flooding, which would be preferred by the proponent and contractors and is more likely based on long term average conditions, there would be a minimal risk of any impacts to Southern Bell Frog breeding habitat.

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

The proposal would remove or modify 16.23 ha of native vegetation that comprises potential habitat for the known population of the Southern Bell Frog in the Billabong Creek riparian corridor in varying condition and quality. Based on the BAM methodology for mapping a Southern Bell Frog, the proposal would remove or modify 8.53 ha of habitat within movement corridors surrounding potential breeding habitat. Construction of access roads and powerlines would affect marginal and infrequently used habitat for these species on higher parts of the floodplain. Construction of the new regulators may result in some clearing or disturbance of instream vegetation including macrophyte beds. These potential residual direct impacts to habitat comprise a conservative upper limit noting that the majority of the proposal footprint would be subject to partial and/or temporary vegetation removal. There are extensive areas of equivalent or higher quality breeding habitat in the local area including:

– suitable breeding habitat associated with extensive macrophyte beds at Wanganella Swamp

EPBC Act Assessment of Significance Southern Bell Frog (*Litoria raniformis*)
– oxbow lagoons with extensive areas of shallow, periodically inundated wetland vegetation that would comprise better quality breeding habitat than the sparsely vegetated, permanent water bodies of Billabong Creek and Forest Creek – smaller patches of macrophyte beds and floodplain depressions equivalent to those in the disturbance footprint throughout the riparian corridor of the Billabong Creek system. The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. The proposed clearing areas are separated by 45 km. Habitat connectivity would be retained around the impact area through extensive areas of similar River Red Gum, Black Box woodland, chenopod shrubland and native grasslands. The proposal does not include the erection of any large or hazardous structures that would isolate any areas of habitat or substantially increase the risk of movement through the landscape. The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. River regulation has adverse impacts on the Southern Bell Frog by reducing inundation of wetlands which form important breeding habitat for the species (Mathwin *et al* 2023). This research also identified that these impacts can be offset through proactive management via the delivery of extra water during breeding season to restore restricted habitat. The proposal would not increase the degree of regulation of the Billabong Creek system but would allow greater operational flexibility by replacing fixed weirs with regulators. Based on modelling of the likely effects of the operation of the proposal, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators and a general improvement in the delivery of environmental water requirements. These hydrological changes would not adversely affect wetland breeding habitat for the species (Cardno 2024a, 2024b). Given this minor quantum of impact and the presence of alternative, higher quality habitat resources the proposal is unlikely to have an adverse effect on habitat for the species to the extent that the local important population of the species would be likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
Disturbance associated with vegetation clearing and vehicle traffic during construction or operation of the proposal may, in general, increase the potential for the spread, introduction and establishment of weed and pest species. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting weed propagules. Environmental inductions, visual barriers and/or exclusion fencing will be used to exclude personnel and vehicles from habitat outside the proposal footprint. To further mitigate the risk of pathogens being brought onto and/or spread through the proposal footprint all vehicles, plant and equipment will be cleaned down (wash/blow down) and certified weed free prior to initial entry to site; all vehicles, plant and equipment will strictly adhere to the approved roads, tracks, easements and work areas to minimise contact with vegetation.
Introduce disease that may cause the species to decline, or
As described for invasive species above, the proposal may, in general, increase the potential for the spread, introduction and establishment of diseases and pathogens. The proposal does not include any higher risk activities such as transport of biological material. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting disease. To further mitigate the risk of pathogens being brought onto and/or spread through the proposal footprint, all vehicles, plant and equipment will be cleaned and inspected. Personnel, vehicles and equipment will be restricted to work areas to minimise contact with sensitive habitat.
Interfere substantially with the recovery of the species
The proposal would interfere with the recovery of the Southern Bell Frog by removing or modifying habitat, which is noted as a key threat for this species (Cth DCCEEW 2024b). As described above, the proposal would remove or modify a maximum of 16.23 ha of native vegetation that comprises potential habitat for the known population of the Southern Bell Frog in varying condition and quality. The potential residual direct impacts to habitat comprise a conservative upper limit. The species would occupy the proposal footprint on occasion as an extension of use of habitat on the Billabong Creek and Forest Creek floodplains but would not be limited to, or reliant on, the habitat at the proposal footprint. The proposal would make a minor contribution to habitat fragmentation but not sever an important connecting link or isolate any areas of habitat. The proposal would have a minor adverse impact on habitat critical to the survival of these species in the context of extensive areas of such habitat in the locality and surrounding region. The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. Operational hydrological changes are not likely to adversely affect wetland habitat for the species (Cardno 2024a, 2024b). The reduction in extent of habitat would be minor. The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Given this minor quantum of impact and the presence of alternative habitat resources the proposal would not interfere substantially with the recovery of these species.

EPBC Act Assessment of Significance Southern Bell Frog (*Litoria raniformis*)
Conclusion of assessment of significance
Based on consideration of the above criteria, the proposal is unlikely to have a significant effect on an important population of the Southern Bell Frog, as: – The proposal would remove or modified a small proportion of an extensive, connected area of potential habitat on the Billabong Creek and Forest Creek floodplains. – The proposal is unlikely to have an adverse effect on the size or breeding cycle of an important population of the species. – The proposal will only result in a minor increase in the degree of fragmentation between retained areas of habitat for the species and will not result in any isolation of habitat. – Construction impacts would be minor and temporary, macrophytes and other understorey vegetation would be allowed to regenerate across the majority of the disturbance footprint and as such a negligible proportion of the wetland habitat available for these species in the locality would be removed or fragmented in the longer term. – Operation of the proposal would not have an adverse effect on wetland dependent species or their habitats.

H-7 Corben's Long-eared Bat (*Nyctophilus corbeni*)

Distribution

Corben's Long-eared Bat has a patchy distribution through the Murray Darling Basin including parts of southern central Queensland, central western New South Wales, north-western Victoria and eastern South Australia (TSSC 2016).

Habitat requirements

Corben's Long-eared Bat inhabits a variety of vegetation types, including Brigalow woodland, Buloke woodland, River Red Gum forest and Black Box woodland, but is most frequently recorded in box/ironbark/cypress-pine vegetation communities that occur in a north-south belt along the western slopes of the Great Dividing Range and into the Murray-Darling flood plain (TSSC 2016). The species generally roosts solitarily in dead trees or dead spouts of live trees. This species travels large distances, and most roost sites are used just for a single day, with consecutive roost sites generally around four kilometres apart. Maternity colonies of 10-20 individuals have been observed in dead trees. Corben's Long-eared Bat appears to have favour: extensive patches of vegetation (as distinct from small or fragmented remnants); old growth vegetation; and woodland or forest with a tree stratum above a dense, cluttered understorey layer (TSSC 2016).

No critical habitat for the species has been identified (DCCEEW 2023c).

Habitat in the study area

There is potential foraging and roosting habitat for the Corben's Long-eared Bat in treed patches PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland, PCT 10 River Red Gum - Black Box woodland wetland and PCT 13 Black Box - Lignum woodland wetland and potential additional foraging habitat in derived shrubland and grassland as well as PCT 44 Forb-rich Speargrass - Windmill Grass - White Top grassland, PCT 46 Curly Windmill Grass - speargrass - wallaby grass grassland, and PCT 160 Nitre Goosefoot shrubland wetland. The study area does not contain any of the drier box/ironbark/cypress-pine vegetation that the species is most commonly recorded in (TSSC 2016). The native vegetation in the study area would be marginal habitat for the species as it occurs as relatively narrow and fragmented patches in an agricultural landscape with only occasional patches of dense understorey vegetation. There are no NSW Bionet records of the species within the locality (DPE 2023a), and the proposal site is located south of the species' main distribution.

The listing advice for the species does not explicitly define the criteria for important populations but notes that a research priority is to identify important populations based on both the genetic qualities of the species across its range and by high densities as indicated by high records of incidence (TSSC 2016). For the purposes of this assessment it is conservatively assumed that a local population of the species, if present at the proposal footprint, would comprise part of an important population as defined in the MNES Guidelines 1.1 (DotE 2013) as it may be

necessary for maintaining genetic diversity, and/or would be near the southern limit of the species range. There is no direct evidence that the proposal footprint supports an important population.

EPBC Act Assessment of Significance
Corben's Long-eared Bat (*Nyctophilus corbeni*)

According to the DotE (2013) 'significant impact criteria', 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

As described above, a population of Corben's Long-eared Bat that could occur at the proposal footprint is conservatively assumed to comprise an important population as defined in the MNES Guidelines 1.1 (DotE 2013).

The factors that could potentially lead to a long-term decrease in the size of an important population of Corben's Long-eared Bat include direct harm, loss of foraging habitat affecting an ecologically significant proportion of local populations or loss of important breeding habitat.

The proposal would result in direct impacts to native vegetation and associated threatened species habitat through:

– clearing of 5.29 ha of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure
– clearing of 10.94 ha of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure.

The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works.

Corben's Long-eared Bat was not recorded in the proposal footprint but are known to occur in similar habitats in the region and may occur in the proposal footprint on occasion.

The proposal would remove or modify 6.03 ha of woodland or forest with potential roost sites within a total of 16.23 ha of native vegetation in varying condition across the Hartwood and Wanganella proposal footprint. The proposal footprint provides potential foraging habitat for the species as well as potential diurnal or maternity roost sites in dead and/or hollow-bearing trees. Clearing of vegetation may, in general, directly harm roosting bats. The proposal would include fauna management protocols including pre-clearing surveys and salvage and treatment of any resident fauna. This would partially mitigate impacts on the local populations of the species if any bats are roosting in the proposal footprint during vegetation clearing works. There are no NSW Bionet records of the species within the locality (DPE 2023a) and the study area does not contain any of the drier box/ironbark/cypress-pine vegetation that the species is most commonly recorded in (TSSC 2016). Given the limited extent and duration of the proposed works and marginal quality of habitat to be removed, the proposal is unlikely to directly harm a significant proportion of an important population of the species, if any.

Noise and vibration, light, vehicle movement and other human activities during the operation of the proposal has the potential to disturb individuals roosting in areas adjacent to the proposal footprint and may result in individuals vacating the area. These indirect impacts resulting from the proposal would be temporary in nature and would only last about 18 months during construction of the proposal. Operation of the new regulators would not result in the generation of any additional noise or light. Vegetation management measures recommended for the proposal would help to avoid direct impacts and minimise indirect impacts on habitat adjoining the proposal footprint. This species tends to move roosts each night, and disturbance in a small area would not affect the suitability of roost habitat in the wider area. Extensive areas of comparable foraging and roosting habitat are present in surrounding areas and so the temporary displacement of fauna over short distances would have a minor consequence. The likely magnitude of edge effects or other indirect effects would not be sufficient to tangibly affect the life cycle of the species.

Operation of the proposal would have a minor impact on the hydrology of the Billabong Creek system in the context of the current degree of regulation. The effects of the proposal would be limited to in stream habitats and lower, more frequently inundated parts of the floodplain. No adverse operational impacts on populations of the species or habitat resources that they rely on are likely to occur.

The proposal is therefore unlikely to adversely affect the lifecycle of Corben's Long-eared Bat such that an important population would decline in size.

Reduce the area of occupancy of an important population

The proposal would reduce the overall area of occupancy of the species by reducing the extent of potential habitat. The proposal would remove or modify up to 16.23 ha of native vegetation that is potential habitat for the species within an area of occupancy of many thousands of square kilometres. This maximum disturbance footprint is conservative and the majority would only be subject to partial or temporary impacts, noting:

– other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate
– vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate
– operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

EPBC Act Assessment of Significance
Corben's Long-eared Bat (*Nyctophilus corbeni*)

The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. The proposal would create a small-scale gap in habitat comparable to existing gaps in the landscape that could be easily passed over or through by the species. The maximum gap in habitat created would be around 200 m and would only be during the construction of the proposal. The habitat to be removed or modified comprises a small proportion of that available in the project area and locality which includes many thousands of hectares of similar wetland and riparian vegetation in the Billabong Creek and Forest Creek corridors.

Given the small scale and duration of proposed works there is a minor risk of additional indirect impacts that is likely to be substantially mitigated through standard environmental management measures. Noise, dust and human activity may affect the quality or occupation of habitat adjoining the proposal footprint during construction and periods when the site is occupied.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would be restricted to in stream habitat and lower floodplain environments with low commence to flow levels and would not inundate any flood-sensitive terrestrial vegetation or otherwise reduce the extent of habitat for the species.

Given the extent of habitat in the locality, a population of the species would persist in the local area and region. Therefore, despite removing or modifying a small area of habitat the proposal would not reduce the overall area of occupancy of the important population, if present.

Fragment an existing important population into two or more populations

The species may travel through the proposal footprint on occasion as an extension of the use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the connectivity provided by the proposal footprint to support continued use of the local area. The proposal would include removal of native vegetation cover and erection of structures in up to 16.23 ha of land, with impacts spread across two sites located around 45 km apart. Construction of the regulators and associated infrastructure would reduce connectivity through the proposal footprint by decreasing shelter by removing native vegetation and creating physical barriers. Removal of native vegetation cover and operation of the proposal would reduce connectivity within:

- an irregularly shaped area interrupting east-west habitat connectivity about 150 m wide, and north-south connectivity around 200 m wide at the Hartwood regulator CAZ
- irregularly shaped areas interrupting east-west and north-south habitat connectivity about 0.4 ha in size at the Forest Creek block bank CAZ at Hartwood
- an area interrupting east-west habitat connectivity up to 80 m wide at the Wanganella flood bypass channel
- an irregularly shaped area interrupting east-west habitat connectivity of about 146 m wide, and in the north-south connectivity around 130 m at the Wanganella regulator
- 5 m wide access track corridors
- up to 20 m wide power supply corridors.

These maximum disturbance areas are conservative and the majority would only be subject to partial or temporary impacts, noting:

- Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate.
- Vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate.
- Construction-only access tracks are generally aligned with existing tracks and/or through treeless areas and so upgrade for the proposal would require minimal vegetation removal.
- Operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

Human occupation may also deter bats from moving through or roosting within the local area during construction. Construction would take approximately 18 months but would be paused during high flow periods.

Habitat connectivity would be maintained around the proposal footprint through extensive areas of similar Black Box and River Red Gum woodland and forest. The proposal would not isolate any areas of habitat or sever any connecting links. The proposal does not include the erection of any large or hazardous structures that would increase the risk or energy cost of movement of microbats. Removal of vegetation and construction of infrastructure would only result in a minor increase in the degree of fragmentation between retained areas of habitat for the species and would not result in the isolation of any habitat. The proposal would create a small-scale gap in habitat that could be easily passed over or through by bats. Given the extent of habitat in the locality, populations of the species would persist in the local area and region. Therefore, despite removing or modifying a small area of habitat within fauna movement corridors the proposal would not fragment an important population into two or more populations.

Adversely affect habitat critical to the survival of a species

No Critical Habitat for Corben's Long-eared Bat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat (DCCEEW 2024c).

EPBC Act Assessment of Significance Corben's Long-eared Bat (*Nyctophilus corbeni*)
The listing advice for the species does not explicitly define the criteria for important habitat but implies that it would include suitable woodland and forest with roost sites in dead trees or dead spouts of live trees (TSSC 2016). The proposal would remove or modify 6.03 ha of woodland or forest with potential roost sites within a total of 16.23 ha of native vegetation in varying condition. These potential residual direct impacts to critical habitat comprise a conservative upper limit noting that the majority of the proposal footprint would be subject to partial and/or temporary vegetation removal. Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and so few if any roost sites would be removed. This would be a minor proportion of the extent of similar habitat in the locality and region. There are no NSW Bionet records of the species within the locality (DPE 2023a) and the study area does not contain any of the drier box/ironbark/cypress-pine vegetation that the species is most commonly recorded in (TSSC 2016). During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would be restricted to in stream habitat and lower floodplain environments with low commence to flow levels and would not inundate any flood-sensitive terrestrial vegetation or otherwise adversely affect habitat critical to the survival of the species. Overall, the proposal would have a minor adverse effect on habitat that may be critical to the survival of the species.
Disrupt the breeding cycle of an important population
The proposal would remove or modify 6.03 ha of woodland or forest with potential roost sites within a total of 16.23 ha of native vegetation in varying condition. Removal of vegetation may disrupt the breeding cycle of the species by removing roost sites or displacing or harming individuals within maternity colonies. The proposal would include fauna management protocols including pre-clearing surveys and salvage and treatment of any resident fauna during vegetation clearing works, which is unlikely given the limited extent and duration of vegetation removal. The proposal is unlikely to directly harm or otherwise interrupt the breeding cycle of a significant proportion of a population of Corben's Long-eared Bat, if any. In addition, the loss of habitat spread across two separate locations would not affect the ability of the species to move between their foraging and breeding areas. Indirect impacts such as generation of additional noise and light would occur for approximately 18 months during the construction period. Extensive areas of comparable foraging and roosting habitat are present in surrounding areas and so the temporary displacement of fauna over short distances would have a minor consequence. The proposal is therefore unlikely to substantially disrupt the breeding cycle of an important population of the species.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove or modify 16.23 ha of native vegetation that comprises potential habitat for the species in varying condition and quality. The proposal would result in direct impacts to native vegetation and associated habitat for the species through: – clearing of 5.29 ha of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure – clearing of 10.94 ha of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure. These potential residual direct impacts to habitat comprise a conservative upper limit noting that the majority of the proposal footprint would be subject to partial and/or temporary vegetation removal. Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and so few if any roost sites would be removed. The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. Habitat connectivity would be retained around the impact area through extensive areas of similar River Red Gum, Black Box woodland, chenopod shrubland and native grasslands. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of movement of bats. The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would be restricted to in stream habitat and lower floodplain environments with low commence to flow levels and would not inundate any flood-sensitive terrestrial vegetation or otherwise adversely affect habitat for the species. There is no direct evidence of the species in the proposal footprint, no NSW Bionet records of the species within the locality (DPE 2023a) and the study area does not contain any of the drier box/ironbark/cypress-pine vegetation that the species is most commonly recorded in (TSSC 2016). The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Given this minor quantum of impact and the presence of alternative habitat resources the proposal is unlikely to have an adverse effect on habitat for the species to the extent that it would be likely to decline.
Result in invasive species that are harmful to a species becoming established in the species' habitat

EPBC Act Assessment of Significance Corben's Long-eared Bat (*Nyctophilus corbeni*)
Disturbance associated with vegetation clearing and vehicle traffic during construction or use of the regulator may, in general, increase the potential for the spread, introduction and establishment of weed and pest species. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting weed propagules. Environmental inductions, visual barriers and/or exclusion fencing will be used to exclude personnel and vehicles from habitat outside the proposal footprint. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned down (wash/blow down) and certified weed free prior to initial entry to site; all vehicles, plant and equipment will strictly adhere to the approved roads, tracks, easements and work areas to minimise contact with vegetation.
Introduce disease that may cause the species to decline, or
As described for invasive species above, the proposal may, in general, increase the potential for the spread, introduction and establishment of diseases and pathogens. The proposal does not include any higher risk activities such as transport of biological material. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting disease. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned and inspected. Personnel, vehicles and equipment will be restricted to work areas to minimise contact with sensitive habitat.
Interfere with the recovery of the species
The proposal would interfere with the recovery of the species by removing or modifying habitat, which is noted as a key threat for the species (DCCEEW 2024b). As described above, the proposal would remove or modify a maximum of 16.23 ha of habitat for the species at the proposal footprint. There is no direct evidence of the species in the proposal footprint, no NSW Bionet records of the species within the locality (DPE 2023a) and the study area does not contain any of the drier box/ironbark/cypress-pine vegetation that the species is most commonly recorded in (TSSC 2016). Much of the habitat is marginal in terms of extent, age class, vegetation structure, species composition or general condition. The species may occupy the proposal footprint on occasion as an extension of the use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the habitat at the site. The proposal would make a minor contribution to habitat fragmentation but not sever an important connecting link or isolate any areas of habitat. The proposal would have a minor adverse impact on habitat that is potentially critical to the survival of the species in the context of extensive areas of such habitat in the locality and surrounding region. The reduction in extent of habitat would be minor. The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Given this minor quantum of impact and the presence of alternative habitat resources the proposal would not interfere substantially with the recovery of the species.
Conclusion of assessment of significance
The proposal is not likely to have a significant impact on Corben's Long-eared Bat given: – The limited extent of native vegetation to be removed in comparison to the extensive areas of alternative habitat in the locality. – The limited quality of habitat to be removed, noting that the proposal footprint does not contain any of the drier box/ironbark/cypress-pine vegetation that the species is most commonly recorded in (TSSC 2016) and that much of the habitat is marginal in terms of extent, age class, vegetation structure, species composition or general condition. – The proposal is unlikely to have an adverse effect on the size or breeding cycle of a population of the species. – The proposal will only result in a minor increase in the degree of fragmentation between retained areas of habitat for the species and will not result in any isolation of habitat. – The proposal footprint is unlikely to be important to the recovery of the species.

H-8 Grey Snake (*Hemiaspis damelii*)

Distribution

The Grey Snake is known from fragmented subpopulations within a broad extent of occurrence from southern NSW to southeastern Queensland. In NSW, the locations of records of the species suggest that it occurs as separate subpopulations associated with the lower reaches of major westerly flowing rivers, including the Gwydir, Namoi, Castlereagh, Macquarie, Lachlan and Murrumbidgee River systems. There are a relatively large number and relatively recent recorded observations of the species in the Lowbidgee floodplain region in NSW (Cth. DCCEEW 2022) which is part of the Murrumbidgee River floodplain between Balranald and Hay, around 100 kilometres northwest of the study area (NSW Government 2016).

Habitat requirements

The Grey Snake occurs in woodlands and chenopod shrublands associated with ephemeral wetlands on floodplains. The conservation advice for the species does not explicitly define the criteria for important habitat but notes that key habitat attributes including presence of breeding habitat for the frog species that are its main prey and heavy clay soils which provide and cracks and crevices that provide shelter for the species and its prey (Cth. DCCEEW 2022). In the Lowbidgee floodplain region the Grey Snake's habitat includes the margins of ephemeral wetlands within River Red Gum and Black Box vegetation communities and Tangled Lignum (*Duma florulenta*) wetlands (Cth. DCCEEW 2022).

No critical habitat for the species has been identified (DCCEEW 2023c).

Habitat in the study area

The Grey Snake was not recorded in the proposal footprint but are known to occur in similar habitats in the region and may occur in the proposal footprint on occasion.

The study area is entirely located on the Murrumbidgee Channels and Floodplains Mitchell landscape (DPIE 2016) which comprises Quaternary alluvium on seasonally inundated floodplains with grey and brown clay soils (DECC 2002).

There is suitable shelter and foraging habitat for the Grey Snake across much of the Wanganella and Hartwood sites. This includes within: PCT 7 River Red Gum - Warrego Grass - herbaceous riparian tall open forest wetland, PCT 10 River Red Gum - Black Box woodland wetland and PCT 13 Black Box - Lignum woodland wetland and PCT 160 Nitre Goosefoot shrubland wetland; and potentially also PCT 44 and PCT 46 floodplain grasslands during wet periods. Core habitat for the species would include the oxbow lakes at Wanganella and wetlands in the vicinity of the block bank at Hartwood that were observed to support abundant frog populations over multiple field survey rounds in 2022 and 2023. The extent of potential habitat would increase during occasional inundation of the broader floodplain to include inundated depressions in forest, woodland, chenopod shrubland and grassland.

EPBC Act Assessment of Significance Grey Snake (*Hemiaspis damelii*)
According to the DotE (2013) 'significant impact criteria', an action is likely to have a significant impact on a critically endangered or 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 factors that could potentially lead to a long-term decrease in the size of a population of the Grey Snake include direct harm, loss of foraging habitat affecting an ecologically significant proportion of the populations or loss of important habitat. The proposal would result in direct impacts to native vegetation and associated threatened species habitat through: – clearing of 5.29 ha of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure – clearing of 10.94 ha of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure. The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. The Grey Snake was not recorded in the proposal footprint but is known to occur in similar habitats in the region and may occur in the proposal footprint on occasion.

EPBC Act Assessment of Significance
Grey Snake (*Hemiaspis damelii*)

The proposal would remove or modify a total of 16.23 ha of native vegetation in varying condition across the Hartwood and Wanganella proposal footprint, much of which provides foraging and shelter habitat for the species. Clearing of vegetation and vehicle traffic may, in general, directly harm resident Grey Snakes. The proposal would include fauna management protocols including pre-clearing surveys and salvage and treatment of any resident fauna. This would partially mitigate impacts on the local population of the species if any individuals are sheltering in the proposal footprint during vegetation clearing works. There is no direct evidence of the species occurring in the proposal footprint despite targeted surveys over multiple seasons. Given the limited extent and duration of the proposed works the proposal is unlikely to directly harm a significant proportion of the populations of the species, if any.

Noise and vibration, light, vehicle movement and other human activities during the operation of the proposal has the potential to disturb individuals occurring adjacent to the proposal footprint and may result in individuals vacating the area. These indirect impacts resulting from the proposal would be temporary in nature and would only last about 18 months during construction of the proposal. Operation of the new regulators would not result in the generation of any additional noise or light. Vegetation management measures recommended for the proposal would help to avoid direct impacts and minimise indirect impacts on habitat adjoining the proposal footprint. Extensive areas of comparable floodplain habitat are present in surrounding areas and so the temporary displacement of fauna over short distances would have a minor consequence. The likely magnitude of edge effects or other indirect effects would not be sufficient to tangibly affect the life cycle of the species.

Operation of the proposal would have a minor impact on the hydrology of the Billabong Creek system in the context of the current degree of regulation. The effects of the proposal would be limited to in stream habitats and lower, more frequently inundated parts of the floodplain. These hydrological changes are not likely to adversely affect wetland habitat for the species (Cardno 2024a, 2024b). No adverse operational impacts on populations of the species or habitat resources are likely to occur.

The proposal is therefore unlikely to adversely affect the lifecycle of the Grey Snake such that a population would decline in size.

Reduce the area of occupancy of the species

The proposal would reduce the overall area of occupancy of the species by reducing the extent of potential habitat. The proposal would remove or modify up to 16.23 ha of native vegetation that is habitat for the species. This maximum disturbance footprint is conservative and the majority would only be subject to partial or temporary impacts, noting:

– other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate
– vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate
– operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. The proposal would create a small-scale gap in habitat comparable to existing gaps in the landscape that could be passed through by the species. The maximum gap in habitat created would be around 200 m and would only be during the construction of the proposal. The habitat to be removed or modified comprises a small proportion of that available in the project area and locality which includes many thousands of hectares of similar wetland and riparian vegetation in the Billabong Creek and Forest Creek corridors.

Given the small scale and duration of proposed works there is a minor risk of additional indirect impacts that is likely to be substantially mitigated through standard environmental management measures. Noise, dust and human activity may affect the quality or occupation of habitat adjoining the proposal footprint during construction and periods when the site is occupied.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would be restricted to in stream habitat and lower floodplain environments with low commence to flow levels and would not adversely affect habitat for the species.

Given the extent of habitat in the locality, a population of the species would persist in the local area and region. Therefore, despite removing or modifying a small area of habitat the proposal would not reduce the overall area of occupancy of the species.

Fragment an existing population into two or more populations

The species may travel through the proposal footprint on occasion as an extension of the use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the connectivity provided by the proposal footprint to support continued use of the local area. The proposal would include removal of native vegetation cover and erection of structures in up to 16.23 ha of land, with impacts spread across two sites located around 45 km apart. Construction of the regulators and associated infrastructure would reduce connectivity through the proposal footprint by decreasing shelter by removing native vegetation and creating physical barriers. Removal of native vegetation cover and operation of the proposal would reduce connectivity within:

– an irregularly shaped area interrupting east-west habitat connectivity about 150 m wide, and north-south connectivity around 200 m wide at the Hartwood regulator CAZ

EPBC Act Assessment of Significance
Grey Snake (*Hemiaspis damelii*)

– irregularly shaped areas interrupting east-west and north-south habitat connectivity about 0.4 ha in size at the Forest Creek block bank CAZ at Hartwood
– an area interrupting east-west habitat connectivity up to 80 m wide at the Wanganella flood bypass channel
– an irregularly shaped area interrupting east-west habitat connectivity of about 146 m wide, and in the north-south connectivity around 130 m at the Wanganella regulator
– 5 m wide access track corridors
– up to 20 m wide power supply corridors.

These maximum disturbance areas are conservative and the majority would only be subject to partial or temporary impacts, noting:

– Other than the regulator structures and their immediate vicinity, as few trees as possible would be trimmed or removed to allow construction and understorey vegetation would be allowed to regenerate.
– Vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate.
– Construction-only access tracks are generally aligned with existing tracks and/or through treeless areas and so upgrade for the proposal would require minimal vegetation removal.
– Operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

Human occupation may also deter snakes from the local area during construction. Construction would take approximately 18 months but would be paused during high flow periods.

Habitat connectivity would be maintained around the proposal footprint through extensive areas of similar Black Box, River Red Gum woodland and chenopod shrubland. The proposal would not isolate any areas of habitat or sever any connecting links. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of movement. Removal of vegetation and construction of infrastructure would only result in a minor increase in the degree of fragmentation between retained areas of habitat for the species and would not result in the isolation of any habitat. Given the extent of habitat in the locality, populations of the species would persist in the local area and region. Therefore, despite removing or modifying a small area of habitat within fauna movement corridors the proposal would not fragment a population of the Grey Snake into two or more populations.

Adversely affect habitat critical to the survival of a species

No Critical Habitat for the Grey Snake as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat (DCCEEW 2024c).

According to the conservation advice for the species, habitat critical to the survival of the Grey Snake would include areas of suitable floodplain wetland vegetation with cracking clay soils and that supports frog populations (DCCEEW 2024b). The proposal would remove or modify a maximum of 16.23 ha of forest, woodland, shrubland and grassland that contains wetlands with these features and that may be habitat critical to the survival of the Grey Snake. This is a minor proportion of the extent of similar critical habitat in the locality and region.

These potential residual direct impacts to critical habitat comprise a conservative upper limit noting that the majority of the proposal footprint would be subject to partial and/or temporary vegetation removal.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators that would not adversely affect habitat critical to the survival of the species.

Overall, the proposal would have a minor adverse effect on habitat that is critical to the survival of the species.

Disrupt the breeding cycle of a population

The proposal would remove or modify 16.23 ha of native vegetation that comprises potential habitat for the species in varying condition and quality. Removal or modification of this habitat may disrupt the breeding cycle of the species by reducing foraging resources available or displacing or harming resident snakes. A breeding population of the species may be present in the wider locality given the extensive areas of suitable floodplain wetland vegetation and presence of the species in similar habitat around 100 km away on the Lowbidgee floodplain (Cth DCCEEW 2022). There is no direct evidence of the species breeding or otherwise occurring at the study area or proposal footprint despite surveys over multiple seasons.

Clearing of vegetation may, in general, directly harm resident fauna. The proposal would remove vegetation in up to 16.23 ha of land, a portion of which contains soil cracks or other shelter substrate for the species. The proposal would include fauna management protocols including pre-clearing surveys and salvage and treatment of any resident fauna during vegetation clearing works. Given the limited extent and duration of vegetation removal the proposal is unlikely to directly harm or otherwise interrupt the breeding cycle of a significant proportion of a population of the Grey Snake, if any. In addition, the loss of habitat spread across two separate locations would not affect the ability of the species to move between breeding areas.

EPBC Act Assessment of Significance Grey Snake (*Hemiaspis damelii*)
Indirect impacts such as generation of additional noise and light would occur for approximately 18 months during the construction period. Extensive areas of comparable foraging and nesting habitat are present in surrounding areas and so the temporary displacement of fauna over short distances would have a minor consequence. The proposal is therefore unlikely to substantially disrupt the breeding cycle of a population of the species.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove or modify 16.23 ha of native vegetation that comprises potential habitat for the species in varying condition and quality. The proposal would result in direct impacts to native vegetation and associated habitat for the species through: – clearing of 5.29 ha of native vegetation at Wanganella for construction of the regulator, power supply and access tracks and associated infrastructure – clearing of 10.94 ha of native vegetation at Hartwood for construction of the regulator, power supply and access tracks and associated infrastructure. These potential residual direct impacts to habitat comprise a conservative upper limit noting that the majority of the proposal footprint would be subject to partial and/or temporary vegetation removal. The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. Habitat connectivity would be retained around the impact area through extensive areas of similar River Red Gum, Black Box woodland, chenopod shrubland and native grasslands. The proposal does not include the erection of any large or hazardous structures that would substantially increase the risk or energy cost of movement. The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators which would not adversely affect habitat for the species. The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Given this minor quantum of impact and the presence of alternative habitat resources the proposal is unlikely to have an adverse effect on habitat for the species to the extent that it would decline.
Result in invasive species that are harmful to a species becoming established in the species' habitat
Disturbance associated with vegetation clearing and vehicle traffic during construction or use of the regulator may, in general, increase the potential for the spread, introduction and establishment of weed and pest species. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting weed propagules. Environmental inductions, visual barriers and/or exclusion fencing will be used to exclude personnel and vehicles from habitat outside the proposal footprint. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned down (wash/blow down) and certified weed free prior to initial entry to site; all vehicles, plant and equipment will strictly adhere to the approved roads, tracks, easements and work areas to minimise contact with vegetation.
Introduce disease that may cause the species to decline, or
As described for invasive species above, the proposal may, in general, increase the potential for the spread, introduction and establishment of diseases and pathogens. The proposal does not include any higher risk activities such as transport of biological material. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting disease. To further mitigate the risk of pathogens being brought onto and/or spread through the site all vehicles, plant and equipment will be cleaned and inspected. Personnel, vehicles and equipment will be restricted to work areas to minimise contact with sensitive habitat.
Interfere with the recovery of the species
The proposal would interfere with the recovery of the species by removing or modifying habitat, which is noted as a key threat for the species (DCCEEW 2024b). As described above, the proposal would remove or modify a maximum of 16.23 ha of habitat for the species at the proposal footprint. These potential residual direct impacts to habitat comprise a conservative upper limit noting that the majority of the proposal footprint would be subject to partial and/or temporary vegetation removal and much of the impact area contains marginal habitat. Impacts to core wetland habitat with cracking clay soils would be restricted to a small proportion of the total area affected. The species may occupy the proposal footprint on occasion as an extension of the use of habitat in adjoining areas of native vegetation but would not be limited to, or reliant on, the habitat at the site. The proposal would make a minor contribution to habitat fragmentation but not sever an important connecting link or isolate any areas of habitat. The proposal would have a minor adverse impact on habitat critical to the survival of the species in the context of extensive areas of such habitat in the locality and surrounding region.

EPBC Act Assessment of Significance Grey Snake (*Hemiaspis damelii*)
The reduction in extent of habitat would be minor. The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Given this minor quantum of impact and the presence of alternative habitat resources the proposal would not interfere substantially with the recovery of the species.
Conclusion of assessment of significance
The project is not likely to have a significant impact on the Grey Snake given: – The limited extent of habitat to be removed or modified in comparison to the extensive areas of alternative habitat resources in the locality. – The proposal is unlikely to have an adverse effect on the size or breeding cycle of a population of the species. – The proposal will only result in a minor increase in the degree of fragmentation between retained areas of habitat for the species and will not result in any isolation of habitat. – The proposal footprint is unlikely to be important to the recovery of the species.

H-9 Slender Darling Pea (*Swainsona murrayana*)

Distribution

Swainsona murrayana is distributed mainly throughout NSW, but is also found in Victoria, South Australia and Queensland (Cth DCCEEW 2024b). Within NSW *Swainsona murrayana* has been recorded in the Jerilderie and Deniliquin areas of the southern riverine plain, the Hay plain as far north as Willandra National Park, near Broken Hill and in various localities between Dubbo and Moree (NSW DCCEEW 2024b).

Habitat requirements

Swainsona murrayana occurs on clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams with varied vegetation types, including Bladder Saltbush, Black Box and grassland communities on level plains, floodplains and depressions (NSW DCCEEW 2024b). The species often occurs in association with *Swainsona murrayana* include Maireana species *(Maireana spp.*), Wallaby-grass (*Austrodanthonia spp*), and Speargrass (*Austrostipa spp.*) (DEWHA 2008).

Cth DCCEEW (2024b) presents the results of an unpublished NSW Scientific Committee assessment of the *Swainsona murrayana* population in NSW. The population size of *Swainsona murrayana* is highly variable and has been recorded from at least 60 geographically distinct sub populations across NSW, with up to 200 000 individuals estimated to occur within these sub populations. Plant abundance is generally described as locally common to abundant in NSW, with counts ranging from single plants to at least 1000 plants made at various sites. Small numbers appear to represent incidental records, with potential population sizes likely to be much larger (Cth DCCEEW 2024b).

Swainsona murrayana is a perennial herb, which produces a winter-spring growth. The species flowers in spring to early summer and then dies back after flowering. It re-shoots readily and often covers extensive areas after good cool-season rains. The pollination of *Swainsona murrayana* is thought to occur by one bee species, *Trichocolletes maximus*. Bee populations may decline during extended drought and *Swainsona murrayana* may be susceptible to reproductive failure in response (Cth DCCEEW 2024b). It is suspected that the species may require some disturbance to reproduce and persist in suitable habitat and it has been known to occur in paddocks that have been moderately grazed or occasionally cultivated (DEWHA 2008). Apparently healthy, flowering populations of *Swainsona murrayana* were present at the edges of cultivated cropland and irrigation ditches on the Murrumbidgee floodplain at the time of the September 2022 surveys for this assessment (pers. obs.).

Habitat in study area

There is potential habitat for *Swainsona murrayana* throughout the proposal footprint at both Wanganella and Hartwood associated with PCT 10 River Red Gum - Black Box woodland wetland, PCT 13 Black Box - Lignum woodland wetland, grassland and shrubland derived from clearing of these Black Box communities, PCT 44 Forb-rich Speargrass - Windmill Grass - White Top grassland and PCT 46 Curly Windmill Grass - speargrass - wallaby grass grassland.

Swainsona murrayana was recorded during targeted surveys within a small area at Hartwood. The species has been confirmed as absent from the majority of the potential habitat at the study area through targeted survey during the survey period required by the BAM (NSW DCCEEW 2024b). No *Swainsona murrayana* individuals were recorded within the proposal footprint. A total of 172 *Swainsona murrayana* individuals were recorded in the vicinity of the proposed access track to the Hartwood Regulator and borrow pit, with all of these individuals outside of the direct impact area. Species polygons were mapped according to the BAM and threatened flora survey guidelines (DPIE 2020a) based on GHD accredited assessor's assessment of the area of occupied, suitable microhabitat surrounding the identified population. The species polygon encompasses contiguous vegetation zones in which the species was detected in the proposal footprint, consistent with the species polygon guidance for the species presented in the TBDC (DCCEEW 2024a). A total of 2.22 hectares of species polygons have been mapped around the recorded *Swainsona murrayana* population as shown on Figure 5.13.

Swainsona murrayana plants produce winter-spring growth and die back to persistent rootstock after flowering, re-shooting readily after cool-season rains. Abundant quantities of seed can be produced under favourable conditions (Cth. DCCEEW 2024b). September 2023 surveys after two successive years of above-average cool season rains revealed a population of the species at Hartwood but no above-ground plants in the proposal footprint. The extent of above-ground plants in the *Swainsona murrayana* population and the associated risk of impact would depend on the timing of construction and prevailing rainfall conditions in the prior year. A pre-construction assessment of the *Swainsona murrayana* population would be conducted including supplementary survey as appropriate if the construction period coincides with the August to November flowering period for the species (Cth. DCCEEW 2024b). If this assessment reveals a more extensive *Swainsona murrayana* population at the study area then further impact mitigation may be appropriate. Pre-construction assessment requirements for *Swainsona murrayana* are detailed in Table 8.9.

No important populations of the *Swainsona murrayana* are noted in the approved conservation advice for the species (DEWHA 2008) and no critical habitat has been identified (DCCEEW 2024c). According to the MNES significant impact guidelines 1.1 (DotE 2013) an 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: key source populations either for breeding or dispersal; populations that are necessary for maintaining genetic diversity; and/or populations that are near the limit of the species' range. The population recorded in the study area is not near the limit of the species' overall area of occupancy (DEWHA 2008). However, this population contains around 172 individuals within at least 2.2 hectares of occupied habitat in a relatively extensive patch of native vegetation on the Billabong Creek floodplain at Hartwood. There is only one other record of the species on the NSW Bionet within 20 kilometres of the study area (NSW DCCEEW 2024a) and so the population at Hartwood is likely to make a notable contribution to the species regional extent and to maintaining genetic diversity of the species. For the purposes of this assessment it is assumed that the local population at Hartwood and any other individuals of the species that could occur at the proposal footprint, would comprise part of an important population as defined in the MNES Guidelines 1.1 (DotE 2013).

EPBC Act Assessment of Significance Slender Darling Pea (*Swainsona murrayana*)
According to the DotE (2013) 'significant impact criteria', 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**
As described above, the Slender Darling Pea population recorded at Hartwood is considered an important population as defined in the MNES significant impact guidelines 1.1 (DotE 2013). The factors that could potentially lead to a long-term decrease in the size of this important population include direct harm or loss of habitat affecting an ecologically significant proportion of the local population. The proposal would result in direct impacts to habitat surrounding a population of around 172 individuals of the species through removal or modification of up to 2.22 ha of native vegetation at Hartwood for construction of the power supply, borrow pit and access tracks. This 2.22 ha of suitable habitat within *Swainsona murrayana* species polygons is part of a total of 9.35 ha of potential habitat for the species that would be removed or modified across both regulator sites. No above ground *Swainsona murrayana* plants were recorded in the proposal footprint despite targeted surveys under suitable conditions over multiple seasons. The small area containing the recorded individuals at Hartwood is located outside the proposal footprint and would not be directly affected. Around 3.57 ha of the total area of potential habitat to be affected is located at Wanganella, 45 km from the known population.

EPBC Act Assessment of Significance
Slender Darling Pea (*Swainsona murrayana*)

Vehicle movement, accidental damage/harm and other human activities during the operation of the proposal has the potential to disturb the recorded individuals at Hartwood. The proposed impact mitigation and environmental management measures including the installation of temporary exclusion fencing around the recorded population at Hartwood, are likely to mitigate against erosion, sedimentation, accidental damage/harm or any other indirect effects on the recorded individuals during the construction of the proposed works.

A pre-construction assessment of the local *Swainsona murrayana* population would be conducted to confirm the extent of above-ground plants including supplementary survey as appropriate if the construction period coincides with the August to November flowering period for the species (Cth. DCCEEW 2024b). If this assessment reveals a more extensive *Swainsona murrayana* population at the study area, then further impact mitigation would be implemented to help avoid direct harm to any above-ground plants.

Operation of the proposal would have a minor impact on the hydrology of the Billabong Creek system in the context of the current degree of regulation. The effects of the proposal would be limited to in stream habitats and lower, more frequently inundated parts of the floodplain. No adverse operational impacts on the population of *Swainsona murrayana* or habitat for the species are likely to occur.

Despite suitable potential habitat occurring within the proposal footprint, the proposal is unlikely to directly harm any plants or otherwise lead to a long-term decrease in the size of an important population of *Swainsona murrayana* within the proposal footprint.

Reduce the area of occupancy of an important population

The small area containing the important population of *Swainsona murrayana* recorded at Hartwood is located outside the proposal footprint and would not be directly affected. The proposal would reduce the overall area of occupancy of the species by reducing the extent of potential habitat. The proposal would remove or modify up to 2.22 ha of core habitat within *Swainsona murrayana* species polygons as part of a total 9.35 ha of native vegetation that is potential habitat for the species, within an area of occupancy of many thousands of square kilometres. This maximum disturbance footprint is conservative, and the majority would only be subject to partial or temporary impacts, noting:

– other than the regulator structures, operational access tracks and their immediate vicinity, understorey vegetation would be allowed to regenerate
– vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate
– *Swainsona murrayana* is tolerant of light grazing, partial vegetation clearing and other human disturbance (DEWHA 2008) and so regenerating understorey vegetation across the proposal footprint would continue to provide habitat for the species.

There are extensive areas of connected, alternative habitat with similar value across the Billabong Creek and Forest Creek floodplains. The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. This impact would not reduce the extent or quality of *Swainsona murrayana* habitat.

Given the extent of quality habitat in the surrounding locality and small area of habitat to be removed, the small reduction in the area of occupancy of *Swainsona murrayana* would have a minor impact and the species would continue to persist in the local area and surrounding region.

Fragment an existing important population into two or more populations

The proposal traverses mostly agricultural land which has been extensively cleared for agriculture including cropping and grazing. This has resulted in isolated patches of remnant native vegetation and small connected patches, mostly limited to roadside reserves and smaller patches on private properties.

The proposal would include removal of native vegetation cover and erection of structures in up to 16.23 ha of land, of which 2.22 ha is core habitat within *Swainsona murrayana* species polygons as part of a total 9.35 ha of PCTs that are recognised as potential habitat for the species (NSW DCCEEW 2024b). Construction would reduce connectivity throughout the proposal footprint by decreasing vegetation cover and creating physical barriers that may interrupt seed fall, movement of pollinators or other ecological processes.

Removal of native vegetation cover and operation of the proposal would reduce connectivity within:

– an irregularly shaped area interrupting east-west habitat connectivity about 150 m wide, and north-south connectivity around 200 m wide at the Hartwood regulator CAZ
– irregularly shaped areas interrupting east-west and north-south habitat connectivity about 0.4 ha in size at the Forest Creek block bank CAZ at Hartwood
– an area interrupting east-west habitat connectivity up to 80 m wide at the Wanganella flood bypass channel
– an irregularly shaped area interrupting east-west habitat connectivity of about 146 m wide, and in the north-south connectivity around 130 m at the Wanganella regulator
– 5 m wide access track corridors, including a track through the known population of the species

EPBC Act Assessment of Significance
Slender Darling Pea (*Swainsona murrayana*)

– up to 20 m wide power supply corridors, including a corridor adjacent to the known population of the species.

These maximum disturbance areas are conservative and the majority would only be subject to partial or temporary impacts, noting:

– around 3.57 ha of the total area of potential habitat to be affected is located at Wanganella, 45 km from the known population
– other than the regulator structures and their immediate vicinity understorey vegetation would be allowed to regenerate
– vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate across the majority of the corridor
– construction-only access tracks are generally aligned with existing tracks and so upgrade for the proposal would require minimal vegetation removal
– operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

Swainsona murrayana is tolerant of light grazing, partial vegetation clearing and other human disturbance (DEWHA 2008) and so regenerating understorey vegetation across the proposal footprint would continue to provide habitat for the species. The local population occurs on either side of an existing farm access track that would be upgraded and used for the proposal. The further removal or modification of small areas of potential habitat in an already highly fragmented and modified landscape would not fragment the population of this disturbance tolerant species into two or more populations.

Adversely affect habitat critical to the survival of a species

There is no registered critical habitat for *Swainsona murrayana* on the Register of Critical Habitat (DCCEEW 2024c).

The proposal would include removal or modification of native vegetation within 2.22 ha of core habitat within *Swainsona murrayana* species polygons as part of a total 9.35 ha of PCTs that are recognised as potential habitat for the species (NSW DCCEEW 2024b). This is a very small proportion of the extent of similar critical habitat in the surrounding study area and locality. This would comprise a minor adverse effect on habitat that is critical to the survival of these species given:

– around 3.57 ha of the total area of potential habitat to be affected is located at Wanganella, 45 km from the known population
– other than the regulator structures and their immediate vicinity understorey vegetation would be allowed to regenerate
– vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate across the majority of the corridor
– construction-only access tracks are generally aligned with existing tracks and so upgrade for the proposal would require minimal vegetation removal
– operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes.

Swainsona murrayana is tolerant of light grazing, partial vegetation clearing and other human disturbance (DEWHA 2008) and so regenerating understorey vegetation across the proposal footprint would continue to provide habitat for the species. Construction impacts would be minor and temporary and as such a negligible proportion of the habitat available for the species in the locality would be removed or fragmented in the longer term.

During operation, there would be a very minor increase in the depth and frequency of inundation of the weir pools upstream of the two proposed regulators. These hydrological changes are not likely to adversely affect habitat critical to the survival of the species (Cardno 2024a, 2024b).

Disrupt the breeding cycle of an important population

The proposal would result in direct impacts to habitat surrounding a population of around 172 individuals of the species. No above ground *Swainsona murrayana* plants were recorded in the proposal footprint despite targeted surveys under suitable conditions over multiple seasons. The small area containing the recorded individuals at Hartwood is located outside the proposal footprint and so the proposal is unlikely to directly affect the breeding cycle of this population through removal of reproductive plants. This species is dependent on seasonal conditions to germinate and will often re-sprout and flower prolifically following winter and spring rain (DEWHA 2008). Based on this, it is possible that the distribution of the population recorded at Hartwood during the seasonal targeted surveyed may differ when construction of the proposal commences. A pre-construction assessment of the local *Swainsona murrayana* population would be conducted to confirm the extent of above-ground plants including supplementary survey as appropriate if the construction period coincides with the August to November flowering period for the species (Cth. DCCEEW 2024b). If this assessment reveals a more extensive *Swainsona murrayana* population at the study area, then further impact mitigation would be defined and implemented to help avoid impacts to the breeding cycle of the species.

Based on 2023 survey results, the proposal would affect 2.22 ha of core habitat within *Swainsona murrayana* species polygons as part of a total of 9.35 ha of potential habitat for the species that would be removed or modified across both regulator sites. The proposal may, in general, affect the breeding cycle of the species by decreasing vegetation cover and creating physical barriers that may interrupt seed fall, movement of pollinators or other ecological processes. The pollination of *Swainsona murrayana* is thought to occur by one bee species, *Trichocolletes maximus* (Cth DCCEEW 2024b). Bees would be able to readily traverse the narrow and temporary gaps in habitat created by the proposal.

EPBC Act Assessment of Significance Slender Darling Pea (*Swainsona murrayana*)
Swainsona murrayana may require some disturbance to reproduce and persist in suitable habitat and it has been known to occur in paddocks that have been moderately grazed or occasionally cultivated (DEWHA 2008). Due to the mobility of the pollinator species and persistence of *Swainsona murrayana* in disturbed habitat, the proposal is unlikely to disrupt the breeding cycle of potential occurrences of *Swainsona murrayana* within the proposal.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove or modify 2.22 ha of core habitat within *Swainsona murrayana* species polygons as part of a total 9.35 ha of PCTs that are recognised as potential habitat for the species (NSW DCCEEW 2024b). Construction would reduce connectivity throughout the proposal footprint by decreasing vegetation cover and creating physical barriers that may interrupt seed fall, movement of pollinators or other ecological processes. These maximum disturbance areas are conservative and the majority would only be subject to partial or temporary impacts, noting: – around 3.57 ha of the total area of potential habitat to be affected is located at Wanganella, 45 km from the known population – other than the regulator structures and their immediate vicinity understorey vegetation would be allowed to regenerate – vegetation removal and excavation of soil would occur within a small portion of the overhead power supply routes and understorey vegetation would be left undisturbed or would be allowed to regenerate across the majority of the corridor – construction-only access tracks are generally aligned with existing tracks and so upgrade for the proposal would require minimal vegetation removal – operational access tracks are aligned with existing tracks and would require minimal upgrade or increases in traffic volumes. *Swainsona murrayana* is tolerant of light grazing, partial vegetation clearing and other human disturbance (DEWHA 2008) and so regenerating understorey vegetation across the proposal footprint would continue to provide habitat for the species. The local population occurs on either side of an existing farm access track that would be upgraded and used for the proposal. The proposed action would increase the degree of habitat fragmentation in the project area but would not permanently isolate any areas of habitat. Habitat connectivity for groundcover plants and pollinator species would be retained around and through the impact area and extensive adjoining areas of similar native grasslands, Black Box woodland, and chenopod shrubland. The further removal or modification of small areas of potential habitat would not have an adverse effect on habitat for the species to the extent that the local important population of the species would be likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
Disturbance associated with vegetation clearing and vehicle traffic during construction or use of the camp may, in general, increase the potential for the spread, introduction and establishment of weed and pest species. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting weed propagules. Environmental inductions, visual barriers and/or exclusion fencing will be used to exclude personnel and vehicles from habitat outside the proposal footprint. To further mitigate the risk of pathogens being brought onto and/or spread through the proposal footprint all vehicles, plant and equipment will be cleaned down (wash/blow down) and certified weed free prior to initial entry to site; all vehicles, plant and equipment will strictly adhere to the approved roads, tracks, easements and work areas to minimise contact with vegetation. In addition to the impacts of invasive flora, overgrazing or degradation of habitat by rabbits, feral pigs and goats is recognised as a threat to the species (DEWHA, 2008). The proposal is unlikely to introduce any pest fauna to the local area or increase the abundance or impact of pest fauna species that are already present.
Introduce disease that may cause the species to decline, or
As described for invasive species above, the proposal may, in general, increase the potential for the spread, introduction and establishment of diseases and pathogens. The proposal does not include any higher risk activities such as transport of biological material. Construction and environmental management plans will specify measures for restricting access to native vegetation and minimising the risk of transmitting disease. To further mitigate the risk of pathogens being brought onto and/or spread through the proposal footprint, all vehicles, plant and equipment will be cleaned and inspected. Personnel, vehicles and equipment will be restricted to work areas to minimise contact with sensitive habitat.

EPBC Act Assessment of Significance
Slender Darling Pea (*Swainsona murrayana*)

Interfere substantially with the recovery of the species

There is no recovery plan for this species. The proposal would interfere with the recovery of *Swainsona murrayana* by removing or modifying habitat, which is noted as a key threat for this species (DEWHA 2008). As described above, the proposal would remove or modify a maximum of 9.35 ha of native vegetation that comprises potential habitat for the known population of *Swainsona murrayana* in varying condition and quality. The potential residual direct impacts to habitat comprise a conservative upper limit. No above-ground plants have been recorded in the proposal footprint and the species would not be limited to, or reliant on, the habitat at the proposal footprint.

The proposal would make a minor contribution to habitat fragmentation but not sever an important connecting link or isolate any areas of habitat. The proposal would have a minor adverse impact on habitat critical to the survival of the species in the context of extensive areas of such habitat in the locality and surrounding region.

The proposed impact mitigation and environmental management measures are likely to mitigate against erosion, sedimentation or any other indirect effects on adjacent habitat during the proposed works. Operational hydrological changes are not likely to adversely affect habitat for the species (Cardno 2024a, 2024b).

The above-ground population of *Swainsona murrayana* and the majority of the occupied habitat in the local area would be undisturbed. *Swainsona murrayana* is tolerant of light grazing, partial vegetation clearing and other human disturbance (DEWHA 2008) and so regenerating understorey vegetation across the proposal footprint would continue to provide habitat for the species. The surrounding locality and region contain many thousands of hectares of similar vegetation and equivalent habitat resources. Construction impacts would be minor and temporary and as such a negligible proportion of the habitat available for the species in the locality would be removed or fragmented in the longer term. Given this minor quantum of impact and the presence of alternative habitat resources the proposal would not interfere substantially with the recovery of these species.

Conclusion of assessment of significance

Based on consideration of the above criteria, the proposal is unlikely to have a significant effect on an important population of *Swainsona murrayana* given:

- No above-ground plants would be directly affected based on recent targeted surveys under appropriate conditions.
- The proposal would remove or modify a small proportion of an extensive, connected area of potential habitat on the Billabong Creek and Forest Creek floodplains.
- The proposal is unlikely to have an adverse effect on the size or breeding cycle of an important population of the species.
- The proposal will only result in a minor increase in the degree of fragmentation between retained areas of habitat for this species and will not result in any isolation of habitat.
- Construction impacts would be minor and temporary, understorey vegetation would be allowed to regenerate across the majority of the disturbance footprint and as such a negligible proportion of the wetland habitat available for this disturbance-tolerant species in the locality would be removed or fragmented in the longer term.
- Operation of the proposal would not have an adverse effect on the species or its habitat.



ghd.com

→ The Power of Commitment