Mt Gilead Stage 2 Biodiversity Certification Application

Response to public submissions

13 September 2022

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Terms and acronyms used in this report

Abbreviation	Description
APZ	Asset Protection Zone
BAM	Biodiversity Assessment Methodology (BC Act 2016)
BBAM	BioBanking Assessment Methodology (TSC Act 1995)
BC Act	*NSW Biodiversity Conservation Act* 2016
BCA	Biodiversity Certification application
BCAA	Biodiversity Certification Assessment Area
BCAM	Biodiversity Certification Assessment Methodology
BCAR	Biodiversity Certification Assessment Report
Biodiversity Certification	An assessment process for areas of land that are proposed for development provided for under the TSC and BC Acts. The process identifies land that can be developed and measures to offset the impacts of development, either within the BCAA and/or outside of the BCAA.
BSA	Biodiversity Stewardship Agreement
CCC	Campbelltown City Council
CCKPoM	Campbelltown Comprehensive Koala Plan of Management
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
CLEP	Campbelltown Local Environment Plan 2015
Core Koala Habitat	An area of land identified by the processes in SEPP 44 to contain a resident koala population or identified in an approved KPoM
CPAR	Cumberland Plain Assessment Report (part of Cumberland Plain Strategic Assessment)
CPCP	Cumberland Plain Conservation Plan (part of Cumberland Plain Strategic Assessment)
CPLS	Cumberland Plain Land Snail
CPW	Cumberland Plain Woodland (a critically endangered ecological community listed under the BC Act)
CS&E	Office of NSW Chief Scientist and Engineer
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DOP	former NSW Department of Planning (now part of DPE)
DPE	NSW Department of Planning and Environment
DPIE	Former NSW Department of Planning, Industry and Environment (now DPE)
EES	Environment, Energy and Science Group (part of DPIE)
EMP	Environmental Management Plan

Abbreviation	Description
EP&A Act	*NSW Environmental Planning and Assessment Act* 1979
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999
GREA	Georges River Environment Alliance
GMGA	Greater Macarthur Growth Area
HBT	Hollow Bearing Tree
Important Koala Habitat	The term used in the CPAR and CPCP to describe both primary corridors (critical to the long term viability of koalas) and secondary corridors (if enhanced would support the population)
KFT	Koala Food Tree (as defined by Schedule 2 of SEPP 44) and includes Forest Red Gum (*Eucalyptus tereticornis*) and Grey Gum (*E. punctata*) in the BCAA/study area
Koala Movement Corridors	Areas of habitat which facilitate movement and dispersal of koalas between habitat patches which would otherwise be disconnected
LEP	Local Environment Plan
LGA	Local Government Area
MGS1	Mount Gilead Stage 1
MGS2	Mount Gilead Stage 2
NCC	Nature Conservation Council (of NSW)
OEH	former NSW Office of Environment and Heritage (now part of DPIE)
PoM	Plan of Management
Potential Koala Habitat	An area of native vegetation where the trees listed in Schedule 2 of SEPP 44 constitute at least 15%of the total number of trees in the upper or lower strata of the canopy (or as identified in an approved KPoM)
PKFT	Preferred Koala Food Tree (as recognised by the CCKPoM) and includes Woollybutt (*E. longifolia*) and Grey Box (*E. moluccana*) in the BCAA/study area
Primary Koala Corridors	Defined by DPIE (2019) as connected areas of koala habitat that are contiguous (gaps between trees less than 100m) and greater than 380 ha in area
Regional Koala Population	Defined by DPIE as the single, contiguous koala population extending from Campbelltown through Wollondilly to Wingecarribee
RFEF	River-flat Eucalypt Forest (an endangered ecological community listed under the BC Act)
RMS	NSW Roads and Maritime Services
SCKHCS	South Campbelltown Koala Habitat Connectivity Study
Secondary Koala Corridors	Defined by DPIE (2019) as movement corridors that are less than 50m wide or not connected at both ends to other koala habitat and contain between 100 and 380 ha of habitat
SEPP	NSW State Environmental Planning Policy
SLA	Koala Strategic Linkage Area (as defined in the Campbelltown CKPoM)
SSTF	Shale Sandstone Transition Forest (a critically endangered ecological community listed under the BC Act)

Abbreviation	Description
Strategic Biodiversity Assessment	A form of biodiversity certification only available to planning authorities such as the DPIE or a Local Government to support significant regional development and planning processes
Strategic Conservation Area	A term used in the CPAR to identify large remnants of native vegetation with good connectivity or areas with the potential to enhance connectivity to identify potential conservation lands for further investigation.
TAP	Technical Assurance Panel
TEC	Total Environment Centre
TSC Act	Now repealed NSW *Threatened Species Conservation Act* 1995
WSUD	Water Sensitive Urban Design

1 Introduction

Eco Logical Australia (ELA) has been engaged by Campbelltown City Council (CCC) to prepare a report responding to submissions on the Biodiversity Certification Assessment Report for a proposed residential development on part of the Mount Gilead Property (Mt Gilead Stage 2) in the southern part of the Campbelltown Local Government Area (LGA) (ELA 2020) (**Appendix A** – Exhibited Biocertification Assessment report dated 27 November 2020).

The land originally proposed for biocertification is shown in **Figure 1** and comprised parts of Lot 1 and 2 DP1218887, Part Lot 2 DP 249393 and Part Lot 1 DP622362, Appin Road, Gilead. Since the exhibition of the biocertification application, amendments to the land proposed for biocertification has been reduced to reflect change in land ownerships. Lot 1 DP 622362 no longer forms part of the Biodiversity Assessment. **Figure 2** shows the current boundary of the land proposed for biocertification.

An application for the conferral of biodiversity certification can only be made by a planning authority. Campbelltown City Council is the applicant for biodiversity certification.

CCC must give notice of its intention to seek biodiversity certification in accordance with the public notification requirements of Section 126M of the now repealed *Threatened Species Conservation Act* 1995 (TSC Act).

A public notice regarding the exhibition was published in the Sydney Morning Herald and Macarthur Chronicle newspapers on Tuesday 15 December 2020. A public notice was also placed in the Macarthur Advertiser. The application was exhibited for 64 days between 15 December 2020 and 17 February 2021 with copies of the application and associated reports available for viewing at Council's Civic Centre, HJ Daley Library and Eagle Vale Central Library or by downloading from Council's website.

The exhibition period exceeded the statutory 28 day requirement and was further extended by 2 days to Friday 19th February 2021.

626 submissions (including one petition with 20 signatures) were received in the notified exhibition period and a further 53 after the close of exhibitions (**Appendix B**).

All the submissions were reviewed and comments noted.

Of the 626 submissions, 603 were 'template' submissions using one of three templates with identical points made/issues raised (with very minor differences in opening sentences followed by the same dot or numbered points). 17 submissions were made by individuals ranging from single sentences objecting to the proposal to more detailed comments. Six detailed submissions were made by organisations (Nature Conservation Council (NCC # 533), Georges River Environmental Alliance (GREA #576), Save Mt. Gilead Inc. (#609), Save Sydney's Koalas Inc. (#624), the Total Environment Centre (TEC #625) and the National Parks Association Macarthur Branch (#626)).

A geographic breakdown of the submissions is provided in **Table 1**.

All submissions either objected to the application or stated that a decision should be delayed until after decisions regarding regional infrastructure (specifically the Menangle and Appin Road Link Road) were made and broader issues with the Greater Macarthur Growth Area (GMGA), including the Cumberland Plain Conservation Plan (CPCP) were finalised.

Comments have been grouped by "issue" and are presented in **Table 2** and responded to in **Section 3**. Comments that have been raised by more than one submission have been grouped to avoid repetition. Five broad issues were raised in the 626 submissions as summarised below.

1. Lack of Planning proposal/Integrated approach with transport and other infrastructure across the Greater Macarthur Growth Area (GMGA)
2. Issues to do with the Biocertification Assessment Methodology (BCAM) (in adequate surveys, differences in species recorded between MGS1 and MGS2, not addressing measure to avoid and mitigate impacts, not achieving an improve or maintain outcome, impacts to red flag entities, no assessment of cumulative impacts, in adequate biodiversity offsets).
3. Unacceptable impacts to the strategically significant Campbelltown / Macarthur local koala population and critical koala habitat including:-
    a. Lack of conformity with the Chief Scientist & Engineer's (CS&E) recommendations, Campbelltown Koala Plan of Management and GMGA 2040 Interim Plan
    b. Inadequate protection of all koala movement corridors, inadequate width of corridors, need for buffers to movement corridors, objection to use of buffers for Asset Protection Zones, drainage basins and passive recreational activities, need for koala underpasses on Appin Road and need for floppy top koala exclusion fencing).
4. Unacceptable impacts to endangered ecologically communities and other threatened species
5. Other issues not covered by BCAM (loss of rural land, impacts to heritage areas, impacts to cultural heritage, increase in noise, sound, light, air and water pollution, impacts of climate change).

The first four issues are relevant to the biocertification assessment process and application, whilst the fifth issue is not part of the biocertification assessment process and are addressed through other processes (i.e. the regional planning process, rezoning of the land, development application and conditions of consent).

Table 1: Geographic breakdown of submissions received

Geographical Breakdown	Received by 19 February 2021	Received after 19 February 2021
Campbelltown	24	5
Camden/Wollondilly (Macarthur excluding C'town)	21	4
Southern Highlands	3	1
Metropolitan Sydney (Excluding above regions)	181	13
Rest of NSW	82	5
Rest of Australia	98	4
International	47	2
Unspecified	169	19
Petition	1 signed by 20	0
Total	**626**	**53**

This report provides a summary of the submissions, along with a response to the issues raised and whether any changes or additions to the original documentation will be made as a result of these submissions.

As the majority of submissions raised the lack of a planning proposal, none conformity with the CS&E recommendations (**Appendix C**), Campbelltown Council's Comprehensive Koala Plan of Management (CCKPoM) and the need for the protection of all koala movement corridors in the study area, **Section 2** provides a chronological summary of the planning process undertaken by the NSW Department of Planning and Environment (DPE) (and former agencies) over the past 7 years in the GMGA and the recommendations made to protect the Campbelltown / Macarthur koala population and koala habitat in and around the study area.

2 Summary of Planning process relevant to the identification of Koala corridors in Greater Macarthur Area

In 2015, the then NSW Department of Planning (DoP) released a preliminary strategy and action plan for the Greater Macarthur area, the '*Greater Macarthur Land Release Investigation Preliminary Strategy and Action Plan*'. The plan identified immediate opportunities to deliver up to 35,000 homes in Menangle Park and Gilead and identified these areas as 'Priority Growth Precincts' as they were logical extensions to the Campbelltown-Macarthur Regional City (DoP 2015). The report stated that '*the land in the precinct was relatively unencumbered by constraints to development and had less requirements for substantial transport and utility infrastructure upgrades than other parts of the Greater Macarthur Growth Area'* (DoP 2015).

The Greater Macarthur Growth Area (GMGA) has since been adopted and confirmed as a land release area in the Greater Sydney Commissions' Greater Sydney **Region Plan** – a Metropolis of three cities and the Western City **District Plan**. In response to the strategic importance of Greater Macarthur, the NSW Government exhibited '*Greater Macarthur 2040 - An Interim Plan for the Greater Macarthur Area*' in November 2018 (DPE 2018) which includes a **Structure Plan** (**Figure 3**) which identified urban capable land, employment lands, environmental conservation lands (including proposed indicative koala corridors) and indicative transport corridors.

In 2019, the Office of NSW Chief Scientist & Engineer (CS&E) was asked to review previous studies, reports and recommendations then provide independent expert advice on protecting the Campbelltown koala population. Over various reports prepared by the CS&E (April 2020, February 2021 & May 2021) the CS&E provided 4 overarching principals to ensure the adequacy of koala protection measures.

1. increasing and improving existing habitat by, for example, establishing the Georges River Koala Reserve
2. improving connectivity by constructing koala movement crossings and protecting koalas from urban threats with exclusion fencing
3. active monitoring and using adaptive management for koalas
4. adopting good practices for disease prevention including vaccinations.

In finalising the advice, the CS&E detailed 31 principles for protecting koalas in the Greater Macarthur and Wilton growth areas and surrounding regions.

In Jan 2021, the Government established a Technical Assurance Panel (TAP), Chaired by the Executive Director of the Department of Planning with representatives from the Environment, Energy and Science Division of DPIE, Transport for NSW, Sydney Water and CCC to work through the recommendations of the CS&E and further assessment of fauna underpasses along Appin Road to finalise the Master planning of the site and progress the planning proposal.

In December 2021, the NSW Department of Planning, Industry and Environment (DPIE) published an update to the Greater Macarthur 2040. This update provides an overview of what has happened since the release of Greater Macarthur 2040 Interim Plan in November 2018, a status update of key strategic projects and an outline of the steps needed to finalise the plan. Importantly the update included indicative koala corridors that will be secured over time in the Greater Macarthur Growth Area, which includes parts of Campbelltown City Council and Wollondilly Shire Council (**Figure 4**). The indicative koala corridors apply all the CS&E's advice to ensure they support safe koala movement and are a priority for protection and ecological restoration over the long term.

DPIE advised Lendlease in December 2021 that the details regarding koala corridors at Gilead as recommended by the CS&E were now resolved (**Appendix D**). The Biodiversity Certification Assessment Report has now been updated to ensure the Master plan is consistent with the advice provided by DPIE (**Appendix E).**

In August 2022 the Cumberland Plain Conservation Plan (CPCP) was approved by the NSW Minister for the Environment, The CPCP will be implemented through to 2056 and represents one of the largest strategic conservation planning exercises ever undertaken in Australia.

This response to submissions report has been prepared taking into account the latest Government policy positions regarding koala corridors within Greater Macarthur and the April 2020, February 2021 and May 2021 CS&E recommendations regarding the protection of koala movement corridors, fauna crossing for linear infrastructure, threat mitigation disease management and adaptive management.

Table 2: Summary of issues raided by submission type/number

Submission Number	533	576	609	624	625	626	489	497	Template #1	Template #2	Template #3	7	14	38	50	94	253	309	312	330	379	451	557	583	586
	NCC	GREA	Save Mt Gilead	Save Sydney's Koalas	TEC	NPA			5	313	285														
Planning issues																									
Need for planning proposal/Integrated approach	X		X	X	X		X			X	X			X											
Master Plan exhibited is out of date, old maps					X																				
Density and nature of development not specified			X		X																				
Regional Transport Options in GMGA / Link Roads not considered	X	X	X					X			X														
Other infrastructure requirements (sewerage/water) not assessed								X																	
Other approvals required (WM Act)				X																					
Changes to MGS1 and flow on effects to MGS2			X	X		X																			
Appin Road upgrade not assessed	X		X	X	X																				
Need for CPCP to be completed prior to decision on MGS2																									
Cumulative impacts of development (MGS1 / MGS2 & CPSA) and development creep on MGS1	X		X	X	X	X	X	X																	
Increased urban temps & climate change not assessed				X																					
Biocertification process and method issues																									
Inadequacy of assessment reports			X			X																			
Assessment of State/Regional Biodiversity Link missing from the application					X																				
Differences between species recorded in MGS1 and MGS2			X																						

Submission Number	533	576	609	624	625	626	489	497	Template #1	Template #2	Template #3	7	14	38	50	94	253	309	312	330	379	451	557	583	586
Measures to avoid impacts			X	X			X				X														
Improve or Maintain outcome not achieved		X	X	X																					
Impacts to Red Flags			X	X			X																		
Assessment of cumulative impacts																									
Inadequate Biodiversity Offsets	X	X	X	X			X				X								X	X					
Biobank sites (Medhurst not connected, Browns Bush impacted by Appin Rd upgrade)			X				X																		
Impacts to Strategic Koala population issues																									
Extinction of Koalas in NSW / Key NSW Population that is Chlamydia free	X	X		X	X	X	X									X		X					X		X
Impact of 2019/20 bushfires not considered					X		X							X											
Strategic Location of Mt Gilead between Georges and Nepean Rivers	X	X	X	X	X	X																			
Loss and/or fragmentation of Koala habitat	X				X	X			X	X		X	X			X	X			X	X				
Lack of conformity to CS&E Recommendations	X	X	X	X	X	X	X	X	X	X	X			X	X				X	X				X	X
Contrary to advice of CCC and CKPoM				X	X	X		X	X	X														X	
Contrary to recommendations of GMGA 2040 Interim Plan re Nepean River Corridor	X	X	X	X	X					X	X			X											
Connection between Georges & Nepean Rivers	X	X		X	X	X	X		X			X		X											
Need to protect ALL east-west corridor on Gilead	X	X	X	X	X		X		X			X			X						X				X
Queries over timing of construction of three creek crossings							X																		
Width of Koala corridors	X		X	X	X	X		X	X					X						X				X	X
Buffers to koala corridors		X	X	X	X	X		X	X	X	X									X					
Averaging of corridors & use of adjoining properties				X	X	X	X	X	X	X	X			X											
Primary Nepean River corridor - 425m + buffers		X	X	X	X	X	X	X	X	X	X			X						X					X

Submission Number	533	576	609	624	625	626	489	497	Template #1	Template #2	Template #3	7	14	38	50	94	253	309	312	330	379	451	557	583	586
Menangle Creek (A) 390-425m + buffers				X	X	X			X	X															
Increase Menangle Creek corridor in MGS1 to 250m							X																		
Woodhouse Creek (B) 390-425m + buffers		X	X	X	X	X			X	X															
Nepean Creek (C) - 390m + buffers		X		X	X			X	X	X	X			X						X					X
Consistency with CCKPoM corridors - 425m				X	X	X			X																
Edge effects to Koalas (traffic, noise, pollution, dogs)			X	X		X		X			X									X				
Impacts of noise and light on wildlife				X					X																
Unacceptable works/activities in corridor /buffers				X				X	X	X	X									X					
Location of APZs		X	X	X				X		X	X									X					
Floppy top koala exclusion fencing				X		X	X	X	X	X															
Need for koala underpasses at Appin Rd	X	X	X	X	X	X	X	X	X	X	X														
All Koala Offsets to be met on-site (not Appin/Noorumba)				X	X					X	X								X						
Koala credit deficit				X	X																				
Inadequate Koala Conservation Plan				X	X	X																			
Reject proposal and declare a Koala Sanctuary																									
Assessment & impact to critically endangered ecological communities																									
CPW Impacts		X		X																					
SSTF Impacts		X		X																					
RFEF Impacts				X																					
Assessment & impacts to other threatened species		X																							
Native animal & human impacts									X																
Pomaderris brunnea		X	X	X																					

Submission Number	533	576	609	624	625	626	489	497	Template #1	Template #2	Template #3	7	14	38	50	94	253	309	312	330	379	451	557	583	586
Large-eared Pied Bat																									
Fishing Bat		X	X	X																					
Micro-bats		X																							
Swift Parrot		X																							
Cumberland Land Snail		X		X																					
Squirrel Gliders		X		X																					
Protection of Hollow-bearing trees		X		X																					
Other issues (Not addressed by BCAM)																									
Heritage listing - Double dipping Homestead Biobank		X																							
Heritage values				X																					
Cultural Heritage Values				X																					
Loss of Rural Land									X																
Erosion in gullies/ Storm water run-off and management and water quality pollution		X																							
Heat & Air pollution impacts to humans & native F&F from Climate Change								X	X																
Sub-totals	**14**	**27**	**26**	**44**	**27**	**20**	**17**	**16**	**20**	**16**	**15**	**3**	**1**	**9**											
Support or Object to proposal	Delay	-	Object	Object	Object	Object	Object	Object	Oppose	Oppose	Oppose	Object	_	Delay	Object	Object	Object	Object	Object	Object	Object	Object	Object	Object	Object

Notes: Template 1 comprises 5 submissions, Template 2 comprises 314 submissions and Template3 comprises 285 submissions.

3 Response to issues raised

3.1 Lack of Planning Proposal and integrated approach with GMGA, the CPCP and regional traffic studies			
Comments	**Raised in key submissions**	**Response**	**Relevant Section of ELA report**
Need for a planning proposal / Integrated approach			
• Lendlease should withdraw its biodiversity certification application for MGS2 until a planning proposal for the site has been finalised. The environmental impacts cannot be adequately assessed unless the scale of development and the edge effects of traffic, noise and light pollution are better known. • The assessment of the application should be delayed until a planning proposal is developed for the property. The rural zoning of MGS2 has not changed to residential and Lendlease has not finalised its Masterplan. The environmental impacts cannot be properly assessed if the density of the proposed development and its potential edge effects on wildlife are not known. • The MGS2 biodiversity application should be suspended until broader planning is completed to address the protection of the Campbelltown region koala population. Important decisions remain about growth area and transport infrastructure in an	T2, T3 & #38, #489, #497, #533 #576, #609, #624, #625, #626	The Menangle Park and Gilead Priority Precincts of the Greater Macarthur Growth Area have been planned as part of a Department of Planning led planning process since 2015 and have included consideration of major transport links. The Department released a draft Structure Plan in 2018 (**Figure 2**) that includes urban capable land, key conservation land and primary/secondary koala corridors with the preferred assessment being a biodiversity certification assessment in parallel with the planning process. Lendlease commenced its biodiversity assessments in 2016. The DPE led Strategic Assessment commenced in 2017 (Openlines 2020) and included assessment of transport options. Lendlease and Campbelltown City Council have been liaising with DPIE since November 2017 on the planning process for the Gilead Precinct. The REF for the Appin Road upgrade was exhibited between November and December 2018 by Roads and Maritime Services (RMS 2018) and a Response to submissions report prepared in March 2019 (RMS 2019). The planning proposal for MGS1 included a strip of land within the Mt Gilead Property to allow this road widening to occur. The proposed road includes koala exclusion fencing along the eastern side of Appin Road and on the western side at Noorumba Reserve Biobank site.	**Refer Section 1.1.1 and Appendix B of revised Biocertification Assessment Report (Appendix E)**

3.1 Lack of Planning Proposal and integrated approach with GMGA, the CPCP and regional traffic studies

Comments	Raised in key submissions	Response	Relevant Section of ELA report
around Gilead which will determine the adequacy of koala protection measures in the application (significantly Appin Road upgrade and wildlife underpasses have not been confirmed). • Assessment of the application should be delayed until the design of the Appin Road upgrade and underpasses/overpasses at Noorumba and Beulah are finalised. • Plans for east-west link roads connecting Appin Road, Gilead and Menangle Park are still being formulated. • The CPCP has not been finalised so locking in the MGS2 biocertification is premature and undermines the integrated planning approach needed to secure proper koala protections • The biodiversity certification process encourages planning authorities to assess the biodiversity values of land as part of the strategic planning process and an application for certification will generally be developed in conjunction with a planning proposal. The application cannot proceed until it is known what infrastructure development impacts will occur such as proposed link roads and widening of Appin Road and other infrastructure such as waste and power.		In Jan 2021, the Government established a Technical Assurance Panel (TAP), Chaired by the Executive Director of the Department of Planning with representatives from the Environment, Energy and Science Division of DPIE, Transport for NSW, Sydney Water and CCC to work through the recommendations of the CS&E and further assessment of fauna underpasses along Appin Road to finalise the Master planning of the site and progress the planning proposal. In December 2021 DPIE resolved the details regarding koala corridors as recommended by the CS&E, updates to the Biodiversity Certification Assessment Report have been finalised to ensure the plans are consistent with the advice provided by DPIE. In July 2022 Lendlease submitted a draft planning proposal to DPIE for Mount Gilead Stage 2, this proposal will be followed by an update to the Biodiversity Certification Assessment. As per many comments made in submissions the Biodiversity Conservation assessment was paused while the planning process was progressed to resolve the extent of urban development, infrastructure requirements and ecological corridors across Mount Gilead stage 2.	**Letter from DPE to Lendlease regarding agreed Koala corridors (Appendix D)**

3.1 Lack of Planning Proposal and integrated approach with GMGA, the CPCP and regional traffic studies			
Comments	**Raised in key submissions**	**Response**	**Relevant Section of ELA report**
• Should the biodiversity certification application for MGS2 be assessed before a planning proposal for MGS2 has been developed to avoid the risk of major infrastructure (transport routes or other utilities) impacting on agreed conservation measures, including Appin Road upgrade. • No rezoning proposal has been put forward so hard to Masterplan without densities.			
• The Masterplan in the exhibited document is out of date, it is dated July 2019, and thus Masterplan has not been updated in last 2 years as per CS&E report and as requested by the Minister	#625	This statement is incorrect. Figure 4 of the updated Concept Master Plan is dated 12 August 2020. The Master Plan in the originally submitted application (ELA 2019) is dated 20 July 2019. The Biocertification Assessment report was updated prior to exhibition, as requested by the Minister, and has been updated again following exhibition following the TAP process. **Assessment Report updated to reflect latest advice from the CS&E and DPE**	**Updated Biocertification Assessment Report September 2022 (Appendix E)**
Cumulative impacts of development			
• Several submissions raised the issue of the cumulative impacts associated with MGS1, proposed MGS2 and potential development in the rest of the GMGA including the Strategic Assessment and that the cumulative impacts of this	#533,#609, #624, #625, #626	As part of the broader planning process for the Greater Macarthur Priority Growth Area, DPIE is considering the cumulative impacts of development in the Greater Macarthur region on biodiversity with a particular emphasis on the Macarthur Koala population supported by studies undertaken by CCC, ESS and the recommendations of the CS&E.	**Updated Biocertification Assessment Report September 2022 (Appendix E)**

3.1 Lack of Planning Proposal and integrated approach with GMGA, the CPCP and regional traffic studies			
Comments	**Raised in key submissions**	**Response**	**Relevant Section of ELA report**
development to biodiversity and the local Koala population has not been assessed • Several submissions stated that the Government should finalise the CPCP before making a decision on MGS2		It is these reports that have led to the identification and protection of critical koala movement corridors across the GMGA, the mitigation of existing threats to the population (proposed underpasses at Noorumba, Beulah and Ousedale Creeks), an extensive program of habitat protection, consolidation and restoration and a fully funded long term monitoring program will be implemented under the CPCP. The CPCP was approved in August 2022. **Assessment Report updated to reflect approval of the CPCP in August 2022**	
Impacts of associated infrastructure not assessed			
• Several submissions have raised the lack of assessment of the impacts of associated infrastructure including the upgrading of Appin Road, the proposed Link Road between Menangle Park and Appin Road as well as power, sewerage and water infrastructure	#489, #497, #533 #576, #609, #624, #625	MGS2 has included provision for a north-south transport corridor through Mt Gilead joining Menangle Road in the north east of the project site via an elevated Menangle Creek crossing that will allow the free passage of koalas beneath and has made submissions to Transport for NSW regarding the various Menangle Park to Appin Link Road Options to ensure that these do not impact on proposed offset areas. The CPSA and CPCP have also included assessment of various transport options in their assessments. Water and sewerage infrastructure to MGS2 will be subject to environmental assessments, importantly the creation of the biobanks as part of the conservation strategy of the BCA existing habitat will be protected from further impacts from servicing the development. Over 50% of the BCA areas of Mount Gilead Stage 1 & 2 will be retained for conservation, heritage and open space. The proposed development	

3.1 Lack of Planning Proposal and integrated approach with GMGA, the CPCP and regional traffic studies

Comments	Raised in key submissions	Response	Relevant Section of ELA report
• Several submissions have raised the issue of heat sinks and the appropriateness of further urban development in a part of south western Sydney where average temperatures are expected to increase significantly due to climate change		will see an increase in tree canopy cover across the site compared to the current extent of canopy cover. **No changes to Assessment Report required** The proposed development will see a significant increase in tree canopy cover across the site compared to the current extent of canopy cover. Mitigating the impacts of urban heating will be managed through the urban design process and has no bearing on the Biodiversity Conservation Assessment. **No changes to Assessment Report required**	

3.2 Biocertification Process and Method

Comments	Raised in submissions	Response	Relevant Section of ELA report
Adequacy of Flora and Fauna Studies (different suite of species recorded in MGS2 compared to MGS1			
• Stage 1 and 2 are adjacent and have similar soils, topography, landscapes and vegetation types but different suites of species have been recorded that suggest inadequacies and unreliability of the studies (e.g. abundance of Cumberland Plain Land Snails in Stage 2, presence of a significant population of Pomaderris brunnea in Stage 2	#609, #626	Whilst MGS1 and MGS2 have similar soils, topography and vegetation types, the landscapes and landuse histories are quite different. MGS1 is largely cleared with a few isolated, fragmented patches of poor quality vegetation remaining that has been heavily used for agricultural purposes. MGS1 was largely cleared by the 1950's. The current habitat condition is not suitable for Cumberland Plain Land Snail which requires dense ground cover and abundant litter, Squirrel Glider that requires	

3.2 Biocertification Process and Method

Comments	Raised in submissions	Response	Relevant Section of ELA report
		connected habitat and a dense midstory or Pomaderris that is susceptible to grazing (although land snails were recorded in the higher quality vegetation in Noorumba Reserve, Squirrel Glider in Browns Bush and Pomaderris to the east of Appin Road. In contrast, extensive areas of contiguous vegetation remained in MGS2 (in the 1950's). Large parts of MGS2 were not cleared for agricultural use until the 1980's. The creek lines in Stage 2 are 2nd and 3rd order creeks, are more dissected than Stage 1, have been fenced off by the land owner to keep stock out and are accordingly more intact, less disturbed and still support suitable habitat for these species. **No changes to Assessment Report required**	
Impacts to biodiversity values not avoided and minimised			
• We believe that the proposed footprint has failed to apply the avoid option, and has poor mitigation	#609	The Master planning for MGS2 has been an iterative process since 2015 with the ecological constraints informing the development outcomes. Areas of high biodiversity values (vegetation in good condition, strategic wildlife corridors) have largely been avoided other than relatively minor impacts associated with creek crossings where there are no alternatives. When the original Biocertification application was submitted to the Minister by CCC in August 2019, the land proposed for certification was 332.17 ha an included impacts to 76.89 ha of native vegetation. The land proposed for certification has been reduced to 268.72 ha which includes 53.50 ha of native vegetation. **Assessment Report updated post exhibition**	**Updated Biocertification Assessment Report September 2022 (Appendix E)**
In adequacy of Assessment Report			

3.2 Biocertification Process and Method

Comments	Raised in submissions	Response	Relevant Section of ELA report
• Assessment report does not recognise the importance of Gilead's importance as a State/Regional Biodiversity Link	#625, #626	The assessment report has been prepared in accordance with the BCAM. The BCAM has specific definitions of 'State', 'Regional' and 'Local' Biodiversity Links when undertaking assessments. Further, the 'Guide to undertaking Biodiversity Certification Assessments for applicants (OEH 2015a) states that a State or Regional Biodiversity Link is a link that has been approved by the then CEO of OEH for the specific purpose of a Biodiversity assessment. As outlined in Section 1.6 of the Assessment report, the CEO of OEH has not approved any State or Regional Links for use in the BCAM. This does not mean that the assessment has ignored the strategic importance of the east-west corridors at Gilead. On the contrary, consistent with Biolink 2018; 2020 and the recommendations of the CS&E, the application has identified Woodhouse and Menangle Creek as key corridors and has committed to permanently protect, restore and manage these corridors as registered biobank sites. **No changes to Assessment Report required**	Refer Section 1.6 of BCAR (**Appendix E**)
Impacts to Red Flags not avoided			
• Pomaderris brunnea is a species that cannot withstand further loss (i.e. it is a red flag species). This species must at all costs be protected by maximising corridor widths to 425m with buffer zones.	#609, #624, #489	The MGS2 has recorded the presence of a significant new population of this species in south-west Sydney. This population is not protected from harm under the current land tenure and management. Of the 258 plants recorded in the study area, all but 2 will be permanently protected by the proposed Biodiversity Stewardship sites, protecting over 99% of the plants recorded on the site (Up to 23 Pomaderris plants would have been impacted in the original application). **Assessment Report updated post exhibition**	**Updated Biocertification Assessment Report September 2022 (Appendix E)**

3.2 Biocertification Process and Method

Comments	Raised in submissions	Response	Relevant Section of ELA report
Application does not achieve an 'improve or maintain' outcome			
• The inadequate bushland protection and conservation measures will not enable the maintenance and improvement in biodiversity outcomes.	#576 & #609	An 'improve or maintain' outcome is described in Section 2 of the BCAM and is achieved if 'red flag' areas are avoided and all impacts are offset by the number of required credits (or the Director-General of OEH is satisfied that impacts to red flag areas may be offset in accordance with the variation criteria in s2.4 of the BCAM). In accordance with the BCAM, conservation measures may be secured within the BCAA (Section 8) or outside of the BCAA (Section 9). Subject to the Director –General approval of the red flag variation requests for impacts to CPW, SSTF and Pomaderris brunnea) (Section 5 of the assessment report), the conservation measures proposed in the assessment (both on-site and off-site measures) will generate all the required credits for impacts to all vegetation types and all species credit species other that a small 185 credit deficit for Koala, which will be met by the purchase of credits from a registered Biobank or Biodiversity Stewardship site or the Biodiversity Conservation Trust. As such, and in accordance with the BCAM, the proposal is considered to meet an 'improve or maintain' outcome. The land proposed for biocertification comprises largely scattered paddock trees and none-Koala browse species that whilst providing habitat for Koala, is of lower value than intact woodland. Patches of higher quality vegetation, surrounded by open space, are proposed for conservation measures where the quality of habitat in these areas will be enhanced and expanded.	Section 2.4, 8 & 9 of BCAM and Section 4 and 5 of the updated Biocertification Assessment report, September 2022

3.2 Biocertification Process and Method

Comments	Raised in submissions	Response	Relevant Section of ELA report
		The proposed conservation measures permanently protect, manage and restore some 225 ha of endangered communities and habitat for threatened species, including koala. The management of the offset areas includes improving the quality and extent of vegetation and restoration of currently cleared areas. **Assessment Report updated post exhibition**	
The Offset Package is inadequate			
• The offset package includes Noorumba and Beulah Reserves • The offset package includes the Heritage listed Mt Gilead Homestead site. This is double dipping it is already conserved by legislative instrument such as State Heritage Listing. • Medhurst biobank site is not connected to any corridors • Appin West is many miles away which may have some benefits for Wilton Koala's that are genetically distinct from the koalas at Gilead. • Species credit paid into a fund, may support research but fails the 'like for like' standard.	#576, #609 & #625	The proposed offset package for MGS2 does not include the Beulah, Fernhill or West Appin Biobank sites. The package includes 3 new Biodiversity Stewardship Agreement sites (BSAs) sites totalling 225 ha of endangered vegetation types and Koala habitat (Browns Bush, Gilead and Gilead Homestead) and purchase of an additional 185 koala credits from other registered biobank and /or BSA sites or the Biodiversity Conservation Trust. The proposed offsets for MGS2 enhance and complement the offsets provided in MGS1 by further securing habitat along the Menangle Creek corridor, adding connectivity to the Macarthur-Onslow Biobank site to Woodhouse Creek and adding to the proposed Georges River Koala Reserve (Browns Bush Biobank site). All of these new sites are eligible to be registered as Biodiversity Stewardship sites (BSAs) as they have not previously been used as offset sites and have no existing legal requirement to be 'actively managed for conservation' (Heritage listing of the Gilead Homestead does not require the land owner to undertake active management, rehabilitation and	Refer to Figure 37 and Section 6 of revised Assessment Report

3.2 Biocertification Process and Method			
Comments	**Raised in submissions**	**Response**	**Relevant Section of ELA report**
		restoration of koala habitat. Registration of a Homestead Biobank site requires these actions, in perpetuity). Payment into the BCF means that Koala species credits from a registered Biobank or BSA site are purchased and retired. The funds are not used for research, they are used to secure, protect and manage koala habitat and not other species habitat. Accordingly they meet the 'like for like' test. Lendlease will use 99 koala credits purchased from the Noorumba Reserve Biobank site to meet part of the koala offset requirements. These credits fund the management and restoration of core koala habitat in degraded parts of the Noorumba Reserve (a strategic Koala Linkage Area, as they did at West Appin for MGS1) and thus address all 5 of the TECs offset requirements of **Proximate** (they are within or immediately adjacent to the MGS2 study areas, they are **Contiguous** (the habitat areas are all part of corridors linking the Georges and Nepean Rivers), they are **additional** (as they secure, protect and require active management of land that is not currently protected and/or required to be managed for conservation), are **Environmentally Zoned** (all Biobank sites in MGS2 (and MGS1 as part of a new planning proposal that increases the areas available to koalas) are proposed to be zoned Environmental Protection), and are **accessible** to koalas (Lendlease has committed to provide underpasses at Beulah and Noorumba to assist safe passage of koala's across Appin Road (Subject to State Government Approval). **No changes to Assessment Report required**	
Zoning and Wildlife Corridors -			

3.2 Biocertification Process and Method

Comments	Raised in submissions	Response	Relevant Section of ELA report
• Submission # 625 states that all biobank sites must be zoned Environmental Protection.	#625	BSAs are an in perpetuity agreement registered on the land title. They can be registered over any land zoning other than National Park. It is the registration of the BSA on title that protects the biodiversity values of the land and creates the legal obligation of the current and any future land owners to manage the land in accordance with the Agreement, not what the underlying land zoning may or may not permit. Only the Minister for the Environment can terminate a BSA once the credits have been sold/retired. So whilst not required to be zoned C2 (as the requirements of a BSA are a higher standard), all proposed biobank sites in MGS2 are proposed to be zoned C2. **No changes to Assessment Report required**	Section 6 of Biocertification Assessment report

3.3 Impacts to viability of strategically significant Campbelltown / Macarthur koala population

Comments	Raised in submissions	Response / Actions	Relevant Section of ELA report
Concerns regarding the possible extinction of koalas in NSW in next 50 years, importance of the Chlamydia free Macarthur koala population			
• Several submissions raised concerns about the possible extinction of Koalas in NSW within 50 years as found in the Upper House Koala enquiry (Parliament of NSW 2020) and the importance of the chlamydia free Macarthur population as one of the healthiest in the state and thus a key population to protect and enhance	#489, #533, #576, #624, #625, #626	Noted. CCC, DPIE and the NSW Government recognise the importance of this koala population and have taken extraordinary lengths to develop a 'best practice' approach to koala management in urban areas based on the advice of koala experts, CCC, DPIE (2019) and the CS&E Recommendations. The development as proposed will protect over 250 ha of koala habitat, 225 ha of which is in dedicated conservation areas (BSA sites) which has no current land tenure protections. The protection and enhancement of over 250 ha of koala habitat will increase the koala carrying capacity of the site from its current state. **No changes to Assessment Report required**	
Impacts of the 2019/20 summer bushfires on koalas in NSW			
• Several submissions raised concerns about the impacts of the 2019/20 summer bushfires on NSW Koala populations and the need to provide 'escape routes' should wildfires impact the Campbelltown population	#489, #625	The MGS2 project does not affect the likelihood of major bushfires in the Campbelltown/Wedderburn or Holsworthy areas. Should a major bushfire occur in these catchments the extent of unburnt areas and ability to move into unburnt patches of habitat for surviving koalas will be important in the recovery of the population. The MGS2 project has proposed underpasses at Beulah and Noorumba for the safe passage of Koalas across Appin Road (or the reverse direction) to the protected corridors within MGS2 and other connecting habitat along the Nepean River corridor. **No changes to Assessment Report required**	

3.3 Impacts to viability of strategically significant Campbelltown / Macarthur koala population

Comments	Raised in submissions	Response / Actions	Relevant Section of ELA report
Strategic Location of Mt Gilead in relation to connecting the Georges and Nepean Rivers and need to protect ALL east-west corridors as recommended by the CS&E			
• Multiple submissions refer to the strategic importance of Mt Gilead in providing three of the six east-west connecting corridors between the Georges and Nepean River corridors and that Mt Gilead provides the shortest linkage point • Several submissions also state that the CS&E report states that ALL of these corridors must be protected and that MGS2 does not conform to the CS&E's recommendations. • Several submissions state that MGS2 is inconsistent with the recommendations of CCC and the approved CKPOM that states '*all east-west corridors on Mt Gilead MUST be protected*' including the recommendations of Biolink's South Campbelltown Koala habitat Connectivity Study (SCKHCS) (Biolink 2018)	T1, T2, T3 & #489, #533, #576, #624, #625, #626	DPIE (2019) identifies seven (7) east-west corridors connecting the Georges and Nepean Rivers. Six are classified as secondary corridors (A -Menangle Creek, B - Woodhouse Creek, C - Nepean Creek, D - Mallaty Creek, E- Ousedale Creek and F – Elladale and Simpsons Creek) and one as a Primary Corridor (the Cataract River). The CS&E <u>does not</u> recommend the protection of 'ALL' east-west corridors in Mt Gilead. The CS&E states:- 1. the **Menangle Creek to Noorumba Reserve Corridor** (Corridor A) should be used for koala '*<u>if a feasible connectivity structure can be constructed at Appin Road</u>*' and if not it should be fenced (At Appin Rd), isolating the koalas using this area. 2. The **Woodhouse Creek to Beulah Reserve Corridor** (Corridor B) is an important northern connection for the koala population between the Gerges River Reserve and the Nepean River corridor and should be retained with an underpass near Beulah Reserve as proposed by Lendlease, however, the proposed measures for this corridor in ELA (2019) are not adequate and should be improved based on the corridor width measures recommended. 3. The relative importance of Corridor C (**Nepean Creek to Beulah Corridor**) is reduced in terms of its function if Corridor B can be secured. The role of corridor C would need to be visited if Corridor B is not used by Koalas or if its connectivity is temporarily disrupted during the construction of bridges at the Nepean River.	**Updated Biocertification Assessment Report September 2022 (Appendix E)**

3.3 Impacts to viability of strategically significant Campbelltown / Macarthur koala population			
Comments	**Raised in submissions**	**Response / Actions**	**Relevant Section of ELA report**
		The CS&E Report states that *"Not all the identified corridors are suitable to provide connectivity for koalas, but the habitat should be protected for koala habitat, biodiversity values and amenity in the region."* Ultimately the CSE recommends that within the Greater Macarthur there should be east-west connectivity across Appin Road and the expert panel prioritises two locations: i. Beulah Reserve / Woodhouse Creek at Gilead; and ii. Ouesdale Creek at Appin. Following a review of the CS&E advise, DPIE mapped koala corridors across Greater Macarthur and published an update to Greater Macarthur 2040 in December 2021 (**Figure 4**). This purpose of this update was to ensure the ongoing protection of koalas within the growth area, and in line with the Office of the NSW Chief Scientist & Engineer's recommendations, expand some koala movement corridors to ensure they support safe koala movement and are a priority for protection and ecological restoration over the long term. Lendlease have made legally binding irrevocable offers to the NSW Government to deliver, two Koala underpasses at Beulah and Noorumba, consistent with the CS&E (and Biolink 2018) to provide maximum functionality for the Woodhouse and Menangle Creek corridors. Creek crossings will be staged over 15 years such that habitat along Nepean and Menangle Creeks will remain intact until the crossing of Woodhouse Creek and protection of the corridor is complete.	

3.3 Impacts to viability of strategically significant Campbelltown / Macarthur koala population			
Comments	**Raised in submissions**	**Response / Actions**	**Relevant Section of ELA report**
		Further, Figure 5.3 in the approved CCC Comprehensive Koala Management Plan (Phillips 2018), identifies two Strategic Linkage Key Areas (SLAs) which run east to west through Mt Gilead (Woodhouse Creek) or on the northern boundary of Mt Gilead (Menangle Creek). These key SLAs will not be severely impacted by the proposal (other than for elevated creek crossings) and will be enhanced by the proposed BSA site registration with restoration of cleared areas and degraded vegetation to widen the width of each corridor The SCKHCS (Biolink 2018) recommends the protection of 'three' east-west corridors in South Campbelltown, two of which are within Mt Gilead (Menangle Creek and Woodhouse Creek (both of which are proposed to be protected and enhanced)) and a third, Mallaty Creek, which is south of Mt Gilead and not affected by the proposed biocertification. It is considered as part of the CPCP (DPIE 2020). The SCKHCS does not recommend the protection of the Nepean Creek corridor. Following a review of the CS&E advise, DPIE mapped koala corridors across Greater Macarthur and published an update to Greater Macarthur 2040 in December 2021. The updated Biodiversity Certification layout has adopted the corridors as mapped by DPIE. **The Assessment Report has been updated to reflect these changes.**	
Width of Koala corridors, need to provide buffers and permitted activities within buffers			

3.3 Impacts to viability of strategically significant Campbelltown / Macarthur koala population

Comments	Raised in submissions	Response / Actions	Relevant Section of ELA report
• Many submission have stated that the CS&E has recommended all corridors be of a minimum width of 425m (within the development footprint and not averaged over the length of the corridor), plus a buffer 30m either side (which may be vegetated), and that APZs and detention basins must be within the development footprint. • Several submissions also state that Lendlease have included parts of the heritage precinct to inflate the average width of the corridors	T1, T2, T3 & #489, #533, #576, #624, #625, #626	Following a review of the CS&E advise, DPIE mapped koala corridors across Greater Macarthur and published an update to Greater Macarthur 2040 in December 2021. The updated Biodiversity Certification layout has adopted the corridors as mapped by DPIE. **The Assessment Report has been updated to reflect these changes.**	**Updated Biocertification Assessment Report September 2022 (Appendix E)**
• Many submissions have stated that the application does not protect the Nepean River, identified as a Primary Corridor by DPIE 2019, with a minimum preferred width of 425m as stated in the GMGA Structure Plan (DPE 2018) plus 30m buffer each side and 30m APZ	T1, T2, T3 & #489, #533, #576, #624, #625, #626	Following a review of the CS&E advise, DPIE mapped koala corridors across Greater Macarthur and published an update to Greater Macarthur 2040 in December 2021. The updated Biodiversity Certification layout has adopted the corridors as mapped by DPIE. **The Assessment Report has been updated to reflect these changes**	**Updated Biocertification Assessment Report September 2022 (Appendix E)**
• Many submissions state that Nepean Creek should have a wildlife corridor of at least 390 metres plus buffer zones from the top of its banks and a 30 meter Asset Protection Area (APZ).	T1, T2, T3 & #489, #533, #576, #624, #625	The CSE report found that *"Not all the identified corridors are suitable to provide connectivity for koalas, but the habitat should be protected for koala habitat, biodiversity values and amenity in the region."* The CSE report prioritises the protection of Corridor B (Woodhouse Creek) as a primary east-west connector for Gilead. The Lendlease proposal does exactly that. The CSE report also advises that "*Should Corridor B become secured, the relative importance of Corridor C*	**Updated Biocertification Assessment Report**

3.3 Impacts to viability of strategically significant Campbelltown / Macarthur koala population			
Comments	**Raised in submissions**	**Response / Actions**	**Relevant Section of ELA report**
		[Nepean Creek] *is reduced in terms of its function in connecting the Beulah Biobank site to the northern end of the Nepean Corridor*." The MGS2 proposal will protect koala habitat within the Nepean Creek corridor and includes koala exclusion fencing. Following a review of the CS&E advise, DPIE mapped koala corridors across Greater Macarthur and published an update to Greater Macarthur 2040 in December 2021. The updated Biodiversity Certification layout has adopted the corridors as mapped by DPIE. **The Assessment Report has been updated to reflect these changes**	**September 2022 (Appendix E)**
• The Chief Scientist advises that all wildlife corridors on developable land should be between 390 and 425 metres wide with 30-metre buffer zones and 30-metre APZs. • Many submissions state that the width of the proposed Woodhouse Creek corridors is not consistent with the CS&Es recommendations and should not include the existing Beulah and Browns Bush Biobank sites to inflate the average width	T1, T2, T3 & #489, #533, #576, #624, #625, #626	Following a review of the CS&E advise, DPIE mapped koala corridors across Greater Macarthur and published an update to Greater Macarthur 2040 in December 2021. The updated Biodiversity Certification layout has adopted the corridors as mapped by DPIE. **The Assessment Report has been updated to reflect these changes**	**Updated Biocertification Assessment Report September 2022 (Appendix E)**

3.3 Impacts to viability of strategically significant Campbelltown / Macarthur koala population			
Comments	**Raised in submissions**	**Response / Actions**	**Relevant Section of ELA report**
• The Chief Scientist advises that all wildlife corridors on developable land should be between 390 and 425 metres wide with 30-metre buffer zones and 30-metre APZs. • Many submissions state that the width of the proposed Menangle Creek corridor is not consistent with the CS&Es recommendations and should not include the existing Noorumba Biobank site or the Heritage listed part of the Gilead Homestead to inflate the average width • Several submissions state that the Menangle Creek corridor within MGS1 should be increased to 250m consistent with the approved Bulk Earth works DA.	T1, T2, T3 & #489, #533, #576, #624, #625, #626	Following a review of the CS&E advise, DPIE mapped koala corridors across Greater Macarthur and published an update to Greater Macarthur 2040 in December 2021. The updated Biodiversity Certification layout has adopted the corridors as mapped by DPIE. **The Assessment Report has been updated to reflect these changes**	**Updated Biocertification Assessment Report September 2022 (Appendix E)**
Road kill, and need for floppy top koala exclusion fencing			
• Multiple submissions have stated the need for 'floppy top koala exclusion fencing' (not dog proof fencing) to prevent road kill and dog attacks	T1, T2, T3 & #489, #533, #576, #624, #625, #626	In the updated assessment report, Lendlease have committed to fully enclosing/enclaving the entire development with koala exclusion fencing of all movement corridors with standard DPE/RMS endorsed 1500mm high fencing with a 600mm steel panel fencing (that will keep koalas within the safety of the protected corridors and dogs out) as recently installed along Appin and Picton Roads (refer to **Figure 8**). Koala exclusion fencing will also be installed along the length of the Appin Road upgrade adjacent to Mt Gilead by RMS, including the Browns Bush Biobank site. Fencing will be erected in Stages over the expected 15 years development stage of the project and prior to construction activities.	**Updated Biocertification Assessment Report September 2022 (Appendix E)**

3.3 Impacts to viability of strategically significant Campbelltown / Macarthur koala population			
Comments	**Raised in submissions**	**Response / Actions**	**Relevant Section of ELA report**
		The Assessment Report has been updated to clarify that all fencing is Koala exclusion fencing.	
Need for Koala underpasses along Appin Road			
• Multiple submissions have stated that overhead or underground wildlife crossings must be in place at Appin Rd • Multiple submissions state that these underpasses must be at Gilead and not Beulah or Noorumba biobank sites to minimise disruption to vegetation	T1, T2, T3 & #489, #533, #576, #624, #625, #626	Lendlease have offered to fund and construct koala underpass at Beulah and Noorumba consistent with the recommendations of Biolink 2018 and the CS&E (Subject to Stage Government approval). The concept design for an underpass at Beulah Reserve was endorsed by the CS&E. Indicative designs of these underpasses are included at **Figure 8**. Lendlease and DPIE are in ongoing discussions with Transport for NSW regarding the provision of koala underpasses at Beulah and Noorumba Reserve in support of MGS1 and MGS2. The underpasses will be located to balance corridor functionality and ecological impacts of construction. Impacts to vegetation will be minimal and restored following construction. **No changes to Assessment Report required**	
Need to meet all koala offsets on-site including Koala credit deficit			
• Several submissions have stated that all koala offsets should be met on site (i.e. from within Mt Gilead) and not via purchase of credits from Appin West or Noorumba Biobank sites • The deficit koala credits should also be met from Mt Gilead by widening corridors.	#624 #625	The proposed offset package for MGS2 does not include the Noorumba, Beulah, Fernhill or West Appin Biobank sites. The package includes 3 new BSA sites totalling 225 ha of Koala habitat (Browns Bush, Gilead and Gilead Homestead) and purchase of additional credits from other registered biobank sites or the Biodiversity Conservation Trust.	

3.3 Impacts to viability of strategically significant Campbelltown / Macarthur koala population			
Comments	**Raised in submissions**	**Response / Actions**	**Relevant Section of ELA report**
		The proposed offsets for MGS2 enhance and complement the offsets provided in MGS1 by further securing habitat along the Menangle Creek corridor, adding connectivity to the Macarthur-Onslow Biobank site to Woodhouse Creek and adding to the proposed Georges River Koala Reserve (Browns Bush Biobank site). All of these new sites are eligible to be registered as Biobank site as they have not previously been used as offset sites and have no existing legal requirement to be 'actively managed for conservation' (Heritage listing of the Gilead Homestead does not require the land owner to undertake active management, rehabilitation and restoration of koala habitat. Registration of a Homestead Biobank site requires these actions, in perpetuity). Payment into the BCF means that Koala species credits from a registered Biobank site are purchased and retired. The funds are not used for research, they are used to secure, protect and manage koala habitat and not other species habitat. Accordingly they meet the 'like for like' test. Lendlease will use 99 koala credits purchased from the Noorumba Reserve Biobank site to meet part of the koala offset requirements. These credits fund the management and restoration of core koala habitat in degraded parts of the Noorumba Reserve (a strategic Koala Linkage Area, as they did at West Appin for MGS1). Additional koala offsets will be provided that address strategic priorities for the regional koala population. **No changes to Assessment Report required**	
Inadequate Lendlease Koala Management Plan			

3.3 Impacts to viability of strategically significant Campbelltown / Macarthur koala population

Comments	Raised in submissions	Response / Actions	Relevant Section of ELA report
• The Lendlease KMP is inadequate • Several submissions state that Lendlease's corridor and carrying capacity reports lack credibility in regards to statements that the area of koala habitat will ultimately be higher and carrying capacity higher, koalas will not use trees less than 4 years old as stated by Eco Logical Australia because of low fertility soils	#624, #625, #626	Lendlease's Koala Conservation Plan and supplementary reports were prepared as a tool for community information and engagement, they do not form part of the Biodiversity Certification Application documentation. Accordingly no responses are given, however it is noted that In December 2020, Campbelltown City Council noted that *"The amendments [*to the Biocertification Assessment report requested by the Minister (ELA 2020)] *are consistent with the requirements of the Chief Scientist and Engineers Report and address the updated findings of Dr Steve Phillips, whose peer review was recently presented to Council."* **No changes to Assessment Report required**	
• The NSW Minister for Environment & Energy, Matt Kean, announced that he would not be signing off on a biodiversity certification application for Mount Gilead Stage 2 unless the "development meets all the recommendations of the Chief Scientist" • Campbelltown Council must reject this application because it doesn't comply with the Chief Scientist's recommendations and will be rejected by Environment Minister Matt Kean.	T1, T2, T3 & #489, #533, #576, #624, #625	Following a review of the CS&E advise, DPIE mapped koala corridors across Greater Macarthur and published an update to Greater Macarthur 2040 in December 2021. The updated Biodiversity Certification layout has adopted the corridors as mapped by DPIE. **The Assessment Report has been updated to reflect these changes**	**Updated Biocertification Assessment Report September 2022 (Appendix E)**

3.4 Impacts to endangered ecological communities and other threatened species

Comments	Raised in submissions	Response	Relevant Section of ELA report
Threats and cumulative impacts to EECs			
• MGS2 is 3 times size of MGS1 and will impact 5 EECs and 19 threatened fauna species and one threatened plant • The offset package is inadequate for such a huge loss • Several of the impacted species will have a credit deficit	#575 and #624	There are three EECs within MGS2. CPW, STF and RFEF. GMDR is not a listed EEC under either the BC or EPBC Acts. • 11.56 ha of CPW will be impacted, down from 13.85 ha of, of which 7.75 ha is of moderate condition and comprises a red flag area or area of high conservation value. 15.80 ha will be permanently protected and a further 13.54 ha will be restored. • 37.53 ha of SSTF will be impacted, down from 54.79 ha, of which only 4.42 ha is of moderate condition and comprises a red flag area or area of high conservation value. 127.86 ha will be permanently protected and a further 34.18 ha will be restored. • 4.14 ha of RFEF will be impacted, down from 5.96 ha, all of which is in low condition. 19.74 ha will be permanently protected or retained. The offset commitments for impacts to EECs are in excess of the requirements of BCAM. Lendlease will retire all the EEC credits required by the assessment and a further 101 surplus CPW, 997 surplus SSTF and 129 surplus RFEF ecosystem credits. **Assessment Report updated to reflect these changes**	Section 4 and 6 of updated Biocertification report (Appendix E)

3.4 Impacts to endangered ecological communities and other threatened species

Comments	Raised in submissions	Response	Relevant Section of ELA report
• Pomaderris brunnea is an endangered shrub that was observed at 10 locations across Mt Gilead with 253 plants recorded. • This species must be protected at all costs by maximising the corridor widths of Woodhouse and Nepean Creeks to 425m	#575, #609 and #624	The Masterplan has been updated between 2019 and 2022 to widen corridors for Koalas and reduce impacts to Pomaderris brunnea. These changes have resulted in impacts to 23 Pomaderris plants being reduced to 2.**Assessment Report updated to reflect these changes**	**Updated Biocertification Assessment Report September 2022 (Appendix E)**
• Swift Parrot use Mt Gilead and surrounding areas	#576	The Swift Parrot was recently recorded east of Appin Road, near Beulah in May 2018 (BioNet records) . Accordingly, the study area was identified as potential foraging habitat for Swift Parrot. Swift Parrots were considered likely to use the site from time to time as potential habitat is present on site. The species is difficult to survey for due to its nomadic nature and may only visit sites infrequently when winter flowering eucalypts are active. Under the BCAM Species credits are not required for impacts to Swift Parrot foraging habitat, however, the proposal will permanently protect 225 ha of potential foraging habitat and additional foraging opportunities in open space landscape plantings. **No changes to Assessment Report required**	
• Cumberland Plain Land Snails	#575 and #624	The Cumberland Plain Land Snail (CPLS) was recorded in MGS2 in areas with higher quality vegetation comprising native ground covers and abundant litter). There is no credit deficit for CPLS. 1,181 species credits are generated for the 196.88 ha of Cumberland Plain Land Snail habitat conserved, and will be retired for a 289 credit obligation, i.e. 892 surplus credits will be retired.	**Updated Biocertification Assessment Report September 2022 (Appendix E)**

3.4 Impacts to endangered ecological communities and other threatened species

Comments	Raised in submissions	Response	Relevant Section of ELA report
		Assessment Report updated to reflect these changes	
• Squirrel Glider and Greater Glider • Recorded in step gorges of Woodhouse and Menangle Creek where they nest in large tree hollows. Need to address the additional threat of poorly managed urban run-off and increased erosion of gullies and not include stormwater control measures within corridors		The Squirrel Glider was recorded in the Nepean River corridor and the Woodhouse, Menangle and Nepean Creek corridors as shown in Figure 17 of the assessment report. 1,347 credits are generated for the 224.42 ha of conserved Squirrel Glider habitat that will be retire for the 993 credit obligation i.e. 354 surplus Squirrel Glider credits will also be retired. Greater Gliders (Endangered on the EPBC Act but not listed under the TSC/BC Act) have not been recorded in the BCAA despite extensive survey effort. All of the corridors will be fenced with koala exclusion fencing with the habitat areas restored and enhanced under BSA management arrangements. The Master Plan for MGS2 includes a Water Sensitive Urban Design (WSUD), as described in Section 4.7.1 of the assessment report) with collection of urban run-off in stormwater detention swales within the urban footprint. Additional Bio-retention basins are located adjacent to (and sometimes within) the proposed wildlife corridors to temporarily hold, treat and release water into existing creek lines following heavy rainfall events to maintain water quality to match or exceed pre development water quality levels and flows and prevent erosion of gullies (Figure 6).	**Updated Biocertification Assessment Report September 2022 (Appendix E)**
• Southern Myotis (Fishing Bat) • It is important to protect the streamlines and associated rock features and trees that contain		Vegetation along Nepean River, Menangle and Woodhouse Creek where this species is likely to roost/breed will all be protected in registered biobank sites. The Master Plan for MGS2 includes a Water Sensitive Urban Design (WSUD), as described in Section 4.7.1 of the assessment report) with	

3.4 Impacts to endangered ecological communities and other threatened species

Comments	Raised in submissions	Response	Relevant Section of ELA report
nesting hollows for this species by maximising widths of corridors and other WSUD mitigations. • Water quality of streams must be maintained at current condition to support the suite of aquatic insects that are an essential part of the diet of this species		collection of urban run-off in stormwater detention swales within the urban footprint. Additional Bio-retention basins are located adjacent to (and sometimes within) the proposed wildlife corridors to temporarily hold, treat and release water into existing creek lines following heavy rainfall events to maintain water quality to match or exceed pre development water quality levels and flows and prevent erosion of gullies (Figure 6). 856 credits are generated for the 142.74 ha of conserved Myotis habitat that will be retired for the 613 credit obligation i.e. 244 surplus Myotis credits will also be retired. **Assessment Report updated to reflect these changes**	
• Micro-bats	#576	225 ha of foraging habitat for micro-bat species will be permanently protected on-site in proposed BSA sites with additional foraging opportunities in other retained land and open space areas.	

3.5 Other Site Values

Comments	Raised in submissions	Response	Relevant Section of ELA report
Heritage listing			
• The Gilead Homestead site is already heritage listed so registering a biobank site over the homestead area is double dipping	#576	As indicated above, listing under the NSW Heritage Act does not require the land owner to undertake active conservation management of EECs or koala habitat. The proposed Gilead Homestead BSA site will require active management of the BSA area, including restoration and enhancement to the existing poor quality habitat, feral animal control, fencing and is subject to annual reporting, monitoring and compliance checks. **No changes to Assessment Report required**	
Heritage values			
• Submission #624 refers to the historical significance of the property	#624	The Heritage values of Mt Gilead are noted and have been recognised by the heritage listing of the 150 ha homestead site in September 2020. MGS2 will not impact the heritage curtilage of the property. **No changes to Assessment Report required**	
Impacts to Cultural Heritage Values			
Submission #624 refers to the cultural significance of the river (Nepean) to the indigenous Dharawal people	#624	The cultural heritage values of the Nepean River are noted. MGS2 will not impact the cultural heritage values of the Nepean River. The Nepean River corridor will be protected in a biobank site. **No changes to Assessment Report required**	
Loss of rural land			
• General concern for loss of agricultural and scenic values	T1	The Gilead and Menangle Precincts of the GMGA were identified by the Department of Planning in the Greater Macarthur Land Release	

3.5 Other Site Values

Comments	Raised in submissions	Response	Relevant Section of ELA report
		investigation study and the subsequent 2040 Structure Plan as being suitable for urban development. **No changes to Assessment Report required**	
Erosion of gullies and gorges from urban run-off and water quality and/or pollution			
• Submission #576 states that increased urban stormwater runoff is an erosional threat and that it is important that WSUD mitigation measures are implemented to maintain water quality in creeks and streams	#576	The Master Plan for MGS2 includes a Water Sensitive Urban Design (WSUD), as described in Section 4.7.1 of the assessment report) Additional Bio-retention basins temporarily hold, treat and release water into existing creek lines following heavy rainfall events to maintain water quality to match or exceed pre development water quality levels and flows and prevent erosion of gullies (Figure 6). **No changes to Assessment Report required**	
Heat and air pollution linked with Climate Change			
• Submission #497 states that a report on the cumulative effects of air pollution and heat of the new Badgery's Creek airport, the Liverpool Intermodal and 1000's of new homes needs to be assessed.	T1 and #497	In proposing rezoning the site for residential purposes as part of the GMGA, the Minister for Planning has determined that development of the site for residential purposes will not have significant impacts on air quality, heat sinks or climate change. **No changes to Assessment Report required**.	

4 Conclusion

Of the issues raised in the 625 submissions, the vast majority related to non-conformity with the CS&E recommendations regarding protection of strategic koala movement corridors, minimum widths of corridors and the need for buffers to protect the integrity and functioning of these corridors and the lack of a Planning Proposal for the development.

Several issues raised were not relevant to matters the Biodiversity Certification Assessment Methodology (BCAM) is required to address (i.e. suitability of land for urban development (planning matter), impacts to agricultural land (planning matter) and lack on consideration of regional infrastructure (planning matter).

As part of preparing the assessment report, Lendlease and Campbelltown City Council consulted extensively with the DPIE to ensure consistency with the GMGA Structure Plan and the CPCP and have taken on board the recommendations of the CS&E.

The proposal is consistent with the GMGA planning process and protects (and enhances) all strategic east-west koala corridors identified in Councils Comprehensive Koala Plan of Management (Phillips 2018), the South Campbelltown Koala Habitat Connectivity Study (Biolink 2018) and the CS&E recommendations in a 250 ha Koala Conservation Area.

Following a review of the relevant issued raised in the exhibition period, and the planning process undertaken by the DPE (Technical Assurance Panel) after the exhibition period, the Biocertification Assessment report has been updated to:-

1. Widen the Woodhouse Creek, Menangle Creek and Nepean River Koala corridors to be consistent with CS&E recommendations
2. Recalculate the impacts and offset commitments
3. clarify the commitment to install ‘koala exclusion fencing’ along all koala corridors (rather than dog fencing).
4. Confirm that all offset areas will be proposed for C2 zoning.
5. The updated Biodiversity Certification layout has adopted the corridors as mapped by DPIE.
6. Enter into discussions with the owners of the Mt Gilead Homestead regarding the restriction/free range of farm dogs.

The updated Biocertification Assessment Report (ELA 2020 is provided as **Appendix E**.

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Appendix A : Exhibited Biocertification Assessment report and Application (Eco Logical Australia, 27 November 2020)

Appendix B : Compendium of submissions

Provided as a separate Pdf document with names of submitters removed for privacy reasons.

Appendix C : CS&E's Advice on Protection of the Campbelltown Koala Population - 30 April 2020

Appendix D Department of Planning and Environment response to the OCSE Principles and final Koala corridors in Gilead

Appendix E : Updated Biocertification Assessment report (Eco Logical Australia, 5 September 2022)

Appendix F : CS&E's Response to questions regarding the Campbelltown Koala population- February 2021

Appendix G : CS&’s Advice regarding the protection of koala populations associated with the CPCP- 14 May 2021

Appendix A

Exhibited Biocertification Assessment report and Application (Eco Logical Australia, 27 November 2020)

Mt Gilead – Stage 2

Biodiversity Certification Assessment Report & Biocertification Strategy

Prepared for
Lendlease Communities (Figtree Hill) Pty Limited

27 November 2020

DOCUMENT TRACKING

Item	Detail
Project Name	Mt Gilead Stage 2 – Biodiversity Certification Assessment and Biodiversity Strategy
Project Number	15054
Project Manager	Robert Humphries (02) 8536 8620 Suite 2, Level 3, 668-672 Old Princes Highway, Sutherland NSW 2232
Prepared by	Michelle Frolich, Rodney Armistead, Brian Towle, Bruce Mullins, Meredith Henderson, Kris Rixon, Robert Humphries
Reviewed by	Meredith Henderson, Accredited BCAM Assessor #0155
Approved by	Robert Humphries
Status	Final
Version Number	4
Last saved on	27 November 2020
Cover photo	Clockwise from top left: *Sarcochilus hillii*, Cumberland Plains Woodland, Grey Myrtle Dry Rainforest, *Pomaderris brunnea* (Rufous Pomaderris)

This report should be cited as 'Eco Logical Australia 2020. *Mt Gilead Stage 2 – Biodiversity Certification Assessment and Biodiversity Strategy*. Prepared for Lendlease Communities (Figtree Hill) Pty Limited.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Lendlease Communities (Figtree Hill) Pty Ltd

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Abbreviations

Abbreviation	Description
ARA	Adjacent Remnant Area
APZ	Asset Protection Zone
AW	Alluvial Woodland
BAR	Biodiversity Assessment Report
BCAA	Biodiversity Certification Assessment Area
BCT	Biodiversity Conservation Trust
BBAM 2014	Biobanking Assessment Methodology 2014
BC	*Biodiversity Conservation Act* 2016
BCAM	Biodiversity Certification Assessment Methodology
BCS	Biodiversity Certification Strategy
BVT	Biometric vegetation type
CCC	Campbelltown City Council
CCPD	Canopy cover projection density
CEEC	Critically Endangered Ecological Community
CMA	Catchment Management Authority
CPAR	Cumberland Plain Assessment Report
CPCP	Cumberland Plain Conservation Plan
CPSWSGTF	Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (as listed under the EPBC Act)
CPW	Cumberland Plain Woodland
DEC	NSW Department of Environment and Conservation (now OEH)
DECC	NSW Department of Environment and Climate Change (now OEH)
DECCW	NSW Department of Environment, Climate Change and Water (now OEH)
DoTEE	Commonwealth Department of the Environment and Energy
DPE	NSW Department of Planning and Environment (formerly NSW Department of Planning)
DPIE	NSW Department of Planning, Industry and Environment (formerly NSW Department of Planning and Office of Environment and Heritage)
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

Abbreviation	Description
GM2040	Greater Macarthur Growth Area
GMDR	Grey Myrtle Dry Rainforest
IoM	Improve or Maintain
LEP	Local Environment Plan
LGA	Local Government Area
LG Act	NSW *Local Government Act 1993*
Lendlease	Lendlease Communities (Figtree Hill) Pty Ltd
MALD	More appropriate local data
MNES	Matters of National Environmental Significance (EPBC Act)
Mt Gilead	Mt Gilead Pty Ltd
NPW Act	NSW *National Parks and Wildlife Act 1974*
NPWS	NSW National Parks and Wildlife Service (now part of OEH)
NSW	New South Wales
OEH	NSW Office of Environment and Heritage (formerly DECCW, DECC, DEC)
PCT	Plant Community Type
RF	Riparian Forest
RFEF	River-flat Eucalypt Forest
SCKHCS	South Campbelltown Koala Habitat Connectivity Study
SEPP 44	State Environmental Planning Policy No 44 – Koala Habitat Protection
SHW	Shale Hills Woodland (a component of CPW)
SPW	Shale Plains Woodland (a component of CPW)
SSTF	Shale Sandstone Transition Forest
TSC Act	NSW *Threatened Species Conservation Act 1995 (now repealed by the BC Act 2016)*

Definitions

The following table provides definitions for the terminology used in biocertification assessments. Where these terms have been used in the report they have been included in 'quotation marks'.

Definition	Description
Area of High Biodiversity Conservation Value	As described under Section 2.3 of the BCAM. Areas include critically endangered and endangered ecological communities (CEEC and EEC) not in low condition, threatened species that cannot withstand further loss, areas of vegetation that have regional or state conservation significance, and state and regional biodiversity corridors. Also termed Red Flags.
Biodiversity Certification Assessment Area	As described in the BCAM, it includes land where certification is proposed to be conferred and any surrounding or adjacent land. Surrounding and adjacent land may be proposed for biodiversity conservation, or neither certification nor development (Retained Land).
Conservation Area	Land that is proposed for conservation measures.
Conservation Measures	The range of measures identified in Section 126L of the TSC Act
Credit Discounting	Applies where there are existing legal obligations to undertake conservation management actions on land.
Development Area	Land within the Biodiversity Certification area that is proposed for development
Ecosystems Credit	As described under the BCAM, the class of credit for biodiversity certification that are generated for conservation measures or required for the land proposed for certification. Ecosystem credits are also generated/required? for some threatened species that are assumed to be present based on the location of the site and the vegetation types present.
Low Condition	As described in Section 2.3 of the BCAM. To meet the 'low condition' threshold a number of criteria described in the method must be met, including <50% of the lower benchmark value of over-story percent cover for the relevant vegetation type or native vegetation with a site value score of less than 34 (Site value score is described in Section 3.6.2 of the BCAM).
Managed and Funded Conservation Measure	As described under Section 8.1.1 of the BCAM. Examples include entering into a Biodiversity Banking Agreement with respect to the land under Part 7A of the TSC Act and the reservation of land under the *National Parks and Wildlife Act 1974* (NPW Act).
Managed Conservation Measure	As described under Section 8.1.2 of the BCAM. Examples include entering into a conservation agreement under Division 12, Part 4 of the NPW Act and entering into a planning agreement under the EP&A Act that makes provision for development contributions to be used for or applied towards the conservation or enhancement of the natural environment.
Moderate-Good Condition	As described in Section 2.3 of the BCAM. Any vegetation that is not in 'low condition' is in 'moderate to good' condition
More appropriate local data	As described in 3.4 of the BCAM, the Director General may certify that more appropriate local data can be used instead of the data in the Vegetation Benchmark Database, where local data more accurately reflects local environmental conditions.

Definition	Description
Planning Instrument Conservation Measure	As described under 8.1.3 of the BCAM. Application of this measure requires a number of conditions to be met that are described under the relevant Section of the method.
Biometric vegetation type	A plant community classification system used in BioMetric Tools, including the BioBanking Tool, Biodiversity Certification Tool and Property Vegetation Planning Tool
Red Flags	As described in Section 2.3 of the BCAM. See 'Areas of High Biodiversity Conservation Value above.
Retained Land	Land within the Biodiversity Certification Assessment Area that is not land proposed for biodiversity certification or subject to proposed conservation measures.
Species credit	As described in the BCAM, the class of credits for biodiversity certification that are generated for a conservation measure or are required for the land proposed for certification
Tg Score	Response to Management Score (used to calculate the number of species credits at impact sites)
TSPD	Threatened Species Profile Database (data used by the credit calculator tool)

Executive summary

Eco Logical Australia Pty Ltd (ELA) was commissioned by Lendlease Communities (Figtree Hill) Pty Limited (Lendlease) in 2015 on behalf of Campbelltown City Council (CCC) to undertake a Biodiversity Certification Assessment (BCAR) and prepare a Biodiversity Certification Strategy (BCS) for Mount Gilead Stage 2, a proposed residential development at Appin Road, Gilead. The purpose of the assessment is to obtain '*biodiversity certification*' of land proposed for residential development and associated infrastructure from the Minister for the Environment. Biocertification is conferred by the Minister if the '*conservation measures'* proposed in the biocertification application result in an overall '*improvement or maintenance'* in biodiversity values.

The application was submitted to the Minister for the Environment in August 2019 by CCC under the Savings and Transitional provisions of the *Biodiversity Conservation Act* 2016 and has been revised and updated, as requested by the Minister, following the Chief Scientist and Engineers Independent Report on the Protection of the Campbelltown Koala population in April 2020 and the release of the Cumberland Plain Assessment Report (CPAR) and draft Cumberland Plain Conservation Plan (CPCP) in August 2020.

The '*Biodiversity Certification Assessment Area'* (BCAA) defined for the study encompasses a total area of 672.52 ha and includes 266.48 ha of existing/remnant native vegetation communities comprising five Biometric vegetation types (BVTs). These BVTs form components of the vegetation communities, Cumberland Plain Woodland (CPW) and Shale Sandstone Transition Forest (SSTF), which are listed as critically endangered ecological communities (CEECs) under the now repealed NSW *Threatened Species Conservation Act 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act) *1999*, and River-Flat Eucalypt Forest (RFEF) which is listed as an endangered ecological community (EEC) under the TSC Act and is being considered for listing under the EPBC Act. The remaining 406.76 ha of the assessment area is exotic vegetation and cleared land.

Whilst a number of threatened flora and fauna species have been recorded near or within the assessment area, only five species (Koala, Squirrel Glider, Cumberland Plain Land Snail, Southern Myotis and *Pomaderris brunnea)* requires specific assessment under the BCAM for impacts to habitat. These species are classified as '*species credit'* species and impacts to these species cannot be assessed by the vegetation types under the BCAM.

The BCAA and proposed impacts are described in **Section 1**. The biodiversity values of the BCAA are described in the Biodiversity Assessment Report (BAR) in **Section 2**. Explanation for data used in the assessment is provided in **Section 3**. The biodiversity credit calculations and strategy for achieving an 'improve or maintain' outcome are provided in **Sections 4** and **6** respectively.

The application proposes to directly impact 328.30 ha of the assessment area of which 75.72 ha is mapped as native vegetation and threatened species habitat in various condition states, and includes 10.53 ha of a SSTF, 8.99 ha of CPW SPW and 0.03 ha of CPW SHW in 'moderate to good' biometric condition, 4.31 ha of vegetation within riparian buffers, and 6 individuals of the endangered plant *Pomaderris brunnea*, which are categorised as '*red flag areas'* or '*area of high biodiversity conservation value*' by the BCAM.

Impacts to red flag areas that cannot be avoided require a '*variation*' approval from the Minister that addresses specific red flag viability criteria before Biocertification can be conferred. A request for a red flag variation addressing the 'degraded' condition /low viability of these red flag areas is included in

Section 5. The remaining areas to be impacted are not '*areas of high biodiversity conservation value*', or are cleared of native vegetation.

The application proposes to permanently protect and manage for conservation, 198.16 ha of lands in the BCAA (194.42 ha of which will generate ecosystem credits), 2.98 ha being a red flag vegetation conservation area buffer (that will not generate ecosystem credits) and 0.76 ha of retained dams and tracks, which are proposed to be conserved as registered Biobank sites. Applications to register four Biobank sites (Browns Bush, Gilead - Homestead, Gilead and Medhurst Biobank sites) were submitted by the relevant landholders in August 2020. Biobanking Agreements are recognised as '*100% permanently managed and funded'* conservation measures under s.126L (i) of the TSC Act and Section 8.1.1 of the BCAM, and will provide in-perpetuity conservation protection and management on the land title. The 198.16 ha of conservation lands includes 2.75 ha of CPW and SSTF that will be protected as Natural Areas under the Local Government Act 1993 which are 90% permanently managed conservation measures under BCAM.

In addition to this proposed conservation measure, 146.06 ha of land within the BCAA will be 'retained' as either rural land, public open space and existing easements which includes 23.53 ha of retained native vegetation, whilst currently cleared areas will be subject to some landscape tree plantings as well as passive recreation to further enhance habitat for Koala.

Collectively, these Biobank sites and retained open space will form a 244.8 ha fenced, dog and vehicle prohibited, Gilead Koala Conservation Reserve of 250m minimum width, that will be subject to a Koala Conservation Plan including on-going management and mitigation of threats, community education and involvement and ongoing monitoring.

This Biodiversity Certification Assessment has found that **1,623** biocertification *'ecosystem credits'* are required for direct and indirect impacts to five BVTs (17 credits for CPW SHW, 269 for CPW SPW, 1,202 credits for SSTF, 123 for RFEF and 12 for Grey Myrtle Dry Rainforest (GMDR) and **4,985** '*species credits'* are required for impacts to Koala (1,942 credits), Squirrel Glider (1,501 credits), Cumberland Plain Land Snail (476 credits), Southern Myotis (978 credits) and *Pomaderris brunnea* (88 credits).

The proposed Biobank sites and Natural Areas in the 'land subject to *conservation measures*' will generate **2,152** ecosystem credits (147 for CPW SHW, 304 for CPW SPW, 1,424 for SSTF, 193 for RFEF and 84 GMDR), i.e. subject to the approval of the red flag variation requests, all ecosystem credits are met and significantly exceeded by the proposed on-site conservation measures. These same Biobank sites will generate **5,522** species credits (1,175 Koala, 1,180 Squirrel Glider, 1,018 Cumberland Plain Land Snail, 752 Southern Myotis and 1,446 *Pomaderris brunnea* species credits i.e. there will be a deficit of 320 Squirrel Glider species credits, 767 Koala credits and 226 Southern Myotis credits. The deficit of credits for Squirrel Glider (320), Koala (767), and Southern Myotis (226) will be met by the purchase of additional species credits from registered Biobank or Biodiversity Stewardship sites in the region or via the purchase of biodiversity credits from the Biodiversity Conservation Trust (BCT). Lendlease (Credit ID holder 650) already holds 99 Koala credits from the Campbelltown Koala population purchased from the Noorumba Reserve Biobank site (BA239).

All surplus ecosystem (529) and species credits (1,900) generated by on-site conservation measures will be retired in accordance with the requirements of the BCAM.

Indirect impacts have been considered in accordance with the BCAM and have been determined to be negligible on the basis that all direct impacts have been assessed on the assumption of complete loss of all biodiversity values, even where impacts are only partial loss as a result of establishing Bushfire

Asset Protection Zones (APZ) and all proposed conservation areas have a 30m buffer provided by perimeter roads (15m) and Local Open Space/APZs that will retain biodiversity values, in particular canopy trees that will provide additional foraging resources for Koala.

Subject to the Minister's approval of the request for a red flag variation, the proposal can meet an '*improve or maintain*' outcome and is eligible for biodiversity certification. If the Minister confers biocertification on the requested land, CCC as the consent authority for future development applications is no longer required to assess impacts to biodiversity values as these have already been addressed by the Minister and '*conservation areas*' will be required to be managed in perpetuity for conservation.

1. Preamble

1.1 Project background

Eco Logical Australia Pty Ltd (ELA) was commissioned by Lendlease Communities (Figtree Hill) Pty Ltd (Lendlease), on behalf of Campbelltown City Council (CCC), to undertake a Biodiversity Certification Assessment of proposed residential development over 672.52 ha of land to the west of Appin Road, Gilead (the Biodiversity Certification Assessment area or BCAA), in the Campbelltown Local Government Area (LGA), and to prepare a Biocertification Certification Strategy (BCS) to meet a 'maintain and improve' biodiversity outcome.

The study area is located on four lots accessed from Appin Road (Lots 1 and 2 DP1218887, Part Lot 5 DP1240836, Lot 2 DP603674 and Lot 1 DP603675) and two lot accessed from Menangle Road (Lot 1 DP622362 and Lot 2 DP 249393). The study area is immediately west of the Mt Gilead Stage 1 residential development that was rezoned in 2017 and biodiversity certified in July 2019 (Figure 1). The lands form part of the Menangle-Gilead Priority Precinct in the Greater Macarthur Growth Area for which the former Department of Planning and Environment released a preliminary land use study in 2015 (DPE 2015) and Interim Plan in 2018 (DPE 2018) and the now Department of Planning, Industry and Environment (DPIE) have recently (August 2020) prepared and exhibited a draft Cumberland Plain Strategic Assessment Report (CPAR) and draft Cumberland Plain Conservation Plan (CPCP) (Openlines 2020 and DPIE 2020) (Figure 2).

An application for biocertification must follow the Biodiversity Certification Assessment Methodology (BCAM) (Department of Environment, Climate Change and Water [DECCW] 2011) and meet the requirements of Section 126K of the *Threatened Species Conservation Act* 1995 (TSC Act), i.e. be accompanied by a BCS.

The BCAM was developed by the New South Wales (NSW) Office of Environment and Heritage (OEH) and was gazetted by the NSW government in February 2011. The methodology may be applied to land for which '*biocertification is sought'*, and is conferred by the Minister for the Environment if the '*conservation measures'* proposed in the biocertification application result in an overall '*improvement or maintenance'* in biodiversity values. This is referred to under the methodology as satisfying the '*improve or maintain test*' (IoM test).

The methodology provides an equitable, transparent and scientifically robust framework with which to address the often competing demands of urban development and biodiversity conservation. If the Minister for the Environment is satisfied that an IoM outcome has been achieved, he/she may confer biocertification on 'land'. If the Minister confers biocertification on land, a consent/approval authority does not have to take biodiversity issues into consideration when assessing development applications, i.e. for the purpose of s.5A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), the development or activity is not subject to an Assessment of Significance for threatened species, populations or ecological communities.

This Biodiversity Certification Assessment commenced in 2015 with detailed ecological studies throughout 2015, 2016, 2017 and 2020. In August 2017, the TSC Act was repealed by the *Biodiversity Conservation Act* 2016. At the same time, a Savings and Transition Order was gazetted that allowed this application to continue to be assessed under the 2011 BCAM and TSC Act until 24 August 2019 on the basis that the application was 'significantly advanced'.

The application was submitted to the Minister for the Environment in August 2019 by CCC and has now been revised and updated, as requested by the Minister, following the Chief Scientist and Engineers Independent Report on the Protection of the Campbelltown Koala population in April 2020 and the release of the Cumberland Plain Assessment Report and draft Cumberland Plain Conservation Plan in August 2020.

Only a '*Planning Authority'* as defined by section 126G of the TSC Act may apply to the Minister for biocertification. Campbelltown City Council (CCC) is a Planning Authority as defined by section 126G. CCC resolved to be the applicant for this application on 11 June 2019.

The field work was undertaken by a number of accredited assessors employed by Eco Logical Australia between 2015 and 2017 (Dr Meredith Henderson, Brian Towle, Bruce Mullins, Tammy Paartalu, Rebecca Dwyer and Greg Steenbeeke (Accreditation Numbers 0155, 0229, 0156, 0074, 0095 and 0110 respectively) who were supported by other ELA field ecologists (Elizabeth Norris, Dr Rodney Armistead, Alex Gorey, Suzanne Eacott, Dr. John Golan, Mitchell Scott and Jack Talbert) with the credit calculations undertaken by Michele Frolich (BAM Accredited), supervised by Dr Meredith Henderson (Accredited Assessor 0155) in 2019. Brief Cvs for key field staff involved in the project are provided in **Appendix A**. Additional survey data that has covered parts of the BCAA has also been included including Biolink (2018) and WSP in RMS (2018).

1.2 Description of project timelines, management and governance

The application for biocertification of Mt Gilead Stage 2 is being undertaken in parallel with the Greater Macarthur Growth Area land use study (DPE 2015) and the Cumberland Plain Assessment Report (CPAR) (Openlines 2020) being led by the Department of Planning, Industry and Environment (DPIE) and Cumberland Plain Conservation Plan 2020-2056 (CPCP) (DPIE 2020) but is not part of the Strategic Assessment and is not subject to the proposed land uses in the CPCP. However, the Minister for the Environment has requested that the assessment be revised to take into consideration the recommendations of the Chief Scientist and Engineers Independent Report on the Protection of the Campbelltown Koala population in April 2020.

Stage 2 is a 328 ha Urban Development primarily containing low and medium residential development with associated, infrastructure, retail & educational facilities, public spaces, active & passive open spaces areas and conservation lands. Development is likely to commence in 2024 and take up to 10 years to complete in seven indicative stages, depending on demand for housing. A summary of the consultations between Campbelltown City Council and DPIE regarding a planning proposal can be found in **Appendix B.**

1.1.1 Strategic Context

This application for Biodiversity Certification is consistent with the DPE structure Plan as outlined in the NSW Department of Planning & Environment's Greater Macarthur 2040 Interim Plan for the Greater Macarthur Growth Area. This document outlines a 'Vision for Greater Macarthur' which includes Mount Gilead with Menangle Park as a 'Priority Precinct' due to proximity to the Campbelltown-Macarthur regional city and the relatively direct access to existing infrastructure. Additionally, actions for facilitating growth within this Priority Precinct are detailed including upgrades to adjacent roads including Appin Road and the Hume Highway (DP&E 2015, 2018).

1.3 Community Consultation and Stakeholder Engagement

The DPE publicly exhibited the Greater Macarthur Land Release Strategy in 2015 (DPE 2015) and the Greater Macarthur 2040 Interim Plan for the Greater Macarthur Growth Area (GM2040) in November

2018. The GM2040 report included a Structure Plan incorporating the Menangle and Gilead Precinct showing urban capable land, indicative transport corridors, indicative Koala corridors and environmental conservation lands subject to the Cumberland Plain Conservation Plan (Figure 3).

Lendlease have prepared a Concept Masterplan (Figure 4) that addresses the Structure Plan, notes the recommendations from the CPCP including proposed E2 Zoning for retained vegetation/wildlife corridors and have made submissions to DPE regarding the rezoning of the land.

1.4 Biodiversity certification assessment area and proposal

The Biodiversity Certification Assessment Area (BCAA) encompasses a total area of 672.57 ha and is located close to Campbelltown city centre within the Campbelltown LGA in south-western Sydney. The site is accessed off Appin and Menangle Roads and includes land proposed for biodiversity certification or 'land to be certified'' (328.30 ha), and therefore proposed for development, 75.72 ha of which is native vegetation), conservation areas or '*land subject to conservation measures*' (198.16 ha) which includes 266.48 ha of existing native vegetation and regeneration and restoration of 30.17 ha of cleared/degraded land and 2.98 ha of red flag buffers), and '*retained land*' i.e. land that is not proposed for development or subject to conservation measures (146.06 ha which includes 23.53 ha of vegetation in public open spaces that will be enhanced by landscape plantings)(Table 1 and Figure 5).).

Table 1: Proposed biocertification land uses and lots in the BCAA

Development footprint	Area (ha)	% of BCAA	Area of native vegetation (ha)	% of native vegetation
Land proposed for Biodiversity Certification (Urban development and associated infrastructure - roads, bio-detention basins, APZs)	328.30	48.82	75.72 existing vegetation 252.58 cleared land	28.41
Land proposed for conservation (195.41 ha to be registered as 4 Biobank sites and 2.75 ha Natural Areas)	198.16	29.46	167.23 existing vegetation 30.17 to be restored 0.76 tracks/dams	62.75
Retained lands (land excluded from this assessment) includes Mt Gilead Homestead lands, Local Open Space and existing easements.	146.06	21.72	23.53 existing vegetation	8.83
Total	**672.52**	**100**	**266.48**	**100**

The BCAA includes approximately 266.48 ha of existing native vegetation comprising five Biometric Vegetation types, three of which are listed as Critically Endangered Ecological Communities (CEECs) under the TSC/BC Act and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and one of which is listed as an Endangered Ecological Community (EEC) under the TSC Act (**Table 2**). The remaining areas (approximately 406.04 ha) comprise exotic pasture which fits the definition of 'cleared land' as defined by the BCAM (DECCW 2011) i.e. areas where there is no canopy or shrub layer and the ground cover is greater than 50% exotic cover or areas that will be restored to native vegetation within proposed offset areas.

The regional location of the BCAA is shown in Figure 2 and details of the lots that make up the biocertification land uses in the BCAA are shown in Figure 1 and presented in **Table 1**. The areas proposed to be impacted (land to be certified or '*development areas*'), land subject to conservation measures or '*conservation areas*', and '*retained land*' in the BCAA are shown in Figure 5.

Also shown in Figures 2, 4 and 5 are the locations of existing Biobank sites (Beulah, Noorumba Council Reserve, Noorumba-Mt Gilead, Macarthur-Onslow Mt Gilead and the Hillsborough Biobank sites) and the Dharawal National Park.

Table 2: Biometric vegetation types and their conservation status in the BCAA

Biometric vegetation type	Area (ha)	TSC Act	EPBC Act
HN526 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	27.45	RFEF (EEC)	Currently being considered for listing as a TEC
HN528 Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion	36.21	CPW SPW (CEEC)	CPSWSGTF (CEEC)*
HN529 Grey-Box – Forest Red Gum grassy woodlands on shale of the Southern Cumberland Plain, Sydney Basin Bioregion	8.74	CPW SHW (CEEC)	CPSWSGTF (CEEC)*
HN538 Grey Myrtle dry rainforest of the Sydney basin Bioregion and South East Corner	8.33	N/A	N/A
HN556 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	184.87	SSTF (CEEC)	SSTF (CEEC)
Cleared land	406.04	NA	NA
Total	**672.52**		

* CPSWSGTF = Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest

1.5 Biocertification Assessment Process and Implications

Under the BCAM, the impact of development and conservation measures on biodiversity values is quantified using '*biodiversity credits*' which are defined by each of the BVTs (ecosystem credits) and threatened species present (species credits). In this regard, the methodology determines the number of credits that are required to offset the adverse impacts of development on biodiversity values and the number of credits that can be generated by undertaking recognised '*conservation measures*' as outlined in s126L of the TSC Act that will improve biodiversity values within the BCAA. Where the number of credits that are created is equal to, or exceeds the number required, the '*improve or maintain*' test described under the methodology is considered to be satisfied, provided '*red flags*' have been avoided, or a red flag variation has been approved by the Director General of the OEH.

'*Red flags*' are regarded as '*areas of high biodiversity conservation value*' in section 2.3 of the BCAM, and include vegetation types that are >70% cleared in the Catchment Management Authority Area (CMA), CEECs and EECs listed under the TSC Act and/or EPBC Act, certain threatened species that are regarded as not being able to withstand further loss in the CMA, and areas that are recognised as biodiversity corridors of state or regional significance.

The BCAA includes three 'red flag' entities as defined by Section 2.3 of the BCAM that will be impacted by the proposal:

1. Impacts to endangered ecological communities in 'moderate to good' biometric condition
    a. 'Shale Sandstone Transition Forest in the Sydney Basin Bioregion' (SSTF) involving impacts to 10.53 ha
    b. 'Cumberland Plain Woodland in the Sydney Basin Bioregion' (CPW) involving impacts to 8.99 ha of SPW and 0.03 ha of SHW
2. Impacts to threatened species classified as species that cannot withstand loss in the Threatened Species Profile Database (TSPD)
    a. *Pomaderris brunnea* (6 plants potentially impacted out of 258 recorded plants)
3. Impacts to areas of vegetation recognised as having regional or state biodiversity conservation significance
    a. Vegetation within a riparian buffer 30 m either side of a minor river or major creek (2.44 ha)
    b. Vegetation within a riparian buffer 20 m either side of a minor creek (1.87 ha)

The measures taken to avoid, minimise and mitigate impacts to these '*red flag*' areas are provided in **Section 5**. As all impacts have not been avoided, this assessment report includes red flag variation requests (**Section 5**).

1.6 Assessment Methodology/Consultation with the OEH

In accordance with the OEH's Biodiversity Certification Guide for applicants (OEH 2015a), CCC and ELA consulted with the OEH prior to and throughout the assessment of the Mount Gilead Stage 1 assessment to ensure that all decisions and assumptions meet the requirements of the BCAM.

This Stage 2 assessment has been prepared consistent with the Stage 1 agreements reached with OEH and other biodiversity certification assessments in the Sydney region, including:-

- The version of the Biocertification calculator tool to be used for calculations (Version 1.9_HN556 201216 has been used)
- Amendments to hollow bearing tree and fallen log benchmarks for HN528 and HN556 (1 and 50m have been used respectively)
- There being no State or Regional Biodiversity Links approved by the CEO of OEH for this assessment (there are only local biodiversity links)
- All remnant vegetation mapped as intact, thinned/modified or scattered paddock trees, has been considered as Koala habitat for species credit calculations
- The width of buffers to protect red flag areas (being 30 m including a maximum of 15 m in any perimeter roads, and where possible including open space and Asset Protection Zones between urban areas and conservation lands)
- The consideration of Southern Myotis as a species credit species for potential breeding habitat (breeding habitat assumed to be present within 100 m of a hollow bearing tree that is within 200m of all 'permanent' water bodies greater than 3 m width). However, as the threatened species profile data (TSPD) in Version 1.9_HN556 201216 of the BCAM calculator tool has not been updated since 2012, we have used a Tg value (threatened species response to management) of 0.45 instead of 0.13 consistent with the Tg value in the BBAM 2014 tool and the final version of the TSPD before the repeal of the TSC Act. This TSPD also does not classify Southern Myotis as a red flag species. As Version 1.09_HN556_201216 of the BCAM tool does not recognise these changes, the credit calculations for this species have been calculated using Equation 10 of the BCAM with a Tg score of 0.45.

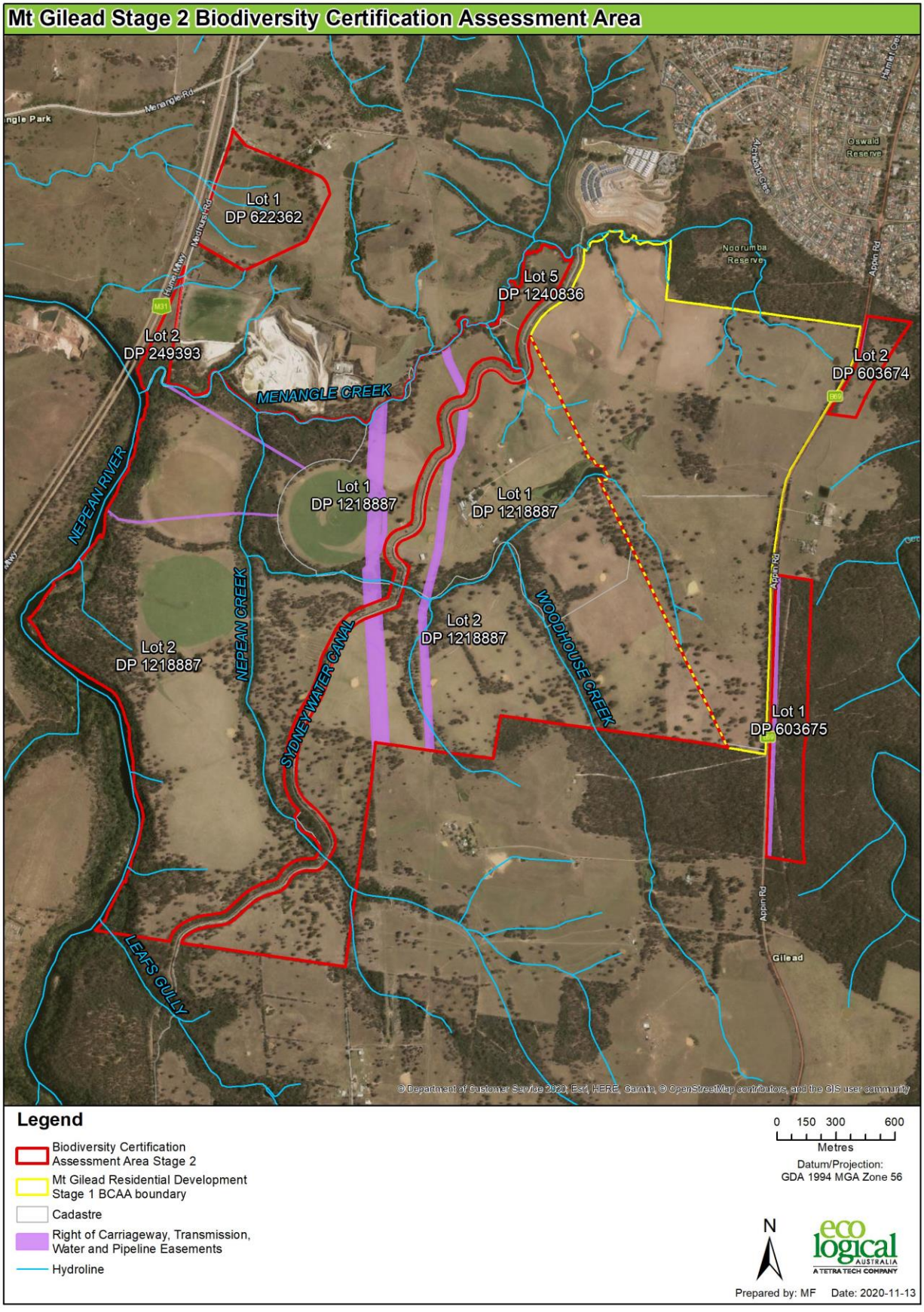


Figure 1: Mt Gilead Stage 2 Biodiversity Certification Assessment Area boundary

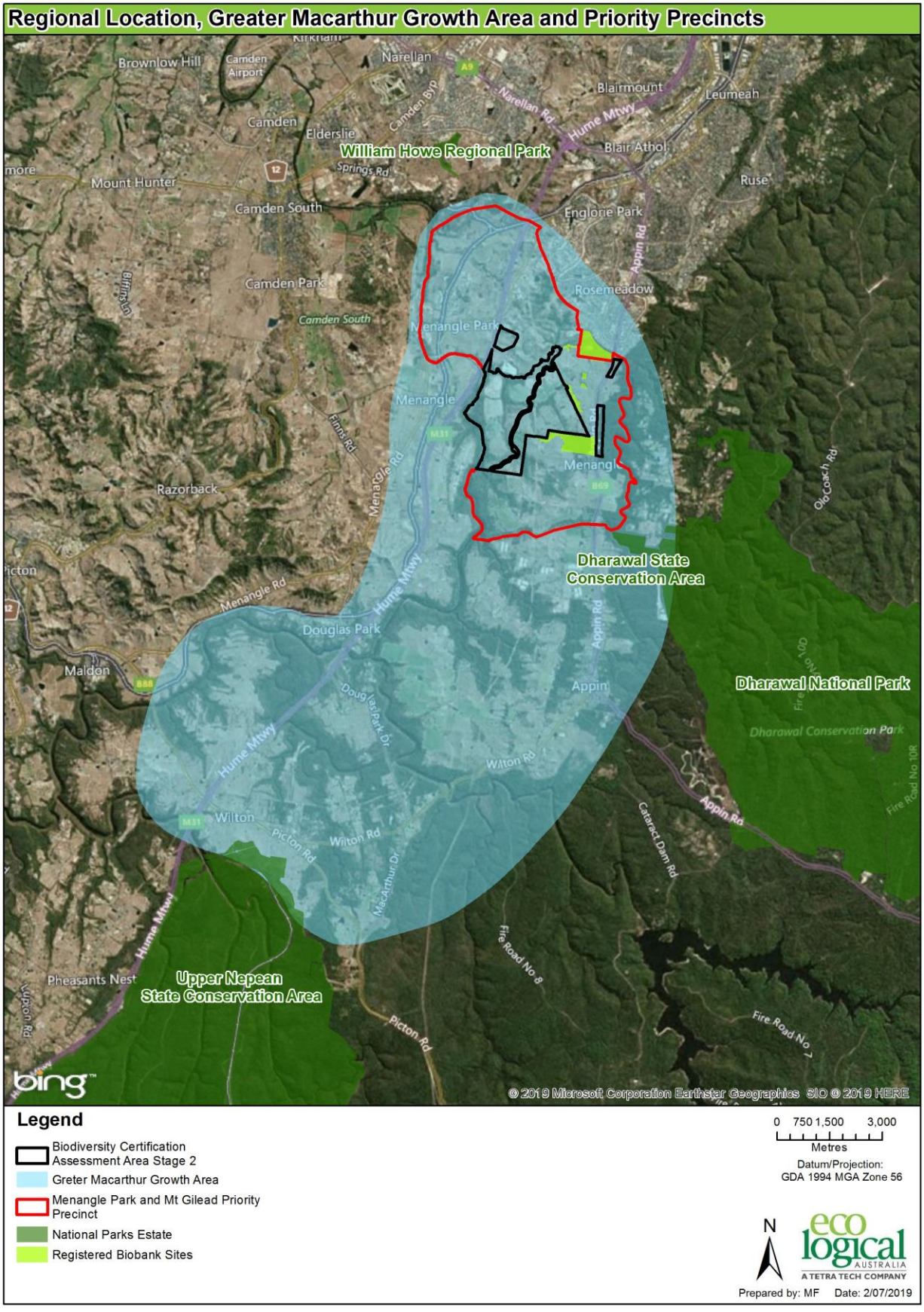


Figure 2: Regional location of the Mt Gilead Stage 2 Biodiversity Certification Assessment Area, Greater Macarthur Growth Area and Priority Precincts

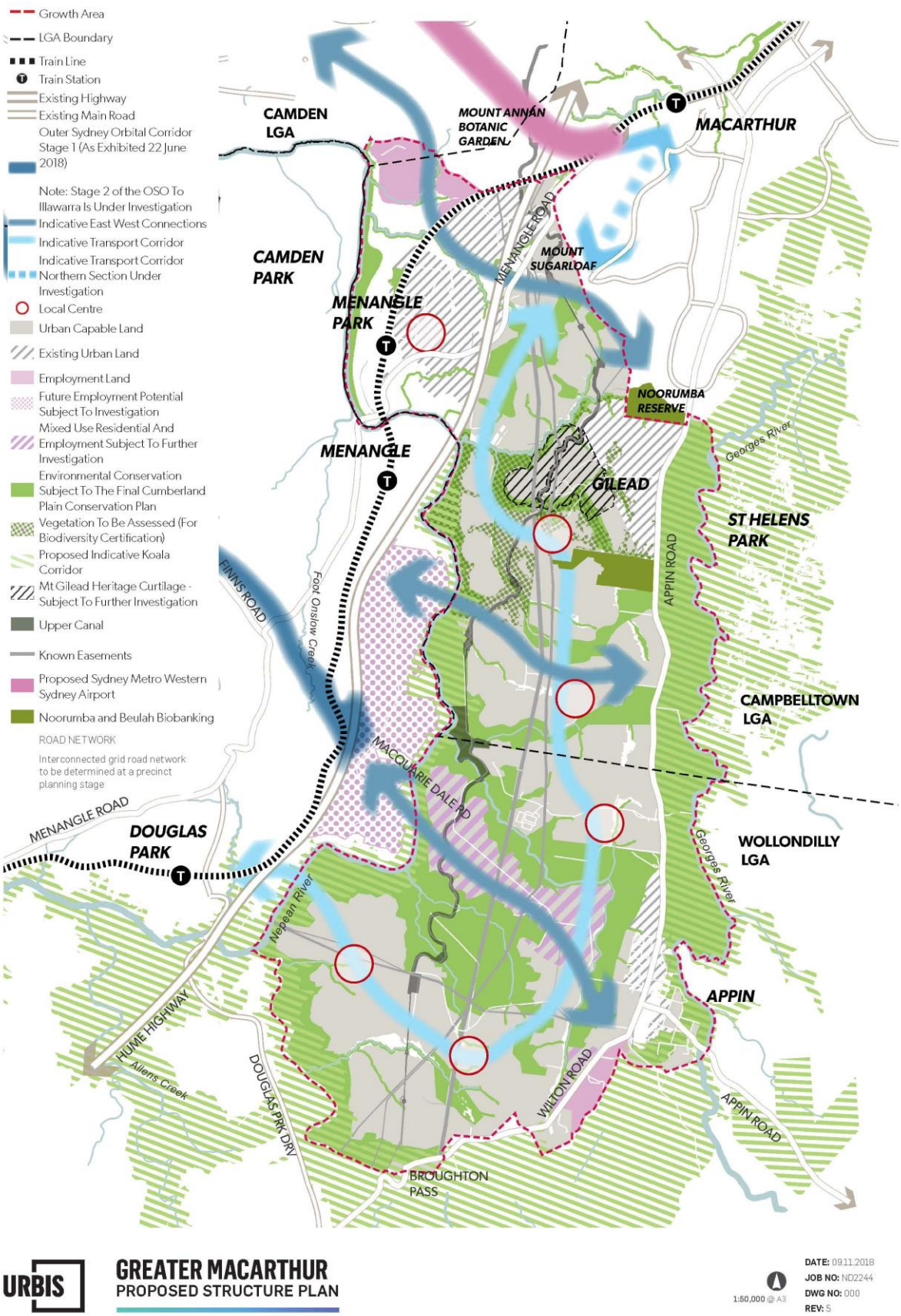


Figure 3: Department of Planning Macarthur Structure Plan (Source DPE 2018)

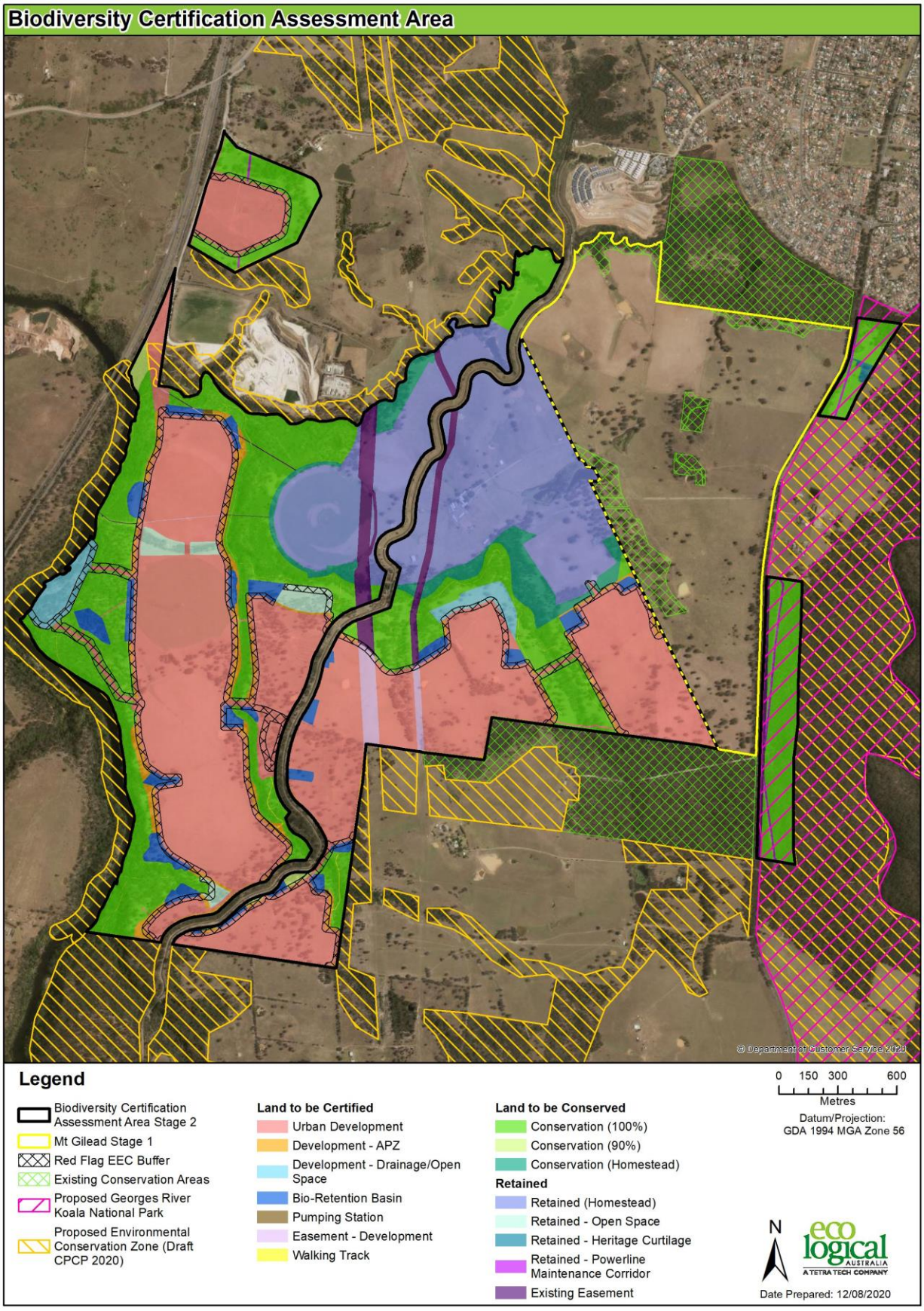


Figure 4: Concept Master Plan

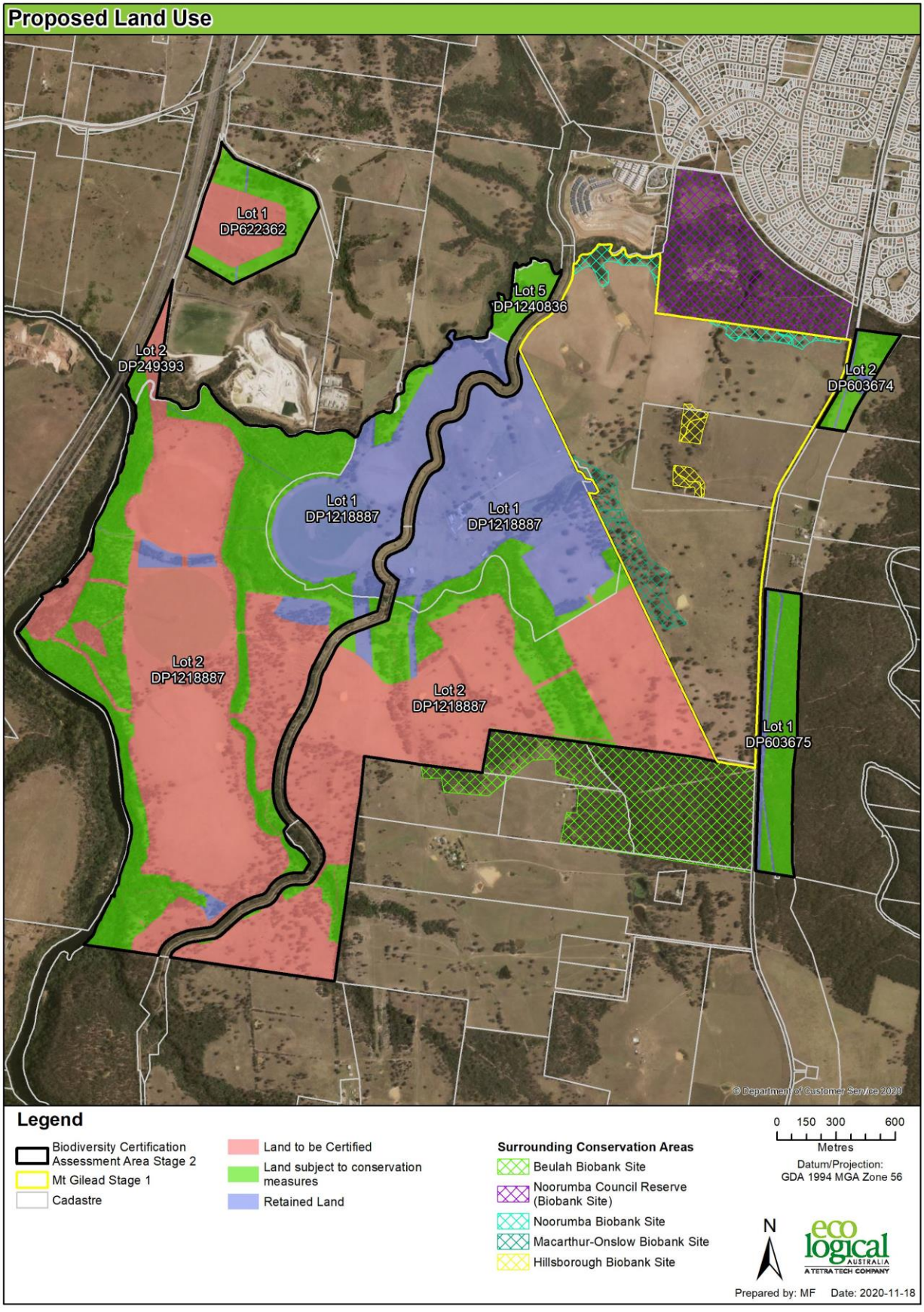


Figure 5: Mt Gilead Biodiversity Certification Assessment proposed land use

2. Biodiversity Values Assessment Report – Methodology and Results

An application for biodiversity certification must include an assessment of the biodiversity values of the BCAA undertaken in accordance with the BCAM. The results of the assessment of ecological values are to be included in a report titled '**Biodiversity Assessment Report**'. This section addresses this requirement.

Assessment of the biodiversity values within the BCAA involved numerous surveys and assessments across multiple seasons. An assessment of the biodiversity values of the BCAA in accordance with the BCAM commenced in January 2015 and built on work undertaken by ELA in 2006 (ELA 2006). All information and data collected by ELA since 2006, and other consultants has been used to prepare this Biodiversity Assessment Report (BAR).

2.1 Literature and data review

Several previous reports were reviewed to identify vegetation types/condition and biodiversity values recorded within the BCAA and surrounding areas (NPWS 2001, ELA 2006). The following sections present a brief summary of the methodology and results for each of these studies, as they relate to the current BCAA.

Additionally, searches of the Atlas of NSW Wildlife and EPBC Protected Matters Search Tool were undertaken to update searches of these databases taken as part of previous reports and ecological assessments (ELA 2006; ELA 2017b). The biocertification credit calculator version 1.09_HN556_201216 was also used to determine ecosystem and species credit threatened species, validating these against the threatened species profile ecological data from the *BioNet Atlas of NSW Wildlife* (see Step 1 in **section 2.2.2**).

Mt Gilead Flora and Fauna Assessment (ELA 2006)

A flora and fauna assessment of the 810 ha Mount Gilead Property (which includes the current BCAA and lands to the east that were certified in 2019) was undertaken by ELA in 2006. ELA completed field surveys between 16 and 28 February 2006 and 1 and 6 March 2006 (total of 56 person hours). Surveys were designed to validate vegetation communities and their condition, identify threatened flora species present, map recovery potential, assess fauna habitat features present, including for Koala (feed trees), and assess riparian health. The overall aim of the survey was to determine and document the ecological significance of the area for input into rezoning documentation. No intensive survey methods such as vegetation plots or fauna trapping were undertaken and flora and fauna species were recorded opportunistically. However, some more detailed survey was undertaken for aquatic habitat/health and Koala.

Four vegetation communities were identified within the study area: Alluvial Woodland ; Riparian Forest; Cumberland Plain Woodland (CPW); and Shale Sandstone Transition Forest (SSTF). All four vegetation types were identified as Endangered Ecological Communities under the TSC Act (as listed at the time). The condition of the vegetation communities ranged from poor to good given the history of disturbance in the study area.

A total of 170 flora species were recorded. One threatened fauna species, Brown Treecreeper (*Climacteris picumnus*), was also recorded. Suitable habitat for threatened flora and fauna species was considered to be present. Key habitat features for fauna were:

- Diverse vegetation communities (forest, woodland, grassland).
- Diverse vegetation community structures (forest, shrubby woodland, grassy woodland, grassland, riparian, wetland).
- Large numbers of hollow-bearing trees.
- Woody debris and leaf litter in many remnant vegetation communities.
- Outcropping rock, rock crevices and, significantly, rock on rock.
- Ephemeral and permanent rivers, creeks and tributaries.
- Dams and “wetlands” with open water and emergent vegetation.
- Instream woody debris, rocks and vegetation along river, creeks and tributaries.

Mt Gilead Stage 1 Rezoning F&F Assessment (ELA 2014)

ELA (2014) undertook an ecological assessment of a 210 ha Stage 1 area. Field survey was undertaken over five days on 25 and 26 March, 4 April, 27 June, and 20 September 2013. Survey followed the Biobanking and Biocertification methodologies (DECC 2009; DECCW 2011a). It involved undertaking biometric plots and riparian and aquatic habitat assessments, and also targeted flora and fauna species identified by the biodiversity credit calculator and a review of NSW Wildlife Atlas data as requiring field survey.

Three vegetation communities were recorded: CPW, SSTF, and River-Flat Eucalypt Forest (RFEF). The vegetation communities were highly modified through a long history of grazing, pasture improvement and weed invasion, and erosion was present in places, although some patches of SSTF were in good condition.

A total of 154 flora species, comprising 67 native species and 87 introduced species, and 82 fauna species, were recorded. Fauna species recorded were comprised of 58 birds, 13 microbats, five other mammals, three frogs, one reptile, and two fish. No threatened flora species were recorded, but six threatened bat species and one threatened bird species were recorded. These were *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat), *Mormopterus norfolkensis* (East-coast Freetail Bat), *Falsistrellus tasmaniensis* (Eastern False Pipistrelle), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat), *Myotis macropus* (Southern Myotis), *Scoteanax rueppellii* (Greater Broad-nosed Bat), and *Glossopsitta pusilla* (Little Lorikeet). There was potential for other threatened species, such as Koala, to be present given the presence of food trees in the study area and nearby records. However, for species such as *Meridolum corneovirens* (Cumberland Plain Land Snail), habitat was scant to absent. Targeted surveys did not record this species within the BCAA despite records from Noorumba Reserve (OEH 2014b, ELA 2017) and in remnant Cumberland Plains Woodland on the eastern side of Appin Road.

The majority of the watercourses were considered substantially to slightly modified and erosion was noted in many of the watercourses. Aquatic habitat was limited, and where present was marginal. Fringing vegetation where present provided suitable habitat for amphibians, birds and fish. The overall rating of the riparian and aquatic condition varied from degraded to moderate.

Noorumba Reserve Biobank Agreement (ELA 2017a)

A Biobank Agreement Credit Assessment report has been prepared for Noorumba Reserve (ELA 2017a). Three plants community types were identified within Noorumba Reserve, namely:

- 'Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion' (PCT849)
- 'Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion' (PCT850)
- 'Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion' (PCT1395)

These three vegetation types were all identified as components of two critically endangered ecological communities listed under the TSC Act, *Cumberland Plain Woodland in the Sydney Basin Bioregion* and *Shale Sandstone Transition Forest in the Sydney Basin Bioregion*. Additionally, two threatened species credit species were identified, *Phascolarctos cinereus* (Koala) and *Meridolum corneovirens* (Cumberland Plain Land Snail).

Mt Gilead Stage 1 Biodiversity Certification Assessment Report & Biocertification Strategy (ELA 2018c)

A Biodiversity Certification Assessment and Biodiversity Certification Strategy was prepared by ELA (2018c) for lands located immediately to the east of the current BCAA between Appin Road and the current BCAA (Mt Gilead Stage 1, **Figure 1).** This report was heavily informed by the previous ecological assessment of this area undertaken by ELA (2014). The methods and results of these two assessments (ELA 2014 & ELA 2017b) are presented concurrently as follows.

Surveys of the Mt Gilead Stage 1 area followed the Biobanking and Biocertification methodologies including biometric plots and riparian and aquatic habitat assessments, and also targeted flora and fauna species identified by the biodiversity credit calculator and a review of NSW Wildlife Atlas data as requiring field survey.

Three plant community types, identified as being highly modified through a long history of grazing, pasture improvement and weed invasion were recorded within the Stage 1 BCAA, namely:

- 'Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion'
- 'Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion' (PCT1395)
- Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion'

These three plant community types were each identified as comprising an Threatened Ecological Community as listed under the TSC Act and areas of these vegetation communities in 'moderate to good' condition were identified as red flag communities.

No threatened flora species were recorded, but seven threatened bat species and one threatened bird species were recorded, namely:

- *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat)
- *Mormopterus norfolkensis* (East-coast Freetail Bat)
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat)

- *Myotis macropus* (Southern Myotis)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Chalinolobus dwyeri* (Large-eared Pied Bat)
- *Glossopsitta pusilla* (Little Lorikeet)

In addition to the threatened species recorded and listed above, Little Eagle, Swift Parrot, Powerful Owl, Koala, Grey-headed Flying Fox, and some migratory species listed under the EPBC Act were identified as having potential to occur in the Stage 1 BCAA given the presence of suitable habitat.

Of the threatened species listed above species, only one species, Koala, was a species credit species identified as being impacted by the land to be certified.

Appin Road Upgrade, Mt Gilead, Biodiversity Assessment (RMS 2018)

WSP undertook a flora and fauna assessment for the proposed Appin Road upgrade between Ambarvale and Mt Gilead (RMS 2018). The study included vegetation type and condition mapping and targeted threatened flora and fauna survey using parallel line traverses and plots, nocturnal fauna surveys, call playback, diurnal bird surveys and Koala Spot Assessments. The study recorded two vegetation types (CPW and SSTF), Koala, Cumberland Plain Land Snail and Little Lorikeet.

South Campbelltown Koala Study – Biolink 2018

Biolink Ecological Consultants were commissioned by CCC in 2017 to undertake a Koala connectivity study in the South Campbelltown and Menangle areas, which was identified as a strategic Koala linkage area in the draft Campbelltown Comprehensive Koala Plan of Management (Biolink 2016). The objectives of the study were to investigate:-

- Koala usage and occupancy,
- the quality and extent of Preferred Koala Habitat; and
- the feasibility of establishing connections across Appin Road.

The study used Rapid-SAT sampling protocols to determine the presence of diagnostic Koala faecal pellets around the bases of Preferred Koala Food Trees. The study recorded evidence of Koala at 12 of 25 sampling points in the study area and concluded that the area was sustaining a resident Koala population and was therefore 'Core Koala Habitat' for planning (SEPP44) purposes.

In addition to recording Koala, the study also recorded two threatened woodland birds: *Artamus cyanopterus* (Dusky Woodswallow) and *Daphoenositta chrysoptera* (Varied Sittella) within the BCAA.

Mt Gilead Stage 2 Biobank Assessments May-August 2020 (ELA 20120a-d)

Additional BBAM Plots and targeted fauna surveys were undertaken between May and July 2020 for Cumberland Land Snail, Koala and Squirrel Glider to supplement the previous surveys. Fauna survey techniques included a combination of remote cameras, spotlighting, call playback and active searches. The survey techniques, habitat types, target species and survey effort for fauna surveys are outlined in Tables 4, 5 & 6. The locations of targeted surveys are shown in Figures 10 and 11.

2.1.1.1 Database Search – BioNet

NPWS 2001 vegetation mapping is shown in Figure 6. The results of the previous threatened flora and fauna records in the locality from database searches are shown in to Figures 7, 8 and 9 and included in **Appendix C.** These results were used to develop the candidate species list in **Section 2.1.3** for targeted survey.

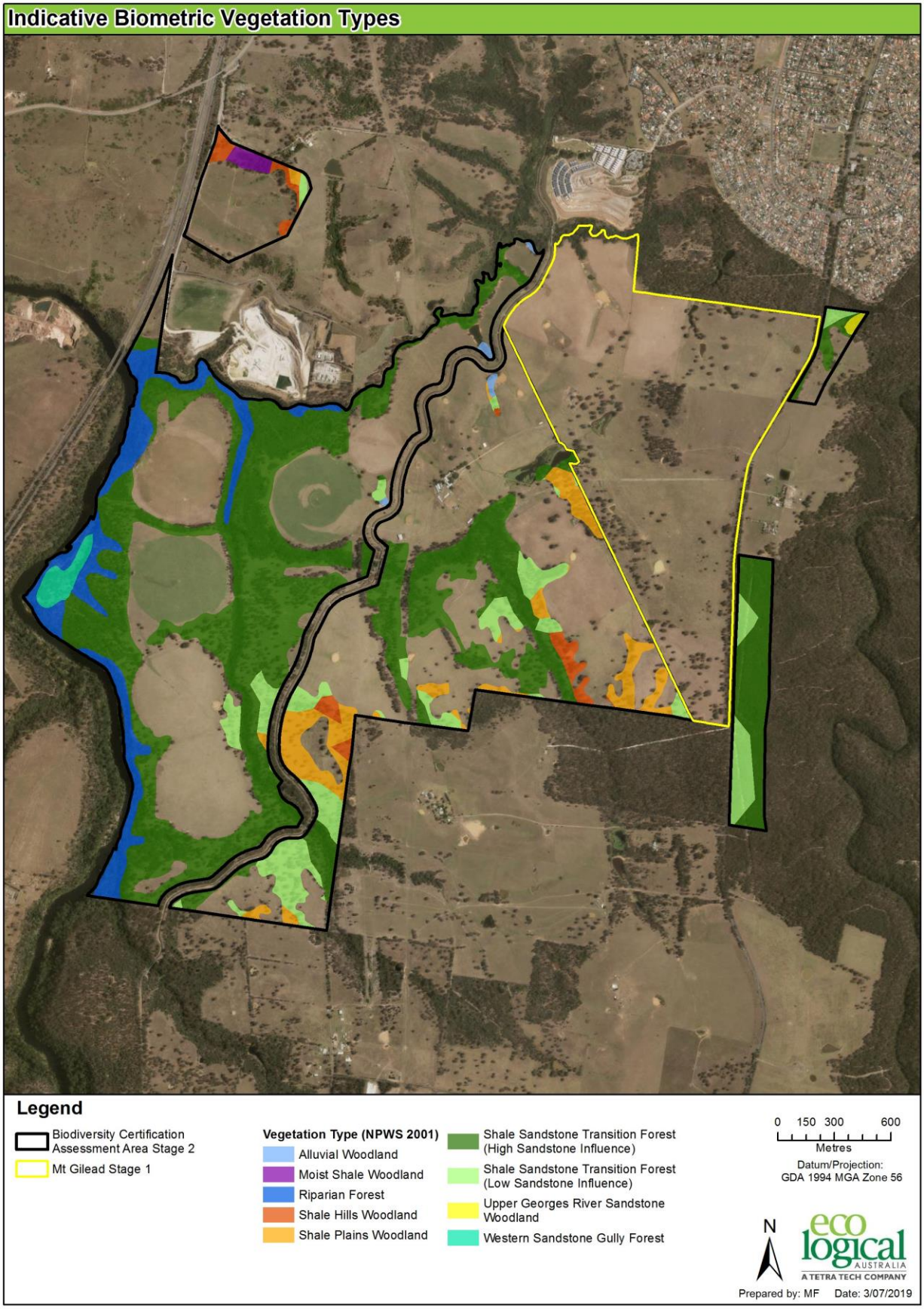


Figure 6: Vegetation units within the BCAA as mapped by NPWS (2001)

2.2 Field Assessment

Field assessment was designed to meet the BCAM requirements for mapping and surveying BVTs and to gather data for use in both this biocertification assessment and the proposed Biobank sites that will be registered to meet the conservation measures commitments.

Relevant legislation and standard technical resources including the *Threatened Biodiversity Survey and Assessment Guidelines for Development and Activities* (Department of Environment and Conservation [DEC] 2004), Threatened Species survey and assessment guidelines: field survey methods for fauna: Amphibians (DECC 2009), NSW Guide to surveying threatened plants (OEH 2016), Species Credit threatened bats and their habitats – NSW survey guide for the Biodiversity Assessment Methods (OEH 2018) and the *Biobanking assessment methodology* (BBAM 2014) (OEH 2014a) underpinned the survey methodologies and provided background information for the ecological assessment. As such, these resources were also reviewed.

2.2.1 Vegetation mapping and condition stratification

Vegetation mapping and condition stratification within the BCAA was undertaken in accordance with the BCAM including 66 biometric plots to determine the vegetation condition and the number of ecosystem credits required to meet an IoM outcome. Vegetation mapping and condition stratification was undertaken by ELA ecologists Brian Towle, Bruce Mullins, Tammy Paartalu, Elizabeth Norris, Greg Steenbeeke, Suzanne Eacott and Alex Gorey which refined previous iterations of vegetation mapping since ELA (2006).

BVTs within the BCAA were identified based upon expert knowledge of field ecologists with extensive experience in the identification and mapping of vegetation communities across the Cumberland Plain as well as a comparison of the species recorded within biometric plots within the BCAA against published lists of Diagnostic and Characteristic species for select vegetation communities described within southern NSW by Tozer *et. al.* (2010), using the OEH vegetation analysis tool developed by Tim Hager and Greg Steenbeeke (**Appendix D**).

2.2.2 Determination of species credit species requiring survey

'*Species credits'* are the class of biodiversity credit created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. All threatened flora and approximately half to two thirds of all threatened fauna species are classified as species credits by the BCAM. Furthermore, some species credit species are also '*red flag species*' which the BCAM defines as "*a species that cannot withstand further loss in the CMA because it is extremely rare/critically endangered, restricted or its ecology is poorly known*".

The BCAM requires targeted survey for threatened flora and fauna that are considered to be '*species credit'* species on the land that will be impacted by development. Alternatively, species credit species can be assumed to be present. Where a survey or expert report confirms that a species credit species is present or likely to use potential habitat on land proposed for biodiversity certification, then a survey must also be undertaken or '*expert report*' prepared for that species on land to be used as an offset confirming its presence or likely presence. The biocertification credit calculator uses the survey results to calculate the number of credits required to offset the loss of the threatened species on land to be certified and the number of credits generated on land subject to conservation measures to determine whether the '*improve or maintain*' test is satisfied provided a '*red flag species*' is not impacted.

Species that require species credits for the land proposed for biodiversity certification or are being used to generate species credits for a proposed conservation measure were identified and assessed in

accordance with the seven steps outlined in Section 4.3 of the BCAM. The results of the candidate species identification and assessment process are presented in **Appendix C.**

Step 1. – Identify candidate species for initial assessment

A list of candidate species was filtered into the BCAA using biocertification credit calculator version 1.9 and validated against the threatened species profile ecological data from the BioNet Atlas of NSW Wildlife. This list is presented in **Appendix C**.

Step 2. – Review list to include additional species

The list of candidate species was reviewed to include additional species for assessment. This was undertaken using the results of previous surveys of the BCAA (ELA 2006) and surrounding areas (Noorumba Reserve, ELA 2015) and additional database searches undertaken by ELA which included:

- A search of the Atlas of NSW Wildlife database to identify records of threatened flora and fauna species located within 5 km radius of the site. The most recent search of the database was undertaken in July 2019; with previous searches having been undertaken as part of earlier surveys of the BCAA (ELA 2006).
- A search of the EPBC Act protected matters search tool website to generate a report to assist to determine whether matters of national environmental significance (NES) were located within 10 km radius of the site (search performed in July 2019).

All threatened flora and fauna species records within 5km of the BCAA are shown in Figures 7, 8 and 9.

Step 3. – Identify candidate species for further assessment

The list of candidate species was reviewed to identify only those species that required further assessment in the BCAA. The species that were removed and a justification supporting the removal of these species from the candidate list are provided in **Appendix C**.

The following species were identified as candidate species requiring targeted surveys to determine whether they occurred within the BCAA and were subjected to targeted surveys as outlined in **Section 2.2.3**:

Flora species:

- *Acacia bynoeana* (Bynoe's Wattle)
- *Acacia pubescens* (Downy Wattle)
- *Callistemon linearifolius*
- *Cynanchum elegans* (White-flowered Wax Plant)
- *Epacris purpurascens* var*. purpurascens*
- *Eucalyptus benthamii* (Camden White Gum)
- *Grevillea parviflora subsp. parviflora*
- *Gyrostemon thesioides*
- *Haloragis exalata* subsp. *exalata* (Square Raspwort)
- *Hypsela sessiliflora*
- *Marsdenia viridiflora* (Native Pear)
- *Persicaria elatior* (Tall Knotweed)
- *Persoonia bargoensis* (Bargo Geebung)
- *Pimelea spicata* (Spiked Rice-flower)
- *Pomaderris brunnea* (Rufous/Brown Pomaderris)
- *Pterostylis saxicola* (Sydney Plains Greenhood)

- *Pultenaea pedunculata* (Matted Bush-Pea).

Fauna species:

- Australasian Bittern (*Botaurus poiciloptilus*)
- Cumberland Plain Land Snail (*Meridolum corneovirens*)
- Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) – Breeding habitat
- Eastern Pygmy-possum (*Cercartetus nanus*)
- Giant Burrowing Frog (*Heleioporus australiacus*)
- Green and Golden Bell Frog (*Litoria aurea*)
- Grey-headed Flying-Fox (*Pteropus poliocephalus*) – Breeding Habitat)
- Koala (*Phascolarctos cinereus*)
- Large-eared Pied Bat (*Chalinolobus dwyeri*)
- Little Bentwing Bat (*Miniopterus australis*) – Breeding habitat
- Red-crowned Toadlet (*Pseudophryne australis*)
- Regent Honeyeater (*Anthochaera phrygia*)
- Rosenberg's Goanna (*Varanus rosenbergi*)
- Southern Myotis (*Myotis macropus*) – Breeding habitat
- Squirrel Glider (*Petaurus norfolcensis*)

Steps 4 and 5. – Identify potential habitat for species requiring further assessment and determine whether species is present

The following species credit species identified in Step 3 were recorded within the BCAA:

Flora species:

- *Pomaderris brunnea*

Fauna species

- Cumberland Plain Land Snail (Meridolum corneovirens)
- Koala (*Phascolarctos cinereus*)
- Squirrel Glider (*Petaurus norfolcensis*)
- Southern Myotis (*Myotis macropus*) foraging, breeding habitat assumed to be present.

While the Grey-headed Flying-fox, Little Bentwing Bat, Eastern Bentwing Bat were also recorded within the BCAA, the identification of these species as species credit species applies only to the breeding habitat of these species. No breeding habitat was recorded for the Grey-headed Flying-fox, Little Bentwing Bat and Eastern Bentwing Bat within the BCAA. The maternity caves of the Little Bentwing Bat and Eastern Bentwing Bat have very specific temperature and humidity regimes and no suitable caves are present within the land to be certified in the BCAA. Grey-headed Flying-foxes roost and breed in conspicuous, often large, communal camps typically in lowland rainforest, swamps forest and gullies. No camps for the Grey-headed Flying Fox were observed within the BCAA. No caves suitable as breeding habitat for the Large-eared Pied -Bat were recorded in land to be certified.

Step 6 – identify the threatened species that trigger a red flag

Pomaderris brunnea is classified as a species in the BCAM credit calculator tool and TSPD "*which cannot withstand further loss within the Hawkesbury Nepean CMA*". *Pomaderris brunnea* is therefore a red flag species. As 6 individuals will be impacted in the land to be certified (5 in APZ areas), a red flag variation request has been prepared (**Section 5**).

Whilst Southern Myotis is classified by the BCAM credit calculator tool as a 'red flag' species – breeding habitat, it is not identified in the TSPD (or BioNet) as a red flag species for breeding habitat. As the TSPD contains updated ecological information for use in a biocertification assessment it is not considered a red flag species for this assessment.

Cumberland Plain Land Snail, Koala, Squirrel Glider are all species identified in the TSPD and BCAM as species which can withstand further loss within the Hawkesbury Nepean CMA and therefore do not trigger a red flag.

Step 7 finalise the boundary of the species polygon and area of impact

Habitat polygons and the number of species credits required was calculated for the species listed below. Habitat polygons were developed based on ELA's expert opinion of the habitat areas and were informed by known records, identification of suitable habitat and published data including biometric vegetation types with which species are associated.

- *Pomaderris brunnea* (Figure 15)
- Koala (Figure 16)
- Squirrel Glider (Figure 17)
- Cumberland Plain Land Snail (Figure 18)
- Southern Myotis (Figure 19 and Figure 20).

For the Koala, all remnant vegetation and scattered trees have been identified as 'habitat' as per the Mt Gilead Stage 1 assessment, as Koalas are a mobile species and will use scattered paddock trees to rest and forage in and will move across open ground to access suitable habitat areas.

For the Cumberland Land Snail, the species was only recorded in the higher quality remnants of CPW and SSTF where a canopy, mid-storey and native understory with fallen logs and litter was present (Vegetation Zones 4, 8, 9, 13 & 14), it was not recorded in the pasture improved/grazed vegetation zones, DNG or scattered trees veg zones. Habitat polygons for the Cumberland Plain Land Snail were mapped based on the presence of records for the species following targeted survey and habitat suitability. The type and condition of the vegetation where individuals were present in the study area, and the connectivity of these patches to other patches was then used to map other areas of potential habitat in the BCAA. Area of existing higher quality vegetation within proposed Biobank sites which were adjacent to areas where CPLS was recorded were included as habitat on the basis that these areas will be managed for conservation and habitat suitability will improve. Conversely, degraded areas where the species was not recorded and that will be impacted, have not been included as habitat.

Similarly, the Squirrel Glider was recorded in seven locations across the BCAA, all within intact, higher condition, riparian and adjacent vegetation. Accordingly, and consistent with the ecology/habitat requirements of this species, only the higher quality vegetation was mapped as habitat, isolated individual trees and small patches of vegetation without a mid-storey and greater than 30 m from intact vegetation was not considered suitable habitat.

Areas of potential breeding habitat were identified for Southern Myotis in accordance with previous advice from OEH. Potential habitat for Southern Myotis was assessed as any native vegetation within 100 m of a hollow bearing tree that was within 200 m of a permanent waterbody of at least 3m width. The Nepean River, all 2nd and 3rd order sections of Menangle, Woodhouse and Nepean Creeks, and all farm dams broader than 3 m were mapped as permanent water sources suitable for foraging. The Sydney Water Canal which bisects the BCAA was not included in the potential breeding habitat polygon

as the water is heavily chlorinated by Sydney Water at Broughton Pass and at various points along the route to Prospect Reservoir, therefore not providing suitable foraging habitat.

2.2.3 Flora surveys

Targeted surveys for threatened flora species identified as requiring further assessment (see **section 2.2.2**) have been undertaken over several seasons and years. The timing and effort of these surveys is outlined in **Table 4** with survey locations shown in Figure 10. Targeted surveys for threatened species involved a combination of random meanders to identify suitable areas of habitat and transect based surveys throughout areas identified as suitable habitat as well as any species recorded in the 66 plots.

Targeted flora surveys were undertaken in Summer (2006, 2015, 2016, 2017), Autumn (2006, 2015, 2016 & 2020) and Spring (2015). The surveys were undertaken at a suitable time of year to allow for identification of each of the species requiring further assessment (see **section 2.2.2**) as identified in the Threatened Species Profile Database (**Table 3**).

Table 3: Months in which targeted flora surveys were conducted and months in which "Candidate" species can be surveyed (from Threatened Species Profile Database)

Columns highlighted in green indicate months in which targeted threatened flora surveys were conducted.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acacia bynoeana	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
Acacia pubescens	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Callistemon linearifolius	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
Cynanchum elegans	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Epacris purpurascens var. *purpurascens*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eucalyptus benthamii	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grevillea juniperina subsp. *juniperina*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grevillea parviflora subsp. *parviflora*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gyrostemon thesioides	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Haloragis exalata subsp. *exalata*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hypsela sessiliflora	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Marsdenia viridiflora	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Persicaria elatior	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes
Persoonia bargoensis	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes
Pimelea spicata	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pomaderris brunnea	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pterostylis saxicola	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Pultenaea pedunculata	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Thesium australe	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes

Table 4: Flora survey timing and effort

Survey date	Survey methodology / target	Survey Area	Survey effort	Reference
Mt Gilead Due diligence assessment				
16 and 28 February & 1 and 6 March 2006	Random meanders & opportunistic observations	Mt Gilead Property (BCAA & areas to the west)	56 person hours (Steve Ward, Bruce Mullins)	ELA (2006) Mt Gilead Preliminary Flora and Fauna Assessment
Mt Gilead MDP Lands Biocertification Assessment				
25th and 26th March, 4th April, 27th June & 20th September 2013	Floristic plots and targeted threatened fauna survey	Mt Gilead MDP Lands	80 person hours Bruce Mullins, Belinda Failes	ELA (2014) Mt Gilead Rezoning Assessment
29 August 2016	Floristic plots	Stage 1 BCAA	8 hours Bruce Mullins	ELA (2018) Mt Gilead Biocertification Assessment
9-10 April 2015	Floristic plots	Stage 1 BCAA	32 person hours, BCAA Enhua Lee and Mitch Palmer	ELA (2015) Macarthur-Onslow and Noorumba-Mt Gilead Biobank Assessments
Mt Gilead Balance Lands Biocertification Assessment				
28 January & 3, 4 and 9 February 2015	Floristic plots & opportunistic observations	Stage 2 BCAA	110 person hours Bruce Mullins, Brian Towle, John Gollan and Rebecca Dwyer	ELA (2015) Mount Gilead Balance lands due diligence

29 September and 1 October 2015	Targeted threatened flora surveys	Stage 2 BCAA	32 person hours Bruce Mullins, Meredith Henderson	Mt Gilead Stage 2 Biocertification Assessment
21 October 2015	Targeted threatened flora surveys	Stage 2 BCAA	32 person hours (Brian Towle, Tammy Paartalu)	Mt Gilead Stage 2 Biocertification Assessment
February 2016	Vegetation community validation, targeted threatened species surveys	Illawarra Coal and properties immediately north of BCAA.	48 person hours Greg Steenbeeke and Suzanne Eacott	Mt Gilead Stage 2 Biocertification Assessment
15 March 2016	Targeted threatened flora surveys	BCAA	12 person hours	Mt Gilead Stage 2 Biocertification Assessment
9, 10, 12, 16, 18, 19, 20, 23 & 25 January 2017	Floristic Plots and random meanders	Balance Lands	288 hrs Brian Towle, Liz Norris, Suzanne Eacott, Alex Gorey	Mt Gilead Stage 2 Biocertification Assessment
May-July 2020	32 Floristic Plots and random meanders	Lands subject to Conservation Measures (Biobank sites)	128 person hours Bronwyn Callaghan, Katy Wilkins, Alex Gorey, Griffin Taylor-Dalton, Michelle Frolich, Robert Humphries	Mt Gilead Stage 2 Biobank Assessments (ELA 2020a-d)

2.2.4 Fauna surveys

Surveys for fauna species identified as requiring further assessment (**section 2.2.2**) were conducted from December 2016 to March 2017 by ELA ecologists Rodney Armistead, Mitchell Scott, Jack Talbert, Byron Heffernan, and Alexander Gorey. Fauna survey techniques included a combination of remote cameras, hair tubes, nest boxes/hanging baskets, spotlighting, call playback and active searches. The survey techniques, habitat types, target species and survey effort for fauna surveys are outlined in **Table 5**. The locations of fauna surveys are shown in Figure 11.

Table 5: Survey techniques and survey effort for fauna

Previous studies	Survey area	Effort	Results
ELA (2006)	Mt Gilead property (810 ha).	- Four-day survey on 16th and 28th February 2006 and the 1st and 6th March 2006 (total of 56 person hours). - Fauna habitat features were recorded opportunistically. - Targeted Koala searches were undertaken at six sites.	- No threatened fauna species were recorded, but key habitat features were present which could support a range of common and threatened fauna species. - Potential Koala habitat as defined by the State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP 44) was recorded
ELA (2014)	Mt Gilead Stage 1 (210 ha). Rezoning Assessment	- Five-day survey on 25th and 26th March, 4th April, 27th June, and 20th September 2013. - Birds were surveyed over 20-30 minute intervals at four sites over four mornings, depending on whether one or two observers were present. - Microbat surveys were undertaken using two ultrasonic Anabat detectors at three sites (one Anabat at two sites and one Anabat at one site) targeting areas where bats are likely to be present over two consecutive nights over a period of 12 hours between 1800 hours and 0600 hours. - Habitat features for fauna across the study area, such as hollow-bearing trees, rocks and rocky outcrops, water bodies, were opportunistically recorded. As some features were assessed to be unsuitable for the frog target species (*Heleioporus australiacus* (Giant Burrowing Frog) and *Litoria aurea* (Green and Golden Bell Frog)), targeted survey for these were not undertaken. - Riparian and aquatic habitat assessments included mapping the top of bank	- Seven threatened species (six bats and one bird) were recorded: Eastern Bentwing Bat, East-coast Freetail Bat, Eastern False Pipistrelle, Yellow-bellied Sheathtail Bat, Southern Myotis, Greater Broad-nosed Bat, and Little Lorikeet. - One migratory species was recorded: Cattle Egret. - There was potential for Koala to be present, but a low likelihood for Cumberland Plain Land Snail to be present. - The overall rating of the riparian and aquatic condition varied from degraded to moderate.

Previous studies	Survey area	Effort	Results
		using a differential GPS, classifying the condition and recovery potential of steam reaches, categorising each stream using the Strahler method, and identifying heavily degraded streams or areas of overland flow that do not meet the definition of 'river' and are suitable for removal. Assessments were undertaken over one and a half days.	
ELA 2016	Mt Gilead Stage 1 (210 ha). Biocertification Assessment	48 diurnal person hrs, 30 November, 7 & 12 December 2016 24 nocturnal person hours Assessment for presence of *Myotis macropus* and *Litoria aurea* habitat	- No threatened frogs recorded
ELA 2015-2018	Mt Gilead Stage 2	**General / non-specific fauna surveys, searches and / or habitat assessments for threatened invertebrate, birds, reptiles and mammal** General visual searches and surveys for specific threatened species habitats (hollow-bearing trees, koala feed trees, crevice, cracks and caves in rock formations, termite mounds). 133 person hours Searches for direct evidence of the presence or site occupancy of a threatened species (including direct sighting, listening for calls or observations of carcasses). Searches for indirect evidence of the presence or site occupancy of fauna species (tracks, scats and other signs of fauna including foraging digs made by bandicoots and scratches on trees made by Koalas. **General / various sized terrestrial mammals, bird or reptile species**. Remote movement sensing camera trap stations were baited with universal bait (consisting of rolled oats, honey, peanut butter) and sardines. -1085 remote	- Koala, Squirrel Glider and Cumberland Plain Land Snail recorded

Previous studies	Survey area	Effort	Results
		camera survey nights Small sized hair-tubes (opening of tube is 50 mm in diameter) baited with universal bait (consisting of rolled oats, honey, peanut butter) and sardines targeting small sized mammal species (0.01 to 0.150 kg in average body mass) – 3,575 hair tube nights Large sized hair-tubes (opening of tube is 150 mm in diameter) baited with universal bait (consisting of rolled oats, honey, peanut butter) and sardines targeting medium to large sized mammal species (0.150 to 10 kg in average body mass – 3,510 hair tube nights Nest boxes and hanging basket style nest boxes that have been designed to accommodate Eastern Pygmy Possums (opening into nest box >30 mm in diameter) – 14 nest boxes for 910 survey nights **Microchiropteran Bats -** 50 anabat nights Anabat ultra-sonic microbat call recorders **Various nocturnal mammals and birds** Spotlighting and nocturnal searches. Spotlighting was undertaken from moving vehicle and on-foot.	Six species of threatened microchiropteran bats recorded • *Chalinolobus dwyeri* (Large-eared Pied Bat) (vulnerable) • *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) (vulnerable) • *Miniopterus australis* (Little Bentwing Bat) (vulnerable) • *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat) (vulnerable) • *Micronomus* (*Mormopterus*) *norfolkensis* (Eastern Freetail Bat) • *Myotis macropus* (Large-footed Myotis) (vulnerable)

Previous studies	Survey area	Effort	Results
			Two additional potential species were also recorded *Scoteanax rueppellii* (Greater Broad-nosed Bat) (vulnerable) and *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat)
		Cumberland Land Snail - – 38 person hours Searches for CPLS were conducted by searching forest floor debris located at the base of these two tree species. Searches were conducted during or after rainfall.	Cumberland Land snail recorded
		Green and Golden Bell Frog surveys – 14 person hours Random dip netting and visual surveys using polarised sunglasses for tadpoles. Call play back and active searches during optimal climatic conditions (following at least 50mm of rain, warm stormy nights with a forecast for further rain to occur.	Green and Golden Bell frog and Giant Burrowing frog not recorded
		Giant Burrowing Frog Surveys – 60 person hours Nocturnal call play back and active searches on foot along 5 km of waterway. Surveys consisted of moving through creek lines and paddock run off areas. Areas of slow flowing water or large pools were targeted during these surveys Surveys were conducted during optimal climatic conditions (following at least 50mm of rain, warm stormy nights with a forecast for further rain to occur	
RMS 2018	Appin Rd between Noorumba and	Spotlighting (2 nights x 2 people x 2 hours) call playback (2 nights x 2 people x 2 hours)	The following threatened species were recorded in the study area:-

Previous studies	Survey area	Effort	Results
	Beulah	diurnal bird survey (10, 20 minute surveys, 16 hours opportunistic observations) Koala SAT assessments (2 SAT assessments) Cumberland Land Snail searches (4 person hours), and opportunistic sightings	• Koala • Cumberland Plain Land Snail • Little Lorikeet • Cattle Egret (EPBC Act migratory species)
Biolink 2018	Mt Gilead Menangle Creek, Woodhouse and Mallaty Creek corridors	21-23 November 2017, 25 Koala SAT sampling sites	- Koala, or evidence of Koala, recorded at 12 of 25 sampling locations across Mt Gilead property - Dusky Woodswallow and Varied Sittella also recorded
ELA 2020	Mt Gilead Stage 2 Biobank Sites	Remote movement sensing camera trap stations were baited with universal bait (consisting of rolled oats, honey, peanut butter) – 23 cameras for 42 nights - 966 trap nights Spotlighting (3 nights x 4 people x 2 hours) Cumberland Plain Land Snail searches (44 person hours), and opportunistic sightings.	The following threatened species were recorded during surveys: • Koala • Squirrel Glider • Cumberland Plain Land Snail

Table 6: Summary of survey techniques and survey effort for fauna surveys

Target species or guilds	Survey method	General habitat type	Total survey effort*
General / non-specific fauna surveys, searches and / or habitat assessments for threatened invertebrate, birds, reptiles and mammal	General visual searches and surveys for specific threatened species habitats (hollow-bearing trees, koala feed trees, crevice, cracks and caves in rock formations, termite mounds). Searches for direct evidence of the presence or site occupancy of a threatened species (including direct sighting, listening for calls or observations of carcasses). Searches for indirect evidence of the presence or site occupancy of fauna species (tracks, scats and other signs of fauna including foraging digs made by bandicoots and scratches on trees made by Koalas.	Pasture with scattered paddock trees or open and disturbed woodland habitats	75 person hours.
		Woodland habitat	30 person hours.
		Riparian, sandstone creek-line with woodlands and / or rainforest habitats	28 person hours.
General / various sized terrestrial mammals, bird or reptile species.	Remote movement sensing camera trap stations were baited with universal bait (consisting of rolled oats, honey, peanut butter) and sardines	Pasture with scattered paddock trees or in open and disturbed woodland habitats	Total of 697 survey nights at fourteen (14) locations.
		Pasture with scattered trees near to or at farm dam habitats	Total of 66 remote camera survey nights.
		Riparian, sandstone creek-line with woodlands and / or rainforest habitats	Total of 322 survey nights at five (5) locations. Additional 23 cameras for 42 nights - 966 trap nights in May-July 2020
	Small sized hair-tubes (opening of tube is 50 mm in diameter) baited with universal bait (consisting of rolled oats, honey, peanut butter) and sardines targeting small sized mammal	Pasture with scattered trees near to or at farm dam habitats	43 hair-tubes set for 65 consecutive days. Total survey effort of 2,795 hair-tube survey nights.

Target species or guilds	Survey method	General habitat type	Total survey effort*
	species (0.01 to 0.150 kg in average body mass)	Sandstone creek-line, riparian vegetation or within woodlands, Swamp She-oak Forest and / or rainforest habitats	12 hair-tubes set for 65 consecutive days. Total survey effort of 780 survey nights.
	Large sized hair-tubes (opening of tube is 150 mm in diameter) baited with universal bait (consisting of rolled oats, honey, peanut butter) and sardines targeting medium to large sized mammal species (0.150 to 10 kg in average body mass)	Pasture with scattered trees near to or at farm dam habitats	42 hair-tubes set for 65 consecutive days. Total survey effort of 2,665 hair-tube survey nights.
		Sandstone creek-line, riparian vegetation or within woodlands, Swamp She-oak Forest and / or rainforest habitats	13 hair-tubes set for 65 consecutive days. Total survey effort of 845 survey nights.
	Nest boxes and hanging basket style nest boxes that have been designed to accommodate Eastern Pygmy Possums (opening into nest box >30 mm in diameter)	Pasture with scattered trees near to or at farm dam habitats	8 nest boxes/hanging baskets for 65 consecutive nights. Total survey effort of 520 survey nights.
		Sandstone creek-line, riparian vegetation or within woodlands, Swamp She-oak Forest and / or rainforest habitats	6 nest boxes/hanging baskets for 65 consecutive nights. Total survey effort of 390 survey nights.
Microchiropteran bats including targeted surveys for *Chalinolobus dwyeri* (Large-eared Pied Bat), *Miniopterus*	Anabat ultra-sonic microbat call recorders.	Pasture with scattered paddock trees or open and disturbed woodland habitats	27 anabat recording nights

Target species or guilds	Survey method	General habitat type	Total survey effort*
schreibersii oceanensis (Eastern Bentwing Bat) and *Myotis macropus* (Large-footed Myotis).		Sandstone creek-line with woodlands and rainforest habitats	8 anabat recording nights
		Pasture with scattered trees and farm dam habitats	15 survey nights and in addition a further 15 hours (over three separate survey nights) were conducted using a hand held whilst conducting other surveys at a farm dam.
Various nocturnal mammals and birds	Spotlighting and nocturnal searches. Spotlighting was undertaken from moving vehicle and on-foot.	All broad habitat types.	One survey night. Additional spotlight surveys were not undertaken after it had been determined that the target nocturnal species, (Grey-headed Flying-fox, Koalas and Squirrel Glider) were present within the BCAA. Additional Spotlighting June/July 2020 (3 nights x 4 people x 2 hours)
General invertebrate – targeting *Meridolum corneovirens* (Cumberland Plain Land Snail (CPLS))	Undertaken during other opportunistic searches within the subject site. Searches for CPLS were conducted by searching forest floor debris located at the base of these two tree species. Searches were conducted during or after rainfall.	Pasture with scattered paddock trees or open and disturbed woodland habitats – focusing in patches mapped as Cumberland Plain Woodland and dominated by *E. tereticornis* and *E. moluccana*.	38 person hours over 4 days. 44 person hours over 6 days in 2020

Target species or guilds	Survey method	General habitat type	Total survey effort*
Targeted *Litoria aurea* (Green and Golden Bell Frog (GGBF)) surveys	Random dip netting and visual surveys using polarised sunglasses for tadpoles.	GGBF survey were conducted at one farm dam and associated creek line only.	4 person hours.
	Call play back and active searches during optimal climatic conditions (following at least 50mm of rain, warm stormy nights with a forecast for further rain to occur.		10 hours over three survey nights.
Targeted surveys for Giant Burrowing Frog and Red-crowned Toadlet	Random dip netting and visual surveys using polarised sunglasses for tadpoles. Surveys were conducting while moving through sandstone dominated creek lines on foot. Dip netting was conducted in any large pools that were encountered.	Riparian, sandstone creek-lines / gorge habitats with woodlands and / or rainforest habitats	28 person hours of daytime searching within sandstone creek lines.
	Nocturnal call play back and active searches on foot. Surveys consisted of moving through creek lines and paddock run off areas. Areas of slow flowing water or large pools were targeted during these surveys Surveys were conducted during optimal climatic conditions (following at least 50mm of rain, warm stormy nights with a forecast for further rain to occur.		32 survey hours.

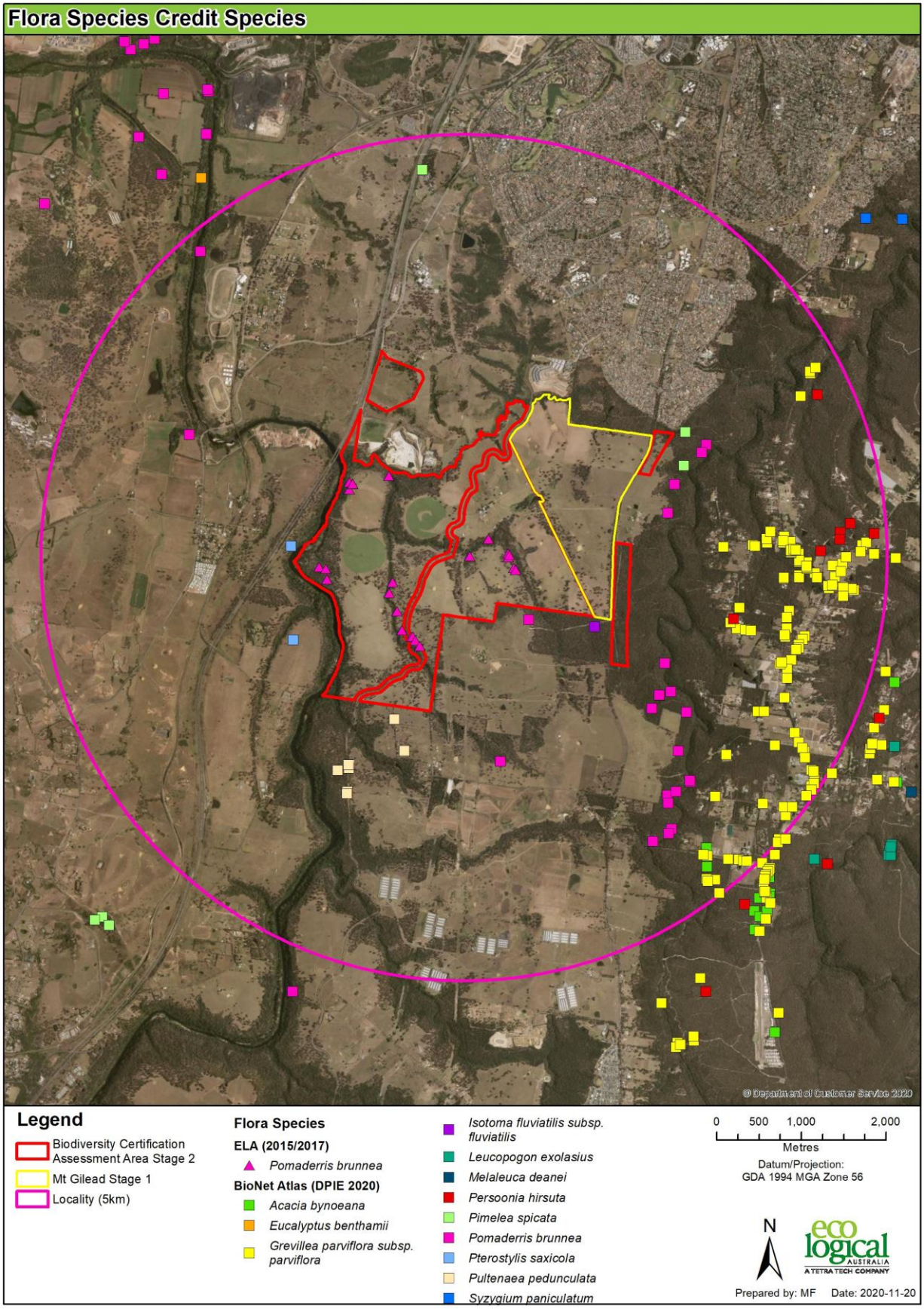


Figure 7: Threatened flora records within 5km of the BCAA (Source Atlas of NSW Wildlife and ELA, unpublished)

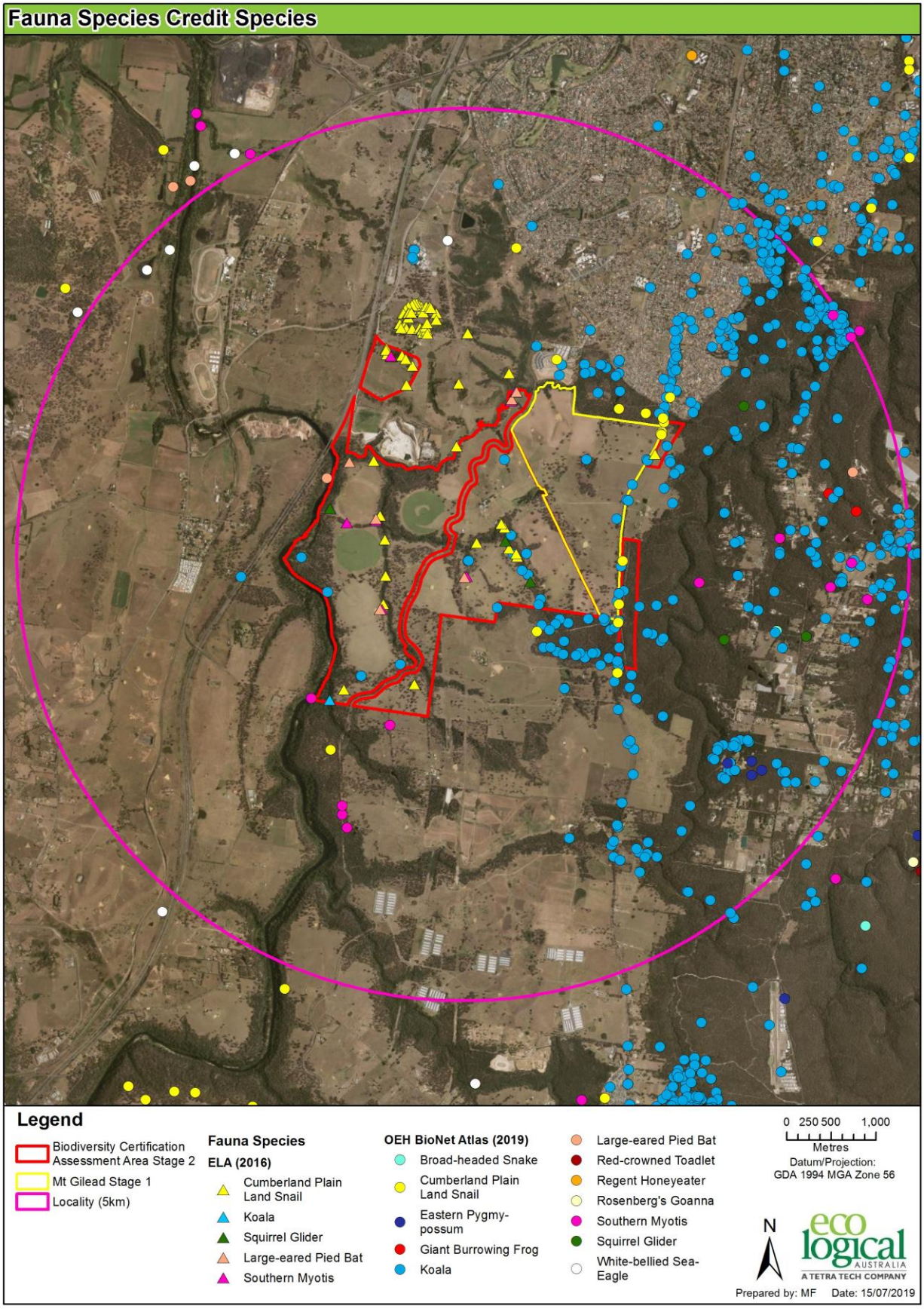


Figure 8: Threatened species credit fauna records within 5km of the BCAA (Source Atlas of NSW Wildlife and ELA, unpublished)

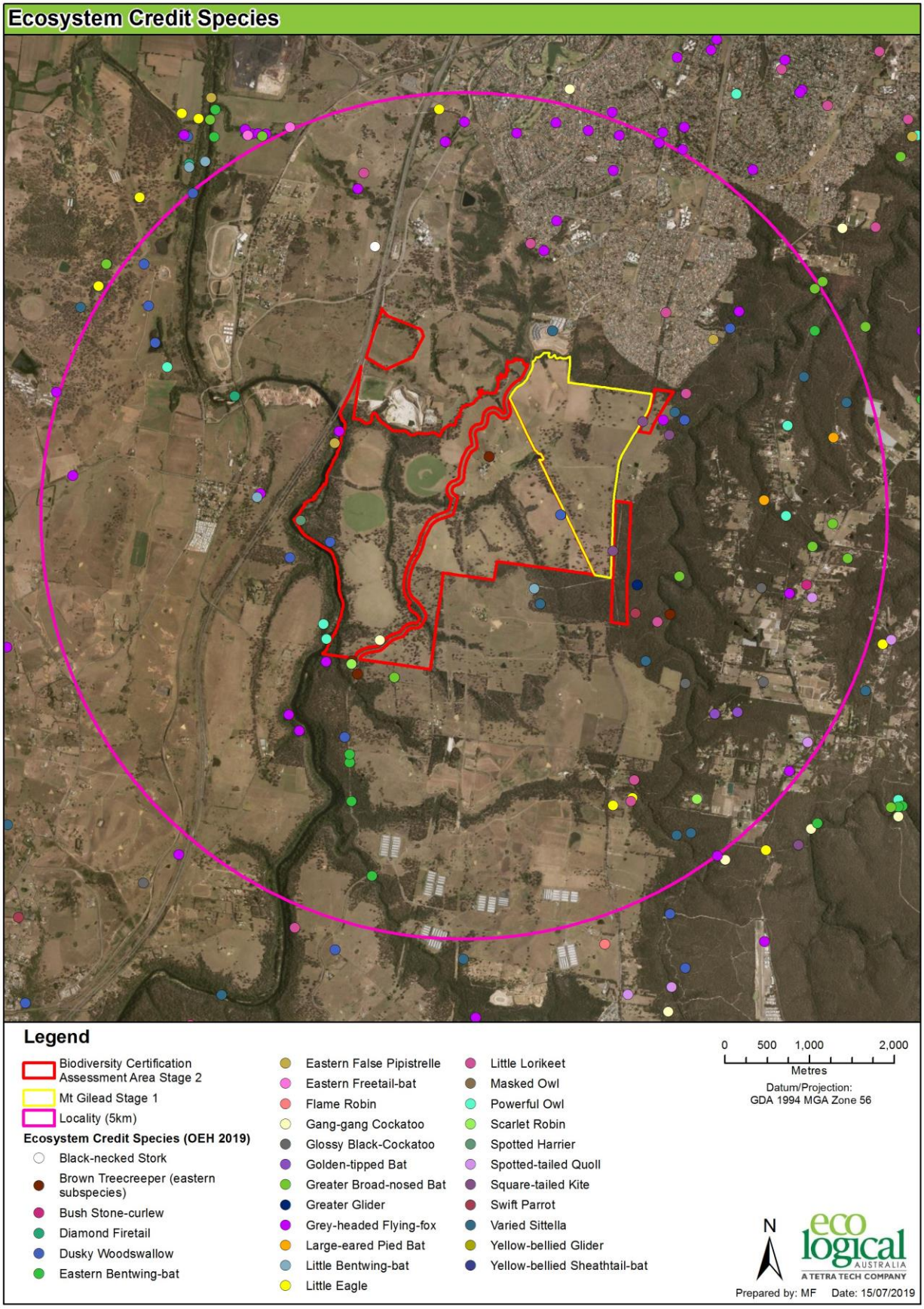


Figure 9: Threatened ecosystem credit fauna records within 5km of the BCAA (Source Atlas of NSW Wildlife and ELA, unpublished)

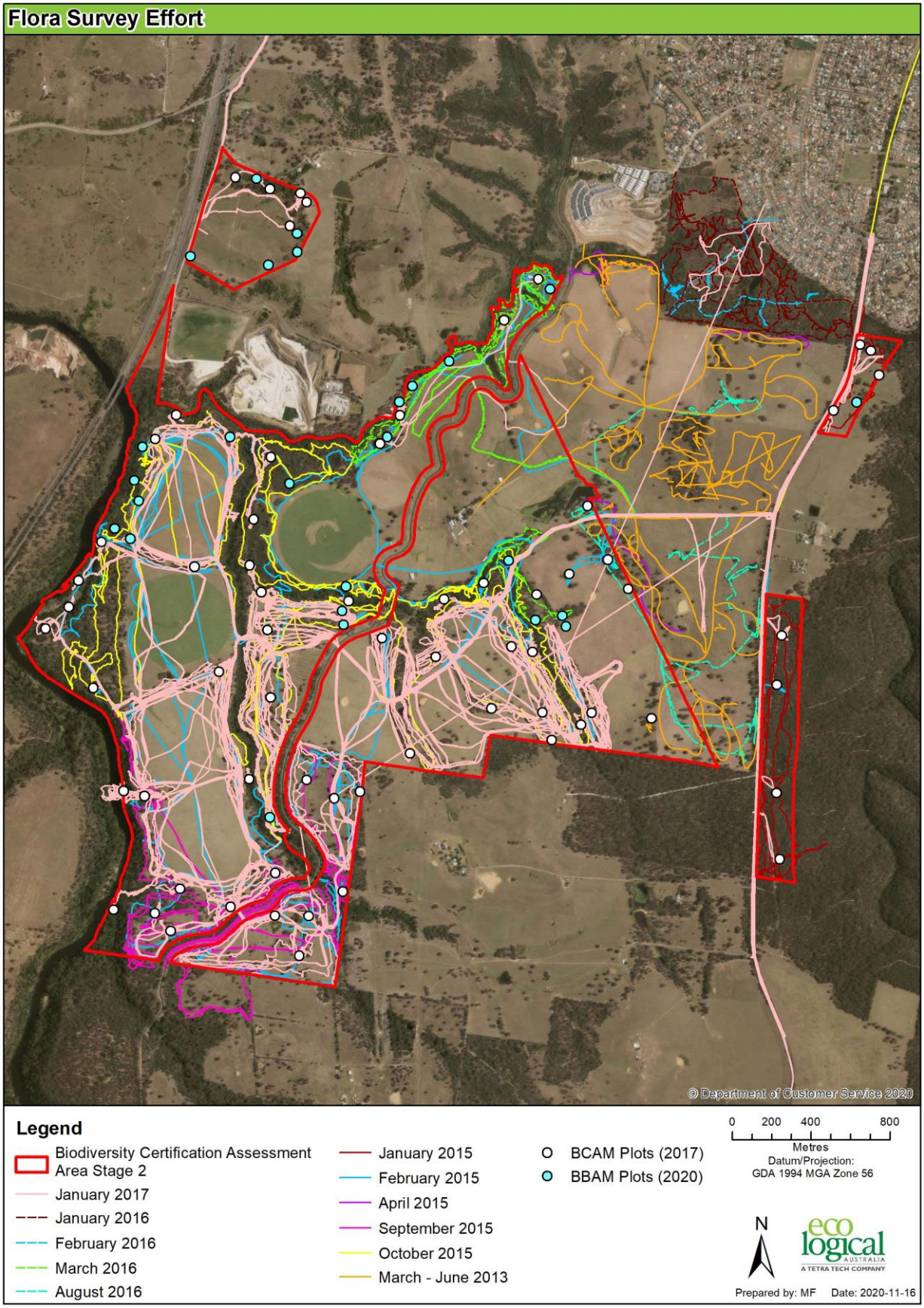


Figure 10: Combined flora survey effort across the BCAA and adjacent properties

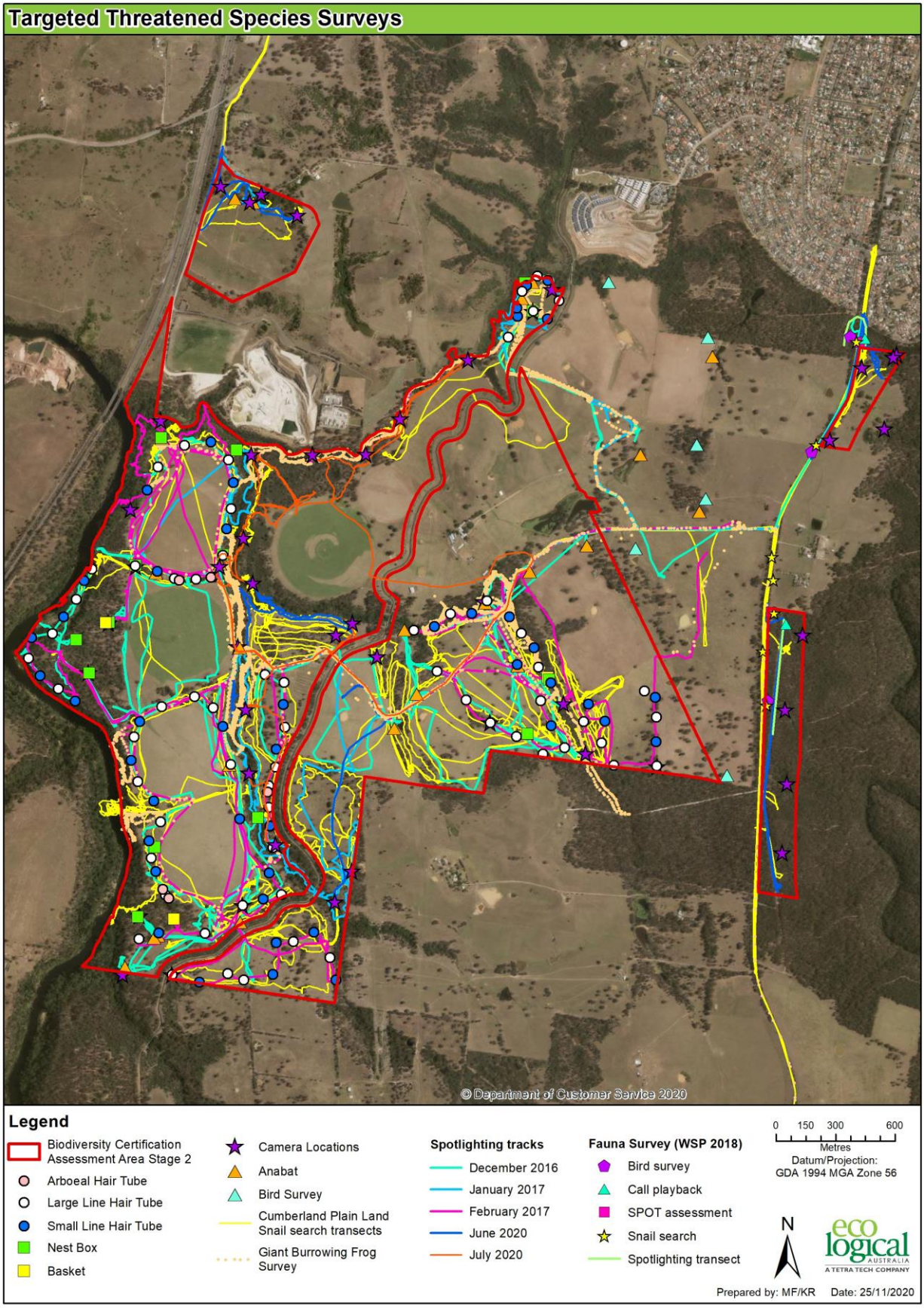


Figure 11: Fauna survey locations within and adjacent to the BCAA

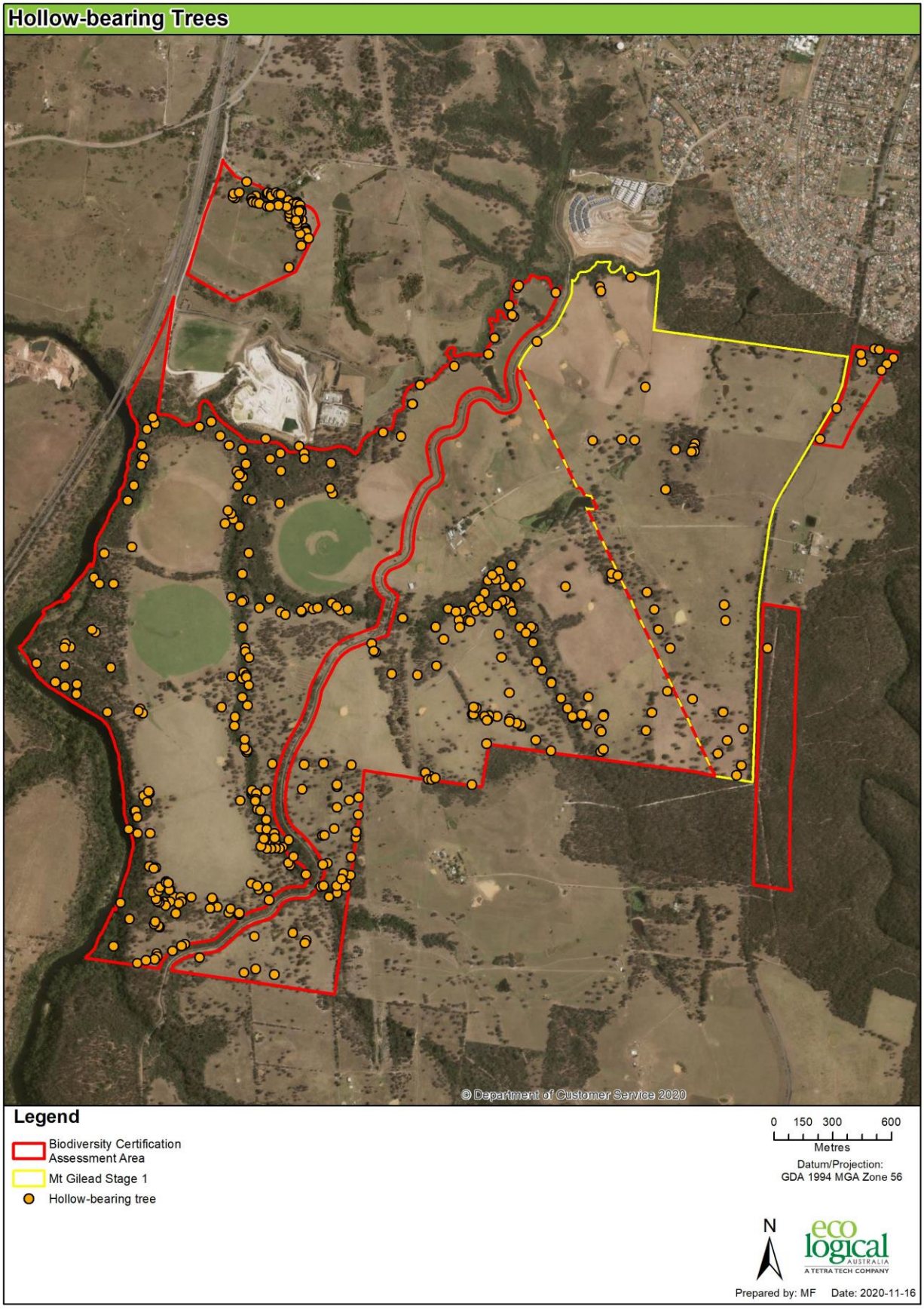


Figure 12: Location of Hollow Bearing Trees across the BCAA

2.3 Results

2.3.1 Biometric vegetation types

Field surveys identified five vegetation communities (with names following Tozer *et al*. 2010) within the BCAA, comprising five BVTs. The relationship between vegetation communities, BVTs and TECs are presented in **Table 7**.

Table 7: Vegetation communities (after Tozer et al. 2010), Biometric vegetation types and Endangered ecological communities listed under the *Threatened Species Conservation Act 1995*, within the BCAA

Vegetation community (following Tozer et al 2010)	Biometric vegetation type equivalent (DECC 2008a)	TSC Act
Cumberland River Flat Forest (CRFF)	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
Cumberland Shale Plains Woodland (SPW)	Grey-Box – Forest Red Gum grassy woodlands on flats of the Southern Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion
Cumberland Shale Hills Woodland (SHW)	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	
Cumberland Shale Sandstone Transition Forest (SSTF)	Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	Shale Sandstone Transition Forest in the Sydney Basin Bioregion
Grey Myrtle Dry Rainforest (GMDR)	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	Not listed

The distribution of vegetation communities within the BCAA are shown in Figure 13**.** Within the BCAA two vegetation communities, Grey Myrtle Dry Rainforest (GMDR) and Cumberland River Flat Forest (CRFF), were associated with drainage lines with GMDR occurring along incised sandstone gullies formed by lower order tributaries and CRFF occurring on deep alluvial soils adjoining the Nepean River. Two vegetation communities, Shale Plains Woodland (SPW) and Shale Hills Woodland (SHW) were identified as occurring on clay soils, typically on the upper slopes and crests of the low hills and away from the influence of drainage lines. On the mid to lower slopes and edges of the drainage lines, Shale Sandstone Transition Forest (STTF) was recorded.

Comparison of species lists collected from biometric plots against OEH's vegetation analysis tool was undertaken to compare the field identification of vegetation communities against published characteristic and diagnostic species lists (Tozer *et al.* 2010). Generally, only those biometric plots surveyed within the least disturbed areas of the site (areas classified as 'good' ancillary code, see

section 2.3.2) where cattle have been largely excluded, contained the minimum required number of native species in order to make robust statistical comparisons against OEH's vegetation tool. Areas where cattle have been excluded were limited to areas of SSTF and GMDR and only individual plots within these vegetation communities contained the minimum number of native species and diagnostic species for positive confirmation of the vegetation community at the 95% confidence interval. No plots within areas mapped as SPW, SHW or CRFF contained the minimum number of native species required to make an assessment of the number of diagnostic species for these communities. Nonetheless, an assessment of the species lists collected for biometric plots within the BCAA using OEH's vegetation tool was undertaken for the majority of biometric plots (highly disturbed plots with very few native species were not assessed) in order to see which vegetation communities the species lists from individual plots most closely resembled. An assessment of the results for each vegetation community identified within the BCAA is summarised below whilst the detailed analysis is provided in **Appendix D**.

Analysis of species lists from biometric plots within areas mapped as GMDR generally supported the identification of this vegetation community, although select plots within areas mapped as GMDR also showed affinities to other vegetation communities, most commonly Western Sydney Dry Rainforest (WSDR). While species lists from biometric plots show that some areas mapped as GMDR were similar to floristic lists for WSDR, the occurrence of WSDR within the areas was dismissed on the basis of the geology (Hawkesbury Sandstone within areas mapped as GMDR as opposed to Wianamatta Shale in WSDR) and the dominance of *Backhousia myrtifolia* (Grey Myrtle), which although present in WSDR, does not form one of the dominant canopy species.

Species lists collected from biometric plots within areas of CRFF did not align closely with this community when analysed using OEHs vegetation tool, with each plot aligning to different vegetation communities including SPW, GMDR and CRFF. The variability in the predicted vegetation communities when using OEH's vegetation tool is attributed to the highly modified nature of areas identified as CRFF within the BCAA and the relatively few native flora species recorded within biometric plots in those areas mapped as CRFF. Furthermore, one of the more common canopy species within this vegetation community within the BCAA, *Casuarina cunninghamia* subsp. *cunninghamia* (River Oak), is not listed as either a diagnostic or characteristic species for this community by Tozer *et. al.* (2013), although this species is recorded by Tozer (2010) within 'Alluvial Woodland', which forms part of the CRFF vegetation community. The distinct location of CRFF within the BCAA, in association with the banks of the Nepean River and lower stretches of Menangle Creek, on alluvial soils in combination with the floristic patterns observed, were considered reliable indicators of both the presence of this vegetation community and distribution within the BCAA despite the limited floristic diversity.

Analysis of species lists from biometric plots within areas mapped as SSTF generally supported the identification of this vegetation community, although select plots within areas mapped as SSTF also showed affinities to other vegetation communities, most commonly SPW. Generally, those areas with comparatively little disturbance (not grazed, pasture improved or selectively cleared), were strongly aligned with SSTF while more disturbed sites which have been selectively thinned and grazed commonly aligned more closely with SPW. This result is considered to be an artefact of the nature of disturbance within these areas (grazing and selective clearing generally removing the canopy and shrub layer and increasing the cover of groundcover species, particularly grasses).

Species lists collected for biometric plots within areas mapped as SPW consistently aligned with the SPW vegetation community when analysed using OEH's vegetation tool. This result supports the mapping of BVTs for SPW across much of the BCAA. Species lists collected for biometric plot data within areas mapped as SHW also aligned to SPW. Nonetheless, the mapping of SHW follows the

identification of BVTs as made during the field assessment, which follows the descriptions of these two communities by Tozer (2010) with SHW occurring at higher elevations, steeper slopes and more undulating country with a relatively high degree of ruggedness compared to SPW. SHW was thus restricted to the northern part of the BCAA on Lot 1 DP 622362.

The five BVTs identified within the BCAA correspond to three threatened ecological communities listed under the TSC and EPBC Acts (**Table 7**). It is noted that the 'Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion' BVT is identified within the OEH's Vegetation Information System Classification Database as forming part of the Western Sydney Dry Rainforest in the Sydney Basin Bioregion EEC but were not identified as forming part of the EEC listed under the TSC Act due to geology and soil types present as discussed above. The areas of Grey Myrtle Dry Rainforest (GMDR) within the BCAA were restricted to deeply incised drainage lines where underlying Hawkesbury Sandstone bedrock was exposed which formed the parent material for the sandy soils present within areas of this vegetation type. The Western Sydney Dry Rainforest EEC occurs on clay soils derived from Wianamatta Shale. Additionally, the dominance of *Backhousia myrtifolia* (Grey Myrtle) in the GMDR within the BCAA is distinct from the Western Sydney Dry Rainforest EEC which does not commonly include this species.

2.3.2 Vegetation type ancillary codes and threatened status

The BCAM requires that vegetation within the BCAA is divided into vegetation zones delineated by the different vegetation types present within the BCAA and broad condition categories, or ancillary codes. Across all vegetation types within the BCAA eight ancillary codes were identified. The different ancillary codes within each vegetation type and the specific vegetation zones are outlined in **Table 8** and their distribution within the BCAA is shown in Figure 14 together with the plots taken in each zone. A brief description of each of the ancillary codes is provided below.

Vegetation was categorised as 'Good' where all structural layers of the relevant vegetation type were present and there was relatively low cover of exotic species. This generally corresponded to areas where little or no grazing has occurred. Where moderate to high grazing pressure has occurred resulting in a very open or absent mid-storey and moderate to high exotic cover within the ground layer vegetation was categorised as 'Pasture improved/grazed'. Where large scale vegetation clearing had occurred and only isolated canopy trees with no mid-storey and an almost entirely exotic ground layer was present, vegetation was categorised as 'Scattered Trees'. Other ancillary codes recorded included 'Dense Weedy' which occurred in areas with a dense mid-storey of African Olive

Two additional ancillary codes, 'Thinned/shrubby' and 'DNS', were identified within the SSTF vegetation type and corresponded to areas where the canopy had been removed (DNS) or thinned (Thinned/shrubby) and a shrubland (DNS) or dense shrubby open-woodland (Thinned/shrubby) was observed. One ancillary code (DNG) represented a derived native grassland within areas of SPW and SHW where the canopy and mid-storey structural layers were absent, due to past clearing, but a predominantly (greater than 50%) native grassy ground-layer remained. Finally, one area of the CRFF vegetation community had previously been disturbed by sand extraction and was in an advanced state of regeneration, termed 'Regen'.

The number of plots collected for each vegetation zone within the BCAA is shown in **Table 8**. For each zone the number of plots collected met, or exceeded, the minimum number of plots required for each vegetation zone.

Table 8: Ancillary vegetation codes for each BVT including areas and number of plots collected for each vegetation zone

Veg Zone	BVT ID	PCT Name	Ancillary	Condition	EEC	Total Area BCAA (ha)	Plots required	Plots collected	Plot #'s
1	HN526	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Weedy	Low	RFF	24.45	3	4	MG19, MG20, MG21, MG22
2	HN526	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Scattered trees	Low	RFF	0.58	1	1	MG39
3	HN526	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Regen	Low	RFF	2.42	1	1	MG37
4	HN528	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Pasture improved/grazed	Mod-Good	CPW (SPW)	28.60	3	13	BB04, BB09, BB11, MG06, MG08, MG14, MG25, MG30, MG38, MG44, MG46, MG47, MG48
5	HN528	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Scattered trees	Low	CPW (SPW)	4.50	1	4	BB05, BB10, MG16, MG36
6	HN528	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	DNG	Low	CPW (SPW)	3.11	1	2	BB01, MG45
7	HN528	Cleared - restore to SPW	Cleared	Low	CPW (SPW)	10.75	2	2	MGCL02, MGCL04
8	HN529	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Good	Mod-Good	CPW (SHW)	2.42	1	1	MG32
9	HN529	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Weedy	Low	CPW (SHW)	2.59	1	1	MG33
10	HN529	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	DNG	Low	CPW (SHW)	3.73	1	2	MG34, MG35
11	HN529	Cleared - restore to SHW	Cleared	Low	CPW (SHW)	6.21	1	1	MGCL01
12	HN538	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	Good	Mod-Good	WSDR	8.33	1	5	BB02, MG01, MG40, MG41, MG43
13	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	Good	Mod-Good	SSTF	104.45	5	12	BB03, BB12, MG02, MG04, MG07, MG09, MG17, MG18, MG28, MG29, MG31, MG42
14	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	Thinned/Shrubby	Mod-Good	SSTF	10.18	2	3	MG11, NW05, NW06
15	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	Pasture improved/grazed	Low	SSTF	57.65	4	9	BB06, BB07, BB13, MG03, MG12, MG15, MG23, MG24, MG27
16	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the	Scattered trees	Low	SSTF	6.85	1	3	A2_2013, BB08, MG26

Veg Zone	BVT ID	PCT Name	Ancillary	Condition	EEC	Total Area BCAA (ha)	Plots required	Plots collected	Plot #'s
		Cumberland Plain, Sydney Basin Bioregion							
17	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	DNS	Mod-Good	SSTF	5.07	1	2	MG10, MG13
18	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	DNG		SSTF	0.67	1	1	MGCL05
19	HN556	Cleared - restore to SSTF	Cleared	Low	SSTF	14.09	2	5	MGCL03, NW11, NW12, NW13, H11
		Sub-total - Vegetation				**296.65**	**33**	**72**	

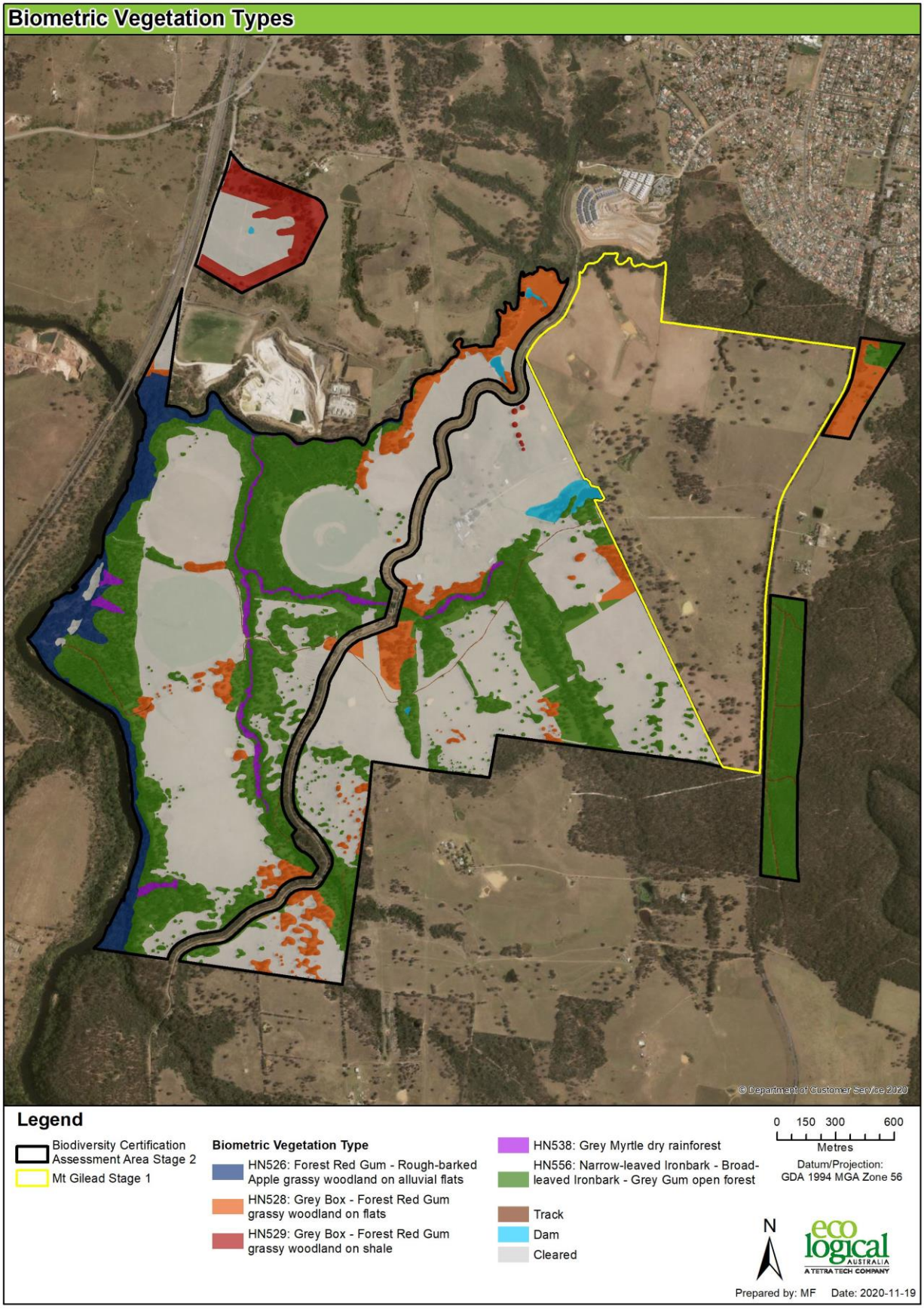


Figure 13: Biometric Vegetation types within the BCAA as mapped by ELA 2015-2017

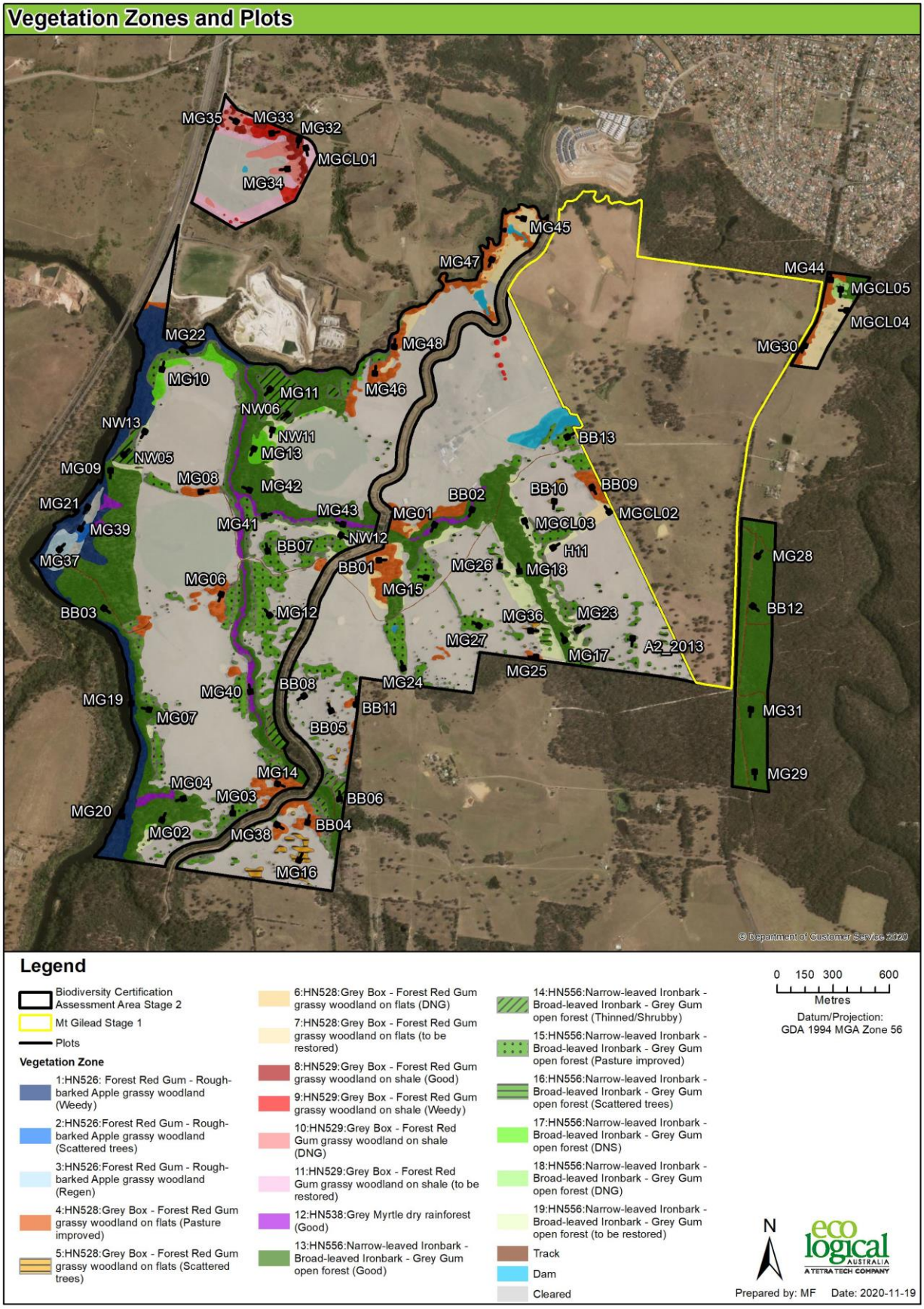


Figure 14 Vegetation Zones and plots as mapped by ELA 2015-2017 and refined 2020

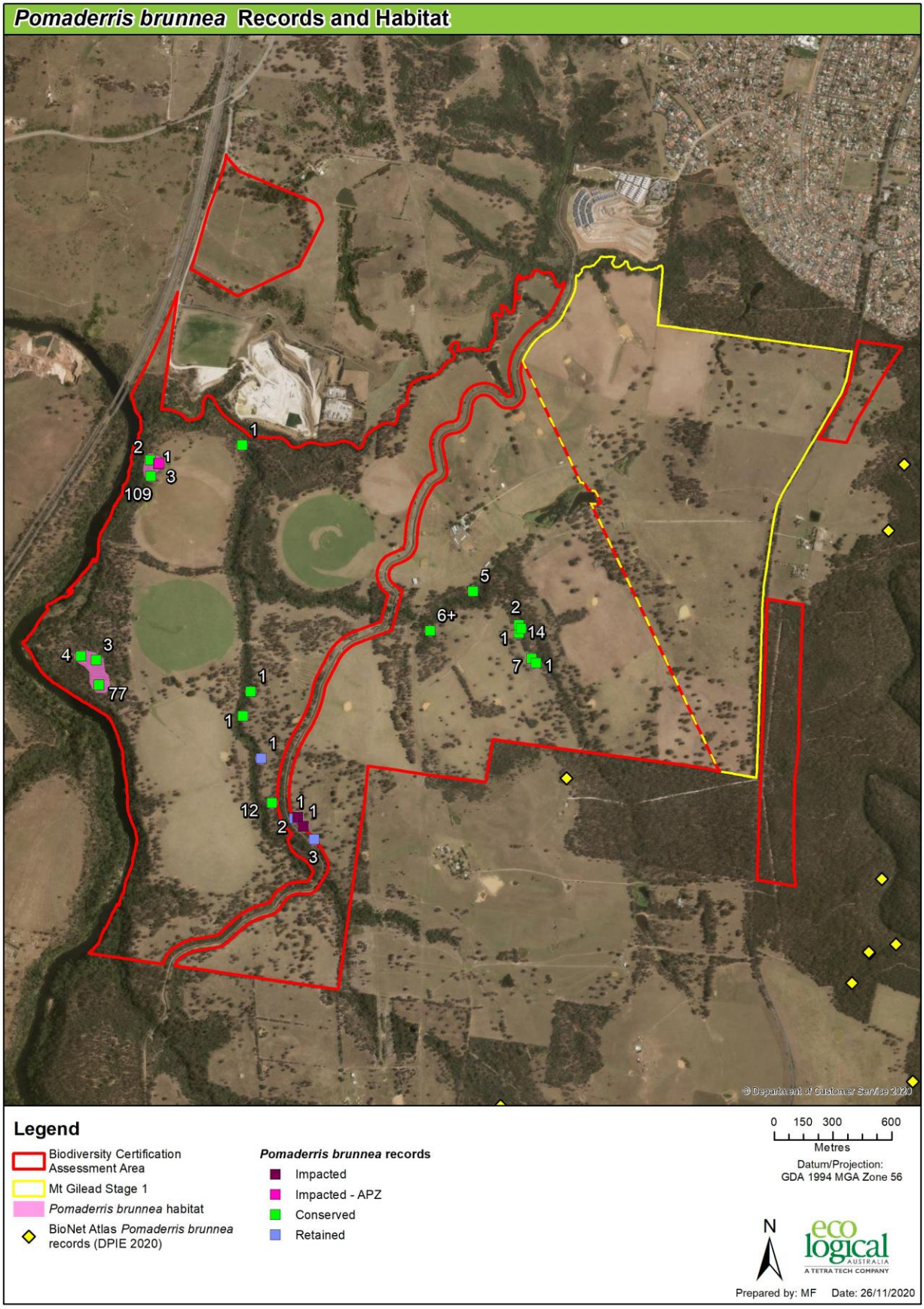


Figure 15: Location of *Pomaderris brunnea* within the BCAA and habitat polygon

2.3.3 Flora species

A total of 287 native and 137 exotic flora species were recorded in the biometric plots used for this assessment. A full list of species recorded in plots is provided in **Appendix E**.

One threatened flora species was recorded by ELA during the current field survey, *Pomaderris brunnea* (Rufous Pomaderris). A total of 253 *Pomaderris brunnea* individuals have been recorded within the BCAA, with an additional five plants recorded outside the BCAA within the Upper Canal corridor which bisects the BCAA. Within the BCAA *Pomaderris brunnea* was restricted to the SSTF vegetation community, or at the ecotone of this community and adjacent vegetation types. The location of records of *Pomaderris brunnea* are shown in Figure 15.

2.3.4 Fauna species

A total of 124 native vertebrate fauna species, comprising 68 birds (two threatened and one migratory species), 17 microbats (including eight threatened species), one megabat (Grey-headed Flying Fox), 11 terrestrial and arboreal mammals (including two threatened species), 11 frogs, 13 reptile, three fish and one threatened invertebrate, were recorded in the Stage 2 BCAA by ecologists). A full list of species recorded by ELA is provided in **Appendix F**, together with a list of species recorded by remote cameras (**Appendix G**), hair tubes (**Appendix H**) and anabats (**Appendix I)**.

Threatened and migratory fauna species

Threatened fauna species recorded within the BCAA during targeted surveys and by others are:-

Birds

- Brown Treecreeper
- Dusky Woodswallow
- Glossy Black Cockatoo
- Scarlet Robin (BioNet)
- Powerful Owl (BioNet)
- Square-tailed kite
- Little Lorikeet
- Varied Sittella (Biolink 2018).

Mammals (including micro and macro bats)

- Koala
- Squirrel Glider
- Grey-headed Flying-fox

- *Miniopterus australis* (Little Bentwing Bat)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat)
- *Mormopterus norfolkensis* (Eastern Coastal Freetail Bat)
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat)
- *Myotis macropus* (Southern Myotis)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Chalinolobus dwyeri* (Large-eared Pied Bat)

Other

- Cumberland Plain Land Snail

Of the above species, only Koala, Squirrel Glider, Southern Myotis and Cumberland Plain Land Snail are species credit species and have been identified as being impacted by the land to be certified. The other species that have been recorded or have the potential to occur within the BCAA which are species credits species (Little Bentwing Bat, Eastern Bentwing Bat, Large-eared Pied Bat and Grey-headed Flying Fox) are only species credit species when breeding habitat is being impacted. No breeding habitat was recorded within the land to be certified so these species do not require further assessment as species credit species in this assessment.

Species habitat polygons for these species have been prepared as described in Section 2.2 and are shown in Figures 16-20. The area of habitat entered into the credit calculator tool is provided in Table 17.

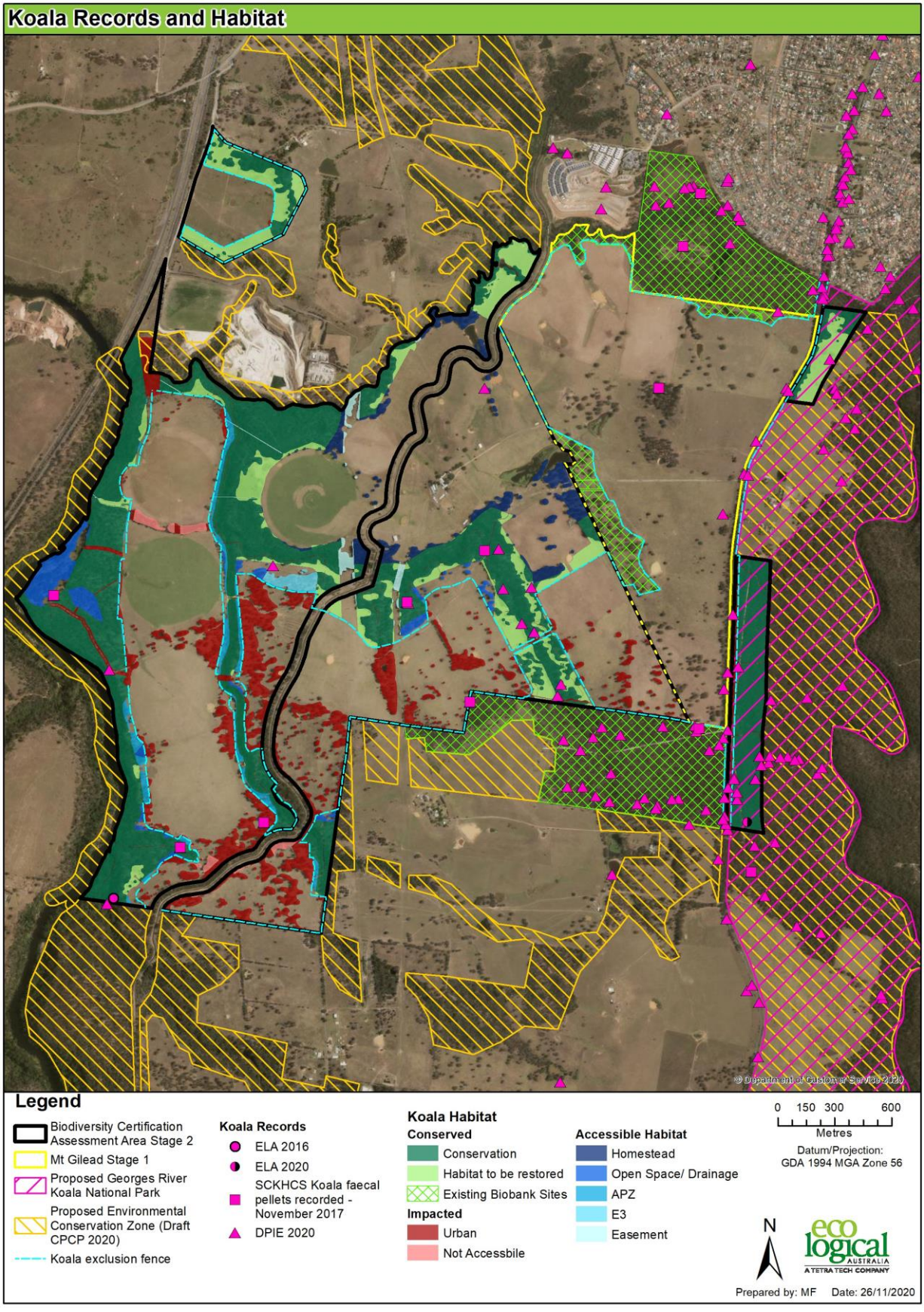


Figure 16 Records and habitat polygon for Koala within the BCAA

Figure 17: Records and habitat polygon for Squirrel Glider

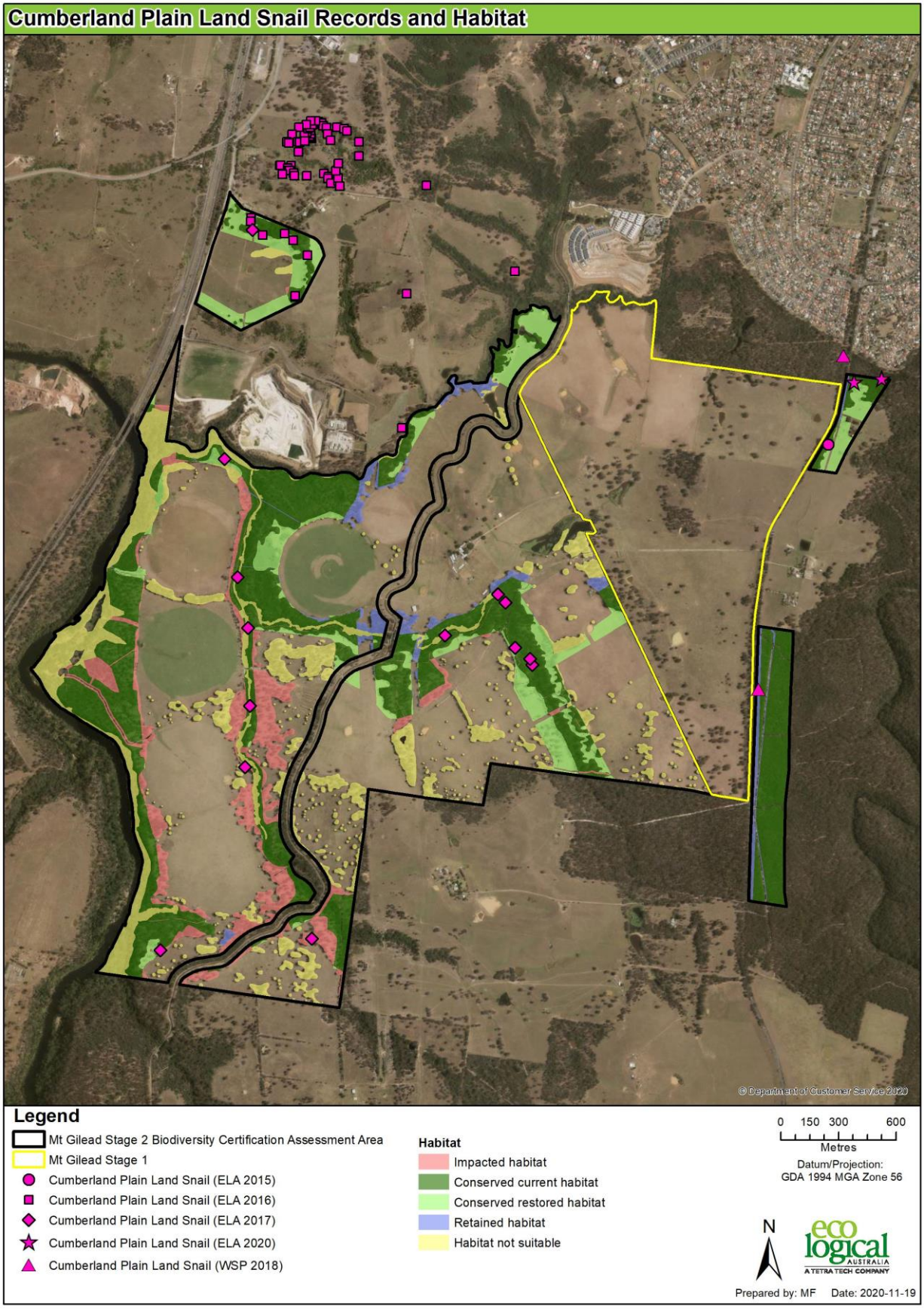


Figure 18: Records and habitat polygon for Cumberland Plain Land Snail

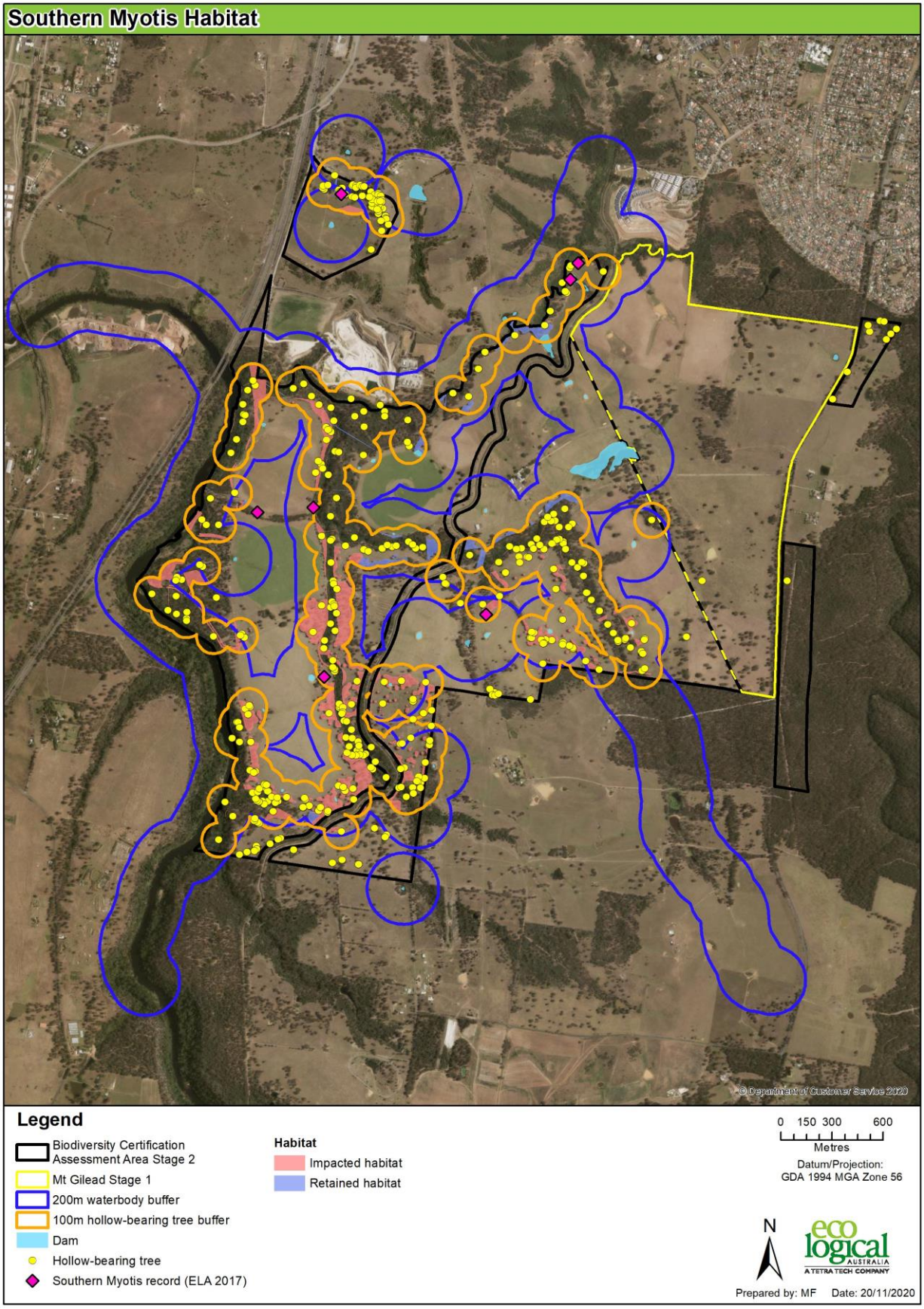


Figure 19: Records and habitat polygon for Southern Myotis prior to impacts and dam-dewatering

Note: Prospect Canal not included as a water body suitable as foraging habitat as water is heavily chlorinated

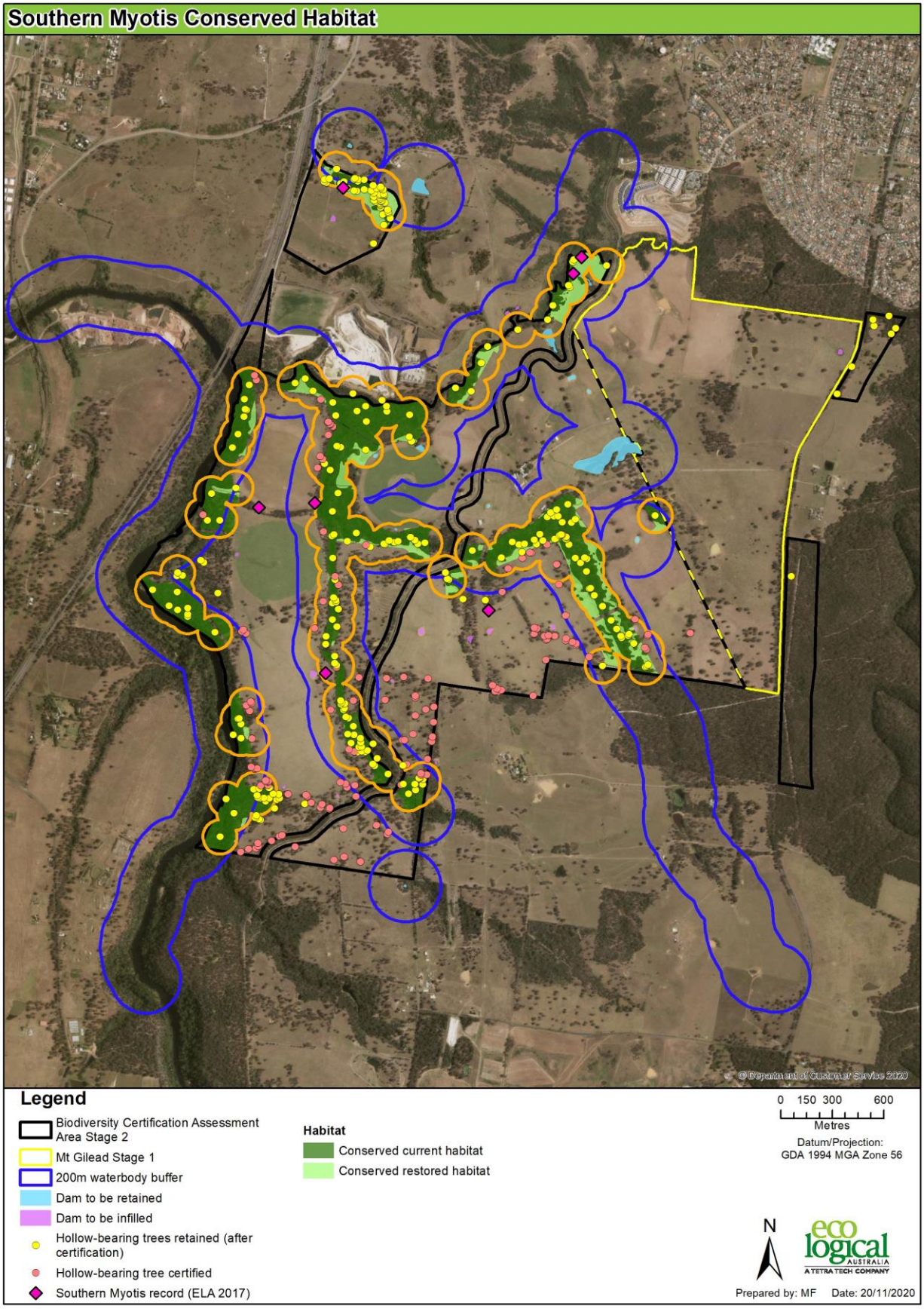


Figure 20: Records and habitat polygon for Southern Myotis post impacts, loss of hollow bearing trees and dam-dewatering

Note: Prospect Canal not included as a water body suitable as foraging habitat as water is heavily chlorinated

2.3.5 Red flag Areas

In accordance with Section 2.3 of the BCAM, a 'red flag area' is an area regarded as having high biodiversity conservation values if it contains one or more of the following:

- a critically endangered or endangered ecological community listed under the TSC Act or EPBC Act, and the vegetation is not in low condition (i.e. it has a site value score of > 34).
- a vegetation type that is greater than 70% cleared as listed in the Vegetation Types Database (that is, has 30% or less remaining of its estimated distribution in the catchment management authority (CMA) area before the year 1750), and the vegetation is not in low condition (i.e. it has a site value score of > 34).
- one or more threatened species identified in the Threatened Species Profile Database that cannot withstand further loss in the CMA area.
- an areas of vegetation recognised as having regional or state biodiversity conservation significance which includes:
    - land that is mapped or defined as a state or regional biodiversity link;
    - a riparian buffer 40 m either side of a major river on the coast and tablelands
    - a riparian buffer 30 m either side of a minor river or major creek on the coast and tablelands
    - a riparian buffer 20 m either side of a minor creek on the coast and tablelands.

Much of the BCAA comprises a red flag area with three of the five biometric vegetation types within the BCAA (SPW, SHW and SSTF) identified as a critically endangered or endangered ecological community listed under the TSC Act or EPBC Act and being classified as in 'moderate to good' condition (Table 9). Areas recognised as having regional or state biodiversity conservation significance are present within the BCAA including vegetation within the riparian buffer (30 m) of a minor river (the Nepean River) and within the riparian buffer (20 m) of a minor creek (Woodhouse, Menangle and Nepean Creeks). These areas therefore also represent red flag areas.

In addition, one flora species recorded within the BCAA (*Pomaderris brunnea*) is identified in the Threatened Species Profile Database as a species which cannot withstand further loss in the Hawkesbury Nepean CMA. The threatened fauna species recorded within the BCAA are all identified as species which 'can withstand further loss' within the database and are therefore not regarded as red flag areas.

The distribution of all red flag vegetation (EECs in moderate to good condition), red flag areas (riparian buffers) and threatened species that cannot withstand loss across the BCAA is shown in Figure 21.

Table 9: Vegetation zones that meet the definition of a red flag area (SV score > 34)

Red flag vegetation zones highlighted in red

Veg Zone	Vegetation	BVT ID	Ancillary Code	Condition	Red Flag (Site Value Score)	TOTAL Veg Area
1	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Weedy	Low	20	**24.45**
2	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Scattered trees	Low	21	**0.58**
3	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Regen	Low	32	**2.42**
4	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	Pasture improved / grazed	Mod-Good	39	**28.60**
5	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	Scattered trees	Low	33	**4.50**
6	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	DNG	Low	16	**3.11**
7	Cleared - restore to SPW	HN528	Cleared	Low	7	**10.75**
8	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	Good	Mod-Good	59	**2.42**
9	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	Weedy	Low	32	**2.59**
10	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	DNG	Low	19	**3.73**
11	Cleared - restore to SHW	HN529	Cleared	Low	7	**6.21**
12	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	HN538	Good	Mod-Good	60	**8.33**

Veg Zone	Vegetation	BVT ID	Ancillary Code	Condition	Red Flag (Site Value Score)	TOTAL Veg Area
13	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Good	Mod-Good	83	**104.45**
14	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Thinned/Shrubby	Mod-Good	41	**10.18**
15	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Pasture improved / grazed	Mod-Good	33	**57.65**
16	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Scattered trees	Low	28	**6.85**
17	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	DNS	Mod-Good	35	**5.07**
18	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	DNG		11	**0.67**
19	Cleared - restore to SSTF	HN556	Cleared	Low	8	**14.09**
	Sub-total - Vegetation					**296.65**

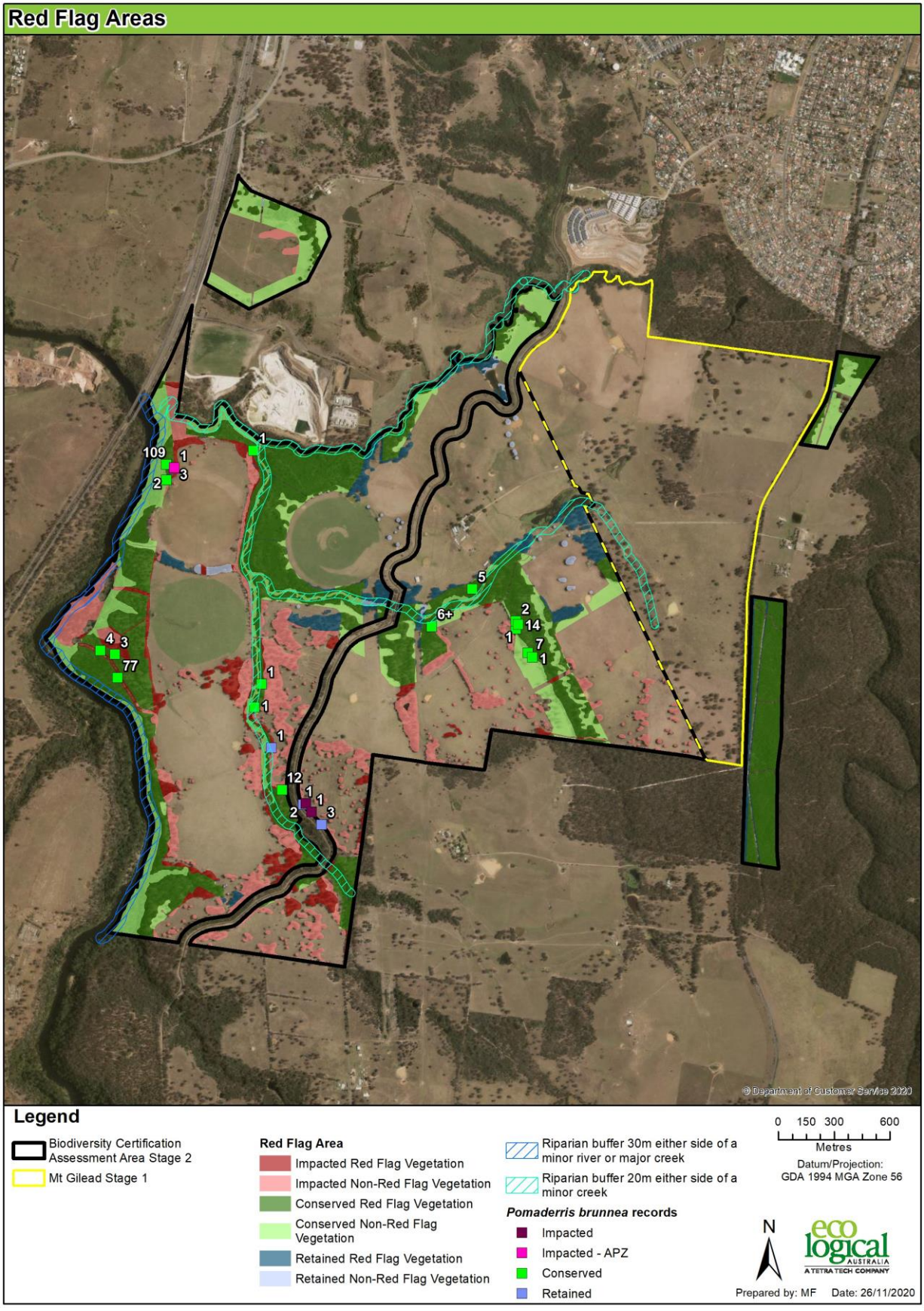


Figure 21: Red flag Vegetation, species and areas within the BCAA

3. More Appropriate Local Data used in the Biocertification Assessment

The BCAM outlines the methods by which general biodiversity values are assessed and measured in the BCAA to determine whether the conferral of biodiversity certification on land, as demonstrated in the application for biodiversity certification, improves or maintains biodiversity values (DECCW 2011a). These methods, along with the methods by which measurements of threatened species, assessments of indirect impacts on biodiversity values, and calculations of ecosystem and species credits are made, were followed in the Biocertification Assessment (Section 4).

According to the methodology, BVTs are used as surrogates for assessing general biodiversity levels. Information on each BVT, including a description, the vegetation class and formation to which it belongs, and percent cleared value, are contained within the Vegetation Types Database held by the OEH. A range of quantitative measures that represent the benchmark conditions for vegetation types are contained within the Vegetation Benchmark Database, also held by the OEH. The Vegetation Benchmark Database is organised by CMA, and as such, information for the same BVTs that may occur across different CMAs are repeated across CMAs, although the range of measures representing benchmark conditions can differ between CMAs to reflect variations in BVTs across their range.

Generally, default data contained in the Vegetation Benchmark Database are used when undertaking an assessment of, and measuring, general biodiversity values. However, the BCAM specifies that the Director General may certify that 'more appropriate local data' (MALD) can be used instead of the data in this database, 'where local data more accurately reflects local environmental conditions' (section 3.4 of the BCAM). Benchmark data that more accurately reflect the local environmental conditions for a BVT may be collected from local reference sites, or obtained from relevant published sources. Data other than benchmark data may also be obtained from relevant published sources. The Director General must provide justifications for certifying the use of local data. The certified local data can then be used in applying the methodology.

ELA considered that some of the benchmark values for 'Grey-Box – Forest Red Gum grassy woodlands on flats of the Southern Cumberland Plain, Sydney Basin Bioregion' and 'Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion', as contained in the Vegetation Benchmark Database, were not accurate reflections of the benchmark condition of these BVTs. This is because the database contained low or benchmark values that were not consistent with the vegetation types i.e. zero values for hollow-bearing trees and length of fallen logs, which would be expected to have some hollows and logs when in benchmark condition.

ELA has previously consulted with the OEH on this matter with regard to 'Grey-Box – Forest Red Gum grassy woodlands on flats of the Southern Cumberland Plain, Sydney Basin Bioregion'. An outcome of a previous discussion between ELA and Tim Hagar of the OEH was that 'local' benchmark data for the number of trees with hollows and for the length of fallen logs could be added for this BVT, with one and 50 m added for the number of trees with hollows and the length of fallen logs, respectively. This was to be consistent with other woodland/open forest vegetation types on the Cumberland Plain, and is consistent with the assessment undertaken for the Brownlow Hill Stages 1 and 2 Biobank Sites and other assessments undertaken by the OEH on the Cumberland Plain.

ELA also consulted with the OEH on this matter with regard to 'Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion' (email

correspondence with Tim Hager and John Seidel on 20 April 2015). The OEH advised that 'local' benchmark data for the number of trees with hollows and for the length of fallen logs could be added for this BVT, with one and 30 m added for the number of trees with hollows and the length of fallen logs, respectively. However, more recently, the Vegetation Information System has been updated and these benchmarks have now been amended to one and 50 m for the number of trees with hollows and the length of fallen logs, respectively.

As this is an error in the Biobanking Tool datasets, it is not considered that a formal application for the use of local benchmark data is required to be submitted to the OEH for approval. Accordingly, the local (or amended) benchmark values for the number of trees with hollows and the length of fallen logs in the two BVTs were used in this Biocertification Assessment (**Section 4**).

4. Biocertification Credit Assessment

This section details the results of the biodiversity certification assessment conducted to the requirements of the BCAM. Information is technical in nature, and relies on a broad understanding of the BCAM to understand the methods applied. Readers should make themselves familiar with the BCAM before reviewing this section of the document.

4.1 Biodiversity certification assessment area

The BCAA and proposed land use is shown in Figure 5 and is comprised of:

- Lands proposed for biodiversity certification – impacts to native vegetation and threatened species habitat in these areas 'requires' biodiversity credits;
- Land proposed for conservation – generates biodiversity credits; and
- Lands where the current land use will be retained (retained lands) – neither requires nor generates biodiversity credits.

The footprint proposed for 'biocertification' is 328.30 ha (75.72 ha of which comprises native vegetation as defined by the BCAM) (Table 10 and Figure 5) which includes APZs and certified open space that is counted as impacted but which will retain some biodiversity values and be managed as open space.

The land proposed for 'conservation measures' totals 198.16 ha (167.23 ha mapped as native vegetation and 30.17 ha to be restored to native vegetation (this includes 2.98 ha of the red flag vegetation buffer area that is not part of the of 30 m in the APZ/open space areas that will be managed for conservation but will not generate ecosystem credits (see **Section 6.3 & 6.4**).

146.06 ha of land has been identified as neither impacted nor subject to conservation measures, and has therefore been assessed as 'retained land' (i.e. credits are neither required nor generated). Some of this land includes public open space areas where vegetation will be retained and enhanced amongst passive recreation areas (walking/cycling paths, BBQ areas etc).

Table 10: Land use breakdown

Development footprint	Area (ha)	% of BCAA	Area of native vegetation (ha)	% of native vegetation
Land proposed for Biodiversity Certification (Urban development and associated infrastructure - roads, bio-detention basins, APZs)	328.30	48.82	75.72 existing vegetation 252.58 cleared land	28.41
Land proposed for conservation (195.41 ha to be registered as 4 Biobank sites and 2.75 ha Natural Areas)	198.16	29.46	167.23 existing vegetation 30.17 to be restored 0.76 tracks/dams	62.75
Retained lands (land excluded from this assessment) includes Mt Gilead Homestead lands, Local Open Space and existing easements.	146.06	21.72	23.53 existing vegetation	8.83
Total	**672.52**	**100**	**266.48**	**100**

4.2 Vegetation mapping and zones

As outlined in **Section 2.3.1**, five BVTs were identified in the BCAA which has been mapped into 19 vegetation zones (Table 8 and **Table 11**). There was 266.48 ha of vegetation mapped in total, with the dominant vegetation type being '*Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin'* (184.87 ha). The BCAA also supported 36.21 ha of '*Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin*', 8.74 ha of '*Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin*', 27.45 ha of '*Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion*' and 8.33 ha of '*Grey Myrtle dry rainforest of the Sydney basin Bioregion and South East corner*'. The remaining parts of the BCAA are categorised as cleared land (406.92 ha), which in the context of the BCAM includes exotic vegetation.

Table 11: Area of vegetation within the BCAA

Biometric vegetation type	Area (ha)	TSC Act	EPBC Act
HN526 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	27.45	RFEF (EEC)	Currently be considered for listing as a TEC
HN528 Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion	36.21	CPW SPW (CEEC)	CPSWSGTF (CEEC)*
HN529 Grey-Box – Forest Red Gum grassy woodlands on shale of the Southern Cumberland Plain, Sydney Basin Bioregion	8.74	CPW SHW (CEEC)	CPSWSGTF (CEEC)*
HN538 Grey Myrtle dry rainforest of the Sydney basin Bioregion and South East Corner	8.33	N/A	N/A
HN556 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	184.87	SSTF (CEEC)	SSTF (CEEC)
Cleared land	406.04	NA	NA
Total	**672.52**		

Table 12: Area of vegetation zones assessed within the BCAA

Veg Zone	Vegetation	BVT ID	Ancillary	BioMetric Condition	Land proposed for certification	Land subject to conservation measures	Retained land	Red Flag Buffer	Total
1	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain	HN526	Weedy	Low	5.31	19.08	0.06	0	24.45
2	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain	HN526	Scattered trees	Low	0.52	0.06	0.00	0	0.58
3	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain	HN526	Regen	Low	2.17	0.25	0.00	0	2.42
4	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain	HN528	Pasture Improved	Mod-Good	8.99	12.94	6.40	0.27	28.60
5	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain	HN528	Scattered trees	Low	3.83	0.35	0.32	0	4.50
6	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain	HN528	DNG	Low	0.00	2.56	0.55	0	3.11
7	Cleared - restore to SPW	HN528	Cleared	Low	0.00	9.87	0.88	0	10.75
8	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain	HN529	Good	Mod-Good	0.03	2.38	0.00	0.01	2.42
9	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain	HN529	Weedy	Low	0.08	2.09	0.42	0	2.59
10	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain	HN529	DNG	Low	1.11	2.57	0.05	0	3.73

11	Cleared - restore to SHW	HN529	Cleared	Low	0.00	6.21	0.00	0	6.21
12	Grey Myrtle dry rainforest	HN538	Good	Mod-Good	0.38	7.69	0.26	0	8.33
13	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	Good	Mod-Good	8.07	87.96	5.85	2.57	104.45
14	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	Thinned/Shrubby	Mod-Good	0.90	9.08	0.07	0.13	10.18
15	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	Pasture Improved	Low	37.79	11.95	7.91	0	57.65
16	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	Scattered trees	Low	4.99	1.19	0.67	0	6.85
17	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	DNS	Mod-Good	1.55	3.43	0.09	0	5.07
18	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	DNG		0.00	0.67	0.00	0	0.67
19	Cleared - restore to SSTF	HN556	Cleared	Low	0.00	14.09	0.00	0	14.09
	Sub-total - Vegetation				**75.72**	**194.42**	**23.53**	**2.98**	**296.65**

4.3 Transect/Plot data and site value scores

Appendix 4 of the BCAM defines the minimum number of transects/plots required per vegetation zone area (DECCW 2011a). Data from a total of 72 BioMetric vegetation transects/plots were collected across the BCAA. The transect/plot data imported into the credit calculator tool is provided in **Appendix J**.

Current site value and future site value scores were calculated for each vegetation zone using the transect/plot data collected. The BCAM credit calculator was used to produce the current and future site value scores for development and conservation areas (**Table 13**). Note that some changes were made to default settings for future site scores for 'additional management actions'. Additional gains within conservation areas were calculated above default for six site attributes: Native plant species richness, native over-story cover, native mid-story cover, native ground cover grasses, overstory regeneration and total length of fallen logs (vegetation zones 4, 5, 6, 7, 9, 10, 11, 15, 16, 17, 18 and 19), as shown in Figure 37**,** in line with the rules set out in Appendix 4 of the BCAM. This was done as it is proposed that logs with hollows will be brought into the conservation areas from the adjoining development areas and that where required, supplementary planting of over-story, mid-storey species is proposed. This will both increase native over-story and mid-storey cover, increase native plant species richness and decrease native grass cover (through shading which will thin native grass) over time in those vegetation zones that have these attributes in low condition.

Table 13: Site value scores allocated to each vegetation zone

***Indicates vegetation zones where 'additional management actions' (supplementary planting and/or bringing in logs) has been applied

Veg Zone	Vegetation	BVT ID	Ancillary	Condition	Current Site Value Score	Future Site Value Score (after Development)	Future Site Value Score (with Conservation measures)
1	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Weedy	Low	20	0	40
2	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Scattered trees	Low	21	0	41
3	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Regen	Low	32	0	54

Veg Zone	Vegetation	BVT ID	Ancillary	Condition	Current Site Value Score	Future Site Value Score (after Development)	Future Site Value Score (with Conservation measures)
4	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	Pasture Improved / grazed	Mod-Good	39	0	69***
5	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	Scattered trees	Low	33	0	65***
6	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	DNG	Low	16	0	40***
7	Cleared - restore to SPW	HN528	Cleared	Low	7	0	30***
8	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	Good	Mod-Good	59	0	85***
9	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	Weedy	Low	32	0	62***
10	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	DNG	Low	19	0	40***
11	Cleared - restore to SHW	HN529	Cleared	Low	7	0	29***
12	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	HN538	Good	Mod-Good	60	0	80
13	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges	HN556	Good	Mod-Good	83	0	100

Veg Zone	Vegetation	BVT ID	Ancillary	Condition	Current Site Value Score	Future Site Value Score (after Development)	Future Site Value Score (with Conservation measures)
	of the Cumberland Plain, Sydney Basin Bioregion						
14	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Thinned/Shrubby	Mod-Good	41	0	66***
15	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Pasture Improved / grazed	Low	33	0	66***
16	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Scattered trees	Low	28	0	53***
17	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	DNS	Mod-Good	35	0	59***
18	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	DNG		11	0	36***
19	Cleared - restore to SSTF	HN556	Cleared	Low	8	0	31***

4.4 Landscape Score

The credit calculator calculated a landscape value score of **22** for the land to be certified, and a score of **18.2** for the land subject to conservation measures. The landscape value is calculated from the sum of the scores obtained from the following three attributes:

- percent native vegetation cover in the landscape
- connectivity value

- adjacent remnant area determined according to the Mitchell landscape in which most of the land proposed for biocertification occurs.

Scores for each landscape attribute for 'land to be certified' and 'land subject to conservation measures', as well as an explanation of how the scores were determined, are provided in the sub sections below.

4.4.1 Percent Native Vegetation Cover Score

The percent native vegetation cover calculation was completed within a single 3,000 ha circle (**Figure 22**). The area of vegetation cover was taken from the existing vegetation mapping of the Cumberland Plain (NPWS 2001) and digitised from an aerial photograph at a scale of approximately 1:10,000. The results of the assessment are contained in **Table 14**.

A pre-certification score of **13** was determined with 1,120.62 ha (1120.62/3,000 = 37.4%) native vegetation mapped within the 31-40% native vegetation cover class. Vegetation clearance would result in 1,093.44 ha of vegetation cover (36.0%) remaining in the assessment circle. The post certification score is also **13** because vegetation cover falls within the same 10% increment (31-40%).

Table 14: Native vegetation cover in assessment circle

Circle	Pre-certification			Post-certification		
	Area of vegetation within assessment circle (ha)	Native vegetation cover class (%)	Score	Area of vegetation within assessment circle (ha)	Native vegetation cover class (%)	Score
1 (3,000ha)	1,120.62 (37.35%)	31-40%	13	1,093.44 (36%)	31-40%	13

The land subject to conservation measures (post-biodiversity certification) is 200.55 ha, of which 167.23 ha is currently vegetated land, with 30.17 ha to be restored. Therefore (using Table 3 of the BCAM) a gain of **2.2** is recorded for the percent native vegetation score after conferral of biodiversity certification.

4.4.2 Connectivity Value

The current connectivity value of the site was assessed according to Section 3.7.2 of the BCAM. There are three components of connectivity; these are areas approved as a 'state' or 'regional' biodiversity links by the Director General, the hierarchy and riparian zone width of water courses in accordance with Appendix 1 of the BCAM and an assessment of vegetation connectivity. OEH have advised that there are currently no state or regional biodiversity links approved by the CEO of OEH relevant to the BCAA.

'Minor rivers' and 'major creek', defined as a 'regional biodiversity link', with a riparian buffer either side of a minor river or major creek, occur on land to be developed (**Figure 23**: Connectivity). They also occur on land subject to conservation measures. According to Table 4 of the BCAM the score for a regional biodiversity link is **12**. As a regional biodiversity link is located on land proposed for biodiversity certification and will be impacted it was allocated a score of zero after development (**Table 15**). The vegetation on land subject to conservation is located on land within 30m of the riparian buffer of a minor river. Given this, there is a regional link on land subject to conservation measures, and a score of **12** was allocated post-certification.

Table 15: Connectivity scores allocated for the assessment

Connectivity score	Pre-certification	Post-certification
Land to be certified	12	0
Land subject to conservation measures	12	12

4.4.3 Adjacent Remnant Area

The BCAA predominantly occurs on the Upper Nepean Gorges Mitchell Landscape which is 31% cleared. The vegetation on site is well connected given the areas of moderate to good vegetation are separated by areas of low condition vegetation and cleared land, resulting in an adjacent remnant area (ARA) of 101 ha (**Figure 23**). This receives a score of **10** for Mitchell Landscapes within the 30-70% cleared range.

The land subject to conservation measures also occurs within the same Upper Nepean Gorges Mitchell Landscape with the same ARA of 101 ha. Therefore, the score allocated for the conservation lands is also **10**.

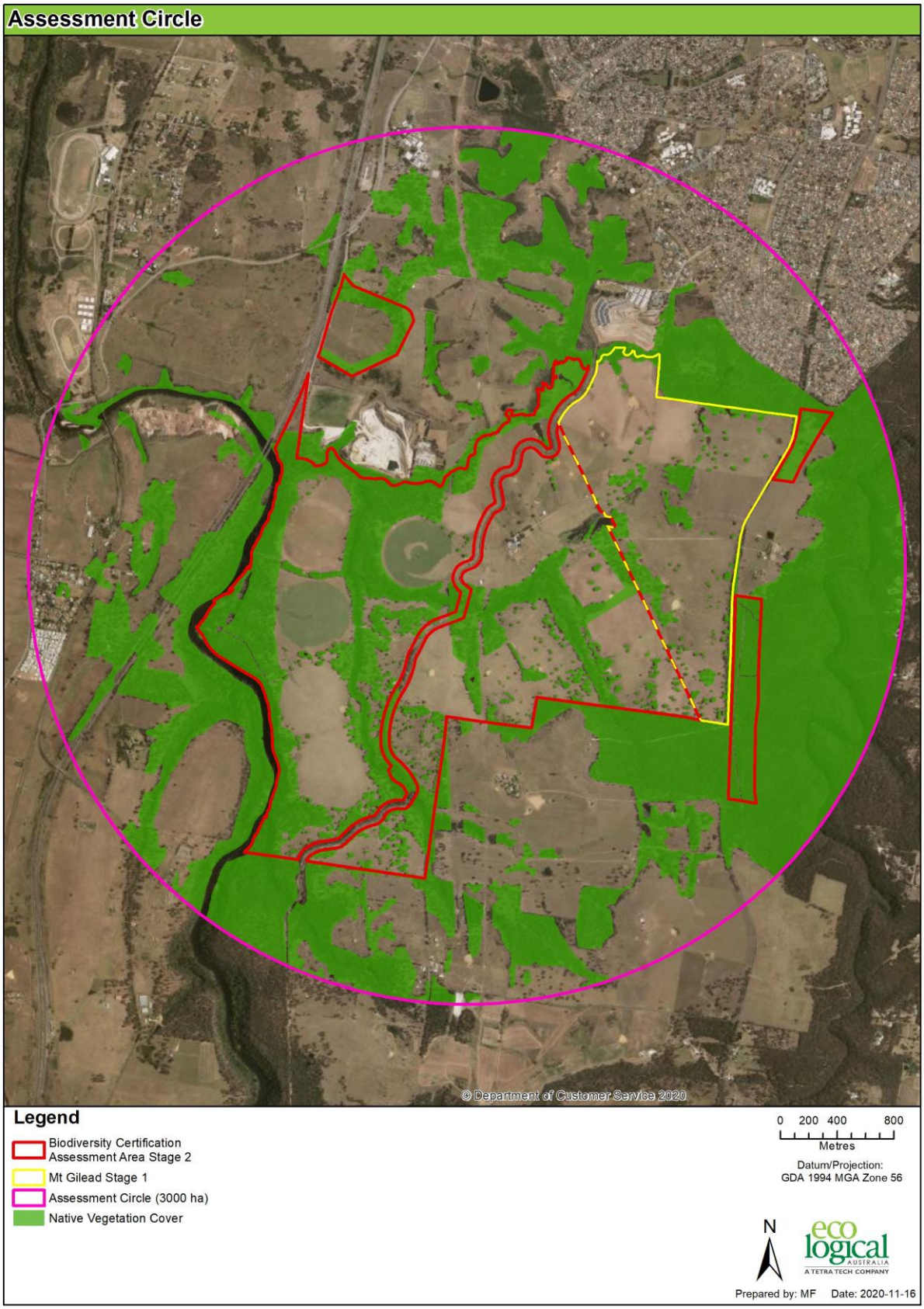


Figure 22: Assessment circle

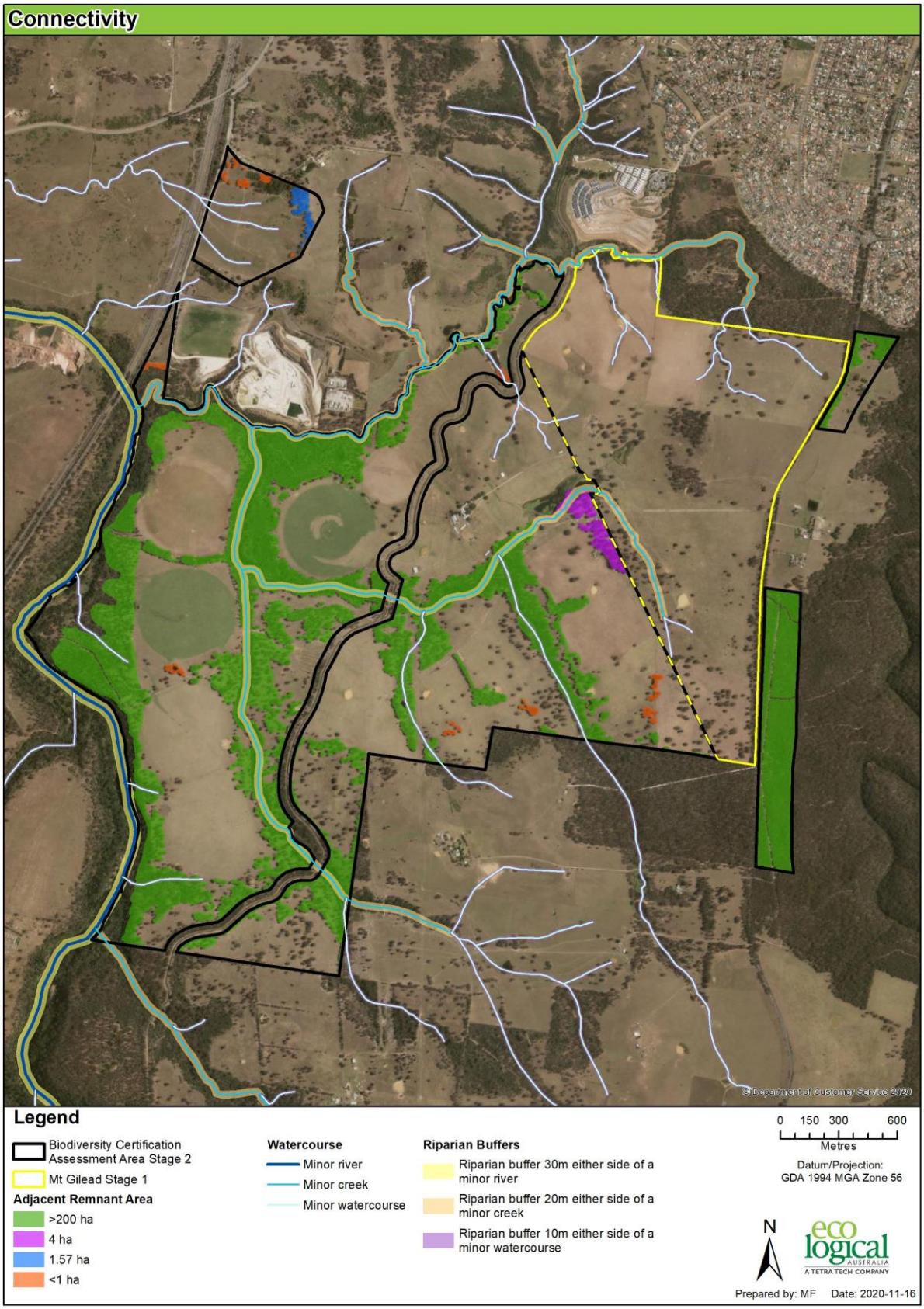


Figure 23: Connectivity

4.5 Red Flags

The BVTs, '*Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion*', *'Grey-Box – Forest Red Gum grassy woodlands on shale of the Southern Cumberland Plain, Sydney Basin Bioregion*' and '*Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion*' have been identified as comprising two CEECs (CPW and SSTF). These vegetation types are therefore 'red-flagged' when in moderate to good condition (a site value score greater than 34/100) under the BCAM (i.e. vegetation zones 4 and 8 for CPW and 13, 14, 15 and 17 for SSTF).

All remaining vegetation zones and vegetation types identified as CEECs/EECs were in 'low' condition because the site value score for these vegetation zones was less than 34/100. Accordingly, these vegetation zones are not red flagged.

The area of impacted red flagged vegetation is shown in **Table 19** and **Figure 28.** Red flag areas should be avoided where possible and can only be impacted in accordance with the variation criteria outlined in Section 2.4 of the BCAM.

A total of 150.72 ha of red flagged vegetation is present within the BCAA of which 0.03 ha of high condition SHW and 8.99 ha of degraded (low condition, site value score less than 40) SPW will be impacted and 8.07 ha of high condition SSTF (sv score 85) and 2.46 ha of degraded (low condition, site value score less than 35 and 41) SSTF will be impacted. The majority of these impacts are to 'degraded' (as defined by BCAM) CPW and SSTF woodland that are currently subject to grazing, pasture improvement, firewood/fence post collection and are thus substantially outside of benchmark condition for many of the site attributes.

A red flag variation request prepared in accordance with the criteria set out in Section 2.4.1 and 2.4.2 of the BCAM is provided in **Section 5** for impacts to CPW and SSTF red flag areas. It is noted that a red flag variation request must be assessed and approved by the OEH before biodiversity certification can be conferred.

Pomaderris brunnea is an endangered shrub that is classified in the TSPD as a species that "cannot withstand loss". Up to 6 plants may be impacted in land proposed for certification (5 are within proposed local open space/APZ areas and some may be able to be protected).

A red flag variation request prepared in accordance with the criteria set out in Section 2.4.1 and 2.4.3 of the BCAM is provided in **Section 5** for impacts to *P. brunnea*. It is noted that a red flag variation request must be assessed and approved by the OEH before biodiversity certification can be conferred.

In addition there are 37.97 ha of vegetation within riparian buffers of minor creeks and rivers of which there will be impacts to 2.44 ha of vegetation within the 30 m buffer area of a minor river (Nepean River) and 1.87 ha of impacts to vegetation within the 20 m buffer area of a minor creek (Menangle, Nepean and Woodhouse Creeks) within the BCAA which are also classified as red flag areas **(Figure 28)**. These impacts are generally associated with three creek crossings in the proposed development footprint, the Nepean River waterfront park and an up to 1.5 m wide bush walking path along these creek lines.

A red flag variation request prepared in accordance with the criteria set out in Section 2.4.1 and 2.4.4 of the BCAM is provided in **Section 5** for impacts to vegetation within riparian buffer areas. It is noted that a red flag variation request must be assessed and approved by the OEH before biodiversity certification can be conferred.

4.6 Buffers on Red flag areas

Where a proposed conservation measure is used to protect land that is a 'red flag area' (i.e. CPW or SSTF in moderate to good condition), the area of the proposed conservation measure must include a buffer to mitigate any negative indirect impacts from development following the conferral of biocertification. The buffer area may be secured via a conservation measure and used to offset the impacts of biodiversity certification, or it may be a retained area in the biocertification assessment area (and not generate any credits) (see Section 6 of the BCAM).

In consultation with OEH for the Stage 1 biocertification assessment, it was determined that an appropriate buffer for the red flag vegetation in the proposed conservation area would be 30 m and this could be partly comprised by any perimeter roads (up to 15 m) separating development from the proposed conservation area and should be classified as a 'retained area' within the BCAA.

The Master Plan (Figure 4) has been designed with perimeter roads, APZs and open space areas providing a minimum 30 m buffer between urban development and conservation areas. These open space/APZs areas have been calculated on the basis of complete loss in the credit calculations, despite retaining biodiversity values (tree canopy). Where the perimeter roads/APZ/open space do not provide a full 30m buffer, the red flag buffer extends into the proposed conservation areas and has been assessed as not generating credits despite the commitment to register and manage these areas as part of the Biobank sites as outlined in Section 6.3 and 6.4. Accordingly the credit calculations have included 2.98 ha of red flag EEC buffer within areas proposed for conservation.

The roads surrounding the conservation buffer area will be fully curbed and guttered with piped stormwater management that will not flow into the conservation area of buffer area.

4.7 Indirect Impacts

The BCAM requires that any application for biodiversity certification must demonstrate how the "*proposed ownership, management, zoning and development controls of the land proposed for biodiversity certification is intended to mitigate any indirect impacts on biodiversity values*" (DECCW 2011a).

Indirect impacts have been considered in accordance with the BCAM and have been determined to be negligible on the basis that all 'direct impacts' have been assessed on the assumption of complete loss of all biodiversity values including where these losses are only partial e.g. for Asset Protection Zones (APZs) or may be reduced due to provision of additional local open space in detailed precinct planning.

The Master Plan (Figure 4) has been designed with perimeter roads and open space areas providing at least a 30m buffer between urban development and conservation areas (thus negligible in direct impacts to actively managed, conservation areas). Further, whilst these open space areas provide a dual role (they serve as bushfire APZs and will also include landscaped bio-retention basins, and walking/cycling paths), as the tree canopy cover in these areas is currently well below APZ requirements, they will largely retain existing trees and will include landscape plantings, including preferred Koala browse species (Forest Red Gum, Grey Box, Grey Gum), to further enhance their habitat for biodiversity values (Koala, Squirrel Glider, Southern Myotis). Figures 24-26 show the typical landscaping of bio-retention basins, the urban/conservation area interface and indicative management of these open space areas.

In effect the APZ areas will provide a buffer between the development lands and the adjacent conservation areas, thereby mitigating and buffering any indirect impacts such as increased weeds, run-off, changed noise and light conditions.

All proposed conservation areas, including buffer areas, will be managed in accordance with Biobank Agreement management plans and their associated reporting, audit and compliance requirements.

4.7.1 Indirect Impacts - Stormwater Management

Inappropriate water, sewer and stormwater management presents potential risks to the integrity of the conservation areas. Water sensitive urban design (WSUD) features will be incorporated in the development. The preferred strategy option for water cycle management includes:

- Vegetated swales incorporated into general streetscape
- Vegetated filter strips located within open areas/parks adjacent and upslope of riparian corridors
- Gross Pollutant Traps strategically located at outlet of stormwater drainage systems
- Bio-retention (filtration) system located at the outlet of stormwater drainage system and off-line from existing waterways (and outside riparian zones where practicable)
- Rehabilitated natural drainage channels incorporating stormwater treatment measures

Stormwater runoff from urban areas will first be treated in off-line bio-retention basins (19.68 ha of the land to be certified containing 9.44 ha of native vegetation) before being discharged to the streams. These basins will treat for water-borne pollutants such as nutrients and suspended solids, and will also reduce discharge rates during small but frequent rainfall events, those which have greater impact on stream erosion.

The detention basins will include appropriate plantings arounds the banks that will provide habitat for birds, frogs and foraging/nesting resources for bats, birds and arboreal mammals, including Koala. This will provide a strong buffer area between the urban development interface and the proposed conservation areas. An indicative design of the bio-retention basins/swales is depicted in Figure 24. The water captured in the detention basins will only be retained for as long as required for it to be released at pre-development flow rates, once discharged (shortly after a rainfall event), the areas quickly dry out as an ephemeral water course. The quantity and quality of the water flowing out of the detention basins into natural watercourses, including through proposed offset areas, will be of a higher standard than pre development rural run-off and no different to the current high and low flow events.

While impacts on vegetation outside those shown on plans will be minimal, there will be some disturbance associated with ancillary works, such as stormwater pipes discharging to streams and sewer mains crossing under vegetated areas. At this point in time it is not possible to ascertain exactly where these impacts will be, however wherever practicable they will be aligned with proposed or existing disturbances such as road crossings of corridors, existing easements and cleared areas. Impacts outside of this are anticipated to affect less than 1-2% of the vegetated areas and will be re-vegetated.

4.7.2 Indirect Impacts - Koala movement corridors

There is potential for some indirect impacts resulting from the fragmentation of movement corridors or cumulative loss of foraging opportunities for some threatened fauna species. For example, removal of vegetation, including scattered paddock trees, and their replacement with residential housing, could impede the movements/access of the species credit species (Koala, Squirrel Gliders), as well as other fauna species.

In March 2018, Campbelltown Council prepared a report on the findings of the South Campbelltown Koala Habitat Connectivity Study (Biolink 2018) and recommended establishing "*at least three east west primary natural asset corridors in the Mt Gilead/South Campbelltown urban release area* (i.e.

Menangle, Woodhouse and Mallaty Creeks*), with minimum widths ranging from 200m-425m with at least one corridor designed specifically for Koalas that achieves an average width of 425m*".

Further, in April 2020, the Office of the Chief Scientist & Engineer released a report (Chief Scientist NSW 2020) providing advice on the protection of the Campbelltown Koala population prepared by the Koala Independent Expert Panel in which a number of recommendations were made regarding priorities to link the Georges River and Nepean River catchments by protecting certain east-west corridors including minimum widths of these corridors, safe crossing points for Koalas across Appin Rd, provision of perimeter roads and vehicle speed limits, koala exclusion fencing and management of koala habitat.

Lendlease have also prepared a Gilead Koala Conservation Plan (Lendlease 2020) to serve as a comprehensive conservation management framework to guide the design, planning, construction, habitation and long-term stewardship of the study area. The plan provides a detailed response to the NSW Chief Scientist & Engineers advice on the protection of the Campbelltown Koala population and alignment with CCC Koala Plan of Management.

The Mt Gilead Koala Management Plan (Lendlease 2020) identifies perimeter roads along all boundaries of these corridors, speed limits of 50kph, 1,500mm high koala exclusion fencing and grids to prohibit cars and dogs and the in perpetuity protection, E2 zoning and fully funded management and monitoring as Biobank sites. The Gilead Koala Conservation areas comprises 244 ha of fenced koala habitat and areas to be restored to koala habitat.

The updated Master Plan (Figure 4) has been designed to in response to these recommendations for the Mt Gilead land holdings and have identified Woodhouse Creek as a the primary Koala movement corridor within the BCAA between the DPIE Primary Koala corridor to the east of Appin Road, through the Beulah Biobank site, along Woodhouse Creek, to the Menangle Creek and Nepean River corridor (Figure 27**)**. Subject to on-going consultation with DPIE and Roads and Maritime Services, a fauna underpass may also be established at Appin Road /Beulah Biobank site to provide a safe crossing point at the upgraded Appin Road. The corridor has a minimum width of 250m along its entire length and an average width of 429m between Appin Rd at Beulah and the Nepean River (Lendlease 2020 – Gilead Koala Conservation Plan).

A second corridor is also provided along Menangle Creek although it is noted that significant parts of this corridor are already impacted by existing development and constraints (bushfires) outside of the Mt Gilead proposal (Gilead Retirement Village) or are landholdings that Lendlease does not have control over (Mt Gilead Homestead and lands to north of Menangle Creek that are subject to the Cumberland Plain Conservation Plan. However, when taking the E2 recommendations of the CPCP into consideration, in conjunction with prosed conservation measures within Mt Gilead, the corridor has a minimum width of 100m (at the Gilead Retirement Village) and an average width of 334m between Appin Rd at Noorumba Reserve and the Nepean River (Lendlease 2020 – Gilead Koala Conservation Plan). Subject to on-going consultation with DPIE and Roads and Maritime Services, a fauna underpass may also be established at Appin Road /Noorumba Biobank site to provide a safe crossing point at the upgraded Appin Road.

4.7.3 Mitigation measures to reduce direct and indirect impacts

Whilst all impacts within the land to be certified have been calculated on the assumption of complete loss, the following mitigation measures have been included to minimise impacts and address potential indirect impacts to areas proposed for conservation and retained areas:

A Construction Environment Management Plan (CEMP) will be prepared for vegetation clearing within the BCAA to guide the development outlined in this biocertification assessment and ensure that all

direct and indirect impacts (e.g. APZs, utilities, access, stormwater run-off etc) are contained within the development footprint and appropriate mitigation measures are put in place to minimise indirect impacts to threatened fauna including Koala and Squirrel Glider. Specifically, this will address the management of the land proposed for conservation measures and its buffer such that surrounding roads will be fully curbed and guttered with no stormwater being discharged into the conservation areas other than that treated within the bio-detention basins.

In addition, the CEMP will include, but not be limited to:

- temporary and permanent protective fencing will be erected around all areas identified for conservation prior to clearing activities to minimise any inadvertent damage
- a fauna pre-clearance protocol
- retention of HBTs where possible and practical
- where trees are removed in the development area, these will be salvaged for fauna habitat values in the proposed Biobank sites (i.e. meeting the additional management requirement if importing logs into the conservation area)
- a de-watering plan for any farm dams that are removed
- monitoring of performance measures and non-compliance.

Further, once registered, each Biobank site will be required to provide an annual report that will include an audit of the implementation of management actions, monitoring of the condition of vegetation and threatened species.

A bioretention basin showing the transition from nature strip to vegetated basin, with footpath on farside and fenced off conservation area in the background.

Established native vegetation within a bioretention basin acting as a buffer to the conservation area in the background.

An aerial view of a bioretention basin functioning alongside residential development and conservation areas

Figure 24: Typical design and landscaping of proposed bioretention basins in open space/EEC buffers

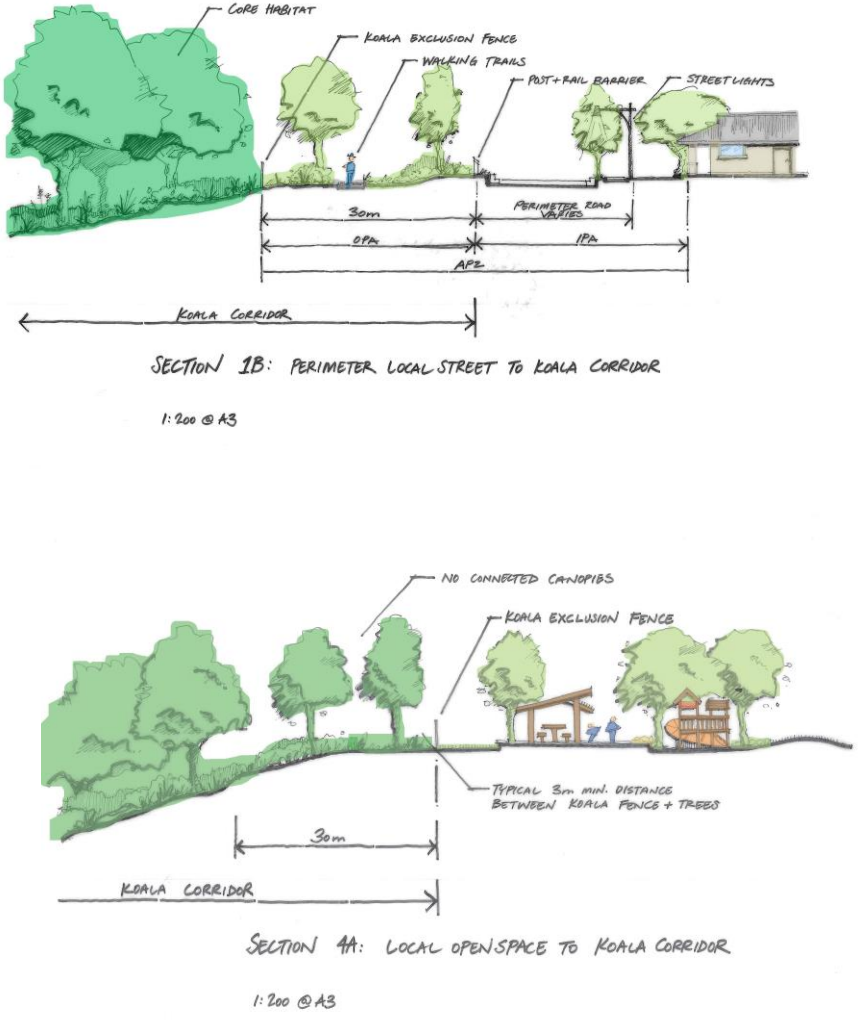
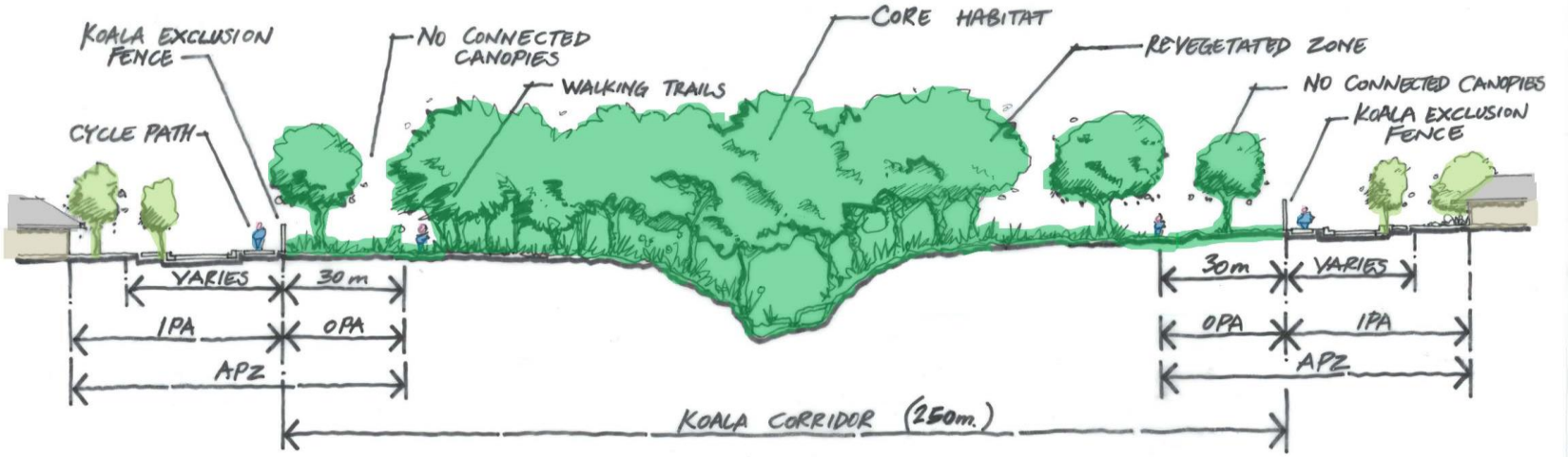


Figure 25: Typical interface of urban development, local open space and offset areas



SECTION A: WOODHOUSE CREEK CORRIDOR

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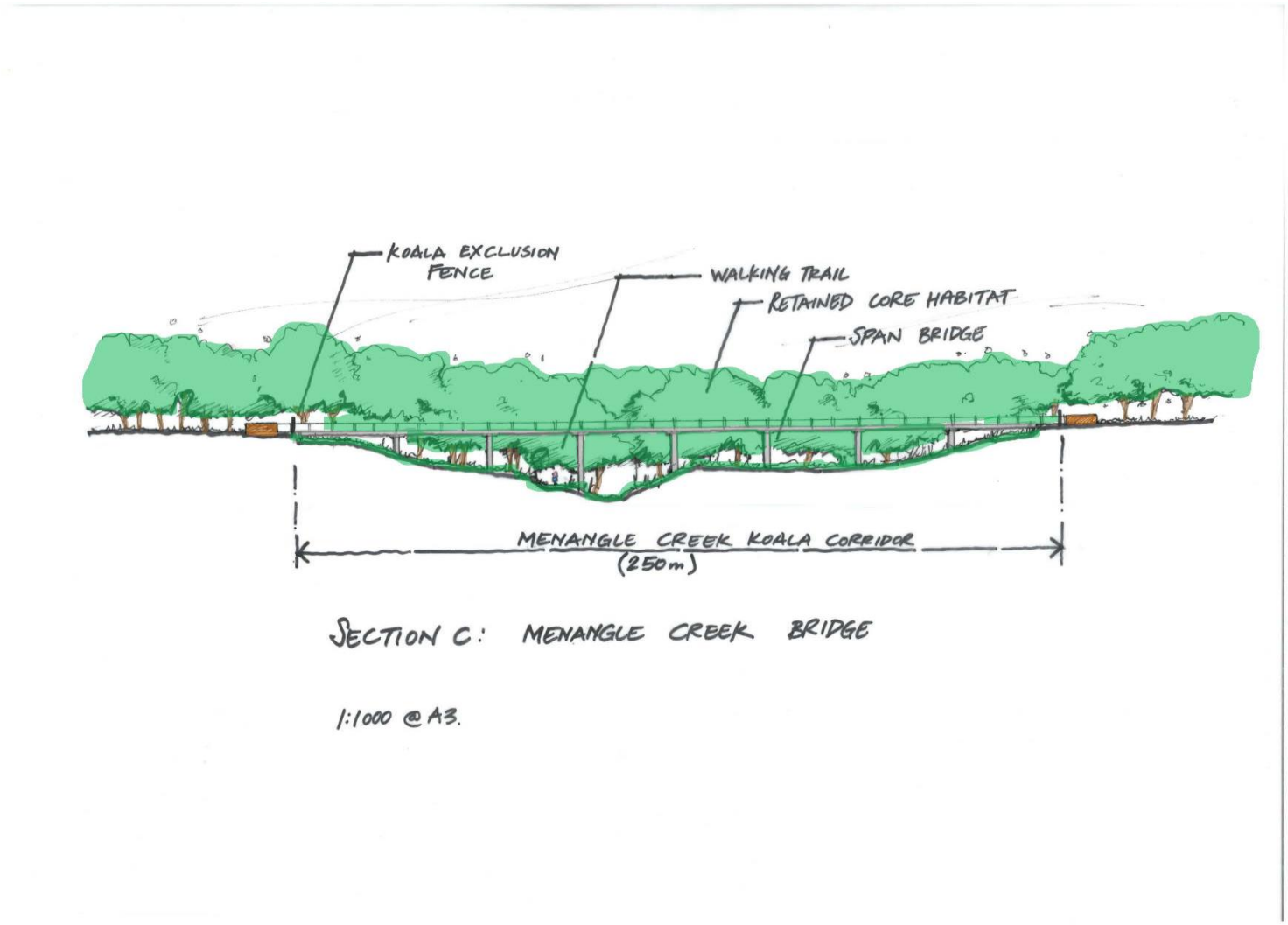

Figure 26: Typical cross section of creek crossing for Koala movement (Woodhouse and Menangle Creeks)

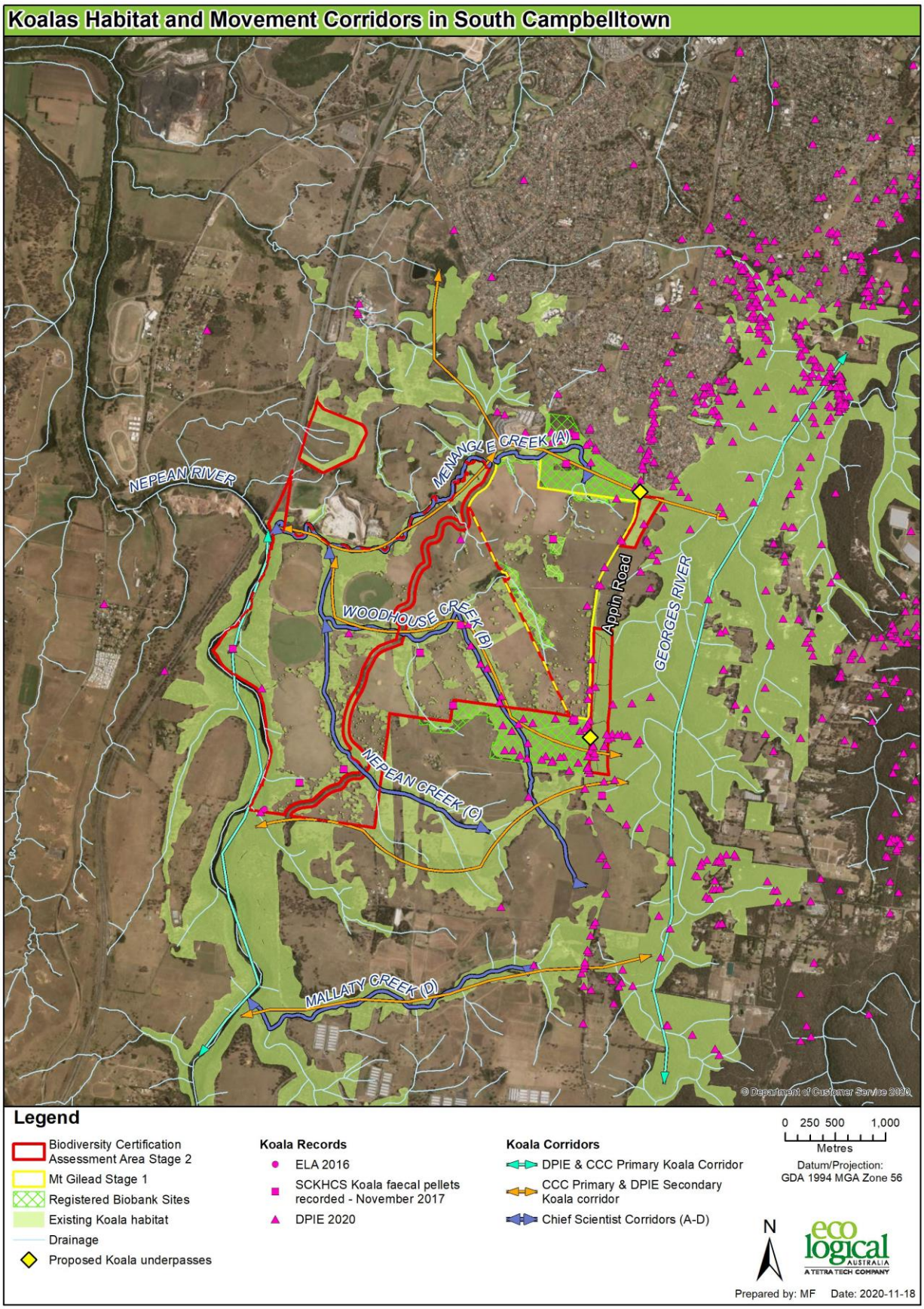

Figure 27 Koala records, habitat and movement corridors in the South Campbelltown Area as identified by CCC, DPIE & Chief Scientist

4.8 Credit Calculations

4.8.1 Ecosystem Credits

Ecosystem credits have been calculated for the loss of vegetation resulting from the proposed development. In total, **1,623** ecosystem credits are 'required' for the proposed development lands within the BCAA (**Table 16**).

As defined in the BCAM, different levels of protection and management for conservation lands results in the 'generation' of a different number of credits as outlined below:

- Areas that are managed and funded in perpetuity (i.e. registration of Biobank sites or gazettal of land as national parks) – 100% credit entitlement – generating **2,123** ecosystem credits;
- Areas that are managed in perpetuity (e.g. classification and management of land as community land 'Natural Area' under the Local Government Act 1993 and adoption of a Plan of Management etc) – 90% credit entitlement – generating **29** ecosystem credits; and
- Areas that are secured through a planning instrument (i.e. environmental zoning) – 25% credit entitlement – there are no areas to be secured through a planning instrument as part of this assessment.

Most of the land subject to conservation measures within the BCAA will be secured by the registration of 4 biobank sites (Browns Bush, Mt Gilead Homestead, Gilead Creek and Medhurst Biobank sites as shown in Figure 38, thus generating **2,154** ecosystem credits as a 100% conservation measure (Applications to register these four biobank sites under the savings and transitional provisions of the BC Act were submitted to DPIE in August 2020).

All ecosystem credits 'required' are 'generated' by the proposed conservation measures, i.e. there will be no credit deficits, however, all 'surplus' credits generated will be 'retired' as a condition of biodiversity certification. Whilst the proposed Biobank sites will all be registered at the same time as certification, the credits will be 'retired' in stages prior to the commencement of any development in accordance with the commitments in **Section 6** of this report.

4.8.2 Species credits

Species credit requirements have been calculated for *Pomaderris brunnea*, Koala, Squirrel Glider, Cumberland Plain Land Snail and Southern Myotis (for which 'breeding habitat' has been assumed to be present for this assessment in the '*land to be certified'* and '*land subject to conservation measures'* as outlined in **Section 2.2**.

A total of **4,985** species credits are required for impacts to *Pomaderris brunnea*, Koala, Squirrel Glider, Cumberland Plain Land Snail and Southern Myotis. The land proposed for conservation measures will generate **5,572** species credits as shown in Table 17. The deficit of Koala, Squirrel Glider and Southern Myotis credits will be met by the purchase of additional credits from registered biobank sites outside of the BCAA, or Biodiversity Stewardship sites or the BCT (subject to an assessment of credit equivalency, as outlined in **Section 6** of this report. Lendlease (Credit ID holder 650) already holds 99 Koala credits from the Campbelltown Koala population purchased from the Noorumba Reserve Biobank site (BA239).

Table 16: Ecosystem credits 'required' for impacts and 'generated' by proposed conservation measures within the BCAA

			Credits required			Credits created			Credits Created	
Veg Zone	Vegetation	Area BCAA (ha)	Area certified (ha)	Credits required	Credits Req/ha	Area Offset (ha)	100% Measure	Credits Gen. / ha	90% Measure	Credit surplus / deficit
1	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	**24.45**	5.31	75	14.12	17.89	178	9.96	11	70
2	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	**0.58**	0.52	7	13.46	0.06	1	16.67	0	
3	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	**2.42**	2.17	41	18.89	0.25	3	12.00	0	
4	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	**28.60**	8.99	195	21.69	12.29	161	13.06	8	35
5	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	**4.50**	3.84	74	19.27	0.35	5	14.29	0	
6	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	**3.11**	0.00	0	11.11	2.56	28	10.94	0	
7	Cleared - restore to SPW	**10.75**	0.00	0	0.00	9.53	99	10.44	3	
8	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	**2.42**	0.03	1	33.33	2.38	30	12.61	0	130
9	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	**2.59**	0.08	2	20.00	2.09	27	12.92	0	
10	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	**3.73**	1.11	15	13.29	2.57	26	10.12	0	
11	Cleared - restore to SHW	**6.21**	0.00	0	0.00	6.21	64	10.31	0	
12	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	**8.33**	0.38	12	32.73	7.69	84	10.95	0	72
13	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	**104.45**	8.07	327	40.52	87.90	949	10.80	1	222
14	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	**10.18**	0.91	21	23.08	9.05	107	11.78	0	
15	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	**57.65**	37.79	737	19.50	11.47	155	13.47	6	
16	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	**6.85**	4.99	85	17.03	1.19	14	11.76	0	
17	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the	**5.07**	1.55	32	20.48	3.43	39	11.34	0	

			Credits required			Credits created			Credits Created	
Veg Zone	Vegetation	Area BCAA (ha)	Area certified (ha)	Credits required	Credits Req/ha	Area Offset (ha)	100% Measure	Credits Gen. / ha	90% Measure	Credit surplus / deficit
	Cumberland Plain, Sydney Basin Bioregion									
18	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	**0.67**	0.00	0	0.00	0.67	7	10.45	0	
19	Cleared - restore to SSTF	**14.09**	0.00	0	0.00	14.09	147	10.43	0	
	Sub-total - Vegetation	**296.65**	**75.74**	**1,623**	**22.44**	**191.67**	**2,123**	**11.08**	**29**	**529**

Table 17: Species credits 'required' for impacts and 'generated' by proposed conservation measures within the BCAA

		Credits required			Credits created				
Species	Area BCAA (ha)	Area certified (ha)	Credits required	Credits Req/ha	Offset Area (ha)	100% Measure	Credits Gen. / ha	90% Measure	Credit surplus / deficit
CPLS	217.81	35.62	476	13.35	168.55	1,011	6.00	7	542
Southern Myotis	159.99	43.68	978	22.21	125.11	751	6.00	1	-226
Koala***	282.21	73.81	1,942	26.32	194.46	1,167	6.00	8	-767
Squirrel Glider	285.25	67.55	1,501	22.22	194.44	1,167	6.00	14	-320
Pomaderris brunnea	253	6	88	14.70	246	1,476	6.00	0	1,388
Total			**4,985**			**5,542**		**30**	**617**

***Of the 73.81 ha of Koala habitat to be impacted, 15.03 ha is to high quality habitat (intact vegetation with a high proportion of preferred Koala feed trees) and of this 15 ha, 9.0 ha is temporary and/or partial impacts (basins to be re-landscaped and APZs), 14,44 and 44,34 ha is to moderate and low quality habitat respectively (modified/thinned vegetation/scattered paddock trees with a low abundance of PKFTs (areas dominated by regrowth Ironbark's).

5. Red Flag Variation Request

5.1 Impact on Red Flagged Areas

The Biodiversity Assessment Report for the ecological values within the BCAA (**Section 2**) identified '*red flags*' as defined by the BCAM, some of which would be impacted by the land proposed for biocertification. The BCAM requires each of the criteria set out in Section 2.4 of the BCAM to be addressed in order for the Director-General to be satisfied that impacts to these '*red flags*' are able to be offset. This section addresses this requirement.

A red flag is triggered under the BCAM when there is an impact on any of the following:

- a vegetation type >70% cleared in the CMA for which it is mapped (not in 'low condition')
- a CEEC or EEC listed under the TSC Act or EPBC Act (not in 'low condition')
- a threatened species that cannot withstand further loss
  - the species is naturally very rare, is critically endangered, has few populations or is a restricted distribution
  - the species or its habitat needs are poorly known
- areas of vegetation recognised as having regional or state biodiversity conservation significance (including vegetation within a riparian buffer 20 m either side of a minor creek, 30 m either side of a minor river or major creek, or 40 m either side of a major river, as defined by Appendix 1 of the BCAM).

The Biodiversity Certification Operational Manual (OEH 2015c) states that each red flag area within the proposed biodiversity certification area should be numbered and listed in a table and shown on a map. Each red flag area impacted will require a separate red flag variation request unless the responses are the same for each entity, i.e. vegetation type is the same, patches are of similar condition, patches have the same connectivity etc.

Four of the BVTs recorded within the BCAA are listed EECs or CEECs

- 'HN526 *Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin* Bioregion' is equivalent to 'River-Flat Eucalypt Forest on the Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregion' (RFEF), which is an EEC listed on the schedules of the TSC Act,
- 'HN528 *Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion*' and 'HN529 *Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion*' are equivalent to 'Cumberland Plain Woodland in the Sydney Basin Bioregion' (CPW) - which is a CEECs listed on the schedules of the TSC Act and EPBC Act
- 'HN556 *Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion'* is equivalent to 'Shale Sandstone Transition Forest in the Sydney Basin Bioregion' (SSTF), which is a CEECs listed on the schedules of the TSC Act and EPBC Act

If these EECs are in 'moderate to good' biometric condition (as defined by the BCAM, i.e. they have a site value score greater than 34/100), they are considered to be 'red flag' vegetation'.

Five out of 19 mapped vegetation zones in the BCAA are in moderate to good condition and have a site value score greater than 34/100 (HN528 Zone 4, HN529 Zone 8, HN556 Zones 13, 14, & 17) (**Table 19** *and Figures 28, 29 and 30*). The BCAA contains 150.72 ha of red flag vegetation of which 19.55 ha will be impacted in these five zones and 115.79 ha will be protected by proposed conservation measures. There are no other vegetation types >70% cleared in the Hawkesbury Nepean CMA within the BCAA.

In addition to the red flagged vegetation, there is 37.97 ha of vegetation within the riparian buffers of a minor river (Nepean River) and major creek (Nepean, Menangle and Woodhouse Creeks) within the BCAA of which 4.31 ha will be impacted by two creek crossings (Woodhouse and Nepean Creeks), the Nepean River Park open space areas and a proposed bush walking track (**Table 18** and Figure 29).

In addition, one flora species recorded within the BCAA (*Pomaderris brunnea*) is identified in the Threatened Species Profile Database as a species which cannot withstand further loss in the Hawkesbury Nepean CMA. The threatened fauna species recorded within the BCAA are all identified as species which 'can withstand further loss' within the database and are therefore not regarded as red flag areas (Figure 15)**.**

The distribution of red flag vegetation on land proposed for biodiversity certification is discussed below for each of the red flag variation criteria outlined in section 2.4 of the BCAM, and are shown in Figure 28, along with red flag vegetation that will be conserved or retained.

Table 18: Impacts to vegetation in areas defined as having regional or state biodiversity links (Riparian buffers)

Riparian Buffer	Area of native vegetation (ha)			
	Impacted	**Conserved**	**Retained**	**Total**
30m either side of minor river	2.44	9.94	0.01	12.39
20m either side of minor creek	1.87	19.68	4.03	25.58
Total	**4.31**	**29.62**	**4.04**	**37.97**

Table 19: Impacts to red flagged vegetation

Veg Zone	Vegetation Type	BVT ID	Ancillary	BioMetric Condition	Current Site Value Score	Red Flag area within BCAA	Red Flag area to be impacted	Red Flag area to be conserved	Red flag area to be retained	Red flag area within EEC buffers
4	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	Pasture Improved / grazed	Mod-Good	39	**28.60**	8.99	12.94	6.40	0.27
8	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	Good	Mod-Good	59	**2.42**	0.03	2.38	0.00	0.01
13	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Good	Mod-Good	83	**104.45**	8.07	87.96	5.85	2.57
14	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Thinned/Shrubby	Mod-Good	41	**10.18**	0.91	9.08	0.07	0.13
17	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	DNS	Mod-Good	35	**5.07**	1.55	3.43	0.09	0.00
	Sub-total - Vegetation					**150.72**	**19.55**	**115.79**	**12.41**	**2.98**

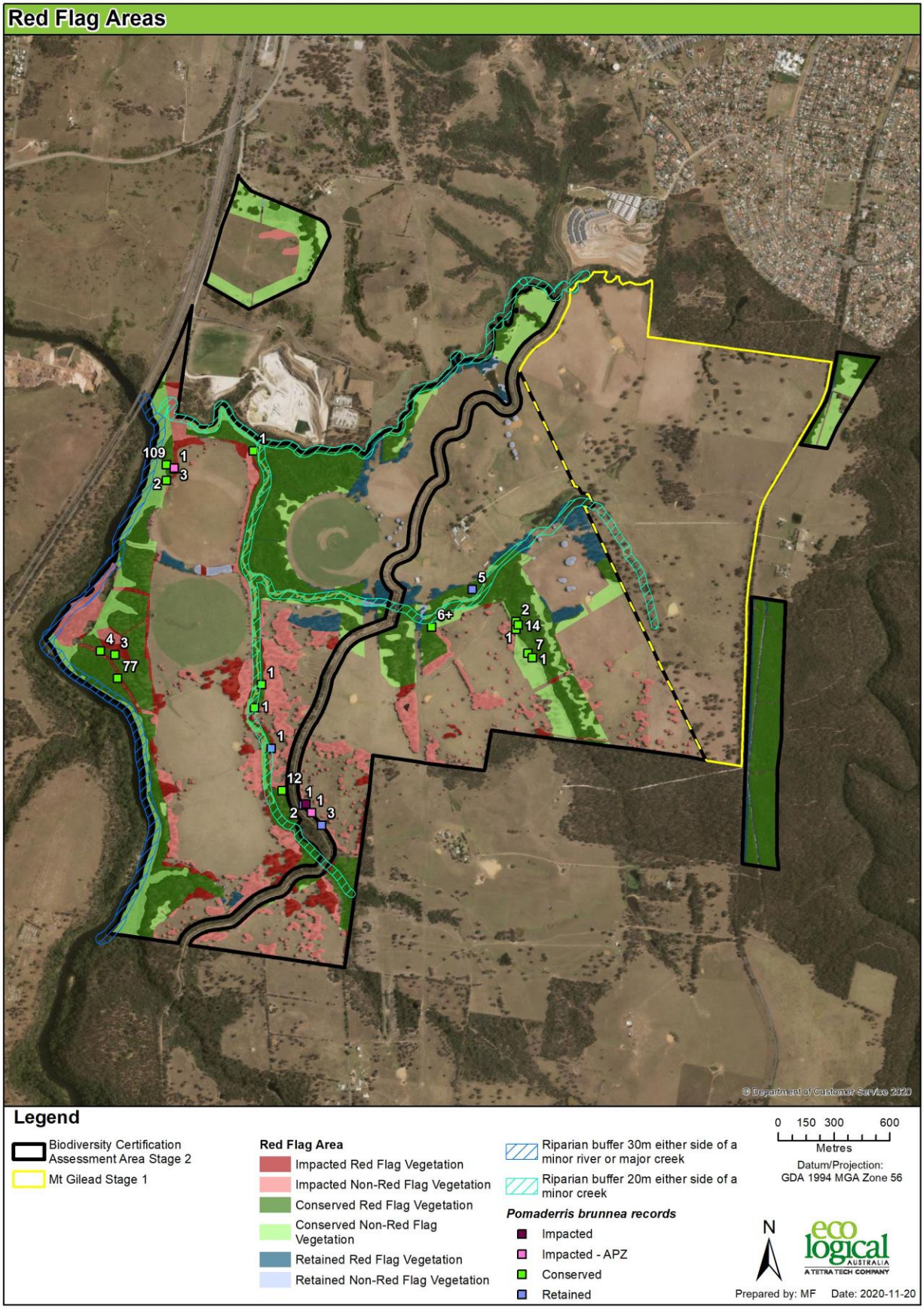

Figure 28: Impacted, conserved and retained red flag vegetation, species and areas of regional or state biodiversity conservation significance

5.2 Red Flag Variation Criteria

The presence of Red Flags within the proposed development area means that Biocertification of the land cannot be conferred unless a red flag variation is granted by the Director General of the OEH. An application for a red flag variation must satisfactorily address the criteria in Section 2.4 of the BCAM (DECCW 2011a) for a proposal to be regarded as improving or maintaining biodiversity values.

The following criteria must be addressed for a vegetation type which is greater than 70% cleared or is a critically endangered or endangered ecological community:

1. Feasibility of options to avoid impacts on red flag area(s) where biodiversity certification is conferred (Section 2.4.1 of the BCAM)
2. Viability must be low or not viable (Section 2.4.2.1 of the BCAM)
3. Contribution to regional biodiversity values must be low (Section 2.4.2.2 of the BCAM).

The following criteria, as outlined in Section 2.4.3 of the BCAM, must be addressed when the red flag area contains a threatened species that cannot withstand further loss:

1. Viability of the red flag area must be low or not viable (Section 2.4.3.1 of the BCAM)
2. Contribution to regional biodiversity values must be low (Section 2.4.3.2 of the BCAM).

The following criteria, as outlined in Section 2.4.4 of the BCAM must be addressed for areas with regional or state biodiversity conservation significance:

a. The width of a riparian buffer with regional or state biodiversity significance must not be substantially reduced
b. The ecosystem functioning of a state or regional biodiversity link, considering migration, colonisation and interbreeding of plants and animals between two or more larger areas of habitat, must not be substantially impacted,
c. The water quality of a major or river, major or minor creek, or a listed SEPP 14 wetland must not be significantly impacted.

The following sections provide the information required for OEH/DPIE to assess a red flag variation for the impacts to:

- 8.99 ha of HN528
- 0.03 ha of HN529
- 10.53 ha of HN556
- 4.31 ha of vegetation in riparian buffers; and
- Up to 6 individuals of *Pomaderris brunnea.*

5.2.1 Avoiding and Minimising Impacts on Red Flag Areas (Criteria 2.4.1 of the BCAM)

The Director General must be satisfied that the feasibility of options to avoid impacts on red flag areas has been considered in the application for biodiversity certification. An application for biodiversity certification can address this requirement by demonstrating that:

a) all reasonable measures have been taken to avoid adverse impacts on the red flag areas and to reduce impacts of development on vegetation remaining within the biodiversity certification area

b) appropriate conservation management arrangements cannot be established over the red flag area given its current ownership, status under a regional plan and zoning and the likely costs of future management.

a) All reasonable measures to avoid adverse impacts

The land within the BCAA has been identified by the DPE as a Priority Precinct in the Greater Macarthur Growth Area (DPE 2015 and 2018). Following an assessment of the biodiversity values of the BCAA and surrounding lands between 2015 and 2017, Lendlease , have developed a Master Plan that is consistent with the Greater Macarthur Structure Plan and is sympathetic to biodiversity values. The Master Plan shown in Figure 4has been developed through numerous iterations to avoid the higher quality vegetation/red flag areas and retain and enhance wildlife corridors, in particular for Koala and Squirrel Glider. As a result of these consideration of options, impacts to 149.83 ha of red flag areas have been avoided with 138.73 ha of this to be permanently protected in proposed biobank sites.

b) Appropriate conservation management arrangements cannot be established over the red flag area given its current ownership, status under a regional plan and zoning, and the likely costs of future management

The BCAA is private land, currently zoned RU2 Rural Landscape in Campbelltown LEP 2015 and is currently used primarily for agricultural production – cattle grazing/horse agistment and some cropping. Under its current zoning and use, the land is not required to be actively managed for conservation.

5.2.2 Assessment criteria for red flag areas that contain CEECs (Criteria 2.4.2 of the BCAM)

Viability (Criteria 2.4.2.1 of the BCAM)

The BCAM states that:

The application for biodiversity certification must demonstrate to the satisfaction of the Director General that the viability of biodiversity values in the red flag area is low or not viable.

For the purpose of the methodology, viability is defined as the ability of biodiversity values at a site to persist for many generations or long time periods. The ecological viability of a site and its biodiversity values depend on its:

- *condition*
- *the area of the patch of native vegetation and its isolation*
- *current or proposed tenure and zoning under any relevant planning instrument*
- *current and proposed surrounding land use*
- *whether mechanisms and funds are available to manage low viability sites such that their viability is improved over time*

In making an assessment that the viability of biodiversity values in the red flag area is low or not viable, the Director General must be satisfied that one of the following factors applies:

a) The current or future uses of land surrounding the red flag area where biodiversity certification is to be conferred reduce its viability or make it unviable. Relatively small areas of native vegetation surrounded or largely surrounded by intense land uses, such as urban development, can be unviable or have low viability because of disturbances from urbanisation, including edge effects; or

b) The size and connectedness of the vegetation in the red flag area where biodiversity certification is to be conferred to other native vegetation is insufficient to maintain its viability. Relatively small areas of isolated native vegetation can be unviable or have low viability; or

c) The condition of native vegetation in the red flag area where biodiversity certification is to be conferred is substantially degraded, resulting in loss of or reduced viability. Native vegetation in degraded condition can be unviable or have low viability. 'Degraded condition' means substantially outside benchmark for many of the vegetation condition variables as listed in Table 1 of the methodology (s.3.6.2), without the vegetation meeting the definition of low condition set out in section 2.3. Vegetation that is substantially outside benchmark due to a recent disturbance such as a fire, flood or prolonged drought is not considered degraded for the purposes of the methodology; or

d) The area of a vegetation type in a red flag area on land where biodiversity certification is conferred is minor relative to the area containing that vegetation type on land subject to proposed conservation measures.

Impacted Red Flag vegetation within the BCAA has been grouped into five Patches based on the Vegetation Zone and site value scores. Each resulting patch has then been assessed against the four a-d viability criteria in Section 2.4.2.1 of the BCAM. Different criteria/factors (a, b, c or d) are considered in assessing the viability of the separate CEEC red flag areas/patches. Not all CEEC red flag areas are discussed under the different factors given viability is dependent on a number of factors, with some factors at play for some CEEC red flag areas and not others. However, each CEEC red flag area is discussed under at least one of the factors to demonstrate that viability of biodiversity values in red flag areas is low or not viable. **Table 20** summarises the criteria that are satisfied by the CEEC red flag area, with detail provided under each criteria, whilst the distribution of red flagged vegetation across the BCAA is shown in Figures 30 & 31.

Table 20: Red Flag Patches and Variation Criteria satisfied

CEEC red flag areas	Section 2.3.2.2. criteria satisfied
HN528 Veg Zone 4 (Patch 1) 8.99 ha with a sv score of 39 Refer to **Figure 29**	A - current and/or future proposed land use surrounding red flag area reduces viability B – Size and connectedness to other vegetation C - Red flag area is substantially degraded
HN529 Veg Zone 8 (Patch 2) 0.03 ha with a sv score of 59 Refer to **Figure 29**	A - current and/or future proposed land use surrounding red flag area reduces viability B – Size and connectedness to other vegetation
HN556 Veg Zone 13 (Patch 3) 8.07 ha with a sv score of 83	D – Area of red flag vegetation impacted is minor relative to the area subject to conservation measures

CEEC red flag areas	Section 2.3.2.2. criteria satisfied
Refer to **Figure 30**	
HN556 Veg Zone 14 (Patch 4) 0.91 ha with a sv score of 41 Refer to **Figure 30**	A - current and/or future proposed land use surrounding red flag area reduces viability C - red flag area is substantially degraded
HN556 Veg Zone 17 (Patch 5) 1.55 ha with a sv score of 35 Refer to **Figure 30**	A - current and/or future proposed land use surrounding red flag area reduces viability C - red flag area is substantially degraded

a) Current or Future Land Use surrounding the red flag areas/patches 1, 2, 4 & 5

Lands surrounding these red flag areas are currently used for grazing and irrigation. This long and ongoing history of grazing and associated rural activities (pasture improvement, tilling, fire wood and post collection) have significantly reduced the viability of CPW and SSTF in these areas (in particular Patches 1, 4 and 5 which have site values scores of ≤41 and thus meet the definition of degraded – see Criteria (c).

The red flag areas generally occur as small patches scattered across large open areas of exotic grassland, cropped and/or grazed land with limited connectivity to larger patches in higher condition. Current land use is likely to result in on-going long-term impacts on the edges of the patches.

It is considered that red flag Patches 1, 2, 4 and 5 meet this criterion.

b) Size and connectedness – Patches 1 and 2

Red Flag Patches 1 and 2 are 8.99 ha and 0.03 ha of SPW and SHW respectively. The 8.99 ha of Patch 1 comprises 13 smaller patches ranging in areas from 0.16 to 2.04 ha. Each of these smaller patches is either isolated/fragmented from other vegetation and/or adjacent to degraded patches of SSTF.

The 0.03 ha of Patch 2 comprises five smaller patches on the edge of other isolated patches of around 0.5 to 1 ha.

It is considered that these small patches have limited viability under current management regimes and permitted land uses and therefore Patches 1 and 2 meet this criterion.

c) Vegetation substantially outside of benchmark condition – Patches 1, 4 & 5

Patches 1, 4 & 5 are considered to be 'degraded' despite their being in biometric 'moderate-good' condition (site vale score > 34/100) as the site value scores for vegetation within these patches are all at the low end of the moderate to good range (i.e. site values scores of 39, 41 and 35 respectively which are very close to a site value score of 34 which is considered low condition and therefore not red flagged).

'Degraded', as defined by the BCAM means "*many of the vegetation condition variables are significantly outside benchmark*" (score of "0" or "1").

Of the 10 attributes measured in the 14 plots within Patch 1 (Veg Zone 4 – refer to **Appendix J – Plot data**) five, or 50% of the 10 attributes had a current score of "0" or "1" (Native mid-storey cover, Native

ground cover grasses, No. of trees with hollows, length of fallen logs and exotic plant cover). Of the remaining five attributes, four have a score of "2" (Native plant richness, ground cover shrubs, ground cover other and over-storey regeneration). The only attribute with a score within benchmark, "3", was native over-storey. This reflects the description of this zone as being remnant tree canopy, lacking a mid-storey with a highly modified ground cover resulting from generations of pasture improvement and grazing.

It is considered that Patch 1 (Veg zone 4) meets this criterion as substantially degraded.

Of the 10 attributes measured in the 10 plots within Patch 4 (Veg Zone 14 – refer to **Appendix J – Plot data**) five of the 10 attributes had a current score of "0" or "1" (Native mid-storey cover, native ground cover grasses, trees with hollows, length of fallen logs and over-storey regeneration). Of the remaining five attributes, three have a score of "2". The only attributes with a score within benchmark, "3", was native plant species richness and native ground cover shrubs where 2 of the 10 plots had a high reading for shrubs. This reflects the description of this zone as being remnant tree canopy, lacking a mid-storey with a highly modified ground cover resulting from generations of pasture improvement and grazing. The overall site condition score for the zone was 41 which is marginally above the 'low condition' threshold of 34

It is considered that Patch 4 (Veg zone 14) meets this criterion as substantially degraded.

Of the 10 attributes measured in the two plots within Patch 5 (Veg Zone 17 – refer to **Appendix J – Plot data**) six of the 10 attributes had a current score of "0" or "1" (Native over-storey and mid-story cover, native ground cover other, trees with hollows, length of fallen logs and over-storey regeneration). Of the remaining four attributes, only three are within benchmark, "3" (native plant species, ground cover grasses and shrubs), but the overall site condition score for the zone was only 35 which is just above the 'low condition' threshold of 34.

It is considered that Patch 5 (Veg zone 17) meets this criterion as substantially degraded.

d) Relative area of red flag vegetation impacted is low compared to area within land subject to conservation measures – Patch 3

There are 8.07 ha of impact to red flag area/Patch 3, which whilst in high condition (site value score 83), is low, relative to the proportion of this vegetation zone in land proposed for conservation measures (87.96 ha or 9.1%). Of the 8.07 ha of impact, 2.21 ha is within APZ zones and 0.31 is a bush walking path up to a maximum of 1.5m wide.

It is considered that Patch 3 (Veg zone 13) meets this criterion.

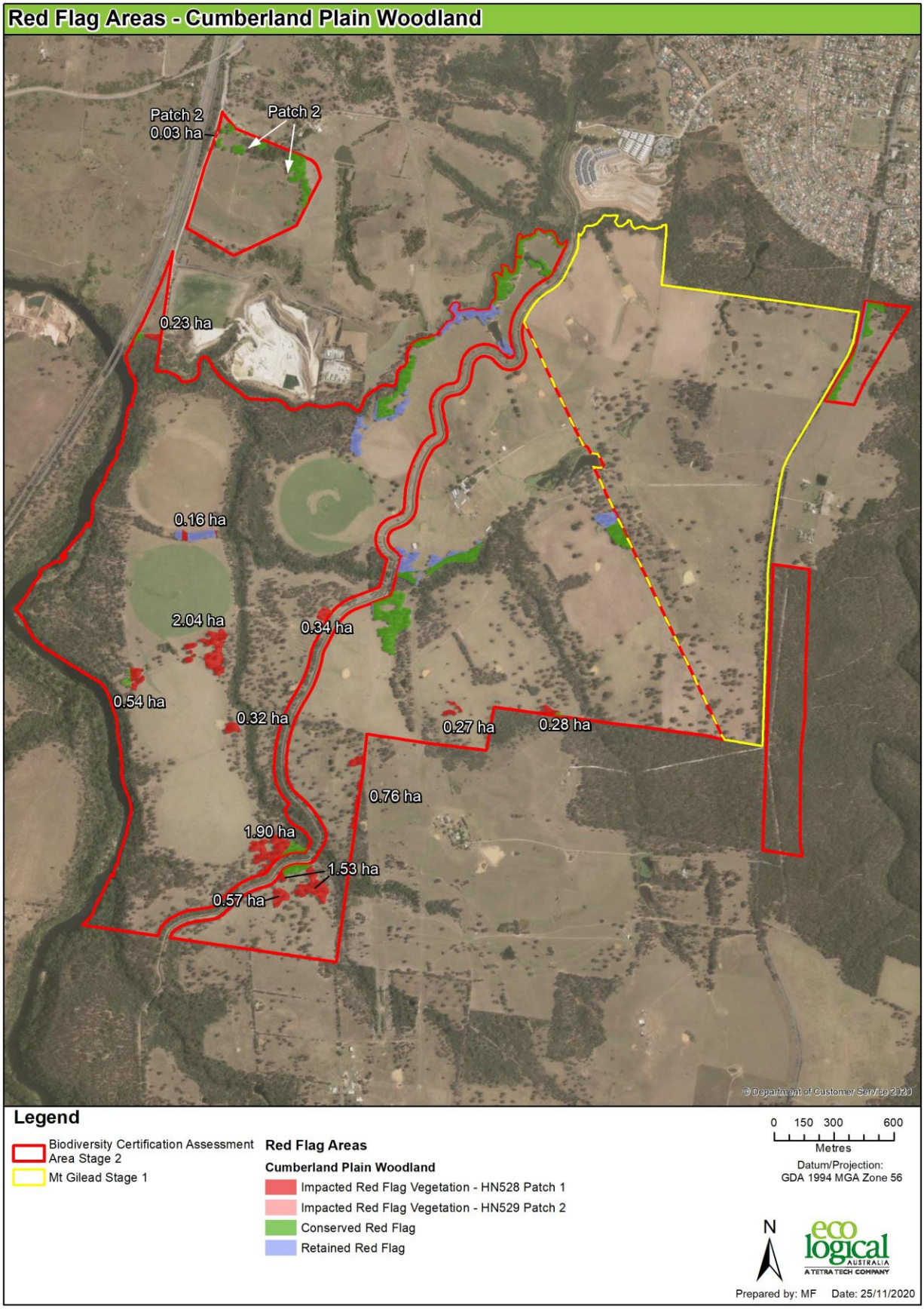

Figure 29: Distribution of impacted and protected Red Flag vegetation Patches 1 and 2 (CPW) within the BCAA

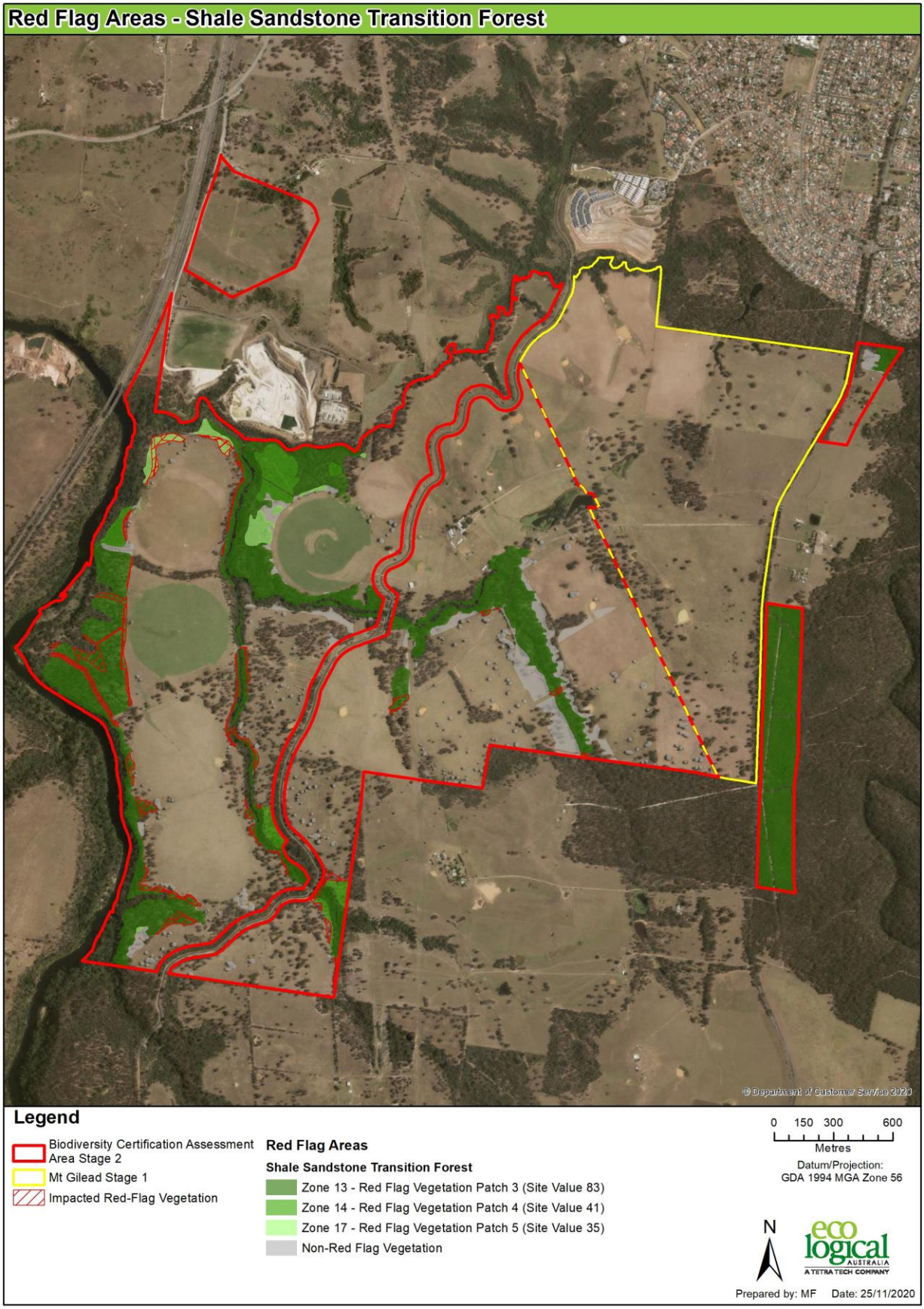

Figure 30: Distribution of impacted and protected Red Flag vegetation Patches 3, 4 and 5 (SSTF) within the BCAA

Contribution to Regional Biodiversity Values (Criteria 2.4.2.2 of the BCAM)

The BCAM states that:

> *The application for biodiversity certification must demonstrate to the satisfaction of the Director General* that *the red flag area on land proposed for biodiversity certification makes a low contribution to regional biodiversity values.*
>
> *In making an assessment that the contribution of the red flag area to regional biodiversity values is low, the Director General must consider the following factors for each vegetation type or critically endangered or endangered ecological community regarded as a red flag area:*
>
> *a) relative abundance: that the vegetation type or critically endangered or endangered ecological community comprising the red flag area is relatively abundant in the region; and*
>
> *b) percent remaining is high: that the percent remaining of the vegetation type or critically endangered or endangered ecological community comprising the red flag area is relatively high in the region; and*
>
> *c) percent native vegetation (by area) remaining is high: that the percent remaining of all native vegetation cover in the region is relatively high.*
>
> *'Region' for the purposes of section 2.4.2.2 means the CMA subregion in which the red flag area is located and any adjoining CMA subregions.*

The contribution to regional biodiversity values was assessed for the red flagged CPW and SSTF in the BCAA, using regional datasets where available. Under the BCAM the 'region' is defined as both the CMA subregion where the red flag area is located (in this case the Cumberland subregion of the Hawkesbury Nepean CMA) and adjoining CMA subregions: the Cumberland (Sydney Metro), Burragorang, Pittwater, Sydney Cataract (Hawkesbury/Nepean), Sydney Cataract (Sydney Metro), Wollemi, and Yengo CMA subregions as shown in Figure 31.

The use of regional vegetation datasets in this assessment, while the best data currently available, does have limitations. The data in some cases is several years old and therefore the extant mapping may require revision.

In addition, most regional vegetation mapping products only map patches greater than a minimum size (for example 0.5 ha) and generally only map vegetation in reasonably good condition. It is highly likely that smaller patches of the red flag vegetation type exist in the relevant regions, however have not been included in this assessment as the patches are too small to map, or the condition is disturbed and therefore has not been mapped.

Information on the contribution to regional biodiversity values, including an assessment of the relative abundance of the red flagged vegetation type, the percent remaining of the vegetation type, and percent native vegetation remaining in the region, is provided below.

a) Relative Abundance

The first measure for the contribution to regional biodiversity values criteria is a measure of relative abundance of the red flagged vegetation types in the 'region'.

Analysis was conducted into the relative abundance of the red flagged vegetation types across the entire 'region'. The associated data layers that were assessed included:

- Sub CMA Cumberland and Yengo (Hawkesbury Nepean) (Cumberland Plain western Sydney vegetation mapping; NPWS 2002);
- Sub CMA Cumberland (Sydney Metro) (Cumberland Plain western Sydney vegetation mapping; NPWS 2002);
- Sub CMA Pittwater (Cumberland Plain western Sydney vegetation mapping; NPWS 2002);
- Sub CMA Burragorang and Wollemi (Hawkesbury-Nepean) (Native Vegetation of the Warragamba Special Area; NPWS 2003a); and
- Sub CMA Sydney Cataract (Hawkesbury-Nepean and Sydney Metro) (Native Vegetation of the Woronora, O'Hares and Metropolitan Catchments; NPWS 2003b).

ELA is confident that the data used capture the majority of the BVTs HN528 SPW, HN529 SHW and HN556 SSTF as the extent of these BVTs are restricted to the 'region' as defined by the BCAM and is largely incorporated into the mapping used. The results of the analysis can be seen in **Tables 21 & 21** and Figures 32 and 33.

The results for the relative abundance assessment within the region for Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion re summarised below:

- 14,350 ha (of which 5,707 ha is in condition class A, B or C) is recorded within the Cumberland (Hawkesbury Nepean) sub CMA, in which the BCAA is located. The clearing of 8.99 ha of red flagged SPW vegetation represents 0.062% of the total extent of the BVT in the Cumberland (Hawkesbury Nepean) sub CMA and 0.16% in condition A, B or C.

- 17,839 ha (of which 6,745 ha is in condition class A, B or C) is recorded within the region in which the BCAA is located, 8.99 ha to be impacted by this proposal represents 0.050% of the extant 'Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion' or 0.13% of the extent of condition class A, B or C in the region.

The results for the relative abundance assessment within the region for Grey-Box – Forest Red Gum grassy woodlands on shale of the Southern Cumberland Plain, Sydney Basin Bioregion is summarised below:

- 9,958 ha (of which 4,309 ha is in condition class A, B or C) is recorded within the region in which the BCAA is located, 0.03 ha to be impacted by this proposal represents 0.0003% of the extant 'Grey-Box – Forest Red Gum grassy woodlands on shale of the Southern Cumberland Plain, Sydney Basin Bioregion' or 0.00069% of the extent of condition class A, B or C in the region.

The results for the relative abundance assessment within the region for '*Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion*' are summarised below:

- 11,555 ha (of which 5,886 ha is in condition class A, B or C) is recorded within the Cumberland (Hawkesbury Nepean) sub CMA, in which the BCAA is located. The clearing of 10.53 ha of red flagged SSTF vegetation represents 0.09% of the total extent of the BVT in the Cumberland (Hawkesbury Nepean) sub CMA and 0.178% in condition A, B or C.

- 21,769 ha (of which 9,949 ha is in condition class A, B or C) is recorded within the region in which the BCAA is located, 10.53 ha to be impacted by this proposal represents 0.048% of the extant '*Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges*

of the Cumberland Plain, Sydney Basin Bioregion' or 0.106% of the extent of condition class A, B or C in the region.

The above information indicates that the impact to the red flagged vegetation/CEECs from the proposal is 'relatively minor' when compared to the amount mapped in the analysed regions.

Table 21: Relative abundance of red flag CPW (SPW&SHW) vegetation in surrounding regions

Biometric vegetation type	Area impacted (ha)	Vegetation condition#	Area in Sub CMA (ha)								Total area in sub CMAs (ha)
			Cumberland (HN)	Cumberland (SM)	Burragorang	Pittwater	Sydney Cataract (HN)	Sydney Cataract (SM)	Wollemi	Yengo	
HN528 Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion	8.99	ABC	5,707	861	0.29	0	0	4	0	173	6,745
		Cmi & Txs	8,643	2,000	95	0	0	57	22	277	11,094
Total			**14,350**	**2,861**	**95.29**	**0**	**0**	**61**	**22**	**450**	**17,839**
HN529 Grey-Box – Forest Red Gum grassy woodlands on shale of the Southern Cumberland Plain, Sydney Basin Bioregion	0.03	ABC									4,309
		Cmi & Txs									5,649
Total			**14,350**	**2,861**	**95.29**	**0**	**0**	**61**	**22**	**450**	**9,958**

Table 22: Relative abundance of red flag SSTF vegetation in surrounding regions

Biometric vegetation type	Area impacted (ha)	Vegetation condition#	Area in Sub CMA (ha)								Total area in sub CMAs (ha)
			Cumberland (HN)	Cumberland (SM)	Burragorang	Pittwater	Sydney Cataract (HN)	Sydney Cataract (SM)	Wollemi	Yengo	
HN556 Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin	10.53	ABC	5,886	593	977	14	49	485	119	1,826	9,949
		Cmi & Txs	5,420	711	1,113	7	54	466	176	1,436	9,383
		Unknown	249	0	874	0	1,106	0	208	0	2,437
Total			**11,555**	**1,304**	**2,964**	**21**	**1,209**	**951**	**503**	**3,262**	**21,769**

Vegetation condition follows NPWS (2002) with A, B, C being patches >0.5 ha in area and canopy cover projection density (CCPD) > 10%. Cmi, Txs being patches > 0.5 ha and CCPD < 10%.

Figure 31: The BCAA within the 'Region' derived from adjacent CMA subregions

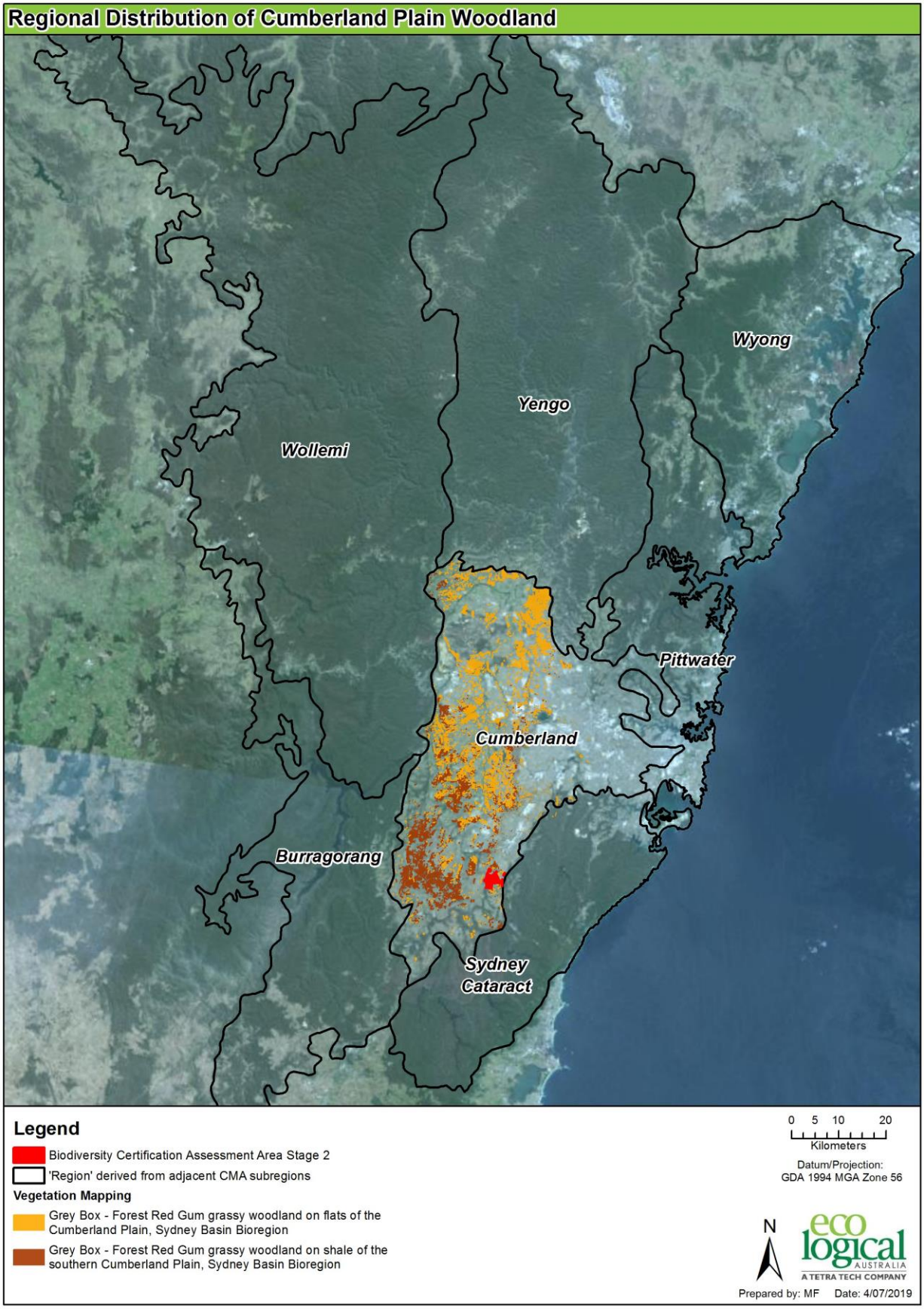

Figure 32: Regional distribution of red flag CPW vegetation

Figure 33: Regional distribution of red flag SSTF vegetation

b) Percent Remaining is high

There are few data sources available to determine the percent remaining of the vegetation type in the 'region'. While the database for BVTs (DECC 2008) has estimates for the percent remaining of each vegetation type, estimates are for entire CMAs, not for individual CMA subregions. Information at the subregion level is required to estimate the percent remaining of the vegetation type in the 'region' given the definition of 'region' includes the CMA subregion in which the BCAA occurs and any adjoining CMA subregions.

Given the lack of data sources to determine the '*percent remaining of the vegetation type in the 'region*', information on the percent remaining of the vegetation type was derived from the former National Parks and Wildlife Service's (NPWS) Cumberland Plain western Sydney vegetation mapping (NPWS 2002), Tozer et al. 2010 Native Vegetation of southeast NSW and the VIS database (OEH 2019). The results of the analysis are shown in **Table 23**.

It is noted that the mapping by NPWS (2002) does not included derived native grasslands in these percent remaining figures, which also meets the biometric condition 'moderate-good' definition or patches less than 0.5 ha in area.

The percent remaining of the red flag vegetation type in the region is not high.

Table 23: Percent remaining of each vegetation type/CEEC

Biometric vegetation type	Area impacted (ha)	% remaining in the Cumberland Plain (ABC condition) (NPWS 2002)	% remaining in the Cumberland Plain (ABC & Tx condition) (NPWS 2002)	Tozer et al. 2010	VIS Data base
HN528 Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion	8.99	7.7%	20.5%	5-25%	7%
HN529 Grey-Box – Forest Red Gum grassy woodlands on shale of the southern Cumberland Plain, Sydney Basin Bioregion	0.03	11.3%	27%	10-25%	12%
HN556 Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin	10.53	22.6%	44.0%	20-40%	20%

c) Percent Native Vegetation (by area) is high

The area of native vegetation was calculated for the region, being the Cumberland (Hawkesbury/Nepean (HN)), Cumberland (Sydney Metro (SM)), Wollemi, Burragorang, Sydney Cataract (HN), Sydney Cataract (SM), Pittwater and Yengo CMA subregions, is shown in **Table 24** and Figure 34. The OEH state-wide vegetation extent layer was used for the assessment (Keith and

Simpson 2006) and was intersected with the six CMA subregions to determine the proportion of each region with native vegetation cover.

Table 24: Native vegetation cover of CMA subregions

Native vegetation cover	Burragorang (ha)	Cumberland (ha)	Pittwater (ha)	Sydney Cataract (ha)	Wollemi (ha)	Yengo (ha)	Total (ha)
Cleared	41,567 (18%)	231,218 (84%)	44,079 (35%)	17,095 (12%)	21,260 (4%)	29,613 (9%)	384,831 (24%)
Vegetated	192,769 (82%)	44,200 (16%)	80,915 (65%)	131,254 (88%)	485,884 (96%)	293,273 (91%)	1,228,296 (76%)
Total	**234,335 (100%)**	**275,418 (100%)**	**124,994 (100%)**	**148,349 (100%)**	**507,144 (100%)**	**322,886 (100%)**	**1,613,127 (100%)**

In total, 76% (1,228,296 ha) of the assessment region contains native vegetation cover. The proportion of vegetation cover for five of the CMA subregions is high, with Burragorang containing 82%, Pittwater containing 65%, Sydney Cataract containing 88%, Wollemi containing 96% and Yengo containing 91% vegetation cover. As stated earlier, the vegetation types impacted are predominantly located on the Cumberland Plain, and therefore very little of the vegetation types are likely to extend into the surrounding five CMA subregions. This assessment demonstrates that the majority of the CMA subregions assessed are relatively well vegetated, however when considering the two Cumberland CMA subregions, which are 16% vegetated, native vegetation cover is low.

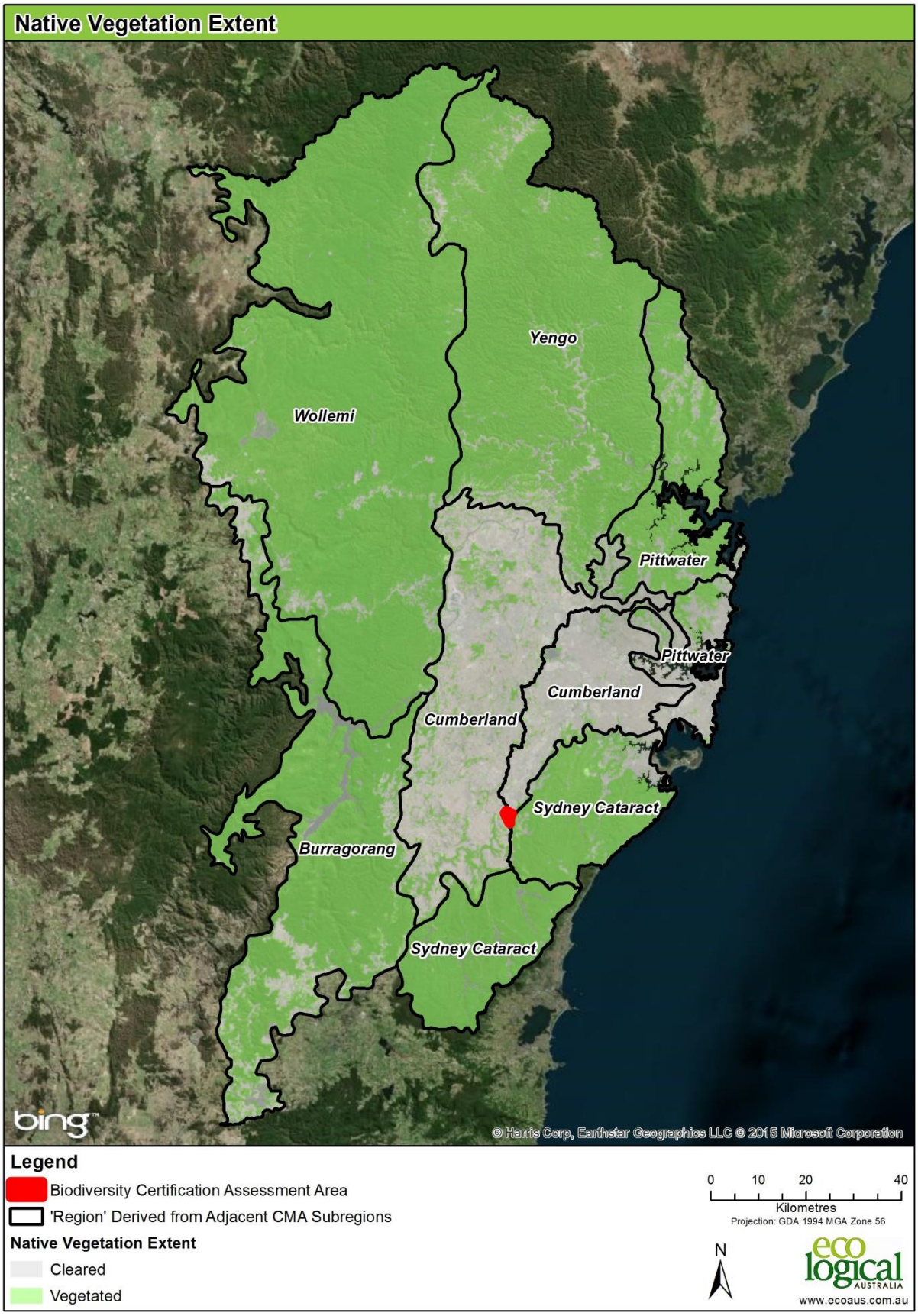

Figure 34: Native vegetation extent

5.2.3 Additional assessment criteria for threatened species that cannot withstand further loss (Criteria 2.4.3 of the BCAM)

Where the red flag area contains a threatened species that cannot withstand further loss as defined in section 2.3 of the methodology, the application for biodiversity certification must demonstrate to the satisfaction of the Director General that:

- the viability of the red flag area must be low or not viable in accordance with section 2.4.3.1
- the contribution to regional biodiversity values of the red flag area is low in accordance with section 2.4.3.2.

Pomaderris brunnea, and endangered shrub was observed at 10 locations across the BCAA with 253 plants recorded, and an additional five plants within the Sydney Water canal (Figure 15). The majority of plants were observed in areas of higher quality, ungrazed SSTF (vegetation Zone 13) or in steep, inaccessible areas along creek lines (Woodhouse and Nepean Creeks) and behind fencing (Nepean River and Sydney Water Canal) where domestic stock had limited access. Outside of these protected areas, plants showed signs of grazing pressure and where regeneration was occurring, plants were noticeably grazed/stunted.

Eight locations where the species was recorded, representing 246 individuals, are in proposed conservation areas and a further five individuals are within the Sydney Water Canal corridor and will not be impacted by the proposed development. Of the 6 plants impacted, 5 are within proposed APZ areas that will be managed as open space and it is likely that a number of these individuals and their habitat will be able to be retained during precinct planning. Only one plant will be directly impacted by road works.

Viability (Criteria 2.4.3.1 of the BCAM)

The BCAM states that:

> *The application for biodiversity certification must demonstrate to the satisfaction of the Director General that the viability of biodiversity values in the red flag area is low or not viable.*
> *For the purpose of the methodology, viability is defined as the ability of biodiversity values at a site to persist for many generations or long time periods. The ecological viability of a site and its biodiversity values depend on its:*

- *condition*
- *the area of the patch of native vegetation and its isolation*
- *current or proposed tenure and zoning under any relevant planning instrument*
- *current and proposed surrounding land use*
- *whether mechanisms and funds are available to manage low viability sites such that their viability is improved over time.*

In making an assessment that the viability of biodiversity values in the red flag area is low or not viable, the Director General must be satisfied that one of the following factors applies:

a. *The current or future uses of land surrounding the red flag area (species) reduce its viability or make it unviable. Relatively small areas of threatened species habitat surrounded or largely surrounded by intense land uses, such as urban development, can be unviable or have low viability because of disturbances from urbanisation, including edge effects.*
b. *The size and connectedness of vegetation in the red flag area to other native vegetation is insufficient to maintain its viability. Relatively small areas of isolated threatened species habitat can be unviable or have low viability.*

c. *The condition of native vegetation in the red flag area is substantially degraded resulting in loss of or reduced viability. Native vegetation in degraded condition can be unviable or have low viability. 'Degraded condition' means substantially outside benchmark for many of the vegetation condition variables as listed in Table 1 of the methodology (s.3.6.2), without the vegetation meeting the definition of low condition set out in section 2.3. Vegetation that is substantially outside benchmark due to a recent disturbance such as a fire, flood or prolonged drought is not considered degraded for the purposes of the methodology.*
d. *The area of a red flag area containing a threatened species on land where biodiversity certification is conferred is minor relative to the area containing that threatened species on land subject to proposed conservation measures.*

Viability Criteria 'a' and 'b' are satisfied

a) Current or Future Land Use surrounding the red flag areas

As indicated for the vegetation types assessment, the lands surrounding the red flag areas where *Pomaderris brunnea* will be impacted are currently used for grazing and irrigation. This long and on-going history of grazing and associated rural activities (pasture improvement, tilling, firewood and post collection) have significantly reduced the viability of *P. brunnea* and its habitat within the Mt Gilead BCAA. The majority of individuals observed were on the banks of steep and rocky creek lines that had protection from domestic stock. In areas where regeneration was occurring, the plants were visibly grazed and stunted.

Given the current and continuing land use, it is considered that the persistence of the 1 plants to be directly impacted is not viable, whereas the long term viability of the 246 plants and associated habitat areas proposed for conservation measures (167 ha of existing vegetation including 118 ha of SSTF will be enhanced through removal of grazing and active conservation management.

d) The area of the red flag area to be conferred is minor relative to the area proposed for conservation measures

The 6 *P. brunnea* plants to be impacted represent 2.4% of the proportion to be subject to proposed conservation measures (6 impacted and 246 to be conserved = 6/246 = 2.4%).

Contribution to regional biodiversity values is low

In NSW, *P. brunnea* is known from 24 scattered populations in five regions (Walcha, Wollemi and lower Colo, the Upper Hunter Valley, the Capertee Valley) and the Nepean River and associated tributaries around Camden and Bargo (NSW Scientific Committee 2014) (Figure 35 **and** Figure 36**)**.

The National Recovery Plan (Sutter 2011) reported a total of 600 plants in NSW and Bremner (in litt June 2012 to Scientific Committee) reported 190 plants in 10 of 18 sites in south-west Sydney.

The 258 plants recorded within the BCAA, an unknown number of plants in the Beulah Biobank site on the southern boundary of the BCAA and further plants recorded at 24 locations east of Appin Road as part of the CPCP (DPIE 2020), are in addition to these earlier estimates. Indeed, BioNet shows 25-30 locations (abundance unknown) between Camden, Camden Park, Elderslie, Menangle, Appin, Wilton, Pheasants Nest and Bargo and southern extensions at Mittagong and Wingello.

Whilst the conservation status of many of these population is unknown, and likely not secure, within the Gilead area, the population within the Beulah Biobank site is permanently protected for conservation, the plants east of Appin Road are within a proposed Biodiversity Stewardship site for the CPCP that will

form part of the proposed Georges River Koala Reserve, and a further 201 ha of habitat, known to contain at least 246 individuals, is proposed for permanent protection within the BCAA.

Based on available information, the population within the BCAA is significant in the context of the status of the species in the region, however the loss of up to 6 plants from within the BCAA will not affect the status of the species in the region. The loss of up to 6 plants from the BCAA is low relative to its abundance in the region, which includes the immediate locality of Gilead.

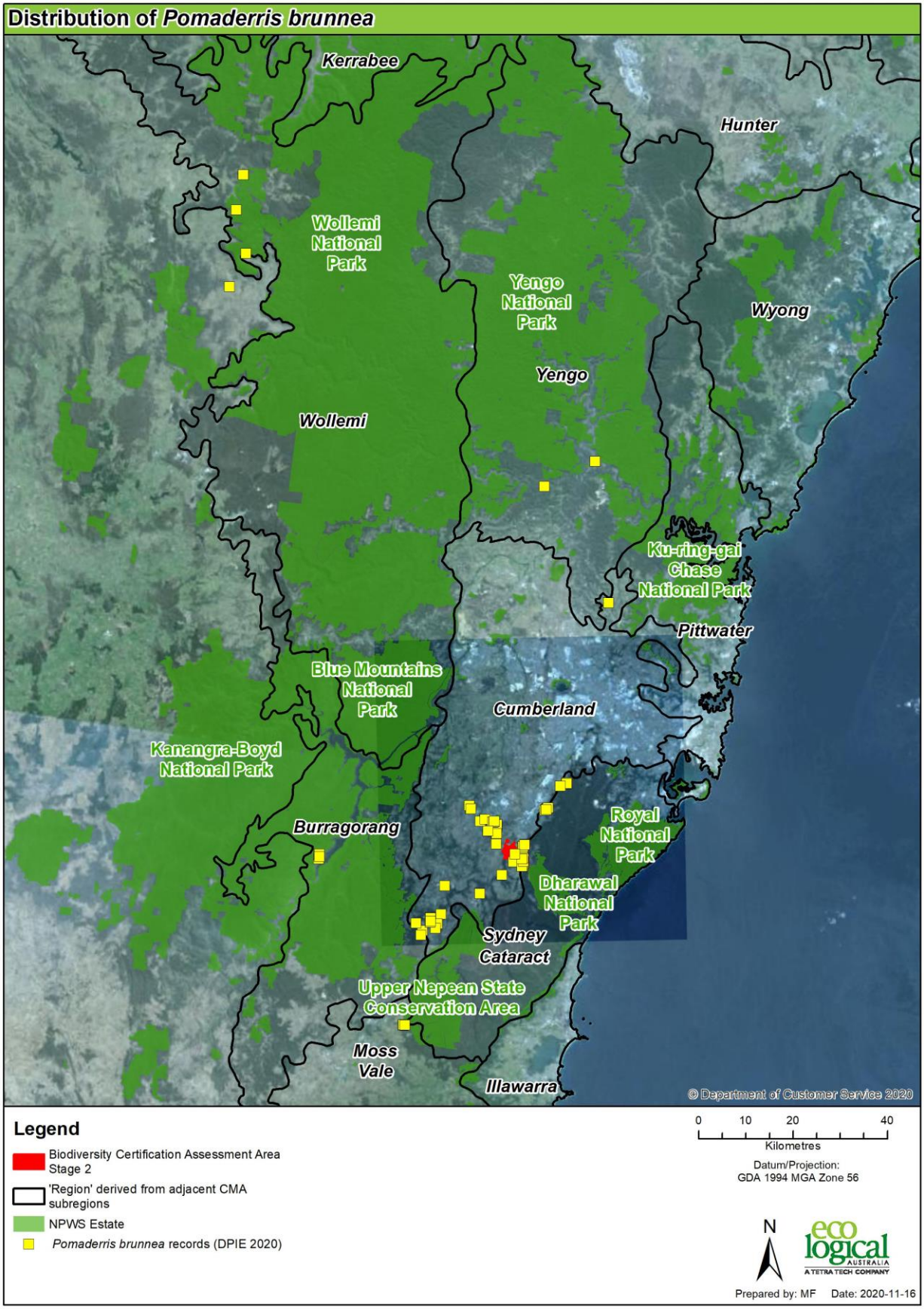

Figure 35: Regional distribution of *Pomaderris brunnea*

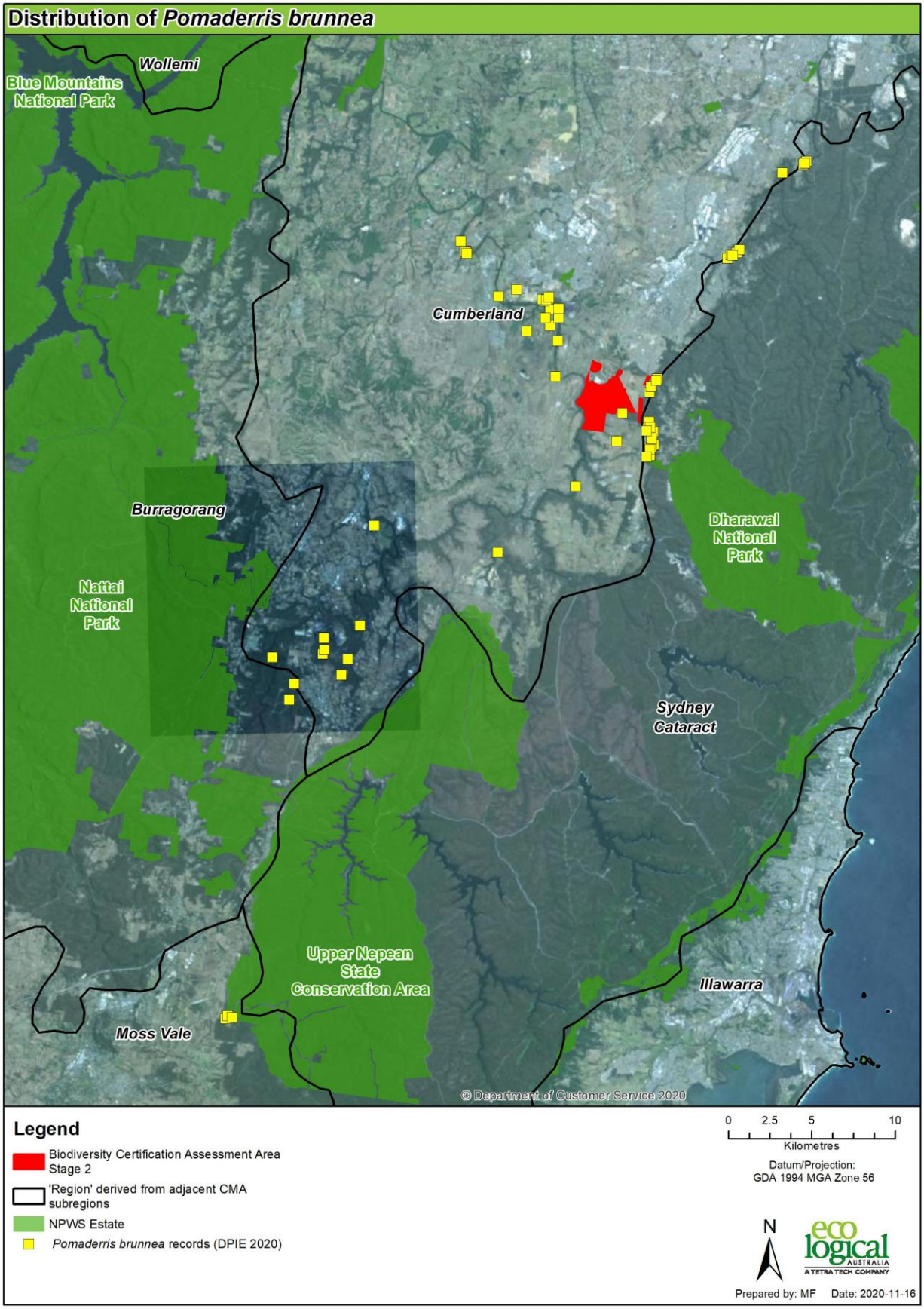

Figure 36: Regional (Camden to Bargo) distribution of *Pomaderris brunnea*

5.2.4 Additional Assessment criteria for areas with regional or state biodiversity conservation significance (Criteria 2.4.4 of the BCAM)

The following criteria, as outlined in Section 2.4.4 of the BCAM must be addressed for areas with regional or state biodiversity conservation significance:

a) The width of a riparian buffer with regional or state biodiversity significance must not be substantially reduced

b) The ecosystem functioning of a state or regional biodiversity link, considering migration, colonisation and interbreeding of plants and animals between two or more larger areas of habitat, must not be substantially impacted,

c) The water quality of a major or minor river, major or minor creek, or a listed SEPP 14 wetland must not be significantly impacted

Width of riparian buffer with regional or state biodiversity significance (Criteria 2.4.4a)

The width of a riparian buffer with regional or state biodiversity significance (i.e. the riparian buffers on major or minor creeks and rivers) must not be substantially reduced.

The land to be certified includes impacts for a major road (Public Transitway) crossing at the Nepean Creek and use of land in an old rehabilitated sand quarry on the banks of the Nepean River as open space.

Whilst the Nepean Creek crossing will impact some vegetation during construction, a bridge will extend over the creek and allow for continuous vegetation linkages along the length of the creek, the width of the riparian buffer will not be substantially reduced.

Vegetation within the proposed river park is within an area previously used for sand and gravel extraction and comprises low condition RFEF (HN526). A one-way access road will link the urban area to this river frontage but will not impact riparian buffers, the area will be fully landscaped with picnic/BBQ areas and car parking and will retain significant areas of tree canopy. The careful landscaping of this area will ensure that the width of the riparian buffer will not be significantly reduced.

Ecosystem functioning of a state or regional biodiversity link (Criteria 2.4.4b)

The ecosystem functioning of a state biodiversity link or a regional biodiversity link must not be substantially impacted, considering migration, colonisation and interbreeding of plants and animals between two or more larger areas of habitat.

There are no registered state or regional biodiversity links as defined by section 3.7.2 of the BCAM that will be impacted by the application for biocertification therefore the ecosystem functioning of a state biodiversity link or a regional biodiversity link will not be substantially impacted.

Water quality of major river, minor river, major creek, minor creek or a listed SEPP 14 wetland (Criteria 2.4.4c)

The water quality of a major river, minor river, major creek, minor creek, or a listed SEPP 14 wetland must not be significantly impacted.

The BCAA are does not include a SEPP 14 wetland, therefore the water quality of a listed SEPP 14 wetland will not be impacted.

The BCAA includes ‘minor rivers’ and ‘minor creeks’ where remnant native vegetation (4.31 ha) will be impacted by creek crossings, walking paths and use of the river foreshore as public open space.

Stormwater runoff from urban areas will first be treated in off-line bio-retention basins before being discharged to the streams. These basins will treat for water-borne pollutants such as nutrients and suspended solids, and will also reduce discharge rates during small but frequent rainfall events, those which have greater impact on stream erosion. These bio-detention basins are all located outside of the riparian buffers and within the urban footprint.

6. Biocertification Strategy

Section 126K of the TSC Act states that biocertification may only be conferred on land by the Minister if the applicant has a biocertification strategy.

Section 126K (2) states that a biocertification strategy is a policy or strategy for the implementation of conservation measures to ensure that the overall effect of biodiversity certification is to improve or maintain biodiversity values. The Biocertification strategy is to be used as the basis for the assessment of the application for biodiversity certification.

A biodiversity strategy is to include the following:

a) the land proposed for biodiversity certification (biodiversity values lost)
b) the land proposed for biodiversity conservation (biodiversity values protected and managed)
c) the proposed conservation measures
d) any person or body proposed as a party to the biodiversity certification

This section addresses these requirements.

6.1 Land proposed for biodiversity certification

The land proposed for biodiversity certification is shown in Figure 5 in **Section 1** of this report.

6.2 Land proposed for biodiversity conservation

The land proposed for biodiversity conservation is shown in Figure 5 in **Section 1** of this report.

Also shown in Figure 5 are areas of '*retained land*' (Existing easements, local open space, Mt Gilead Homestead lands and potential future Public Transit links as identified in the Macarthur Structure Plan.

6.3 Proposed conservation measures

6.3.1.1 Conservation measures within the 'BCAA'

It is proposed that 195.41 ha of the 198.16 ha of land shown in Figure 5 as 'land subject to conservation measures' (including 2.98 ha of retained red flag buffer area) will be secured by the registration of four Biobank sites as shown in Figure 38 (Browns Bush, Mt Gilead Homestead, Gilead and Medhurst Biobank sites). These Biobank sites were submitted to DPIE in August 2020 for assessment and registration.

Biobank sites are categorised as 'Permanently managed and funded conservation measures" and are a 100% Conservation Measure as outlined in section 8.1.1 of the BCAM and will generate 100% of the calculated credits as shown in **Table 25** and **26.**

The Biobank Agreement will include a management plan for the conservation area that will include the standard mandatory suite of biobanking actions to improve biodiversity values by the implementation of the following management actions:

- The erection and maintenance of boundary fencing to prevent in appropriate access
- Removal of rubbish
- The active management and reduction of weeds

- The application of fire, where appropriate
- Replanting or supplementary planting where natural regeneration is insufficient to bring back to benchmark condition within a reasonable timeframe - vegetation zones 4, 5, 6, 7, 9, 10, 11, 15, 16, 17, 18 & 19 (Figure 37)
- Addition of logs to supplement the current low level of logs in vegetation zones 4, 5, 6, 7, 10, 11, 15, 16, 17, 18 & 19 (Figure 37)
- Control of rabbits and foxes (as required)
- The retention of regrowth/native vegetation, dead timber, and rocks
- A requirement for annual monitoring, reporting and audit and compliance.

The in perpetuity cost of these management actions has been assessed and provided for as part of the assessment and registration of these biobank sites.

The current land owners, Mt Gilead Pty Limited (Mt Gilead Homestead and Gilead Biobank sites) and Lendlease Communities (Figtree Hill) Pty Ltd (Browns Bush and Medhurst Biobank sites), will be responsible for the permanent fencing of the conservation area (Koala exclusion fencing), establishment of the walking path/ management trail, initial weed and feral animal control, revegetation/supplementary planting and the bringing in of fallen timber from the adjacent development area.

The land subject to this conservation measure will generate **2,123** ecosystem credits and **5,542** species credits as outlined in **Table 25** and **26.**

A Biocertification Agreement will be entered into between Mt Gilead Pty Ltd (the current land owners of Mt Gilead Homestead and Gilead Biobank sites) and Lendlease Communities (Figtree Hill) Pty Ltd (current owners of the Browns Bush and Medhurst Biobank sites) and the Minister stating that the applications to register the five Biobanks will be registered by 24 August 2021 in accordance with the savings and transitional provisions.

The remaining 2.75 ha of land identified for conservation measures will be transferred to CCC as Community Land - Natural Area under the *Local Government Act* 1993, and a Plan of Management will be prepared and adopted as a 90% Conservation Measures. This measure will generate 29 ecosystem credits and 30 species credits as shown in **Table 25** and **26.**

The number of species credits generated is less than the credits required for impacts to Squirrel Glider (320 additional species credits required) Koala (767 additional species credits required) and Southern Myotis (226 additional species credits required). These additional credits will be secured by purchasing the credits required from a registered biobank site in the region or from a Biodiversity Stewardship site or the Biodiversity Conservation Trust (BCT), subject to a credit equivalency. Lendlease (Credit ID holder 650) already holds 99 Koala credits from the Campbelltown Koala population purchased from the Noorumba Reserve Biobank site (BA239).

6.3.1.2 Conservation measures 'outside' the BCAA

Other than the purchase of an additional 320 Squirrel Glider credits, 668 Koala credits (767-99) and 226 Southern Myotis credits, there are no conservation measures required outside of the BCAA.

6.4 Existing management obligations

The land proposed as Biobank sites are all currently zoned RU2 Rural Landscapes under CLEP 2015. There are no covenants or existing conservation funding arrangements for the land proposed for conservation measures or any existing requirements to actively manage the site for biodiversity

conservation. The entire conservation area is to be managed for ecosystem and species credits. Existing easements (electricity, water, gas and Appin Rd upgrade) have all been excluded from the land proposed for conservation measures as shown in Figure 4.

Mt Gilead Pty Ltd and Lendlease Communities (Figtree Hill) Pty Ltd will however, commence interim conservation management of all proposed offset areas from within 30 days of the date of biodiversity certification being conferred. This will include temporary fencing offset areas (permanent fencing will occur as part of the implementation of the Biobank Agreements), tree planting in open areas, exclusion of stock and weed control.

6.4.1 Timing of credit retirement

It is proposed to "retire" biodiversity and species credits in accordance with the staged development of the certified land as outlined in **Tables 27** and **28** and shown in Figure 39. The proportion and types of credits to be retired is based on the area of vegetation to be cleared (and corresponding number of credits) in each stage of development as outlined in **Section 6.5**.

No clearing of vegetation will occur in any stage until Lendlease Communities (Figtree Hill) Pty Ltd has provided proof of the retirement of the required quantum of credits in accordance with **Tables 27** and **28** and Lendlease Communities have prepared and implemented the CEMP, including pre-clearance surveys. This proof will be in the form of a 'certificate' of credit retirement issued by the OEH.

6.5 Any person or body proposed as a 'party' to the biodiversity certification

As the Conservation measures will not be secured prior to the application for Biocertification being considered by the Minister, a Biocertification Agreement will be entered into between Mt Gilead Pty Ltd, Lendlease Communities (Figtree Hill) Pty Ltd and the Minister stating the following:-

1 Registration of Biobank Agreements

- Lendlease Communities (Figtree Hill No. 2) Pty Ltd will prepare and submit for registration an application to register a Biobank site over 28.24 ha of land as shown in **Figure 38** as Browns Bush Biobank site by 24 August 2021 in accordance with the savings and transitional provisions
- Lendlease Communities (Figtree Hill) Pty Ltd will prepare and submit for registration an application to register a Biobank site over 13.25 ha of land as shown in **Figure 38** as Medhurst Biobank site by 24 August 2021 in accordance with the savings and transitional provisions
- Mt Gilead Pty Ltd will prepare and submit for registration an application to register a Biobank site over 19.91 ha of land as shown in **Figure 38** as Mt Gilead Homestead Biobank site by 24 August 2020 in accordance with the savings and transitional provisions
- Mt Gilead Pty Ltd will prepare and submit for registration an application to register a Biobank site over 131.03 ha of land as shown in **Figure 38** as Gilead Biobank site by 24 August 2021 in accordance with the savings and transitional provisions
- .

2 Transfer of credits from Mt Gilead Pty Ltd to Lendlease Communities (Figtree Hill) Pty Ltd

- Mt Gilead Pty Ltd has committed to making the **225** ecosystem and **478** species credits (available to Lendlease Communities (Figtree Hill) Pty Ltd from the Mt Gilead Homestead Biobank site to meet the credit retirement requirements of this Biocertification application as outlined in **Tables 27** and **28** for Stages 1 and 2 of development.
- Mt Gilead Pty Ltd has committed to making the **1,438** ecosystem and **4,311** species credits available to Lendlease Communities (Figtree Hill) Pty Ltd from the Gilead Biobank site to meet

the credit retirement requirements of this Biocertification application as outlined in **Tables 27** and **28** for Stages 3, 4, 5, 6 and 7 of development.

3 Retirement of credits

- A Biocertification Agreement will be entered into between Lendlease Communities (Figtree Hill) Pty Ltd and the Minister stating that 1 HN528, 17 HN529 and 86 HN556 ecosystem credits and 103 Koala, 40 Squirrel Glider, 5 Cumberland Land Snail and 35 Southern Myotis species credits will be retired prior to the commencement of any works in **Stage 1** of development as shown in Figure 38 and outlined in **Tables 27** and **28**
- A Biocertification Agreement will be entered into between Lendlease Communities (Figtree Hill) Pty Ltd and the Minister stating that 18 HN528, and 189 HN556 ecosystem credits and 244 Koala, 171 Squirrel Glider, 22 Cumberland Land Snail and 95 Southern Myotis species credits will be retired prior to the commencement of any works in **Stage 2** of development as shown in Figure 38 and outlined in **Tables 27** and **28**
- A Biocertification Agreement will be entered into between Lendlease Communities (Figtree Hill) Pty Ltd and the Minister stating that 34 HN528, and 189 HN556 ecosystem credits and 471 Koala, 369 Squirrel Glider, 110 Cumberland Land Snail, 259 Southern Myotis and 29 *Pomaderris brunnea* species credits will be retired prior to the commencement of any works in **Stage 3** of development as shown in Figure 38 and outlined in **Tables 27** and **28**
- A Biocertification Agreement will be entered into between Lendlease Communities (Figtree Hill) Pty Ltd and the Minister stating that 47 HN528, 9 HN538, and 75 HN556 ecosystem credits and 153 Koala, 112 Squirrel Glider, 40 Cumberland Land Snail and 90 Southern Myotis species credits will be retired prior to the commencement of any works in **Stage 4** of development as shown in Figure 38 and outlined in **Tables 27** and **28**
- A Biocertification Agreement will be entered into between Lendlease Communities (Figtree Hill) Pty Ltd and the Minister stating that 25 HN526, 5 HN528 and 97 HN556 ecosystem credits and 123 Koala, 135 Squirrel Glider, 37 Cumberland Land Snail, 99 Southern Myotis and 59 *Pomaderris brunnea* species credits will be retired prior to the commencement of any works in **Stage 5** of development as shown in Figure 38 and outlined in **Tables 27** and **28**
- A Biocertification Agreement will be entered into between Lendlease Communities (Figtree Hill) Pty Ltd and the Minister stating that 98 HN526, 60 HN528, 3 HN538, and 271 HN556 ecosystem credits and 561 Koala, 465 Squirrel Glider, 189 Cumberland Land Snail and 350 Southern Myotis species credits will be retired prior to the commencement of any works in **Stage 6** of development as shown in Figure 38 and outlined in **Tables 27** and **28**
- A Biocertification Agreement will be entered into between Lendlease Communities (Figtree Hill) Pty Ltd and the Minister stating that 104 HN528 and 118 HN556 ecosystem credits and 292 Koala, 209 Squirrel Glider, 74 Cumberland Land Snail and 49 Southern Myotis species credits will be retired prior to the commencement of any works in **Stage 7** of development as shown in Figure 38 and outlined in **Tables 27** and **28 .**

All ‘surplus’ credits will also be retired as a condition of biocertification.

4 Transfer of 2.75 ha of land to CCC

- Starting from 2024 Mt Gilead Pty Ltd will transfer the 2.75 ha of land identified as a 90% conservation measure to Council free of cost ensuring that the boundaries are demarcated by appropriate post and cable fencing or other markers. Subject to all consents, approvals, licences, permits or authorisations being procured, until the transfer to Council, Mt Gilead Pty

Ltd will undertake preliminary management actions including weed and feral animal control, initial stock fencing, bringing in of timber.

- Council will accept transfer of the 2.75 ha of conservation areas and following transfer, to the best of its endeavours, prepare the documents necessary to enable Council to consider whether the Conservation Areas should be classified as Community Land – Natural Area under the Local Government Act 1993.

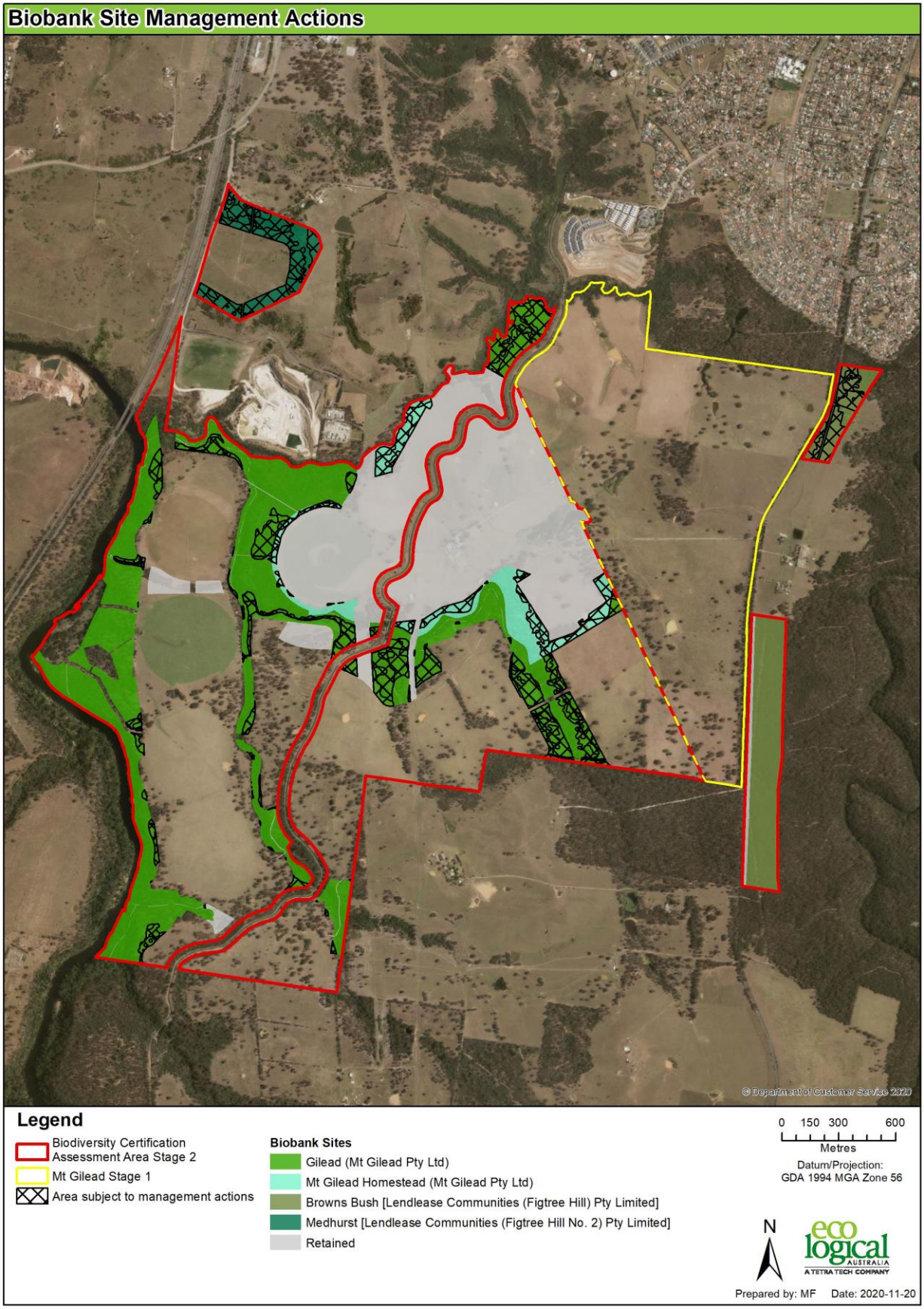

Figure 37: 'Additional' Management Actions (supplementary planting and habitat augmentation) within land proposed for conservation measures

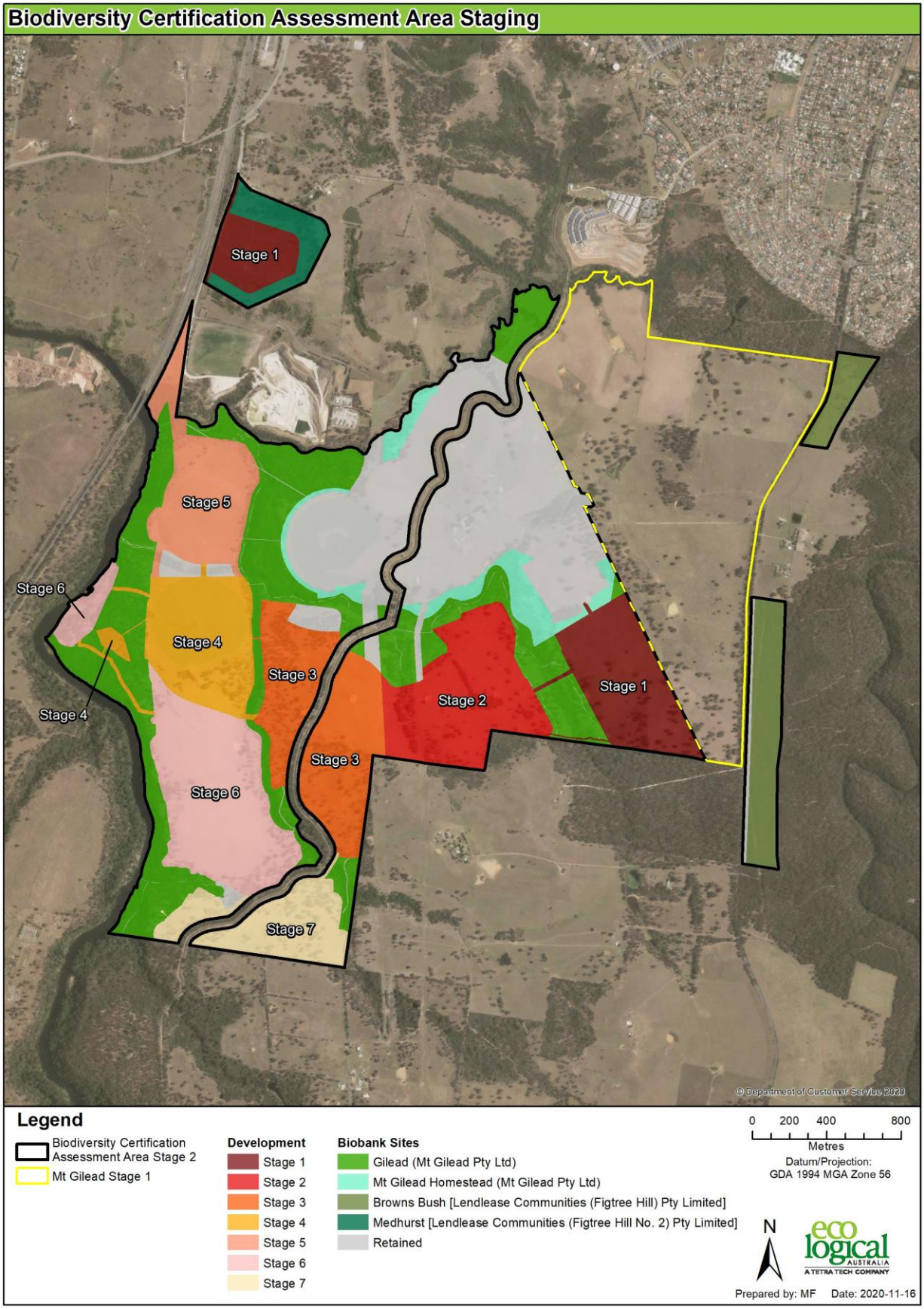

Figure 38: Location of land proposed for registration of Biobank sites and affected parties

Table 25: Summary of ecosystem credit surplus/deficit

Biometric Vegetation Type	Credits Required	Credits generated (100% Measure)	Credits generated (90% Measure)	Credit Status within BCAA
HN526 Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	123	182	11	70
HN528 Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	269	293	11	35
HN529 Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin	17	147	0	130
HN556 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin	1,202	1,417	7	222
HN538 Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	12	84	0	72
Total	**1,623**	**2,123**	**29**	**529*** **

*** All 529 surplus credits will be retired as a condition of biocertification

Table 26: Summary of species credit surplus/deficit

Habitat	Credits Required	Credits generated (100% Measure)	Credits generated (90% Measure)	Credit Status within BCAA
Pomaderris brunnea	88	1,476	0	1,388
Koala	1,942	1,167	8	-767
Squirrel Glider	1,501	1,167	14	-320
Cumberland Plain Land Snail	476	1,011	7	542
Southern Myotis	978	751	1	-226
Total	**4,985**	**5,542**	**30**	**617*** **

*** All surplus Pomaderris brunnea and CPLS species credits will be retired as a condition of biocertification

Table 27: Staging of development and retirement of ecosystem credits

Stage	HN526		HN528		HN529		HN538		HN556		Total Native Vegetation	Total Credits Required	Credits Available***
	Area (ha)	Credits	Area (ha)	Credits	Area (ha)	Credits	Area (ha)	Credits	Area (ha)	Credits			
Stage 1			0.02	1	1.22	17			3.8	86	5.04	104	**Gilead - Homestead** – 74 HN528,140 HN556 **Medhurst** – 147 HN529
Stage 2			0.87	18					8.4	189	9.27	207	**Browns Bush** - 56 HN528, 208 HN556
Stage 3			1.64	34					16.25	366	17.89	400	**Gilead** – 179 HN526, 163 HN528, 78 HN538 & 1,020 HN556
Stage 4			2.24	47			0.27	9	3.33	75	5.84	131	
Stage 5	1.63	25	0.25	5					4.31	97	6.19	127	**Gilead** – 179 HN526, 163 HN528, 78 HN538 & 1,020 HN556
Stage 6	6.36	98	2.85	60			0.11	3	12.02	271	21.34	432	
Stage 7			4.94	104					5.22	118	10.16	222	
Total	**7.99**	**123**	**12.81**	**269**	**1.22**	**17**	**0.38**	**12**	**53.33**	**1202**	**75.73**	**1623**	182 HN526, 293 HN528, 147 HN529, 84 HN5381,417 HN556

*** All surplus credits will be retired as a condition of biocertification

Table 28: Staging of development and retirement of species credits

Stage	Koala		Squirrel Glider		CPLS		Southern Myotis		Pomaderris brunnea		Credits Available
	Area (ha)	Credits	Area (ha)	Credits	Area (ha)	Credits	Area (ha)	Credits	Count	Credits	
Stage 1	3.92	103	1.78	40	0.34	5	1.58	35	0	0	**Gilead – Homestead -** 119 Koala, 119 Squirrel Glider, 113 CPLS, 97 Southern Myotis, 30 P. brunnea **Medhurst -** 81 Koala, 80 Squirrel Glider, 80 CPLS, 41 Southern Myotis
Stage 2	9.27	244	7.68	171	1.68	22	4.28	95	0	0	**Browns Bush -** 168 Koala, 168 Squirrel Glider, 168 CPLS
Stage 3	17.9	471	16.61	369	8.21	110	11.68	259	2	29	**Gilead - 801** Koala, 801 Squirrel Glider, 651 CPLS, 613 Southern Myotis, 1,446 P. brunnea
Stage 4	5.83	153	5.06	112	2.97	40	4.05	90	0	0	
Stage 5	4.67	123	6.06	135	2.79	37	4.46	99	4	59	
Stage 6	21.32	561	20.94	465	14.11	189	15.78	350	0	0	
Stage 7	11.09	292	9.42	209	5.51	74	2.21	49	0	0	
Total	**74.00**	**1,948**	**67.55**	**1,501**	**35.61**	**477**	**44.04**	**978**	6	88	Koala 1,175, Squirrel Glider 1,181, CPLS 1,018, Southern Myotis 752, P. brunnea 1,476

*** Species credits in deficit (i.e. Koala, Squirrel Glider and Myotis will be purchased from registered biobank sites or the BCT prior to the commencement of the relevant stage

6.6 Is an Improve or Maintain Outcome Achieved?

Subject to the Director-General's consideration and approval of the red flag variation requests (**Section 5**), an '*improve or maintain*' outcome can be achieved by the purchase and retirement of credits from the proposed conservation lands within the BCAA and the purchase and retirement of the additional 320 Squirrel Glider credits, 767 Koala credits and 226 Southern Myotis credits.

6.7 Statement of commitments

The following is a summary of the commitments made throughout this biocertification assessment:-

1. A Biocertification Agreement will be entered into between Lendlease Communities (Figtree Hill) Pty Limited (the **Developer**), Lendlease Communities (Figtree Hill) Pty Ltd (**Owner A**), Lendlease Communities (Figtree Hill No. 2) Pty Ltd (**Owner B**), Mt Gilead Pty Ltd (**Owner C**) and the Minister stating that the land proposed for conservation measures within the BCAA (198.16 ha) will be registered as Biobank sites by 24 August 2021 by **Owners A** (Browns Bush Biobank site), **Owner B** (Medhurst Biobank site) and **Owner C** (Mt Gilead Homestead, Gilead Biobank Sites) and all credits generated/created made available to the **Developer** who will retire all of the credits prior to the commencement of each stage of development shown in Figure 38 and summarised in **Tables 27** and **28** to meet the requirements of this application.
2. Within 30 days of the conferral of Biodiversity Conservation, **Owners A, B and C** will erect temporary fencing around the Conservation Areas to prevent access by stock, and commence interim conservation management (stock exclusion, tree planting and weed control) until the Biobank sites referred to in (1) above are registered and credits retired.
3. After the conferral of Biodiversity Certification, and at the written request of the **Developer**, **Owner C** will transfer the following biodiversity credits to the **Developer**
    - **225** ecosystem (3 HN526, 74 HN528, 8 HN538 and 140 HN556) and **478** species credits (119 Koala, 119 Squirrel Glider, 113 Cumberland Land Snail, 97 Southern Myotis and 30 *Pomaderris brunnea*) credits available to Lendlease Communities (Figtree Hill) Pty Ltd from the Mt Gilead - Homestead Biobank site to meet the credit retirement requirements of this Biocertification application as outlined in **Tables 27** and **28** for Stage 2 of development.
    - **1,438** ecosystem 179 HN526, 163 HN528, 76 HN538 and 1,020 HN556) and **14,311** species credits (801 Koala, 801 Squirrel Glider, 651 Cumberland Land Snail, 613 Southern Myotis and 1,446 *Pomaderris brunnea*) credits available to Lendlease Communities (Figtree Hill) Pty Ltd from the Gilead Biobank site to meet the credit retirement requirements of this Biocertification application as outlined in **Tables 27** and **28** for Stages 3 and 4 of development.
4. Lendlease Communities (Figtree Hill) Pty Ltd and Lendlease Communities (Figtree Hill No. 2) Pty Ltd **(Owners A** and **B**) will be responsible for the active management of the 'Browns Bush and Medhurst, Biobank sites' in accordance with the Biobanking Agreement referred to in Point 1 above from the date that all ecosystem and species credits have been retired in accordance with **Tables 27** and **28**.
5. Mt Gilead Pty Ltd (**Owner C**) will be responsible for the active conservation management of the 'Mt Gilead - Homestead and Gilead Biobank sites in accordance with the Biobanking Agreement referred to in Point 1 above from the date that all ecosystem and species credits have been retired in accordance with **Tables 27** and **28**.
6. Subject to the **Developer** obtaining all required consents, approvals, licences, permits or authorisations for vegetation clearing within the BCAA, the **Developer** will prepare a

Construction Environment Management Plan (CEMP) to the satisfaction of Council, prior to clearing in the BCAA to incorporate the Developers Statement of Commitments

a. Lendlease Communities (Figtree Hill) Pty Limited (the Developer) will prepare and implement a Construction Environment Management Plan (CEMP) to the satisfaction of Council, for vegetation clearing within the BCAA to guide the development outlined in this biocertification assessment and ensure that all direct and indirect impacts (e.g. APZs, utilities, access, stormwater run-off etc) are contained within the development footprint and appropriate mitigation measures are put in place to minimise indirect impacts to threatened fauna including Koala, Squirrel Glider and microbats. Specifically, this will address the management of the land proposed for conservation measures and their buffers such that surrounding roads will be fully curbed and guttered with no stormwater being discharged into the conservation areas (treated water from the detention basins within the development footprint will flow into existing riparian areas).

   The CEMP will include, but not be limited to:

   i. temporary and permanent protective fencing will be erected around all areas identified for conservation prior to clearing activities commencing in relevant stages to minimise any inadvertent damage

   ii. hollow-bearing trees within the Biodiversity Certification Area that potentially contain roosting and breeding habitat for threatened microbats will be identified and, where possible, retained

   iii. any trees, or parts thereof, that would be appropriate for use as fauna habitat in the Browns Bush, Medhurst, Mt Gilead Homestead, Woodhouse Creek or Nepean Biobank sites, will be identified and salvaged in accordance with the Biobanking Agreements

   iv. roads surrounding each part of the Conservation Areas will be fully curbed and guttered with piped stormwater management infrastructure to ensure that stormwater will not flow directly into the Conservation Areas

   v. a de-watering plan will be prepared for any farm dams that are removed from the Biodiversity Certification Area

   vi. a fauna pre-clearance protocol will be prepared for the removal of all trees within the Biocertification Area

   vii. lighting around conservation areas designed to minimise impacts to fauna

   viii. monitoring of performance measures and non-compliance.

Further, once registered, each Biobank site will be required to provide an annual report that will include an audit of the implementation of management actions, monitoring of the condition of vegetation and threatened species.

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Appendix A : Project Staff CVs

The following are brief curriculum vitae's for the key project staff. Please note that since this project commenced in 2013, there have been a number of staff movements, and some of the accredited staff who undertook the field work and prepared parts of this assessment report are no longer with Eco Logical Australia. Meredith Henderson, an accredited assessor familiar with the biocertification assessment process, has however, reviewed and endorsed the assessment report.

Robert Humphries – Project Manager

CURRICULUM VITAE

Robert Humphries

MANAGER, BIODIVERSITY OFFSETS PROGRAMS

QUALIFICATIONS

- Bachelor of Applied Science, Ballarat College of Advanced Education 1983-85.
- Master of Applied Science (Research) University of Ballarat 1986-89.

Robert is an ecologist, environmental planner and project manager with over 30 years experience. Since graduating with Bachelors and Masters Degrees in wildlife management in 1985 and 1989, Robert has worked mainly in the public sector with the Department of Environment and Conservation (Victoria) 1988-1996 and the then NSW National Parks and Wildlife Service, now NSW Office of the Environment & Heritage (OEH) 1996-2006. Robert joined Eco Logical Australia in March 2008 after two years working in the urban development sector.

Robert was the Manager of the Threatened Species Section of the NSW Department of Conservation and Environment for over 10 years and has extensive experience of NSW Threatened Species and Environmental Planning legislation, Government policy, the biodiversity of the Greater Sydney and Hunter Regions and the former biodiversity certification and biobanking provisions.

Robert was a member of the Biobanking Ministerial Reference Group from 2007-2012 and was the lead trainer in the BioBanking and Biodiversity Certification Accredited Assessor Training program that Eco Logical Australia developed and implemented under licence from the OEH for 8 years between 2008 and 2015.

Robert is now actively involved in working with land owners wishing to register Land Stewardship Agreements under the new Biodiversity Conservation Act 2016 and sourcing and securing biodiversity credits for proponents.

RELEVANT PROJECT EXPERIENCE

Biobanking, BioCertification and Major Projects (FBA) offset policy development and preparation of gazetted methodologies

- Engaged by the Biodiversity Conservation Trust to forecast the likely demand for BAM credits under the new Biodiversity Conservation Act 2016 Biodiversity Assessment Method (BCT 2017-18)

- Invited by OEH to participate in developing a framework for Biobank management cost benchmarks (OEH 2017)
- Engaged by OEH in consultation with Taylor Fry Consulting Actuaries to develop the NSW Biodiversity Offset Calculator and provide initial credit prices for all ecosystem and species credits in NSW (OEH 2016)
- Engaged by OEH to forecast the likely demand for offsets under the Major Projects Offset Policy 2014 (OEH 2013)
- Biobanking Ministerial Reference Group (NSW Urban Task Force representative) 2007-2012
- Department Planning Part 3A Biodiversity Offsets Policy Development Workshop (Invited Expert to contribute to development of new policy, 2010)
- Development and Project Management of OEH Biobank/BioCertification and FBA Accredited Assessor Training Course (2008-2015, OEH)
- Contracted by OEH to prepare the BBAM 2014 and FBA Operational Manuals (OEH 2015)
- Engaged by OEH to 'test' versions 1 and 2 of the Biobanking credit calculator tool and prepare Sections 4 and 5 of the revised 2009 Operational Manual (2008-2012).
- Prepared the Operational Manual for BBAM 2014 for OEH 2015
- Prepared the Operational Manual for the Framework for Biodiversity Assessment (Major Projects Offset Policy for OEH 2015
- Development of the Credit pricing calculator for Biobank owners (2008, DECC)
- Contracted by OEH to undertake a regional analysis of the likely demand for offsets required under the Major Projects Offset Policy
- Cost comparison of Biobank Credits and traditional offsets negotiated by the RTA for the M7 Motorway (2009, DECCW).
- Likely demand for Biodiversity Credits in the Lower Hunter, Far North Coast, Western Sydney and South Coast Regions (2008, DECC)

Biocertification Assessments
Robert has completed or is currently undertaking formal Biodiversity Certification Assessments for:-

- Mount Gilead Stage 1 Urban Release Area (Campbelltown City Council) Biodiversity Certification conferred July 2019
- Port Macquarie Airport and Area 13 Urban Release Area (Port Macquarie Hastings Council). Biodiversity Certification conferred October 2018
- El Caballo – Gledswood – Lakeside Residential Estate (Camden City Council). Biodiversity Certification conferred June 2018
- Emerald Hills Urban Release Area (Camden City Council). Biodiversity Certification conferred December 2015
- Maquariedale Road, Appin Urban Release Area (Wollondilly Council) Application being considered by OEH
- Tuncurry State Significant Site (Urban Growth NSW). Application being considered by OEH
- Warnervale Town Centre (Wyong Council). Application approved March 2014
- Broulee and South Moruya Urban Release Areas (Eurobodalla Shire Council). Application approved September 2014

Robert has completed informal Biodiversity Certification Assessments for:-

- Greater Sancrox Area for Port Macquarie –Hastings Council (August 2013)
- Glenning Valley Urban Release Area (Travers Ecology and Glenning Valley Partnership 2011);
- Kings Hill Urban Release Area, Port Stephens LGA (Mondell Property Group and Hunter Land 2011);
- Ingleside Release Area, Pittwater/Warringah LGAs (Urban Growth NSW 2011)
- Darkinjung Local Aboriginal Land Council (North Wyong Structure Area)
- Yallah-Marshall Mount Urban Release Area (Wollongong City Council)
- Whitebridge Investigation Area (Urban Growth NSW 2011)
- Balmoral Urban Release Area, north west Sydney (Urban Growth NSW 2013)

Biodiversity Offset Strategies and Packages
Robert has prepared numerous Biodiversity Offset Strategies and Packages to meet policy frameworks and conditions of approval for Major Projects:-

- Prepared an offset strategy for Coppabella Wind Farm near Yass (Goldwind Australia 2018)
- Prepared an offset strategy for the Bango Wind Farm near Yass (CWP Renewables 2018)
- Prepared an offset strategy for the Taralga Wind Farm (Pacific Hydro 2016-2017)
- Prepared an offset strategy for White Rock Wind Farm near Glenn Innes Stages 1 and 2 (Goldwind Australia 2016-2017)
- Prepared an offset strategy for the West Connex Project (2016-2018)
- Prepared an offset strategy for Queanbeyan-Pallerang Regional Council for the Ellerton Rd project (2017-2018)
- Prepared an offset strategy and secured offsets for the North West Rail Line project in north western Sydney (2014)
- North West & South West Growth Centres Biodiversity Offset Strategy for Sydney Water Infrastructure developments (May 2013)
- Biodiversity Offset Strategy for the proposed extension of the Pine Dale Mine (Enhance Place Pty Ltd, July 2013)
- Biodiversity Offset Strategy for proposed Stage 1 Modification, Moolarben Coal Mine (Yancoal, May 2013)
- Biodiversity Offset Strategy for Crudine Wind Farm (Wind Prospect CWP Pty Ltd – 2012)
- Biodiversity Offset Strategy for Sapphire Wind Farm (Wind Prospect CWP Pty Ltd – 2011)
- Biodiversity Offset Strategy for Boco Rock Wind Farm (Wind Prospect CWP Pty Ltd – 2011)
- Biodiversity Offsets review, Cockatoo Coal NSW & Qld Projects (Cockatoo Coal Pty Ltd, 2011)
- Revised Biodiversity Strategy for Tharbogang Quarry and Landfill (Griffith City Council, 2011)
- Improve or Maintain Biodiversity Offset Strategy for proposed rezoning at Greta, Cessnock LGA (Hardie Holdings Pty Ltd, 2011
- Improve or Maintain Biodiversity Offset Strategy for Kings Hill Urban Release Area, Port Stephens LGA (Mondell Property Group, 2011)
- Preparation of Biodiversity offset strategy for the proposed Narrabri Coal mine (Narrabri Coal Operations Pty Ltd, 2011)
- Preparation of Biodiversity offset strategy for proposed modification to Rocglen Coal Mine (Whitehaven Coal Pty Ltd, 2010)
- Preparation of Biodiversity offset strategy for the proposed Werris Creek LOM Coal Mine (Werris Creek Coal Pty Ltd, 2010)
- Preparation of Biodiversity offset strategy for the South West Rail Link (Transport Construction Authority, 2010)
- Preparation of Biodiversity offset strategy for the Richmond Rail Line duplication (Transport Construction Authority, 2011)
- Preparation of Biodiversity offset strategy for the Camden Valley Way Upgrade (NSW RTA, 2011)
- Biodiversity Offset Strategy for the Oxley Highway Upgrade, Port Macquarie (NSW RTA, 2010)
- Preparation of Offset Strategy and package for the Kingsgrove to Revesby Quadruplication Project (2008/09 K2RQ/TIDC Alliance)

Biobank Site Assessments and Registrations
Robert has prepared and/or project managed through to registration **31** BioBanking Agreements and undertaken numerous feasibility studies for State and Local Government Agencies, Corporate entities and private land holders interested in biobanking, including

- A 25 ha Biobank site west of Camden on the Cumberland Plain (Private landholder) (Agreement No. 3, registered in January 2011)
- A 24 ha site in western Sydney (Western Sydney Parklands Trust). (Agreement No. 70, registered in February 2012)
- A 10 ha site at Belrose (WSN Environmental Solutions) (Agreement No. 55, registered in March 2012)
- A 1,500 ha site near Gunnedah to offset an approved Coal mine (Whitehaven Coal) (Agreement No. 43, registered in August 2012)
- A 51 ha Biobank site west of Camden on the Cumberland Plain (Private landholder) (Agreement No. 88, registered in January 2013)
- A 69 ha proposed Biobank for Shoalhaven City Council at (Agreement No. 101, registered in June 2013)

- A 45 ha proposed Biobank for Lake Macquarie City Council at Belmont (Agreement No. 103, registered in June 2013)
- A 54 ha proposed Biobank at the Oaks on the Cumberland Plain (Private landholder) (Agreement No. 100, registered in September 2013)
- A 31.2 ha site (M7 West) in Western Sydney Parklands (Agreement No. 119, registered August 2014)
- A 19.37 ha site (Kemps Creek) in Western Sydney Parklands (Agreement No. 120, registered August 2014)
- A 29 ha site at Puckey's Estate in the Wollongong LGA prepared as part of OEHs Linking Landscapes project (Agreement No. 163, registered March 2015)
- A 72.64 ha site at Salamander for Port Stephens Shire Council (Agreement No. 148 – registered November 2015)
- A 25 ha site at Emerald Hills in the Camden LGA (Agreement No. 159 – registered November 2015)
- A 25 ha site at Dunmore in Shellharbour LGA for Holcim Pty Ltd (Agreement No. 203 – registered December 2015)
- A 56 ha site at Oaklands (Hardwicke Stage 1) in Wollondilly Shire Council (Agreement No. 168, registered March 2017)
- A 24 ha site west of Camden (Brownlow Hill Stage 3) on the Cumberland Plain (Agreement No 156 Registered October 2017
- A 45 ha site at Gilead (Noorumba Reserve) in Campbelltown LGA for Campbelltown City Council (Registered February 2018)
- A 30 ha site at Brownlow Hill (Brownlow Hill Stage 4) for Brownlow Hill Pty Ltd (Agreement No. 274 registered March 2018)
- A 350 ha site at Crooked Corner (Glenara) for Glenara Pastoral Pty Ltd (Agreement No. 353 May 2018)
- A 150 ha site at Oaklands (Hardwicke Stage 2) in Wollondilly Shire Council (Agreement No. 213, registered November 2018)
- A 20 ha site at Murrays Beach (Murrays Beach) for Roads and Maritime Services
- A 12 ha site at Gilead (Mt Gilead-Noorumba) in Campbelltown LGA for Mt Gilead Pty Ltd (Agreement No. 208, registered January 2019)
- A 8 ha site at Gilead (Onslow-Macarthur) in Campbelltown LGA for Mt Gilead Pty Ltd (Agreement No. 209, registered January 2019)
- A 290 ha site near Glenn Innes (Windemere) for Sapphire Wind Farm (Agreement No. 379, registered January 2019)
- A 600 ha site near Bundarra (Rockview South) for Sapphire Wind Farm (Agreement No. 376, registered January 2019)
- A 300 ha site near Casino (Ermilo) for a private land owner (Agreement No. 449, registered January 2019)
- A 80 ha site at Coal Cliff (Illawarra Coke) for the Illawarra Coking Company (Agreement No. 349, registered February 2019)
- 60 ha site at Berkshire Park (Castlereagh) for Waste Assets Management Corporation (Agreement No. XXX, registered February 2019)
- A 400 ha site at Port Macquarie (Partridge Creek) for Port Macquarie Hastings Council (Agreement No. XXX, registered February 2019)
- A 184 ha site (Tangari) near Glenn Innes for White Rock Windfarm (Agreement No. 453, registered February 2019)
- A 90 ha site at Taralga (Rossvale) for Taralga Wind Farm (Agreement No. 452, registered February 2019)

Applications currently being assessed by OEH

- A 20 ha site at Port Macquarie (Thrumster) for Port Macquarie Hastings Council
- A 40 ha site at Elderslie (Gundungurra Reserve) for Camden Council

Management of Biobank Sites for landholders

Robert has been engaged by Biobank site owners to manage their Biobank sites in accordance with their BioBank Agreement Management Plans and prepare the Annual Compliance reports.

- Brownlow Hill Stage 1
- Hardwicke Stage 1 & 2
- Emerald Hills for Macarthur Developments Pty Ltd
- Onslow-Macarthur and Mt Gilead Noorumba Biobank sites for Mt Gilead Pty Ltd
- Dumore Biobank site for Holcim Pty Ltd

Identification and sourcing of Biodiversity credits for proponents
Robert has been engaged by various proponents to source and secure biodiversity credits to meet approval conditions.

- Holcim to source and secure credits for the Lynwood Quarry
- Lendlease Communities to source and secure Cumberland Plain Woodland and Koala credits for the Mt Gilead development at Campbelltown
- Sekisui House to source and secure 294 HN528 Cumberland Plain Woodland credits for the El Cabello biocertification area
- Frazer's Property Group to source and secure 40 HN528 Cumberland Plain Woodland for the Eastern Creek Business Hub project
- RMS to secure various credits for the Growth Centres roads project
- West Connex Pty Ltd to source and secure various credits for the WCX project
- Sekisui House to source and secure 55 HN528 and 6 HN526 credits for the Spurway Drive project
- Pacific Hydro to source and secure 70 HN571 credits for the Taralga Wind Farm
- Private land holder to source and secure 10 Green and Golden Bell Frog species credits for a development at Davistown
- Ecove Pty Ltd to source and secure 28 Green and Golden Bell Frog species credits for the Opal Tower development at Sydney Olympic Park
- Tahmoor Central to source and secure 30 HN56 credits for a development at Tahmoor
- McPhails Wollongong – purchase of 224 SR545 credits

Biobank Statements
Robert has prepared and/or project managed through to approval 6 BioBank Statement applications:-

- Biobank Statement for a Commercial Development, Salamander Way, Port Stephens Council (Biobank Statement 46 issued August 2018)
- Biobank Statement for proposed urban development at West Dapto, Wollongong LGA (Biobank Statement 16 issued October 2014
- Biobank Statement for proposed commercial development at Tahmoor, Wollondilly LGA (Biobank Statement 15 issued September 2014
- Biobank Statement for proposed residential subdivision at Davistown in Gosford LGA (Biobank Statement 7 issued January 2013)
- Biobank Statement for proposed retirement Village residential at Beacon Hill, Warringah LGA (Biobank Statement 3 issued May 2011)
- Biobank Statement for proposed residential subdivision at Forrester's beach (Biobank Statement 2 issued December 2010)

Dr Meredith Henderson – Accredited Assessor – Supervision of credit calculations, targeted survey

Dr Meredith Henderson

PRINCIPAL ECOLOGIST

QUALIFICATIONS

- PhD, Victoria University, Melbourne. Vegetation dynamics in response to fire and slashing in remnants of Western Basalt Plains grasslands and the implications for conservation management.
- Bachelor of Science (Honours), University of Wollongong.
- Accredited BioBanking Assessor (#155)
- BAM Accredited Assessor (BAAS 17001)

Meredith is an ecologist with over 24 years of survey and research experience and is Principal Ecologist in Eco Logical Australia's Sydney Metropolitan Region. Meredith has worked in a range of sectors including state government, University, non-government organisations and the private sector. She has a PhD and Honours degree in terrestrial ecology. Meredith has well developed capabilities in terrestrial plant ecology and environmental assessment.

She is experienced in the design and completion of ecological surveys, environmental impact assessment, monitoring impacts of land management change, literature reviews and synthesis. Meredith has highly developed skills in government and client liaison.

Meredith has managed many large and complex projects. She is an accredited BAM and BioBanking assessor and has been led biodiversity certification projects and application of the major projects assessment and offsetting requirements.

CAPABILITIES

Ecological Survey

- Full floristics vegetation surveys for vegetation mapping, Bega Valley, Illawarra and South Coast (NSW NPWS)
- Vegetation mapping of the Holsworthy Military Area (Janet Cosh Herbarium for Department of Defence)
- Vegetation assessment for bushfire planning and assessment in Lower Snowy area of Kosciuszko National Park (Gary Leonard & Associates for NSW NPWS)
- Monitoring *Trachymene saniculifolia* plant populations in Kanangra Boyd NP (NSW NPWS)
- Camden Council Reserves Vegetation Assessment (Camden Council)
- Full floristics, vegetation validation, biobanking plots, and culvert assessments for NorthConnex EIA (Transurban/RMS)
- Full floristics and biobanking plots for proposed Biodoversity Certification (Hardwicke)
- Targeted threatened species surveys (incl. Koala, Green and Golden Bell Frog and number plant species) for a range of infrastructure and residential development clients

Ecological Impact Assessment

- Rezoning in rural residential area in Dural, NSW (Brown Consulting)
- Flora and fauna assessment for outdoor education facility, Wolgan Valley, NSW (Cranbrook School)
- Flora and Fauna Assessments for residential development, Church Point, Bayview, Balgowlah Heights, North Turramurra (variety of clients)
- Ecological Constraints in Sydney Metropolitan (UrbanGrowth NSW)

- NorthConnex ecological assessment EIS (RMS/Transurban)
- WestConnex the New M5 biodiversity technical report for the EIS (RMS/Sydney Motorway Corporation)
- EPBC Act strategic assessment of procedures and guidelines for works on NSW roads (RMS)

Fuel hazard assessment

- Conduct vegetation fuel hazard assessments and ecological assessments for fire planning and management on the Eyre Peninsula, Mount Lofty Ranges, the SA Murray-Darling, South-east and Kangaroo Island (SA DEH)
- Vegetation fuel hazard assessments for fire behaviour analysis in Mt Taylor, New Zealand (for CSIRO and Bushfire CRC)

Research

- Vegetation survey and assessment following experimental burning and grazing exclusion in Guy Fawkes River Wilderness Area (NSW NPWS)
- Vegetation assessment and monitoring in mallee following experimental burning and bushfires – design and conduct full floristics and habitat assessment (SA Department of Environment & Heritage)
- Vegetation fuel hazard assessments and joint project leader for Project FuSE in SA MDB Region (SA DEH and Bushfire CRC)
- Review of environmental information required for impact assessment and approvals (SA Department of Environment, Water and Natural Resources)

Use of BioBanking and related methods

- Conduct field work for BCAM (SouthWest Land Holdings)
- Conduct biobanking plots and vegetation mapping for use in assessing impacts – NorthConnex (Transurban / RMS)
- Conduct biobanking plots, survey and run calculations for additional site for NorthConnex (Transurban / RMS)
- Provide advice to client on biobanking feasibility (Stockland)
- Lead assessor for WestConnex The New M5 using FBA (Roads and Maritime)
- Lead assessor for BCAM in northern Sydney region (Celestino)
- Lead assessor for BioBanking Agreement in the Illawarra (Holcim)
- Conduct field work for proposed major mining project in NSW central tablelands / slopes
- Lead assessor for BCAM at Sydney Science City (Celestino)
- Lead assessor for BCAM at El Caballo, Gledswood and Lakeside (Sekisui House)
- Provide advice on biobanking at Calderwood Valley Stage 3B North (Lendlease Communities)
- Lead assessor F6 Extension Stage 1 BDAR (Roads and Maritime)
- Lead assessor Stage 3C1 Calderwood BDAR (Lendlease Communities)
- Lead assessor Stage 3BN Calderwood BDAR (Lendlease Communities)
- Project Director Stage 3C2 Calderwood BDAR (Lendlease Communities)
- Lead assessor for BioBanking Agreement at Mt Brown (private investor)

Michelle Frolich - Mapping and credit calculations

CURRICULUM VITAE

Michelle Frolich

BIODIVERSITY OFFSETS PROGRAM CO-ORDINATOR

QUALIFICATIONS AND TRAINING

- Bachelor of Science (Marine Science Honours), University of Sydney, 2007
- BioBanking and Bio-Certification Assessors Training Courses, 2010 and 2013
- Biodiversity Offset Scheme and Biodiversity Assessment Method Training Course, 2017
- BAM Accredited Assessor

Michelle is a Biodiversity Offsets Program Coordinator with over 12 years' experience in Geographic Information Systems, BioBanking, Biocertification, ecological impact assessment and ecological surveys. She has a thorough understanding of the BioBanking Assessment Methodology (BBAM), Biodiversity Certification Assessment Methodology (BCAM) and the Framework for Biodiversity Assessment (FBA) for Major Projects. She has also recently completed the Biodiversity Assessment Method (BAM) training course and is a BAM Accredited Assessor under the NSW *Biodiversity Conservation Act 2016*. Michelle also has extensive experience in Geographic Information Systems such as ESRI ArcGIS and MapInfo Professional.

Michelle is an experienced project manager with skills in field surveys, data analysis, mapping, ecological assessments and reporting. She also has highly developed communication and organisation skills, which she applies when dealing with project teams, clients and government agencies.

Michelle has previously worked in other ecological consultancies and NSW Government agencies.

RELEVANT PROJECT EXPERIENCE

BioBanking, Bio-certification and Framework for Biodiversity Assessment

- Biodiversity feasibility assessments under the BBAM for development and biobank sites (across NSW)
- Biobank Agreement Applications using BBAM (Biodiversity Assessment Report, Total Fund Deposit Spreadsheets, Management Action Plan) in the Hunter Valley and Western Sydney
- Biodiversity assessments for Major Projects (State Significant Developments) under the FBA in Western Sydney and Hunter Valley
- Biodiversity assessments under BCAM for mines in the Hunter Valley for the Upper Hunter Strategic Assessment

Ecological Impact Assessment

- Flora and fauna assessments for proposed developments in the Greater Sydney region
- Species Impact Statements for proposed developments in Western Sydney and the Lower Hunter Valley

Ecological Surveys

- Botanical surveys in the Greater Sydney, Upper and Lower Hunter Valley, and Central West regions
- Feral animal monitoring for a mine within the Hunter Valley
- Targeted surveys for threatened flora and fauna species in the Hunter Valley and Greater Sydney regions
- Pre-clearing and clearing supervision

Bruce Mullins – Senior Field Ecologist – Vegetation Mapping and threatened flora (moved to Eco Planning Pty Ltd, December 2016)

CURRICULUM VITAE

Bruce Mullins

ASSOCIATE - MANAGER, ECOLOGY AND ASSESSMENT - PRINCIPAL ECOLOGIST

QUALIFICATIONS

- Master of Science, University of Technology, Sydney. Factors affecting the vegetation of mined and unmined areas in a montane forest.
- Bachelor of Science, University of Technology, Sydney
- Accredited Biobanking Assessor

Bruce is an ecologist with over twenty years post-graduate experience and is Eco Logical Australia's Senior Ecologist and Manager of the Ecology and Assessment team. Following the completion of a Master of Science thesis examining patch dynamics and plant ecophysiology at an abandoned mine site in the central tablelands of NSW, Bruce has been working as a researcher and environmental consultant. For seven years he managed the environmental consulting activities of Charles Sturt University, principally through the Johnstone Centre, after which time he joined Eco Logical Australia.

Bruce has highly developed skills in research and consulting. He is experienced in the design and execution of ecological surveys, environmental impact assessment, the development of management plans, literature reviews and all aspects of project management.

RELEVANT PROJECT EXPERIENCE

- Parramatta Escarpment shared path and boardwalk, Options study, Parramatta City Council
- Jerrabombera wetlands, vegetation mapping project.
- Plains-wanderer, survey and habitat assessment 2015, OEH
- Floristic Value Score advice, Riverina grasslands, OEH
- Mt Gilead Biocertification Assessment
- Bingara Gorge, Ecological surveys
- Western Sydney Dieback project, bird surveys and advice, Goodman.
- Metropolitan Colliery Vegetation Monitoring Program 2008 - present
- Ecological Assessment, Proposed Hume Highway Duplication, RTA
- Flora and Fauna Impact Assessment, Roadside Vegetation Maintenance, Old Princes Highway, Bulli Tops to Waterfall, Wollongong City Council
- Goodnight Island Ecological Assessment, Studio Internationale
- Research and Monitoring Program, DEFCOMMSTA Morundah, Dept of Defence
- Ecological Expert, Land and Environment Court, Booralie Rd, Warringah, Northern Beaches Council.
- Superb Parrot Surveys, selected sites in ACT 2014 and 2015
- Eastern Highlands Vegetation Surveys, (Kosciusko NP and ACT), DECCW and ACT government.
- West Dapto and Adjacent Growth Areas, Part 3A Assessment, Sydney Water Corporation
- Tharbogang Landfill Biodiversity Offset Strategy, Griffith City Council
- Ecological Equivalence Assessment, Carmichael Mine, central QLD.
- Rapid vegetation assessment, mid to lower Murrumbidgee (Griffith to below Balranald), OEH
- PAS expert advice (Plains-wanderer, *Brachyscome muelleroides* and *Leptorhynchos orientalis*), OEH

- Council Appointed Expert, terrestrial ecology, Proposed Subdivision Hampton Cres Blacktown
- Council Appointed Expert, terrestrial and aquatic ecology, Rooty Hill
- Box-Gum Woodland Mapping and Monitoring Plan for Kapooka Military Area, Dept of Defence
- Monitoring the Impacts of Kangaroo Grazing in the Kapooka Military Area, Dept of Defence
- Monitoring the Impacts of Kangaroo Grazing in Latchford Barracks, Dept of Defence
- North Bandiana Landscape Management Plan, Dept of Defence
- South Bandiana Landscape Management Plan, Dept of Defence
- Vegetation Condition Assessment, South West Slopes, DEWHA
- Flora and Fauna Assessment, Proposed Bayswater 2 Powerstation, Part 3A, AECOM
- Rapid weed assessments, Wilderness areas (Kosciusko, Deua, Monga, Mummel Gulf National Parks), OEH
- Hargraves to Windeyer Powerline Ecological Assessment, Barnson Pty Ltd
- Moolarben Coal Mine Preclearing Survey, Moolarben Coal Operations
- Vegetation Mapping, Mulwala Explosives Facility, Mulwala, Dept of Defence
- Native Grassland Condition Assessment, Tubbo Station, Tubbo Farming.
- Wagga Wagga Linepack Extension, Environmental Licencing Professionals
- Ecological Assessment, Cooktown, QLD, Airservices Australia
- Assessment of Irongrass Natural Temperate Grassland, Tailem Bend, SA, Airservices Australia
- Moorlaben Coal, Flora and Fauna Monitoring 2010-2011, Moolarben Coal Operations
- Tralee Station proposed rezoning, environmental assessment and constraints analysis, Queanbeyan, Urbis.
- Ecological Surveys, Nymagee, Triako mines with Charles Sturt University.
- Ecological Surveys, Cobar, Endeavour mine with Charles Sturt University.
- Ecological assessment, piping Llanillo Bore Drain, Lightning Ridge
- Ecological Assessment, proposed upgrade to Lake Brewster, near Hillston, State Water
- Ecological Assessment, Muggabah and Merrimajeel Creeks, Booligal, Dept Commerce
- Flora survey, Coleambally Irrigation Area, Australian Museum.
- Towra Point Artificial Bird Roosts REF, DECCW
- Southern Highlands Transfer, Identification of Flora and Fauna Constraints, Dept Commerce
- Shoalhaven Water Transfers, Terrestrial Ecology and Wetlands, Dept Commerce
- Wetland Vegetation Surveys for LiDAR comprising the Gwydir Wetlands, DECCW
- Wetland Characterisation and Management, Port Stephens Council
- EPBC Box Gum woodland survey and mapping, Molonglo region, ACT
- Tallawarra Local Environment Study, TRUenergy
- Shellharbour Hardrock Extraction Flora and Fauna Assessment, NSW Dept of Planning
- Campbelltown Biodiversity Study, Campbelltown City Council
- Native Vegetation Guide for the Riverina, Greening Australia
- Buckingbong State Forest Environmental Assessment, Dept of Defence
- Wagga Wagga Planning Studies, Willana Associates
- Historical distribution of Native Grasses through Parkes, Forbes and Lachlan Shires, Western Research Institute
- A review of the ecological health of the Murrumbidgee River, Living Murray
- Systematic Vegetation Surveys, Upper Hunter Valley
- Environmental investigations and vegetation mapping, DEFCOMMSTA properties, Dept of Defence
- Vegetation Condition Assessment, Woodlands Historic Park, Melbourne, Parks Victoria
- Flora survey, Riverine Plain (62 sites), DLWC
- Flora survey, Jingellic, Bogandyera and Clarkes Hill Nature Reserves, NPWS
- Flora survey, Wagga Wagga LGA, DEC
- Googong Environmental Investigations for Local Environment Study, Willana Associates
- Gum Swamp Management Plan and Operation and Maintenance Manual, Gum Swamp, DLWC
- Evaluation of 1750 mapping of vegetation by the Riverina Vegetation Committee, NPWS
- Edwin Land Parkway, Queanbeyan, GHD
- Vegetation validation - Narrandera, Ardlethan, Barmedman and Coolamon 1:100,000 Map Sheets, DECCW
- Scoping Report for the Development of a Biodiversity Strategy and Plan for the Rice Industry, Rice Growers Association

Brian Towle Senior Field Ecologist – Vegetation Mapping and threatened flora (moved to Eco Planning Pty Ltd, December 2016

CURRICULUM VITAE

Brian Towle

SENIOR ECOLOGIST

QUALIFICATIONS

- Bachelor of Environmental Science (First Class Honours). The impacts of recreational vehicle use on vegetation and soils of a Sydney Sandstone Ecosystem. University of New South Wales – 2005.
- Accredited Biobanking Assessor

Brian is a senior ecologist with over 10 years' experience as an environmental consultant. During this time he has worked primarily as a botanist undertaking a range of projects including registered BioBanking agreements, applications for Biodiversity certification, vegetation monitoring programs, large scale vegetation mapping projects, targeted surveys and a range of impact assessments.

Brian has conducted surveys in a range of ecosystems across NSW, and in parts of QLD (Bowen Basin), from the coast to the far western plains including arid woodlands, shrublands and grasslands, wet sclerophyll forests, rainforests and coastal swamps. This experience has exposed him to a diversity of flora and fauna distributed across these ecosystems. Brian has also undertaken research into the ecology of native plants co-authoring publications within peer-reviewed journals.

Brian has a sound knowledge of environmental and planning legislation, and has applied this understanding and his ecological expertise to a range of projects including as an expert witness for the Land and Environment Court. Brian has worked for a range of clients ranging from Local Councils, to state agencies and private industry. This has required him to communicate effectively with a range of professionals and the general public in both written and oral form.

RELEVANT PROJECT EXPERIENCE

Ecological impact assessment

- Macdonaldtown Gasworks remediation (Incoll Management Pty Ltd)
- Southern Sydney Freight Line, Glenfield to Cabramatta (John Holland Pty Ltd)
- Impacts of Pacific Highway Upgrade on Koalas, Bonville (Roads & Maritime Services)
- Powerline corridor widening, Cordeaux (AAJV Pty Ltd)
- Tallawarra Part 3A Ecological Assessment
- Powerline Maintenance works, various locations (Integral Energy)
- Darkes Forest Powerline, Ecological Assessment, central NSW
- Proposed Sewer alignment El Cabello Blanco, Gledswood and Lakeside properties (Sekisui House)
- Threatened Species Impact Statement for proposed residential subdivision at Menai, Sutherland LGA, NSW (Landcom, 2009/10).
- Bald Hill carpark and lookout redesign (Wollgong City Council)
- Lucas Heights Stockpile Assessment (WSN Environmental Solutions)
- Mount Ousley Heavy Vehicle Checking Station REF (Roads & Maritime Services)
- Woodford sewer line extension, (AAJV Pty Ltd)
- Sublime Point Water Treatment Plant Upgrade (Wollongong Council)
- Pinedale Coal Mine Ecological assessment report
- Threatened Species Impact Statement Beacon Hill, Warringah LGA, NSW
- Yallah-Marshall Mount Ecological Sensitivity Analysis (Wollongong Council)

BioBanking and Biocertification Assessments

- Biodiversity Certification Application for 600ha property in south-west Sydney (Lendlease Communities)
- Biodiversity Certification Application for North Tuncurry Crown Land (UrbanGrowth NSW).
- Vegetation mapping and assessment of 54 ha Biobank site on the Cumberland Plain (Private landholder) (Agreement No. 100, registered in September 2013)

Ecological inventory & monitoring

- Monitoring impacts to vegetation associated with longwall mining, Illawarra Coalfields
- Offset sites vegetation monitoring and Landscape Function Analysis (Moolarben Coal Pty Ltd)
- Field validation and mapping of Endangered Ecological Communities (Ku-ring-gai Council)
- Updated vegetation mapping and biodiversity conservation options for the West Dapto urban release area (Wollongong City Council)
- Vegetation community mapping project, Mulwala Defence Facility
- Mapping of vegetation communities of the Darling River Floodplain (Murray-Darling Basin Authority)
- Environmentally Sensitive Land Map update Camden LGA (Camden Council)
- Validation of wetland mapping across the Lachlan River catchment (NSW Office of Environment and Heritage)
- Validation of Groundwater Dependent Ecosystem mapping across the Lachlan River catchment (NSW Department of Primary Industries)

Management Plans

- Black Fellows Hands Reserve Biodiversity Management Plan, Mingaan Aboriginal Corporation
- Biobanking Assessment and Plan of Management, Kempsey & Deerubbin LALCs
- Cooper Park Management Plan (Woollahra Council)

Ecological Review

- Expert Witness Statement, Groundwater Extraction, Bilpin
- Ecological Review, UTS Ku-ring-gai Campus Development, Ku-ring-gai

Publications

Bower, C. **Towle, B** and Bickel, D. (2015). *Reproductive success and pollination of the Tuncurry Midge Orchid (*Genoplesium littorale*) (Orchidaceae) by Chloropid Flies*. Telopea 18: 43-55.

Liz Norris Senior Field Ecologist – Vegetation Mapping and threatened flora (moved to Eco Planning Pty Ltd, December 2016

CURRICULUM VITAE

Elizabeth Norris

SENIOR ECOLOGIST

QUALIFICATIONS

- Bachelor of Science, Macquarie University, Sydney. Biology/Ecology and Palaeontology major, 1983.
- Post Certificate in Electron Microscopy, Sydney Technical College, Transmission and Scanning Microscopy, 1986.
- Master of Science, Macquarie University, Sydney. Thesis entitled: 'A study of the soil and vegetation patterns within part of the Pilliga Forests, and an evaluation of the impact of European settlement on the vegetation', 1997.

Liz has 25 years botanical and ecological research in the New South Wales: Sydney Basin, Coastal New South Wales, Hunter Valley, North and South Western Slopes and Plains, often to remote areas. She has a Bachelor of Science, a post graduate certificate in electron microscopy and a Master of Science (Thesis) "*A study of the soil and vegetation patterns within part of the Pilliga Forests, and an evaluation of the impact of European settlement on the vegetation*".

Liz is a senior botanist/ecologist at Eco Logical Australia (permanent part time). During this time, she has been involved in a large number of systematic floristic surveys, targeted flora surveys, vegetation monitoring, the development of strategic conservation plans, other ecological assessments and an ecological expert to the NSW Land and Environment Court. She has been an employee at the National Herbarium, Royal Botanical Gardens from 1982 – 2009 and has undertaken a range of duties including various research projects and curation of the herbarium collection. Liz has extensive experience as a field botanist, has written species descriptions for the Flora of NSW, and provided technical advice at flora workshops.

RELEVANT PROJECT EXPERIENCE

Ecological Constraints / Impact Assessment

- Ingleside Biodiversity Strategy
- Pre-clearing Assessment for APZ development
- Calderwood Urban Development Ecological Survey
- South Cecil Hills Ecological Constraints Analysis
- Crudine Ridge Wind Farm Ecological Assessment (Wind Prospect)
- Ecological Impact Assessments – various (Integral Energy)
- Biobanking Pilot Assessments (DECC)
- El Caballo Blanco and Gledswood Rezoning Ecological and Bushfire Assessment (Landcom)
- Ballanagamang Biobanking Assessment (Ecotrades)
- Blacktown Olympic Park Site Expansion Flora and Fauna Impact Assessment (Blacktown City Council)
- Marsden Park Industrial Precinct Ecological Assessment & EPBC Surveys (APP)
- Alex Avenue Ecological Assessment (Landcom)
- Area 20 Ecological Assessment (GCC)
- Shoalhaven LGA Rural Residential property Flora survey
- Vegetation survey and targeted orchid survey for SEPP 5 development in Wyong LGA.
- Vegetation surveys for Integral Energy and the NSW Road & Traffic Authority and other authorities

- Raymond Terrace and Medowie Wastewater Transportation System, Hunter Water.
- Flora survey and assessment for proposed water pipeline - fennel Bay to Toronto, Hunter Water.
- Flora survey and report including assessment under EPBC and TSC Acts, Kiama LGA.

Targeted threatened species survey

- Targeted orchid survey, Buckingbong State Forest
- Various targeted flora surveys, Cumberland Plain
- Targeted flora surveys, Maroota State Conservation Area (DECCW)
- Hawkesbury City Council's Council and Crown Reserves Vegetation survey

Vegetation Survey and Mapping

- Vegetation Survey for South-east Corner Biometric Benchmark Project
- Systematic Vegetation Surveys, Upper Hunter Regional Environmental Management Strategy
- Marra NP and Muogomarra NR NPWS flora surveys
- Wetland Vegetation Surveys for LiDAR, Lowbidgee and Gwydir wetlands (DECC)
- Vegetation Survey, Durness Station, Tea Gardens, Great Lakes LGA
- Vegetation Survey, Camerons Gorge Nature Reserve, DECCW
- Vegetation Survey, Maroota State Conservation Area, DECCW
- Wingecarribee LGA Flora survey and targeted threatened species survey
- Baulkham Hills Shire Natural Assets Mapping
- Hawkesbury City Council's Council and Crown Reserves Vegetation survey

Ecological Monitoring

- Systematic surveys of long term monitoring plots within Upland Swamps, Newnes Plateau
- Systematic surveys of long term monitoring plots within Upland Swamps and Riparian communities, Metropolitan Colliery Vegetation Monitoring Program

Ecological Reviews

- EPBC Conservation Advice (DEWHA)
- Review of Threatened Species Nominations (DECCW)

Other

- Vegetation Condition Assessment, South West Slopes, DEWHA
- EPBC Referral - Cumberland Plain Woodland, Wivenhoe

Tammy Paartalu Senior Field Ecologist – Vegetation Mapping and threatened flora (moved to Eco Planning Pty Ltd, December 2016

CURRICULUM VITAE

Tammy Paartalu

SENIOR ECOLOGIST

QUALIFICATIONS

- Bachelor of Environmental Science (First Class Honours), Macquarie University. Thesis title: *Assessing the feasibility of nutrient removal at stormwater outlets using biomass: experimental and comparative studies*
- AusRivas Certification, University of Canberra
- Accredited Biobanking Assessor

Tammy is a senior ecologist with over fourteen years experience conducting and managing a diversity of ecological projects for a variety of clients including local government, the Department of Defence and the private sector. She has worked in a number of large environmental consultancies and prior to joining Eco Logical Australia.

Tammy has experience in the preparation of environment impact assessments in both terrestrial and aquatic environments, constraints and opportunities reporting, fauna monitoring and survey, vegetation and conservation management plans, Part 3A and Section 5A Assessments under the EP&A Act, Local Environment Studies, Review of Environmental Factors, Referrals, Species Impact Statements, Biocertification studies and AusRivas aquatic assessments.

Tammy is experienced in plant identification, vegetation mapping and classification, aerial photograph interpretation and detailed fauna assessments. Tammy has worked on numerous projects in a variety of locations throughout NSW, QLD, VIC and the ACT.

Tammy has undertaken numerous assessments for infrastructure projects including linear infrastructure such as powerlines / energy generation, pipelines road, rail, and wind farms. Some of her key project experience within the infrastructure sector is outlined below.

RELEVANT PROJECT EXPERIENCE

Biobanking / Biocertification

- Tahmoor Biocertification
- Ingleside Chase Biobanking Assessment
- Warringah Biobanking Assessment
- Belrose Biobanking Investigation

Wind farms

- Sapphire Wind Farm, Ecological Assessment (EA), Glen Innes, NSW (includes Biobanking Assessment) (2008-2015)
- Boco Rock Wind Farm, EA, Monaro, NSW (includes Biobanking Assessment) (2008 – 2010)
- Crudine Ridge Wind Farm EA, Sofala, Central West, NSW (includes Biobanking Assessment) (2008 – ongoing)

Vegetation Mapping

- Warringah Natural Areas Survey – Vegetation Mapping Update

- Molonglo Box Gum Woodland Mapping
- Great North Walk Natural Areas Survey
- Mapping of Endangered Ecological Communities on Council Managed Lands (Shoalhaven LGA)

Monitoring
- Metropolitan Colliery vegetation monitoring, Peabody
- Wilpinjong Mine vegetation monitoring, Peabody
- Ulan Vegetation Monitoring and Landscape Function Analysis, Ulan Coal
- Vegetation survey and monitoring, Metropolitan Colliery
- Murrumbidgee (SWS) Vegetation Monitoring Project
- Latchford Barracks and Kapooka Military Area Box Gum Woodland monitoring
- Manildra to Parkes nest box monitoring

Offsets
- Taralga Wind Farm
- Narrabri Offset Site, Ecological Assessment
- Williamsdale Offset Site Assessment – Box Gum Woodland mapping and targeted surveys for *Aprasia parapulchella* and threatened flora
- K2RQ Offset Strategy
- M2G pipeline vegetation offset monitoring

Powerlines / Power generation
- Hargraves to Windenmyer Powerline, Ecological Assessment, central NSW
- Bamarang Gas-fired Power Facility Ecological Assessment
- Integral Energy substation flora and fauna assessments throughout western Sydney

Rail
- North West Rail Link Ecological Assessment
- Kingsgrove to Revesby Rail Quadruplication Offset Strategy
- Cronulla Line Upgrade and Duplication Project

Roads
- Hume Highway Upgrade Ecological Assessment (2007)
- Ulan Road Upgrade, Mudgee flora and fauna assessment (2010)
- Richmond Road Upgrade, Western Sydney (2010)

Impact Assessment
- Tallawarra Part 3A Ecological Assessment
- Narrabeen Lagoon Multi-user Access Trail Ecological Assessment
- Numerous Part 5 Assessments throughout Western Sydney
- Vincentia Ecological Assessment
- Glossy Black Cockatoo Breeding Site Surveys, Vincentia

Rezoning
- Koompahtoo Rezoning Assessment
- Threatened Biodiversity Survey and Assessment Nowra Bomaderry Structure Plan (NBSP) Area
- Threatened Biodiversity Survey and Assessment Rezoning Assessment, Woollamia

Infrastructure / Mining
- Ulan Coal Mine Pre-clearance survey
- Ulan Coal Mine Biodiversity Management Plan and Offset Management Plan
- Pre-mining surveys numerous mines in the Hunter Valley
- Hume Highway Upgrade Environmental Assessment
- Ravensworth Mine Ecological Assessment

Aquatic Assessments
- Morwell River Diversion
- Warringah Creeks Assessment
- Hornsby Shire Council Macroinvertebrate and Diatom Monitoring
- Aquatic habitat assessments for a variety of projects including rail and road projects.

Greg Steenbeeke, Senior Field Ecologist – Vegetation Mapping and threatened flora (seconded form OEH Jan 2016 to January 2017

CURRICULUM VITAE

Greg Steenbeeke

SENIOR ECOLOGIST

QUALIFICATIONS

- Bachelor of Science, University of Sydney. Honours in vegetation mapping and analysis, 1990.
- Post-graduate Diploma in Education, secondary education, University of Western Sydney, 1991.
- Master of Environmental Management, University of New England, 2006.
- Certificate IV in Project Management
- Accredited BioBank, Major Projects FBA and Biocertification Assessor

Greg has more than 25 years of botanical and ecological research experience in New South Wales and southern Queensland: Sydney Basin, North Western Slopes and Plains, New England and Central Tablelands, NSW North Coast and South-east Queensland, often to remote areas. He holds a Bachelor of Science with Honours in vegetation mapping and analysis, a Masters of Environmental Management and has also obtained a graduate Diploma in Education as well as a number of certificate-level courses. Greg's primary expertise is in environmental assessment – in particular in vegetation assessment, monitoring and plant identification in both dry land and wetland habitats. He has been involved in regional and state-scale vegetation mapping projects, as well as intensive site assessments for ecological attributes. He has accreditation in Biobanking and Property Vegetation Planning and was involved in developing and refining both systems within the NSW Office of Environment and Heritage and its predecessors. Apart from life sciences he also has a strong background in geology, governance and policy, and environmental restoration and rehabilitation, as well as community and adult education.

Greg has gained his experience working in NSW government as an ecologist or vegetation expert in their environmental management agencies. Greg recently joined Eco Logical Australia as a Senior Ecologist specialising in vegetation work. He brings to the role a significant involvement with a large number of systematic floristic surveys, targeted flora surveys, vegetation monitoring, development of management and implementation plans at scales from the single property to regional assessments. He has also received training as an expert witness. Greg has extensive experience as a field botanist, has provided significant technical expertise to the development of environmental assessment systems and provided technical advice at environmental management workshops as well as authoring books and guides in the subject. He maintains an active role in botanical taxonomy and has been an author for newly-described species.

RELEVANT PROJECT EXPERIENCE

Ecological Constraints / Impact Assessment (including BioBank Assessments)

- Departmental reviewer role for submissions through legislative instruments within OEH/DECCW
- Undertook Biobanking Pilot Assessments as part of development of BioBanking Scheme (DECC 2006)
- Preliminary BioBank Assessment for "Grasstrees" property, Capertee Valley (Eco Trades Pty Ltd, 2007).
- BioBank Assessments: Noorumba Reserve, Campbelltown City Council (2016); Brownlow Hill (stage 4, 2016); Windemere (2016); Rockview South (2016); Tangari (2016); Taralga (2016); Arcadia (2016); Waitara Creek (2016) and others as required
- Constraints assessments: Luddenham Road corridor (2016); Huskisson West (2016); Mount Gilead west (2016)
- Flora and Fauna Assessments: Kiama (2016); Royalla (2016) ; Vineyard pipeline (2016)

Targeted threatened species survey

- Various targeted flora surveys, Cumberland Plain, Blue Mountains and North Wests Slopes regions

- Targeted threatened species surveys in Capertee Valley, Burragorang Valley, Northern Tablelands and SE Queensland.

Vegetation Survey and Mapping
- Kowmung Valley Vegetation Mapping
- Lower Macquarie Valley floodplain and associated lands surrounding Macquarie Marshes
- Native Vegetation Mapping Project – northern regions: Moree – Kaputar; Nandewar; Brigalow Belt South
- Vegetation Mapping – Western Blue Mountains region

Ecological Monitoring
- *Micromyrtus minutiflora* long-term monitoring sites establishment and baseline as part of the Saving our Species project
- Team leader, Wildcount monitoring for NPWS, 2013, 2015.
- Central Hunter Woodland Vegetation Assessments (2016)
- Metro Colliery upland wetlands monitoring (2016)

Ecological Reviews
- EPBC Conservation Advice (DEWHA) and involvement as state expert in teams developing Recovery Plans for Sydney Turpentine Ironbark Forest, Blue Gum High Forest and the multi-entity Cumberland Region Multispecies Plan (in development).
- Review of and provision of expertise to Threatened Species Nominations (EPBC and NSW TSC) for the relevant Scientific Committees.
- Growth forms and lifeform categorisation for NSW flora species (2005-2016)

Technical Review
- Member of the Technical Working Group for Border Rivers-Gwydir CMA.
- Member of the Technical Working Group for the Western Regional Assessment – Bioregional Assessment of the Brigalow Belt South bioregion.
- Member of the Technical Review Panel for Threatened Species assignments and projects in the NSW Government Saving Our Species program.

Training and Education
- Coordinated and assisted with presenting the Roadside Environment Environmental Assessment workshops for Border Rivers-Gwydir CMA.
- Delivered training on taxonomy and nomenclature, and on simple environmental impact recognition for certificate students in Conservation and Land Management.
- Training workshops in *Plant Propagation* and *Identifying Plants*.
- Trainer / Presenter for *Environmental Assessment* units within Property Planning courses for Border Rivers-Gwydir CMA
- Trainer / Presenter in *Part 5 - Review of Environmental Factors* training for Local Government.

Other
- Review and maintenance of the NSW Vegetation Survey database with NSW DECCW.
- Assisting students (in a supervisor-assistance capacity) on research into vegetation on serpentine and ultramafic soils.
- Editor for the journal *The Orchadian* (2012-2015).
- Various peer reviews for technical and scientific journals including *Cunninghamia*, *Ecological Management and Restoration* and *Telopea*.

Publications
- 2014 – *Thismia megalongensis* (Thismiaceae), a new species of *Thismia* from New South Wales (in *Telopea*)
- 2013 - *Managing and Conserving native Vegetation* (Border Rivers – Gwydir Catchment Management Authority) as co-editor and author of several chapters.
- Various short articles to grey-literature journals including The Orchadian

Trade and other certifications
- Construction Induction (White Card) – Number CGI0129696SEQ01
- Maritime / Boat Driver's Licence 744062
- UWS Contractor – Issued 14 / 11 / 2011
- Class C drivers Licence
- PADI Open Water Diver
- Apply First Aid 03/04/2013

Dr Rodney Armistead – Senior Field Ecologist – threatened fauna

CURRICULUM VITAE

Dr Rodney Armistead

ECOLOGIST

QUALIFICATIONS

- PhD in Conservation Biology from Murdoch University, Perth Western Australia. The impact of Phytophthora Dieback on the Mardo or Yellow Footed Antechinus (*Antechinus flavipes leucogaster*).
- Bachelor of Advanced Science (Honours), Deakin University, Geelong. A phylo-genetic assessment of Swamp Antechinus (*Antechinus minimus*).

Rodney is an ecologist with a Doctor of Philosophy in Conservation Biology with 14 years' experience in environmental research and consulting. Rodney has considerable experience conducting flora, Phytophthora Dieback, terrestrial and aquatic fauna assessments across a variety of desert, alpine, coastal, woodland, tall forests, aquatic and urban habitats in Western Australia, Victoria, Tasmania and New South Wales. He has particular experience in establishing and conducting large broad scale mammals, reptile, frog as well as bird population, biodiversity and presence-absence surveys. He has had the pleasure of surveying such threatened and iconic native fauna species as the Green and Golden Bell Frog, Growling Grass Frog, Spotted Tree Frog, Striped Legless Lizard, Grassland Earless Dragon, Guthega Skink, Grey-headed Flying-foxes, Western and Northern Quoll, Pilliga Mouse, Southern Brown Bandicoots, Brush-tailed Phascogale, Brush-tailed Bettong, Platypus and the Mountain Pygmy Possum.

RELEVANT PROJECT EXPERIENCE

Impact assessments and large scale flora and fauna surveys

- Moxham Quarry, Flora and Fauna Assessment at Moxham Quarry, Northmeade, NSW.
- Bong Road, Flora and Fauna Assessment, West Dapto, NSW
- The Crescent, Flora and Fauna Assessment Helensburgh,
- Bringelly Rd, Flora and Fauna Assessment, Bringelly
- Bingara Gorge, Flora and Fauna Assessment
- Shellharbour wetlands, Flora and Fauna Assessment
- Yennora, Ecological Constraints Assessment
- Calvary, Ecological Constraints Assessment, Victoria Road, Ryde

Targeted Species Surveys and Ecological Monitoring

New South Wales

- Migratory shorebirds and Waders at Cronulla and Kurnell.
- Green and Golden Bell Frog Surveys at Cronulla, Kurnell, Enfield, Port Kembla and Sydney Olympic Park.
- Long-nosed Bandicoot, Inner Western Sydney threatened Population
- Guthega Skink Surveys. Perisher
- Pilliga Mouse surveys in the Pilliga State Forest
- Spot-tail Tiger Quoll surveys in Pilliga State Forest
- New Holland Mouse Surveys in the Pilliga State Forest
- Spot-tail Quoll, Eastern Pygmy Possum, Southern Brown Bandicoot, Giant Burrowing Frog and Broad Headed Snake surveys at Coalcliff

- Grey-headed Flying-fox camp static and fly-out population assessments at Kareela, Cannes, Parramatta River, Burnt Bridge Creek (Manly) and Wolli Creek Camps
- Grey-headed Flying-fox - preparation of management plans for Kareela, Cannes, Parramatta River, Burnt Bridge Creek (Manly) and Wolli Creek Camps
- Grey-headed Flying-fox – assistance and guidance with the preparation of the dispersal plan for the Kareela GHFF camp
- Grey-headed Flying-fox – Vegetation Management Plan for the Centennial Park Flying-fox Camp
- Microchiropteran bat harp-net live capture at Lake Keepit and a Kellyville culvert
- Microchiropteran bat anabat recording and data interpretation at Sydney, Wollongong, Lake Keepit, Mudgee and Newcastle

Western Australia

- Dibbler surveys on Boulanger and Whitlock Islands (University of Western Australia)
- Woylies or Brush-tail Bettong surveys in the southern Jarrah Forest and Dryandra Woodlands (Murdoch University)
- Southern Brown Bandicoot and Brush-tail Phascogale surveys in urban Busselton
- Northern Quoll, Pebble-Mound Mouse and Mulgara surveys in the central and southern parts of the Pilbara (Fortescue Metals and BHP)
- Mulgara, Sandhill Dunnart, Long-tailed Dunnart and Marsupial Mole surveys in the Great Victoria Desert (ecologia, Western Australia Museum and Department of Environment and Sustainability (DSE))

Victoria

- The distribution of Swamp Antechinus in the eastern Otway Ranges. (Deakin University)
- The distribution of Swamp Antechinus on Greater Glennie Island, Bass Strait (Deakin University)
- The distribution of New Holland Mouse at Anglesea and Wilson's Promontory
- The distribution and status of Mountain Pygmy-possums on Mount Buller, Mount Hotham and Bogong High Plains. (Parks Victoria).
- Spotted Tree Frog surveys in north-eastern Victoria (Parks Victoria).
- Platypus surveys in Melbourne's urban Melbourne's urban waterways (Melbourne Water)
- Modified gill net platypus surveys in the Wimmera region. (Project Platypus and Wimmera Catchment Management Authority)
- Platypus surveys in the Mackenzie River, Grampians National Park. (Wimmera Catchment Management Authority)
- Growling Grass Frog surveys in the urban growth areas of Werribee, Cranbourne and outer Melbourne.
- Plains Wanderer surveys in the urban growth areas of Werribee.
- Golden Sun Moth surveys in the urban growth areas of Werribee, Cranbourne and outer Melbourne.
- Micro-bat anabat recording surveys in the urban growth areas of Werribee, Cranbourne and outer Melbourne
- Striped Legless Lizard surveys in the urban growth areas of Melbourne.
- Grassland Earless Dragon surveys in the urban growth areas of Werribee
- Dwarf Galaxias surveys in urban waterways of the Mornington Peninsula, Melbourne.
- Dwarf Galaxias relocation surveys in urban waterways of the Mornington Peninsula, Melbourne.
- Broad Toothed Rat surveys in areas impacted by the Black Saturday Fires
- The distribution of Shearwater and Little Penguin nests and reproductive success on Phillip Island (Phillip Island National Park)

Publications

Western Australia

- Dunstan, W. A., Rudman, T. Shearer, B. L., Moore, N. A., Paap, T., Calver, M. C., Armistead, R. Dobrowolski, M. P., Morrison, B., Howard, K., O'Gara, E., Crane, C., Dell, B., O'Brien, P., McComb, J. A., and Hardy, G. E. St J. (2008) Research into natural and induced resistance in Australian native vegetation of Phytophthora cinnamomi and innovative methods to contain and/or eradicate within localised incursions in areas of high biodiversity in Australia. Eradication of *Phytophthora cinnamomi* from spot infections in native plant communities in Western Australia and Tasmania. Prepared by the Centre for Phytophthora Science and Management for the Australia Government Department of the Environment, Water, Heritage and the Arts.

Victoria

- Cahill, D. M., Wilson, B. A., and Armistead, R. J. (2001). Dieback assessment at Fairhaven Ridge, Ganghook – Lorne State Park, Victoria. A report to Parks Victoria.
- Cahill, D. M, Wilson, B. A., and Armistead, R. J. (2001). Assessment of *Phytophthora cinnamomi* (cinnamon fungus) at Coalmine Road, Anglesea Alcoa lease, Victoria. As report for Alcoa World Alumina, Anglesea.
- Cahill, D. M., Wilson, B. A., and Armistead, R. J. (2001). Assessment of Phytophthora dieback, *Phytophthora cinnamomi* in the Otway National Park, Victoria. A report for Parks Victoria for the Great Ocean Walk.
- The distribution of platypus in waterways in greater Melbourne: spring 2008 and autumn 2009 survey results.

A report prepared by Dr. R. Armistead and Dr. A Weeks for Melbourne Water (2009).

- The distribution of platypus in waterways in greater Melbourne: spring 2009 and autumn 2010 survey results. A report prepared by Dr. R. Armistead and Dr. A Weeks for Melbourne Water (2009).
- The distribution of platypus in waterways in the McKenzie River, Grampians National Park 2008 and 2009 survey results. A report prepared by Dr. R. Armistead and Dr. A Weeks for Wimmera Catchment Management Authority (2009).
- The Mount Hotham Mountain Pygmy Possum Recovery Plan (Biosis Research, Mount Buller and Mount Stirling Alpine Resort Management Board and Parks Victoria)

New South Wales

- Eco Logical Australia (2012). Cannes Reserve, Avalon – Grey-headed Flying-fox camp Management and Species Impact Statement. A report to Pittwater Council
- Eco Logical Australia (2013). Kareela Grey-headed Flying-fox camp management plan. A report to Sutherland Shire City Council
- Eco Logical Australia (2013). Parramatta River Grey-headed Flying-fox camp management plan. A report to NPC Consultants
- Eco Logical Australia (2015). Wolli Creek - Grey-headed Flying-fox camp management plan. A report to Rockdale City Council
- Eco Logical Australia (2015). Burnt Bridge Creek - Grey-headed Flying-fox camp management plan. A report to Manly City Council

Memberships

- Australasian Bat Society.
- Foundation for Australia's Most Endangered Species Ltd

Jack Talbot – Field Ecologist – threatened fauna (left ELA 2017)

CURRICULUM VITAE

Jack Talbert

ENVIRONMENTAL CONSULTANT

QUALIFICATIONS

- Bachelor of Environmental Science (Honours): Major in Land Resources University of Wollongong – 2012
- Rail Industry Safety Induction (RISI)/Rail Industry Work Training – 2014
- OEH approved Grey-headed Flying Fox expert – 2015
- National OHS Construction Induction Training (White Card) – 2010

Jack is an Environmental Consultant who joined Eco Logical Australia in 2013. Jack has over 6 years' experience in the environmental science and consulting sector with a primary focus on planning and approvals and ecological assessments. As a requirement of this role, Jack is well versed in Australian environmental legislation, including the EPBC Act, TSC Act, EP&A Act, FM Act and WM Act.

During his time at ELA Jack has managed numerous large project approvals and referrals under the Commonwealth EPBC Act, as well as Biocertifcation Strategic Assessments under the NSW TSC Act. His clients include some of Australia's largest and most well respected community developers and government departments. He has conducted an array of ecological assessments, both terrestrial and aquatic, across a large portion of NSW and the ACT. His experience includes flora and fauna assessments, riparian assessments, controlled activity approvals, vegetation community mapping, nocturnal surveys, hollow bearing tree assessments and felling supervision, as well as more specialised services including Grey-headed Flying Fox camp management and Green and Golden Bell Frog management plans. He also has highly developed technical skills that can be successfully applied to undertake high quality map production and spatial data analysis using Geographic Information Systems (GIS).

Jack completed a Bachelor of Environmental Science (Honours) at the University of Wollongong in 2012. Jack's honours thesis involved a retrospective analysis of beach morphology incorporating photogrammetric data with LiDAR data to assess the movement of sediment within selected beach embayments along the Wollongong coastline. This helped to inform the Wollongong City Councils' Plan of Management for their coastline. Recommendations were adopted by the council and implemented in a subsequent dune reprofiling project in the Illawarra.

Previously Jack has worked within a Hydrogeological and Environmental Consultancy specialising in groundwater resource definition, testing, assessment certification and associated environmental management extending over a large part of NSW and ACT.

Jack is currently working as an Environmental Consultant, within the planning and approvals discipline, located at the Wollongong office of Eco Logical Australia.

RELEVANT PROJECT EXPERIENCE

Planning and Approvals

- South Campbelltown – Rezoning Strategic Assessment (Mir Group of Companies)
- Mt Gilead – EPBC Act Referral (Lend Lease)
- Mt Gilead Dwzonniks Property – EPBC Act Referral (Lend Lease)
- Mt Gilead – Sydney Water Advice and Constraints (AECOM)
- Sydney Science Park – EPBC Act Referral (Celestino)
- Bingara Gorge Residential – EPBC Act Referral and Preliminary Documentation (Lend Lease)
- Port Macquarie Airport – EPBC Act Referral (Port Macquarie Hastings Council)
- Tamala Park Regional Council/Satterly – EPBC Act Approvals and Advice, Compliance Reporting (Catalina Residential Community)
- Site 68 Multi-story Development - EPBC Act Referral and Advice(Sydney Olympic Park Authority)
- Sutton Road Driver Training Centre – EPBC Act Referral (Canberra Institute of Technology)
- Jacaranda Ponds – EPBC Act Referral (Celestino)
- Riverstone, Vineyards, Leppington, Marsden Park - Biodiversity Consistency Reporting (Department of Planning and Environment)
- Eastern Creek Business Hub - EPBC Act Approvals and Advice (Western Sydney Parklands Trust)
- El Caballo Blanco, Gledswood, Lakeside Residential - EPBC Act Approvals and Advice (Sekisui House)
- Emerald Hills Estate - EPBC Act Approvals and Advice (Macarthur Developments)
- Harrington Grove Residential - EPBC Act Approvals and Advice, Compliance Reporting (Harrington Estates)
- Caval Ridge Mine - EPBC Act Approvals and Advice (BMA)
- Gregory Hills Road Extension – Controlled Activity Approval (Dart West Developments)
- Gregory Hills South Creek – Controlled Activity Approval (Dart West Developments)
- Brickpit Referral - EPBC Act Approvals and Advice (Austral Bricks)
- Narrabri Operations - EPBC Act Approvals and Advice (Santos)

Ecology

- Rydalmere Kirby Street – Flora and Fauna, Riparian, and Bushfire Assessments (Mecone)
- HMAS Creswell – Hyams Beach – Flora and Fauna Assessment (Spotless Facilities)
- Gregory Hills Road Extension – Pre-construction Ecology Works (Dart West Developments)
- Batemans Bay – Grey-headed Flying Fox Active Dispersal (Eurobodalla Shire Council)
- Bulli Hospital Hill – Ecological Constraints Analysis (Alex Urena Design Studio)
- Kareela – Grey-headed Flying Fox Active Dispersal (Sutherland Shire Council)
- Leumea Residential – Koala Nocturnal Surveys (Michael Brown Planning Strategies)
- Kentlyn – Weed Management Plan and Koala Management Plan (Neil Singh)
- Manooka Valley – Gregory Hills – Hollow Bearing Tree Assessment and Nest Box installation (TRM)
- Quakers Hill – Westlink M7 – Constraints Analysis – (AAVJ)
- Swan St Wollongong, Forest Rd Gymea – Sydney Water Validation Assessments and Arboricultural Assessments (Diona)
- El Caballo Blanco Sewer – Flora and Fauna Assessments (Sekisui House)
- Mt Ousely – Tree Felling Supervision (Burnett Trees)
- Bingara Gorge – Weed Management Plan (Cardno)
- Barry Road, Kellyvilles – Clearance Supervision (Design + Planning)
- Warrawong – Green and Golden Bell Frog Management Plan (Kennards Self Storage)
- Oran Park Sewer Main – Clearance Supervision
- Mardsen Park, Townsen Road – Weed Management Plan (Arcadis)
- Cobbity – Biocertification Letter
- Gregory Hills Upper Canal – Pre-clearance and Clearance Supervision (Dart West Development)
- Arncliffe Train Station – Pigeon Nest Removal (NSRU Alliance)
- Rossmore Minh Giac Buddhist Temple – Flora and Fauna Assessment (Formacon Building)
- Berkeley Vale Stage 1 – Hollowing Bearing Tree Assessment (Investa Land)
- Hillview Kellyville all stages – Hollow Bearing Tree Assessment
- Bald Hill Reserve – Flora and Fauna Assessment (Wollongong City Council)
- Moolarben Coal Operations – Spring Fauna Monitoring (Moolarben Coal Operations)
- Moolarben Coal Operations – Hollow Bearing Tree Assessment (Moolarben Coal Operations)
- Ulan Surface Operations – Tree felling supervision (Glencore/Xstrata)
- Pilliga State Forest – Flora and Fauna Surveys (Santos)
- Caval Ridge – Offsets Management Plan (BHP)

- McPhails Residential Development – Species Impact Statement (Don Fox Planning)
- El Caballo Blanco – Flora and Fauna Surveys, Federal Approval of Offsets (Sekisui House)
- Eastern Creek Business Hub – Federal Approval of Offsets (Western Sydney Parklands)
- Emerald Hills Estate – Federal Approval of Offsets (Macquarie Developments)
- Ashlar Golf Course – Green Star Rating Report and Nocturnal Surveys
- Parramatta Park – Flying Fox Population Assessment

Aquatic Ecology

- Moolarben Coal Operations – Stream Stability Assessment (Moolarben Coal Operations)
- HMAS Creswell – Creswell Foreshore – Aquatic Ecology Assessment (Jirgens Civil)
- Rouse/Box Hill – Aquatic Ecology Assessments (Private Developer)
- Caledonia Edgelands – DPI Water Headwater Reclassification (Saturday Studio)
- Grays Point – Aquatic Ecology Assessments (Chris Parkhill Developers)
- Wollongong City Council – Continental Swimming Pool Aquatic Ecology Assessment
- McPhails North – Dam Dewatering and Fauna Relocation (Stocklands)
- Port Hacking Aquatic Surveys – Dredging assessment for Fishing Management Act (Sutherland Council)
- Lime Kiln Bay Wetland – Water Quality Assessment (Hurstville Council)
- El Caballo Blanco – Microbat and Green and Golden Bell Frog Nocturnal Surveys (Sekisui House)
- The Ponds Wetland Restoration – Aquatic Fauna Translocation
- Port Kembla Green and Golden Bell Frog Translocation Plan
- Western Sydney Grown Precinct Riparian Assessment and Top of Bank Mapping
- Department of Planning and Infrastructure Riparian Assessment (Riverstone, Ingleside, Vineyards)
- Wollondilly Council – Top of Bank Mapping

Hydrogeology and Contaminated Sites

- Invincible Colliery Lithgow – Annual Groundwater Monitoring
- Mt Kosciusko National Park – Underground Storage Tank Decommissioning and Soil Validation
- Southern Highlands Coal Action Group Hydrogeological Assessment – Berrima region/Boral Colliery
- Southern Highlands Coal Action Group Hydrogeological Assessment – Sutton Forest region
- Cabonne Council; Canowindra, Cudal, Eugowra –Sewerage Treatment Plant Groundwater Monitoring
- Palerang Council; Bungendore Town Water Supply – Hydrogeological Assessment
- Mt Penny – Quarterly Hydrogeological Assessment and Groundwater Monitoring
- Jerrabomberra Wetlands, ACT – Hydrogeological Assessment
- Tyco Water Sydney – Environmental Monitoring
- Shoalhaven City Council – Landfill Environmental Monitoring
- Wollongong City Council – Coastal Zone Study
- Boggabri Coal - Hydrogeological Assessment and Pump Tests
- Black Wattle Bay – Phase 1 Site Investigation
- Fairfield Council – Phase 1 Site Investigation and Targeted Soil Sampling
- S&Q Projects Leichhardt – Phase 1 Site Investigation
- Australian Enviro Services – UST Validation, Targeted Soil Sampling, Installation of Monitoring Bores
- Burrill Lake – Soil Validation Sampling & Analysis
- Various Residential – Soil Validation Sampling and Reporting
- Boggabri Coal Hydrogeological Assessment and Pump Tests

Mitchell Scott– Field Ecologist – threatened fauna (left ELA 2018)

CURRICULUM VITAE

Mitchell Scott

ENVIRONMENTAL CONSULTANT / ECOLOGIST ***(UPDATED MAY 2018)***

QUALIFICATIONS AND PREVIOUS POSITIONS

- Bachelor of Science (Biology, and Environmental Studies) - Honours (Class I - Ecology) University of Sydney 2012
- Research Assistant – Macquarie University, Sydney 2013
- Research Assistant – Australian National University (ANU), Canberra 2014
- National OHS Construction Induction Training (White Card) 2016
- Lyssavirus immunized - July 2016
- Rail Industry Safety Induction (RISI) Card – 2017

Mitchell is an Environmental Consultant and Ecologist with over 4 years post-graduate experience in environmental consulting and ecological surveys. He has been with ELA since 2015, working with variety of clients at the local (Property Development; Engineering Firms), state (Office of Environment and Heritage [OEH]; NSW Department of Planning & Environment) and federal levels (Department of Environment and Energy).

Mitchell has worked clients from an urban context (UrbanGrowth) and a rural context (Biodiversity Stewardship Sites; Transgrid). He has worked with a variety of stakeholders, including government, private groups, landholders, universities, Indigenous communities and Traditional Owners. He may be utilized in any given stage of a project, from proposal scope, field work, data analysis, use of GIS, report writing, client consultation, and project management.

Mitchell is experienced in assessments under the NSW *Biodiversity Conservation Act 2016* (BC Act) (including BAM methodology and the preparation of BDARs) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Prior to joining ELA, he worked with the Indigenous Yugul Mangi Rangers in southeast Arnhem Land conducting cross-cultural ecological research.

RELEVANT PROJECT EXPERIENCE - SELECT PROJECTS

<u>Project Management</u>

- **Waterloo State Significant Precinct (SSP):** Redevelopment, urban ecological strategy, impact assessment, and community consultation (UrbanGrowth)
- **Flora and Fauna Assessment (FFA) and Biodiversity Management Plan (BMP):** Supporting a Development Application (Aveo Group)
- **Flora and Fauna Assessment (FFA)**: Supporting of rezoning application (Southern Metropolitan Cemeteries Trust)
- **Environmental Planning Advice:** Western Sydney development (Northrop Consulting Engineers Pty Ltd.)

<u>Ecological Surveys</u>

- **Biodiversity Development Assessment Reports (BDAR) using the Biodiversity Assessment Methodology (BAM):** Developments within Greater Sydney Region
- **Mine annual Biodiversity Monitoring, including monitoring of flora and fauna species, and stream stability:** Projects in the Hunter Valley and Central West
- **Nest box monitoring and assessment** (Transgrid: Parkes, New South Wales)
- **Cross-cultural Biodiversity Surveys:** with Yugul Mangi Rangers, SE Arnhem Land, NT.
- **Fauna survey and monitoring:** Operation Wallacea, Buton Island, Sulawesi, Indonesia
- **Fauna survey and monitoring:** Kakadu National Park, NT.

Examples of threatened flora species detected from targeted surveys

- ***Ammobium craspedioides* (Yass Daisy):** Crookwell, NSW, Biobank Site Assessment (Private Landholder)
- ***Darwinia biflora***: Kellyville, Development Application (Group Development Services)
- ***Grevillea juniperina* subsp. *juniperina*:** Blacktown, NSW, Ecological Assessment (Blacktown City Council)
- ***Pimelea spicata* (Spike Rice-flower)**: Camden, NSW, Biobank Site Assessment (Private Landholder)
- ***Prostanthera marifolia**:* Manly, NSW, Saving Our Species (SOS) Project, OEH
- ***Pterostylis ventricosa:*** Jervis Bay, Biobank Site Assessment (Private Landholder)

Examples of threatened fauna species detected from targeted surveys

Amphibians

- ***Litoria aurea* (Green and Golden Bell Frog):** primarily Western Sydney developments (Sydney Olympic Park Authority [SOPA]; Celestino Developments; Orion Consulting Engineers)
- ***Pseudophryne australis* (Red-crowned Toadlet):** Glenorie, NSW, Development Application (Group Development Services).

Mammals (not including microbats)

- ***Cercartetus nanus* (Eastern Pygmy Possum):** Jervis Bay, Biobank Site Assessment (Private Landholder)
- ***Macrotis lagotis* (Greater Bilby):** Tanami Desert, NT (Infrastructure Project)
- ***Petaurus norfolcensis* (Squirrel Glider):** Crookwell, NSW, Biobank Site Assessment (Private Landholder)
- ***Sminthopsis leucopus* (White-footed Dunnart):** Jervis Bay, Biobank Site Assessment (Private Landholder)
- ***Petaurus volans* (Greater Glider):** South Coast NSW, Biobank Site Assessment (Private Landholder)
- ***Phascolarctos cinereus* (Koala):** South Coast NSW, Biobank Site Assessment (Private Landholder)
- ***Pteropus poliocephalus* (Grey-headed Flying-fox):** Monitoring / Dispersal Program - Eurobodella Council, South Coast NSW.

Microbats from Anabat analysis and harp trapping (Impact Assessments; Biobanking; Mine Monitoring):

Non-threatened:

- ***Nyctophilus geoffroyi (Lesser Long-eared Bat); Vespadelus vulturnus (Little Forest Bat); Scotorepens balstoni (Inland Broad-nosed Bat); Mormopterus (Ozimops) planiceps (Southern Freetail Bat).***

Threatened

- ***Falsistrellus tasmaniensis (Eastern False Pipistrelle)***
- ***Myotis macropis (Southern Myotis)***
- ***Saccolaimus flaviventris (Yellow-bellied Sheathtail Bat)***
- ***Scoteanax rueppellii (Greater Broad-nosed Bat)***
- ***Vespadelus troughtoni (Eastern Cave Bat)***

Birds

- ***Pomatostomus temporalis* (Grey-crowned Babbler):** Mine annual fauna monitoring (Mudgee Region)
- ***Polytelis swainsonii* (Superb Parrot):** Mine annual fauna monitoring (Mudgee Region)
- ***Daphoenositta chrysoptera* (Varied Sittella):** Mine annual fauna monitoring (Mudgee Region)
- ***Neophema pulchella* (Turquoise parrot):** Biobanking Project, Crookwell (Private Land Holder)
- ***Climacteris picumnus* (Brown Treecreeper):** Mine annual fauna monitoring (Mudgee Region)

- ***Ninox strenua* (Powerful Owl):** Biodiversity Management Plan for Ingleside, Sydney
- ***Callocephalon fimbriatum* (Gang-gang Cockatoo):** Flora and Fauna Assessment, ACT
- ***Calyptorhynchus lathami* (Glossy Black Cockatoo):** Flora and Fauna Assessment, South Coast NSW

Invertebrates

- ***Meridolum corneovirens* (Cumberland Plain Land Snail):** Western Sydney developments, NSW.

Reptiles:

- ***Hoplocephalus bungaroides* (Broad-headed Snake):** Research Projects with University of Sydney and NSW Parks and Wildlife Services.
- ***Ergernia kintorei* (Great Desert Skink):** Tanami Desert, NT (Infrastructure Project)

ACADEMIC PUBLICATIONS

Putting Indigenous conservation policy into practice delivers biodiversity and cultural benefits.
Ens, E., **Scott, M.L.,** Yugul Mangi Rangers, Moritz, C., and Pirzl, R. (2016) *Biodiversity and Conservation.* DOI:10.1007/s10531-016-1207-6. Accessible here: http://link.springer.com/article/10.1007%2Fs10531-016-1207-6

Multilocus phylogeography reveals fractal endemism in a gecko across the monsoonal tropics of Australia.
Moritz, C., Fujita, M., Rosauer, D., Agudo, R., Bourke, G., Doughty, P., Palmer, R., Pepper, S. Potter, R. Pratt, M., **Scott, M.L.** Tonione, M., & Donnellan, S. (2015) *Molecular Ecology,* DOI: 10.1111/mec.13511

Territoriality in a snake.
Webb, J.K., **Scott, M.L.**, Whiting, M.J. and Shine, R. (2015) *Behavioural Ecology and Sociobiology*, 69:1657-1661

Chemoreception and mating behaviour of a tropical Australian skink.
Scott, M.L., Llewelyn, J., Higgie, M., Hoskin, C.J., Pike, K. and Phillips, B.L. (2015) *Acta Ethologica*, 18(3):283-293.

Chemosensory discrimination of social cues mediates space use in snakes, *Cryptophis nigrescens*.
Scott, M.L., Whiting, M.J., Webb, J.K., and Shine, R. (2013), *Animal Behaviour*, 85(1493-1500).

Alex Gory – Field Ecologist – threatened fauna

CURRICULUM VITAE

ALEX GOREY

ECOLOGIST

QUALIFICATIONS

- Master of Sustainability: University of Sydney – 2015.
- Bachelor of Science: Double major in Environmental Science and Geography, University of Sydney – 2012.
- National OHS Construction Induction Training (White Card) – 2016.
- Lyssavirus Vaccinated December 2016.

Alex has worked as an ecologist for over 3 years. Alex has experience in managing and conducting ecological surveys and reporting associated with the preparation of Flora and Fauna Assessments and Biodiversity Development Assessment Reports under the Biodiversity Assessment Methodology (BAM). Alex is practiced in the application of the NSW *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and other relevant legislation for a range of stakeholders, including land holders, private groups and government. Alex has extensive experience in the preparation of a range of environmental report writing, including constraints advice, planning proposals, Federal referrals and preliminary documentation, Flora and Fauna Assessments, Management Plans, Review of Environmental Factors and Biodiversity Development Assessment Reports.

Prior to joining Eco Logical, Alex completed a Master of Sustainability at the University of Sydney. Alex's research project involved working with Taronga Zoo's sustainability department to improve environmental compliance and help deliver the integration of voluntary sustainability initiatives. Alex also has experience in GIS mapping of coastal environments and assessing both terrestrial and aquatic flora and fauna. Alex has also worked on delivering sustainable economic empowerment for subsistence farming communities in Tanzania.

RELEVANT PROJECT EXPERIENCE

BBAM and BAM Assessments

- Calderwood BDAR Assessment
- Mt Gilead BioBanking Assessment
- Mt Brown BioBanking Assessment
- Cawdor BioBanking Assessment
- Wambo Coalmine Peabody – Hunter Valley
- Rickards Road, Castlereagh – BioBanking Assessment

Planning Proposals and Rezoning

- South Campbelltown Planning Proposal (Mir Group of Companies)
- West Dapto Planning Proposal (Stocklands)
- Jacaranda Ponds Planning Proposal (Celestino)
- Sydney Science Park Planning Proposal (Celestino)

- Corrimal Cokeworks Planning Proposal (Legacy Property)
- Kiama Saddleback Mountain Rd Planning Proposal(Unicomb Development Services Pty Ltd)
- Elizabeth Street, Redfern Planning Proposal (Land and Housing Corporation NSW)

Federal Approvals

- Macarthur Gardens North Preliminary Documentation (Land and Housing Corporation NSW)
- Rickards Road, Castlereagh Post Approvals Management and Referral
- Jacaranda Ponds Preliminary Documentation (Celestino)
- El Caballo Blanco Gledswood Hills Post Approvals Management (Sekisui House)
- CSR Horsley Park Post Approvals Management (CSR & Calibre Consulting)

Impact Assessments

- Barkers Mill - Biodiversity and Riparian Assessment (Macarthur Developments)
- Canyonleigh – Flora and Fauna Assessment (Highlands Heavy Industries)
- Coalcliff - Flora and Fauna Assessment (Ingham Planning)
- Cromer – Flora and Fauna Assessment (Brewster Murray Architects)
- Elizabeth Macarthur Creek – Flora and Fauna Assessment (AECOM)
- Freemans Reach – Vegetation validation and targeted flora and fauna surveys (Celestino)
- Kingswood – Ecological Constraints Analysis
- Delhi Road Upgrade – Flora and Fauna Assessment
- Jacaranda Ponds – Rezoning Planning Proposal
- Oakdale – Constraints Analysis (Michael Brown Planning)
- Quakers Hill – Constraints Analysis (AECOM)
- Western Sydney Parklands Trust – Ecological Constraints Analysis
- Wollongong LGA– Review of Environmental Factors (Wollongong City Council)
- Calderwood Valley – Flora and Fauna Assessments and Ecological Constraints Analysis (Lendlease)
- Gregory Hills Sewer Pipeline - REF (Dart West Developments)
- Kogarah Sewer Pipeline - REF (Rose Atkins Rimmer Infrastructure)
- Camden Road Sewer Pipeline - REF (Rose Atkins Rimmer Infrastructure)
- Riverstone Sewer Pipeline – REF (Rose Atkins Rimmer Infrastructure)

Fauna Handling and Clearance Supervision

- Kellyville Residential subdivision – Dam Dewatering
- Mt Carmel – Hollow bearing tree clearance supervision (Western Earthmoving)
- Schofields – Hollow bearing tree clearance supervision (North Western Surveys)
- El Cabello Blanco Cumberland Plain Land Snail clearance survey (Cardno)
- Glenmore Park Cumberland Plain Land Snail clearance survey (CCL Developments)

Threatened Fauna Management Plans

- Horsley Nest Box Management Plan (Allan Price and Scarratts)
- Manooka Valley – Hollow Bearing Tree Assessment and Nest Box Installation Plan (Green Fields Development Company)
- Warrawong Green and Golden Bell Frog Management Plan (Kennards Self Storage)
- Riverstone Green and Golden Bell Frog Management Plan (Rose Atkins Rimmer Infrastructure)

Targeted Fauna Survey

- Mt Gilead – Targeted Microchiropteran bat surveys, frog surveys and squirrel glider surveys (Lend Lease)
- Glenarra - Targeted Squirrel Glider surveys
- Helensburgh – Targeted microbat surveys
- Jacaranda Ponds – Targeted Koala, microbat and forest owl survey
- Sydney Science Park – targeted migratory bird survey, Green and Golden Bell Frog, Microbat survey
- Calderwood Targeted Powerful owl Survey

Other relevant skills

- Participated in 4-day Advanced Plant Identification Skills for Research and Environmental Assessment Course run by Belinda Pellow and David Keith, 2016.

Appendix B : Planning proposal consultation

Gilead Balance Land Planning Summary. Prepared by GLN Planning Consulting Strategy, 11 July 2019.

Provided as a separate document.

Appendix C : Threatened species likelihood table and assessment of candidate species

The table below lists the threatened species known or considered likely to occur within the BCAA based on previous surveys, Atlas, EPBC Act Protected Matters Search, Biodiversity certification credit calculator tool and/or expert opinion. Those species categorised as 'species credit' species (all threatened flora species and approximately half of all threatened fauna species) that were filtered into the BCAA by the biocertification credit calculator version 1.9 and validated as species credit species against the threatened species profile ecological data from the BioNet Atlas of NSW Wildlife (Step 1 of section 4.3 of the BCAM) are indicated. At this stage of the candidate species assessment, additional species are added to the list if they have been recently listed in the TSC Act, there are records on the Atlas or have been recorded in past ecological surveys/reports (Step 2 of section 4.3 of the BCAM). A Wildlife Atlas search was undertaken by ELA in July 2019 to identify any additional species to be added to the table.

It should be noted that species which are predicted by habitat surrogates as part of the biocertification tool (Ecosystem credit species) are not included within this table. Additionally, species listed as 'Marine' and/or 'Migratory' have not been included in the table below.

The 'Likelihood' and 'Justification' columns justifies the culled list of candidate species for further assessment and the 'Additional survey required' indicates whether additional survey is required to complete a formal Biocertification assessment (Step 3 of section 4.3 of the BCAM).

Five categories for likelihood of occurrence of species are used in this report and are defined below. Assessment of likelihood was based on species' locality records, presence or absence of suitable habitat features within the BCAA, results of previous studies, on site field surveys and professional judgement.

- known/yes - the species is known to occur within suitable habitat within the BCAA.
- likely - a medium to high probability that a species occupies or uses habitat within the BCAA.
- potential - suitable habitat for a species occurs within the BCAA, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur.
- unlikely - a very low to low probability that a species occupies or uses habitat within the BCAA.
- no - habitat within the BCAA and in the immediate vicinity is unsuitable for the species, or, in the case of plants, the species was not located during searches of the BCAA.

TSC/EPBC Act Status

- CE = Critically Endangered species, population or ecological community.
- E = Endangered species, population (E2) or ecological community (E3).
- V = Vulnerable species, population or ecological community.

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Acacia bynoeana	Bynoe's Wattle	E	V	BCAM, Atlas, PMST	*Acacia bynoeana* is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains, and has recently been found in the Colymea and Parma Creek areas west of Nowra. It is found in heath and dry sclerophyll forest, typically on a sand or sandy clay substrate, often with ironstone gravels (OEH 2015d).	No	Potential	Marginal habitat present.	Yes.
Acacia pubescens	Downy Wattle	V	V	BCAM, Atlas, PMST	*Acacia pubescens* occurs on the NSW Central Coast in Western Sydney, mainly in the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. It is associated with Cumberland Plains Woodlands, Shale / Gravel Forest and Shale / Sandstone Transition Forest growing on clay soils, often with ironstone gravel (OEH 2015d).	No	Potential	Marginal habitat present.	Yes
Allocasuarina glareicola		-	E	PMST	*Allocasuarina glareicola* is primarily restricted to the Richmond district on the north-west Cumberland Plain, with an outlier population found at Voyager Point. It grows in Castlereagh woodland on lateritic soil (OEH 2015d).	No	Unlikely	No habitat present and outside known range.	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Asterolasia elegans		E	E	PMST	*Asterolasia elegans* is restricted to a few localities on the NSW Central Coast north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby LGAs. It is found in sheltered forests on mid- to lower slopes and valleys, in or adjacent to gullies (OEH 2015d).	No	Unlikely	Marginal habitat present and outside known range.	No
Astrotricha crassifolia	Thick-leaf Star-hair	V	V	PMST	*Astrotricha crassifolia* is known from two separate disjunct areas, a 'northern metapopulation' near Gosford and a 'southern metapopulation' near Sutherland including the Royal National Park and Woronora Plateau.	No	Unlikely	Marginal habitat present and outside known range.	No
Callistemon linearifolius	Netted Bottle Brush	V		Atlas	*Callistemon linearifolius* has been Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. Within its range it grows in dry sclerophyll forest on the coast and adjacent ranges.	No	Potential	Marginal habitat present	Yes
Caladenia tessellata	Thick Lip Spider Orchid	E	V	PMST	*Caladenia tessellata* occurs in grassy sclerophyll woodland, often growing in well-structured clay loams or sandy soils south from Swansea, usually in sheltered moist places and in areas of increased sunlight. It flowers from September to November (OEH 2015d).	No	Unlikely	Only marginal habitat present	No
Cryptostylis	Leafless Tongue	V	V	PMST	*Cryptostylis hunteriana* is known from a range of vegetation communities including swamp-heath and	No	Unlikely	No suitable habitat	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
hunteriana	Orchid				woodland. The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); where it appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*). Coastal Plains Scribbly Gum Woodland and Coastal Plains Smoothed-barked Apple Woodland is potential habitat on the Central Coast. Flowers between November and February, although may not flower regularly (OEH 2015d).			present.	
Cynanchum elegans	White-flowered Wax Plant	E	E	BCAM, Atlas, PMST	*Cynanchum elegans* is a climber or twiner with a variable form, and flowers between August and May, peaking in November. It occurs in dry rainforest gullies, scrub and scree slopes, and prefers the ecotone between dry subtropical rainforest and sclerophyll woodland/forest. The species has also been found in littoral rainforest; *Leptospermum laevigatum – Banksia integrifolia* subsp. *integrifolia* coastal scrub; *Eucalyptus tereticornis* open forest/ woodland; *Corymbia maculata* open forest/woodland; and *Melaleuca armillaris* scrub to open scrub (OEH 2015d).	No	Potential	Marginal habitat present.	Yes
Dillwynia tenuifolia		V		BCAM	The core distribution is the Cumberland Plain from Windsor and Penrith east to Dean Park near Colebee. Other populations in western Sydney are recorded from Voyager Point and Kemps Creek in the Liverpool	No	Unlikely	Outside known range. Only Marginal	No.

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					LGA, Luddenham in the Penrith LGA and South Maroota in the Baulkham Hills Shire. In western Sydney, may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays (OEH 2015d).			habitat present.	
Epacris purpurascens var. *purpurascens*		V	-	BCAM, Atlas	Found in a range of habitat types, most of which have a strong shale soil influence (OEH 2015d).	No	Potential	Marginal habitat present.	Yes
Eucalyptus benthamii	Camden White Gum	V	V	BCAM, Atlas, PMST	*Eucalyptus benthamii* occurs in wet open forest on well drained sandy alluvial soils along stream channels, small terraces and alluvial flats on valley floors (OEH 2015d).	No	Potential	Habitat Present	Yes
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	Atlas	*Eucalyptus nicholii* is sparsely distributed but widespread on the New England Tablelands from Nundle to north of Tenterfield, being most common in central portions of its range (OEH 2015d). It is widely planted outside its natural range..	No	No	Outside of its known range.	No
Genoplesium baueri	Bauer's Midge Orchid	V	-	Atlas, PMST	Known from coastal areas from northern Sydney south to the Nowra district. Previous records from the Hunter Valley and Nelson Bay are now thought to be erroneous. Grows in shrubby woodland in open forest on shallow sandy soils (OEH 2015d).	No	Unlikely	No suitable habitat present.	No
Grevillea juniperina	Juniper-leaf Grevillea	V		BCAM	Endemic to Western Sydney. Grows on reddish clay to sandy soils derived from Wianamatta Shale and	No	Potential	Suitable habitat	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
subsp. *juniperina*					Tertiary alluvium (often with shale influence), typically containing lateritic gravels. Recorded from Cumberland Plain Woodland, Castlereagh Ironbark Woodland, Castlereagh Scribbly Gum Woodland and Shale/Gravel Transition Forest (OEH 2015d).			present.	
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	V	V	BCAM, Atlas, PMST	*Grevillea parviflora* subsp. *parviflora* is sporadically distributed throughout the Sydney Basin mainly around Picton, Appin and Bargo. Separate populations are also known further north from Putty to Wyong and Lake Macquarie and Cessnock and Kurri Kurri. It grows in sandy or light clay soils over thin shales, often with lateritic ironstone gravels. It often occurs in open, slightly disturbed sites such as tracks (OEH 2015d).	No	Potential	Suitable habitat present.	Yes
Grevillea parviflora subsp. *supplicans*		E	-	BCAM	Has a very restricted known distribution (approximately 8 by 10 km) and is confined to the north-west of Sydney near Arcadia and the Maroota–Marramarra Creek area, in Hornsby and Baulkham Hills LGAs. Occurs in heathy woodland associations on skeletal sandy soils over massive sandstones (OEH 2015d).	No	No	Outside range and only marginal habitat present.	No.
Gyrostemon thesioides		E	-	BCAM, Atlas	Within NSW, has only ever been recorded at three sites, to the west of Sydney, near the Colo, Georges and Nepean Rivers. Grows on hillsides and riverbanks and may be restricted to fine sandy soils (OEH 2015d).	No	Potential	Within range and suitable habitat present.	Yes
Haloragis exalata subsp. *exalata*	Wingless Raspwort	V	V	BCAM, PMST	Square Raspwort occurs in 4 widely scattered localities in eastern NSW. It is disjunctly distributed in the Central Coast, South Coast and North Western	No	Potential	Marginal habitat present.	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					Slopes botanical subdivisions of NSW. It appears to require protected and shaded damp situations in riparian habitats (OEH 2015d).				
Hibbertia puberula subsp. *glabrescens* (formerly *Hibbertia sp. Bankstown*)		CE	CE	BCAM	Currently known to occur in only one population at Bankstown Airport. Occurs on tertiary alluvial soil along Airport Creek within 'Cooks River/Castlereagh Ironbark Forest'.	No	Unlikely	Outside of range and no suitable habitat present.	No.
Hibbertia superans		E		BCAM	Occurs from Baulkham Hills to South Maroota in the northern outskirts of Sydney, where there are currently 16 known sites. The species occurs on sandstone ridgetops often near the shale/sandstone boundary (OEH 2015d).	No	Unlikely	Outside of range and marginal habitat present.	No.
Hypsela sessiliflora			Ex	BCAM	Currently known from only two adjacent sites on a single private property at Erskine Park in the Penrith LGA. Known to grow in damp places, on the Cumberland Plain, including freshwater wetland, grassland/alluvial woodland and an alluvial woodland/shale plains woodland ecotone (OEH 2015d).	No	Potential	Marginal habitat present.	Yes
Leucopogon exolasius	Woronora Beard-heath	V	V	Atlas, PMST	*Leucopogon exolasius* is found along the upper Georges River area and in Heathcote National Park. It is associated with Sydney Sandstone Gully Forest on rocky hillsides and creek banks (OEH 2015d).	No	Unlikely	No suitable habitat present.	No
Leucopogon		E		BCAM	Restricted to north-western Sydney between St Albans	No	No	Outside	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
fletcheri subsp. *fletcheri*					in the north and Annangrove in the south, within the local government areas of Hawkesbury, Baulkham Hills and Blue Mountains. Occurs in dry eucalypt woodland or in shrubland on clayey lateritic soils, generally on flat to gently sloping terrain along ridges and spurs (OEH 2015d).			range and marginal habitat present.	
Marsdenia viridiflora R. Br. subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs		E	-	Atlas	*Marsdenia viridiflora* grows in vine thickets and open shale woodland. Recent records are from Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys. Previously known north from Razorback Range (OEH 2015d).	No	Potential	Suitable habitat present within BCAA. Recently recorded (2018) at St Helens Park, 5km to north-east	Yes
Melaleuca deanei	Deane's Paperbark	V	V	BCAM, Atlas, PMST	Found in heath on sandstone, and also associated with woodland on broad ridge tops and slopes on sandy loam and lateritic soils (OEH 2015d).	No	No	No suitable habitat present.	No
Pelargonium sp. *striatellum*	Omeo's Stork's Bill	E	E	PMST	The species is known to occur in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes. During dry periods, the species is known to colonise exposed lake beds. It is not known if the species' rhizomes and/or soil seedbank persist through prolonged inundation or	No	No	No suitable habitat present.	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					drought (OEH 2015d).				
Persicaria elatior	Tall knotweed	V	V	BCAM	In south-eastern NSW has been recorded from Mt Dromedary (an old record), Moruya State Forest near Turlinjah, the Upper Avon River catchment north of Robertson, Bermagui, and Picton Lakes. Also occurs in in northern NSW and Queensland. Grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	No	Potential	Marginal habitat present.	Yes
Persoonia bargoensis	Bargo Geebung	E	V	BCAM, Atlas, PMST	Associated with woodland to dry sclerophyll forest, on sandstone and clayey laterite on heavier, well-drained, loamy, gravelly soils of the Hawkesbury Sandstone and Wianamatta Shale in the catchments of the Cataract, Cordeaux and Bargo Rivers (OEH 2015d).	No	Potential	Marginal habitat present.	Yes
Persoonia hirsuta	Hairy Geebung	E	E	BCAM, Atlas, PMST	*Persoonia hirsuta* occurs from Singleton in the north, south to Bargo and the Blue Mountains to the west. It grows in dry sclerophyll eucalypt woodland and forest on sandstone (OEH 2015d).	No	Unlikely	Only marginal habitat present.	No.
Persoonia nutans	Nodding Geebung	E	E	BCAM, PMST	Associated with dry woodland, Castlereagh Scribbly Gum Woodland, Agnes Banks Woodland and sandy soils associated with tertiary alluvium, occasionally poorly drained. Endemic to the Western Sydney (OEH 2015d).	No	Unlikely	No suitable habitat present.	No
Pimelea curviflora var. *curviflora*		V	V	BCAM, PMST	*Pimelea curviflora* var. *curviflora* is confined to the coastal area of the Sydney and Illawarra Region. In Sydney it is known from between northern Sydney in	No	Unlikely	Outside known range. Only	No.

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					the south and Maroota in the north-west. It grows on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands (OEH 2015d).			Marginal habitat present.	
Pimelea spicata	Spiked Rice-flower	E	E	BCAM, Atlas, PMST	In western Sydney, *Pimelea spicata* occurs on an undulating topography of well structured clay soils, derived from Wianamatta shale. It is associated with Cumberland Plains Woodland (CPW), in open woodland and grassland often in moist depressions or near creek lines. Has been located in disturbed areas that would have previously supported CPW (OEH 2015d).	No	Potential	Suitable habitat present.	Yes
Pomaderris brunnea	Rufous Pomaderris	V	V	BCAM, Atlas, PMST	*Pomaderris brunnea* occurs in a limited area around the Colo, Nepean and Hawkesbury Rivers, including the Bargo area and near Camden. It also occurs near Walcha on the New England tablelands and in far eastern Gippsland in Victoria It grows in moist woodland or forest on clay or alluvial soils of floodplains and creek lines (OEH 2015d).	Yes	Yes	Recorded within BCAA	Yes
Pterostylis saxicola	Sydney Plains Greenhood	E	E	BCAM, Atlas, PMST	Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where *Pterostylis saxicola* occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils. Restricted to western Sydney between Freemans Reach in the north and Picton in the south. There are very few known	No	Potential Recorded west of Nepean River, November 2018	Suitable habitat present.	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					populations and they are all very small and isolated (OEH 2015d).				
Pultenaea aristata	Prickly Bush-pea	V	V	Atlas, PMST	*Pultenaea aristata* is restricted to the Woronora Plateau where it occurs in dry sclerophyll woodland and wet heath on sandstone.	No	Unlikely	Outside known range and only marginal habitat present.	No.
Pultenaea pedunculata	Matted Bush-pea	E	-	BCAM, Atlas	In NSW, *Pultenaea pedunculata* is known from three disjunct populations, in the Cumberland Plains in Sydney, the coast between Tathra and Bermagui and the Windellama area south of Goulburn. It grows in woodland vegetation but plants have also been found on road batters and coastal cliffs (OEH 2015d).	No	Potential	Suitable habitat present.	Yes
Syzygium paniculatum	Magenta Lilly Pilly	E	V	Atlas, PMST	*Syzygium paniculatum* naturally occurs within rainforest vegetation types, predominately littoral rainforest. It is a widely planted species outside of its natural habitat.	No	Unlikely	Only marginal habitat present.	No
Tetratheca glandulosa		V		BCAM	Restricted to Baulkham Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah, and Wyong LGAs. Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone (OEH 2015d).	No	Unlikely	Outside known range and marginal habitat present.	No
Thelymitra sp.	Kangaloon	CE	CE	PMST	*Thelymitra* sp. *Kangaloon* is only known to occur on	No	No	Outside	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Kangaloon	Sun-orchid				the southern tablelands of NSW in the Robertson / Kangaloon / Fitzroy Falls area at 550-700 m above sea level. It is thought to be a short-lived perennial, flowering in late October and early November. It is found in swamps in sedgelands over grey silty grey loam soils. It is known to occur at three swamps that are above the Kangaloon Aquifer, and that are a part of the ecological community "Temperate Highland Peat Swamps on Sandstone" which is listed under the EPBC Act.			known range. No suitable habitat present.	
Thesium australe	Austral Toadflax	V	V	Atlas, PMST	Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast (OEH 2015d).	No	Potential	Within known range, potential habitat present.	Yes
FAUNA									
Invertebrates									
Meridolum corneovirens	Cumberland Plain Land Snail	E	-	BCAM, Atlas	Associated with open eucalypt forests, particularly Cumberland Plain Woodland. Found under fallen logs, debris and in bark and leaf litter around the trunk of gum trees or burrowing in loose soil around clumps of grass. Urban waste may also form suitable habitat (OEH 2015d).	Yes	Likely	Recorded within BCAA records across Appin Road and in Noorumba	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
								Reserve, no leaf litter accumulation present	
Petalura gigantea	Giant Dragonfly	E	-	Atlas,	Found along the east coast of NSW, this species is associated with permanent swamps and bogs with free water and open vegetation.	No	No	No suitable habitat present	No
Amphibians									
Heleioporus australiacus	Giant Burrowing Frog	V	V	BCAM, Atlas, PMST	Forages in woodlands, wet heath, dry and wet sclerophyll forest. Associated with semi-permanent to ephemeral sand or rock based streams, where the soil is soft and sandy so that burrows can be constructed (OEH 2015d).	No	Potential	Marginal habitat present	Yes
Litoria aurea	Green and Golden Bell Frog	E	V	BCAM, Atlas, PMST	This species has been observed utilising a variety of natural and man-made waterbodies such as coastal swamps, marshes, dune swales, lagoons, lakes, other estuary wetlands, riverine floodplain wetlands and billabongs, stormwater detention basins, farm dams, bunded areas, drains, ditches and any other structure capable of storing water. Preferable habitat for this species includes attributes such as shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading. Large permanent swamps and ponds exhibiting well-established fringing vegetation (especially bulrushes–Typha sp. and spikerushes–	No	Potential	Suitable habitat present	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					Eleocharis sp.) adjacent to open grassland areas for foraging are preferable. Ponds that are typically inhabited tend to be free from predatory fish such as Mosquito Fish (*Gambusia holbrooki*) (OEH 2015d).				
Litoria littlejohnii	Littlejohn's Tree Frog	V	V	Atlas, PMST	Littlejohn's Tree Frog occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops. It appears to be restricted to sandstone woodland and heath communities at mid to high altitude (OEH 2015d).	No	Unlikely	No suitable habitat present	No
Litoria raniformis	Southern Bell Frog	E	V	PMST	Relatively still or slow-flowing sites such as billabongs, ponds, lakes or farm dams, especially where Typha sp., Eleocharis sp. and Phragmites sp. (Bulrushes) are present. This species is common in lignum shrublands, black box and River Red Gum woodlands, irrigation channels and at the periphery of rivers in the southern parts of NSW. This species occurs in vegetation types such as open grassland, open forest and ephemeral and permanent non-saline marshes and swamps. Open grassland and ephemeral permanent non-saline marshes and swamps have also been associated with this species (OEH 2015d).	No	No	Outside known range	No
Pseudophryne australis	Red-crowned Toadlet	V		Atlas	Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have	No	Potential	Marginal habitat present	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					shale lenses or cappings (OEH 2015d).				
Reptiles									
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Atlas, PMST	Typical sites consist of exposed sandstone outcrops and benching where the vegetation is predominantly woodland, open woodland and/or heath on Triassic sandstone of the Sydney Basin. They utilise rock crevices and exfoliating sheets of weathered sandstone during the cooler months and tree hollows during summer (OEH 2015d).	No	Unlikely	No suitable habitat present	No
Varanus rosenbergi	Rosenberg's Goanna	V	-	BCAM, Atlas	Associated with Sydney sandstone woodland and heath land. Rocks, hollow logs and burrows are utilised for shelter (OEH 2015d).	No	Potential	Potential habitat present	Yes
Birds									
Anthochaera phrygia	Regent Honeyeater	E	E & M	BCAM, Atlas, PMST	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of River Oak (*Casuarina cunninghamiana*). Areas containing Swamp Mahogany (*Eucalyptus robusta*) in coastal areas have been observed to be utilised. The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes. As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of	No	Potential	Potential habitat present	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					nectar (OEH 2015d).				
Botaurus poiciloptilus	Australasian Bittern	V	-	PMST	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats. Reedbeds, swamps, streams, estuaries (OEH 2015d).	No	Potential	Marginal habitat present	Yes
Dasyornis brachypterus	Eastern Bristlebird	E	E	Atlas, PMST	Habitat is characterised by dense, low vegetation and includes sedgeland, heathland, swampland, shrubland, sclerophyll forest and woodland, and rainforest, as well as open woodland with a heathy understorey. In northern NSW occurs in open forest with tussocky grass understorey. All of these vegetation types are fire prone, aside from the rainforest habitats utilised by the northern population as fire refuge. Age of habitat since fires (fire-age) is of paramount importance to this species; Illawarra and southern populations reach maximum densities in habitat that has not been burnt for at least 15 years; however, in the northern NSW population a lack of fire in grassy forest may be detrimental as grassy tussock nesting habitat becomes unsuitable after long periods without fire; northern NSW birds are usually found in habitats burnt five to 10 years previously (OEH 2015d).	No	Unlikely	No suitable habitat present	No
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Atlas	Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains. Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of	No	Unlikely	No suitable habitat present	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (OEH 2015d).				
Pezoporus wallicus	Eastern Ground Parrot	V	-	Atlas	Occurs in high rainfall coastal and near coastal low heathlands and sedgelands, generally below one metre in height and very dense (up to 90% projected foliage cover). These habitats provide a high abundance and diversity of food, adequate cover and suitable roosting and nesting opportunities for the Ground Parrot, which spends most of its time on or near the ground.	No	No	No suitable habitat present	No
Mammals									
Cercartetus nanus	Eastern Pygmy-possum	V	-	Atlas	Found in wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath. Pygmy-Possums feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit. Small tree hollows are favoured as day nesting sites, but nests have also been found under bark, in old birds nests and in the branch forks of tea-trees (OEH 2015d).	No	Potential	Marginal habitat present	Yes
Isoodon obesulus	Southern Brown Bandicoot	E	E	Atlas, PMST	This species is associated with heath, coastal scrub, heathy forests, shrubland and woodland on well drained soils. This species is thought to display a preference for newly regenerating heathland and	No	Unlikely	No suitable habitat present	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					other areas prone to fire (OEH 2015d).				
Petaurus norfolcensis	Squirrel Glider	V	-	Atlas	Associated with dry hardwood forest and woodlands. Habitats typically include gum barked and high nectar producing species, including winter flower species. The presence of hollow bearing eucalypts is a critical habitat value (OEH 2015d).	Yes	Known	Recorded within BCAA	Yes
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	PMST	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (OEH 2015d).	No	Unlikely	No suitable habitat present	No
Phascolarctos cinereus	Koala	V	V	BCAM, Atlas, PMST	Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70%, with acceptable Eucalypt food trees. Some preferred Eucalyptus species are: *Eucalyptus tereticornis, E. punctata, E. cypellocarpa, E. viminalis* (OEH 2015d)	Yes	Known	Suitable habitat present	Yes
Mammal-bats									
Chalinolobus dwyeri (Breeding Habitat)	Large-eared Pied Bat	V	V	BCAM, Atlas, PMST	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests. This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces. Found in well-timbered areas containing gullies (OEH 2015d).	Yes	known	Recorded foraging within BCAA	Yes for presence of breeding habitat (caves)

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Miniopterus australis (Breeding habitat)	Little Bentwing Bat	V	-	BCAM, Atlas	East coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub (OEH 2015d).	Yes	Known	Recorded foraging within BCAA	Yes for presence of breeding habitat (caves)
Miniopterus schreibersii oceanensis (Breeding habitat)	Eastern Bent-wing Bat	V	-	BCAM, Atlas	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland. It forages above and below the tree canopy on small insects. Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (OEH 2015d).	Yes	Known	Recorded foraging within BCAA	Yes for presence of breeding habitat (caves)
Myotis macropus (Breeding habitat)	Southern Myotis	V	-	BCAM, Atlas	The Large-footed Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. Will occupy most habitat types such as mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland, close to water. While roosting (in groups of 10-15) is most commonly associated with caves, this species has been observed to roost in tree hollows, amongst vegetation, in clumps of Pandanus, under bridges, in mines, tunnels and stormwater drains, however with specific roost requirements. Forages over streams and pools catching insects and small fish. In NSW females have one young each year usually in November or	Yes	Known	Recorded foraging within BCAA	Yes for presence of breeding habitat (HBT within 200m of water)

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					December (OEH 2015d)				
Pteropus poliocephalus (Breeding habitat)	Grey-headed Flying-Fox	V		BCAM, Atlas, PMST	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas. Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (OEH 2015d).	Yes	Known	Recorded foraging within BCAA	Yes for breeding habitat

Appendix D : Floristic vegetation type analysis

Provided as a separate spreadsheet

Appendix E : Flora species recorded within the BCAA

A full list of all native species recorded within 66 plots is provided below.

A separate spreadsheet includes cover and abundance data by plot, vegetation zone and vegetation type.

Family	Species
Acanthaceae	*Brunoniella australis*
	Brunoniella spp.
	Pseuderanthemum variabile
Adiantaceae	*Adiantum aethiopicum*
	Adiantum formosum
	Adiantum hispidulum
	Cheilanthes distans
	Cheilanthes sieberi
	Pellaea falcata
Amaranthaceae	*Alternanthera denticulata*
	**Alternanthera pungens*
	Alternanthera spp.
	Amaranthus spp.
	**Gomphrena celosioides*
Anthericaceae	*Arthropodium milleflorum*
	Arthropodium spp.
	**Chlorophytum comosum*
	Laxmannia gracilis

Family	Species
	Tricoryne elatior
	Tricoryne spp.
Aphanopetalaceae	*Aphanopetalum resinosum*
Apiaceae	**Cyclospermum leptophyllum*
	**Foeniculum vulgare*
	Platysace lanceolata
Apocynaceae	**Araujia sericifera*
	**Gomphocarpus fruticosus*
	**Gomphocarpus physocarpus*
	**Gomphocarpus spp.*
	Parsonsia straminea
	Tylophora barbata
	**Vinca major*
Araceae	**Zantedeschia aethiopica*
Araliaceae	*Astrotricha latifolia*
Asparagaceae	**Asparagus asparagoides*
	**Asparagus officinalis*
	**Asparagus plumosus*
Asphodelaceae	**Aloe spp.*
Aspleniaceae	*Asplenium flabellifolium*
Asteraceae	**Ageratina adenophora*
	**Ageratina riparia*
	**Asteraceae indeterminate*
	**Bidens pilosa*

Family	Species
	**Bidens subalternans*
	Brachyscome spp.
	Calotis dentex
	**Carthamus lanatus*
	**Carthamus spp.*
	Cassinia laevis
	Cassinia spp.
	Cassinia trinerva
	**Cirsium vulgare*
	**Conyza spp.*
	**Conyza sumatrensis*
	Coronidium elatum
	Cotula australis
	**Delairea odorata*
	**Delairea spp.*
	Euchiton sphaericus
	Euchiton spp.
	**Gamochaeta americana*
	**Gamochaeta calviceps*
	**Gamochaeta spp.*
	**Hypochaeris radicata*
	Lagenophora stipitata
	Olearia viscidula
	Ozothamnus diosmifolius

Family	Species
	Senecio hispidulus
	Senecio linearifolius
	**Senecio madagascariensis*
	Senecio prenanthoides
	**Senecio spp.*
	Sigesbeckia orientalis subsp. orientalis
	**Sonchus oleraceus*
	**Tagetes minuta*
	**Taraxacum officinale*
	**Tragopogon porrifolius subsp. porrifolius*
	Vernonia cinerea
	Vittadinia spp.
	**Xanthium spinosum*
	Xerochrysum bracteatum
Basellaceae	**Anredera cordifolia*
Bignoniaceae	*Pandorea pandorana*
Blechnaceae	*Doodia aspera*
	Doodia caudata
Brassicaceae	**Brassica spp.*
	**Brassicaceae indeterminate*
	**Hirschfeldia incana*
	**Lepidium africanum*
	**Lepidium bonariense*
	Lepidium pseudohyssopifolium

Family	Species
	**Lepidium spp.*
	Rorippa laciniata
Cactaceae	**Opuntia spp.*
	**Opuntia stricta*
Campanulaceae	*Wahlenbergia communis*
	Wahlenbergia gracilis
	Wahlenbergia spp.
Caryophyllaceae	**Cerastium glomeratum*
	**Paronychia brasiliana*
	**Petrorhagia nanteuilii*
	**Polycarpon tetraphyllum*
	**Silene gallica*
	**Spergularia spp.*
	Stellaria flaccida
	**Stellaria spp.*
Casuarinaceae	*Allocasuarina littoralis*
	Allocasuarina torulosa
	Casuarina cunninghamiana subsp. cunninghamiana
Chenopodiaceae	*Atriplex semibaccata*
	**Chenopodium album*
	**Chenopodium ambrosioides*
	Chenopodium carinatum
	**Chenopodium murale*
	Einadia hastata

Family	Species
	Einadia nutans
	Einadia nutans subsp. linifolia
	Einadia nutans subsp. nutans
	Einadia polygonoides
	Einadia spp.
	Einadia trigonos
Clusiaceae	*Hypericum gramineum*
	**Hypericum spp.*
Commelinaceae	*Commelina cyanea*
	**Tradescantia fluminensis*
Convolvulaceae	*Convolvulus erubescens*
	Dichondra repens
Crassulaceae	**Crassula multicava*
	Crassula sieberiana
Cyperaceae	*Carex inversa*
	Carex spp.
	Cyathochaeta diandra
	**Cyperaceae indeterminate*
	**Cyperus eragrostis*
	Cyperus gracilis
	Cyperus spp.
	Fimbristylis dichotoma
	Gahnia aspera
	Gahnia spp.

Family	Species
	Isolepis habra
	Lepidosperma filiforme
	Lepidosperma laterale
	Lepidosperma spp.
	Schoenus melanostachys
Dennstaedtiaceae	*Pteridium esculentum*
Dilleniaceae	*Hibbertia aspera*
	Hibbertia diffusa
	Hibbertia empetrifolia subsp. empetrifolia
	Hibbertia spp.
Doryanthaceae	*Doryanthes excelsa*
Elaeocarpaceae	*Elaeocarpus reticulatus*
Ericaceae	*Astroloma humifusum*
	Astroloma spp.
	Leucopogon juniperinus
	Leucopogon virgatus
	Lissanthe strigosa
Euphorbiaceae	**Euphorbia peplus*
Fabaceae (Caesalpinioideae)	**Gleditsia triacanthos*
	**Senna pendula var. glabrata*
	**Senna septemtrionalis*
Fabaceae (Faboideae)	*Desmodium gunnii*
	Desmodium varians
	Glycine clandestina

Family	Species
	Glycine spp.
	Glycine tabacina
	Hardenbergia violacea
	Hovea linearis
	Indigofera australis
	Jacksonia scoparia
	Kennedia rubicunda
	**Medicago polymorpha*
	Podolobium ilicifolium
	**Trifolium campestre*
	**Trifolium repens*
	**Trifolium spp.*
Fabaceae (Mimosoideae)	*Acacia binervia*
	Acacia brownii
	Acacia decurrens
	Acacia implexa
	Acacia myrtifolia
	Acacia spp.
	Acacia terminalis
	Acacia ulicifolia
Gentianaceae	**Centaurium erythraea*
	**Centaurium tenuiflorum*
Goodeniaceae	*Goodenia hederacea*
Haloragaceae	*Gonocarpus tetragynus*

Family	Species
	Gonocarpus teucrioides
Juncaceae	**Juncus bufonius*
	Juncus spp.
	Juncus usitatus
Lamiaceae	*Clerodendrum tomentosum*
	Mentha satureioides
	Plectranthus parviflorus
	Scutellaria spp.
Lauraceae	*Cassytha glabella*
	Cassytha spp.
Linaceae	**Linum spp.*
	**Linum trigynum*
Lindsaeaceae	*Lindsaea linearis*
Lobeliaceae	*Pratia purpurascens*
Loganiaceae	*Logania albiflora*
Lomandraceae	*Lomandra confertifolia*
	Lomandra confertifolia subsp. rubiginosa
	Lomandra cylindrica
	Lomandra filiformis
	Lomandra filiformis subsp. coriacea
	Lomandra filiformis subsp. filiformis
	Lomandra gracilis
	Lomandra longifolia
	Lomandra multiflora subsp. multiflora

Family	Species
	Lomandra obliqua
Loranthaceae	*Amyema spp.*
Luzuriagaceae	*Eustrephus latifolius*
	Geitonoplesium cymosum
Malvaceae	**Malva parviflora*
	**Modiola caroliniana*
	Sida corrugata
	**Sida rhombifolia*
	**Sida spp.*
Meliaceae	*Melia azedarach*
Menispermaceae	*Stephania japonica*
Moraceae	*Ficus coronata*
	Ficus rubiginosa
	**Morus alba*
Myrsinaceae	**Anagallis arvensis*
	Myrsine howittiana
	Myrsine variabilis
Myrtaceae	*Angophora bakeri*
	Angophora floribunda
	Angophora spp.
	Backhousia myrtifolia
	Callistemon salignus
	Corymbia gummifera
	Corymbia maculata

Family	Species
	Eucalyptus amplifolia
	Eucalyptus botryoides <--> saligna
	Eucalyptus crebra
	Eucalyptus elata
	Eucalyptus eugenioides
	Eucalyptus fibrosa
	Eucalyptus microcorys
	Eucalyptus moluccana
	Eucalyptus pilularis
	Eucalyptus punctata
	Eucalyptus tereticornis
	Kunzea ambigua
	Leptospermum trinervium
	Melaleuca linariifolia
	Melaleuca styphelioides
	Melaleuca thymifolia
	Myrtaceae indeterminate
	Tristaniopsis laurina
Oleaceae	**Ligustrum lucidum*
	**Ligustrum sinense*
	Notelaea longifolia
	**Olea europaea*
	**Olea europaea subsp. cuspidata*
Orchidaceae	*Dendrobium linguiforme*

Family	Species
	Dendrobium speciosum
	Plectorrhiza tridentata
	Sarcochilus hillii
Oxalidaceae	*Oxalis perennans*
	Oxalis spp.
Passifloraceae	*Passiflora herbertiana subsp. herbertiana*
Phormiaceae	*Dianella caerulea*
	Dianella caerulea var. producta
	Dianella longifolia
	Dianella revoluta
	Stypandra glauca
Phyllanthaceae	*Breynia oblongifolia*
	Glochidion ferdinandi var. ferdinandi
	Phyllanthus hirtellus
	Phyllanthus spp.
	Poranthera microphylla
Phytolaccaceae	**Phytolacca octandra*
Pittosporaceae	*Billardiera scandens*
	Bursaria spinosa
	Pittosporum revolutum
	Pittosporum undulatum
Plantaginaceae	**Plantago lanceolata*
	Plantago spp.
	Veronica plebeia

Family	Species
Poaceae	*Anisopogon avenaceus*
	Aristida ramosa
	Aristida spp.
	Aristida vagans
	Austrostipa pubescens
	Austrostipa ramosissima
	Austrostipa spp.
	Austrostipa verticillata
	**Avena barbata*
	**Avena spp.*
	Bothriochloa macra
	Bothriochloa spp.
	**Briza minor*
	**Briza subaristata*
	**Bromus catharticus*
	**Bromus diandrus*
	**Bromus molliformis*
	**Bromus spp.*
	**Chloris gayana*
	Chloris truncata
	Chloris ventricosa
	Cleistochloa rigida
	Cymbopogon refractus
	Cynodon dactylon

Family	Species
	**Dactylis glomerata*
	Dichelachne micrantha
	Dichelachne spp.
	**Digitaria spp.*
	Echinopogon caespitosus
	Echinopogon ovatus
	**Ehrharta erecta*
	**Eleusine tristachya*
	Elymus multiflorus
	Elymus scaber var. scaber
	Elymus spp.
	Enteropogon acicularis
	Entolasia stricta
	Eragrostis brownii
	**Eragrostis curvula*
	Eragrostis leptostachya
	Eragrostis spp.
	Eriochloa pseudoacrotricha
	Eriochloa spp.
	Imperata cylindrica
	Lachnagrostis filiformis
	**Lolium perenne*
	**Lolium spp.*
	Microlaena stipoides

Family	Species
	**Nassella neesiana*
	**Nassella trichotoma*
	Notodanthonia longifolia
	Oplismenus aemulus
	Oplismenus imbecillis
	Panicum effusum
	Panicum simile
	Panicum spp.
	Paspalidium distans
	Paspalidium spp.
	**Paspalum dilatatum*
	**Paspalum spp.*
	**Pennisetum clandestinum*
	**Phalaris spp.*
	Poa labillardierei var. labillardierei
	Poa sieberiana
	**Poaceae indeterminate*
	Rytidosperma racemosum
	Rytidosperma spp.
	**Setaria parviflora*
	**Setaria spp.*
	**Sporobolus africanus*
	Sporobolus creber
	**Sporobolus fertilis*

Family	Species
	**Sporobolus spp.*
	Themeda australis
	**Vulpia spp.*
Polygonaceae	**Acetosa sagittata*
	**Persicaria spp.*
	**Polygonum aviculare*
	Rumex brownii
Polypodiaceae	*Pyrrosia rupestris*
Portulacaceae	*Calandrinia pickeringii*
	Portulaca oleracea
Proteaceae	*Grevillea mucronulata*
	Persoonia linearis
	Stenocarpus salignus
Ranunculaceae	*Clematis aristata*
	Clematis glycinoides
	Clematis spp.
Rhamnaceae	*+Pomaderris brunnea*
	Pomaderris ferruginea
	Pomaderris spp.
Rosaceae	**Rosa rubiginosa*
	**Rubus fruticosus sp. agg.*
Rubiaceae	*Asperula conferta*
	Galium binifolium
	Galium spp.

Family	Species
	Morinda jasminoides
	Opercularia diphylla
	Opercularia hispida
	Opercularia spp.
	Pomax umbellata
Rutaceae	*Boronia rubiginosa*
	Correa reflexa
	Zieria smithii
Sapindaceae	**Cardiospermum grandiflorum*
	**Cardiospermum spp.*
	Dodonaea triquetra
	Dodonaea viscosa
	Dodonaea viscosa subsp. spatulata
Smilacaceae	*Smilax australis*
Solanaceae	**Cestrum parqui*
	**Datura sp.*
	**Lycium ferocissimum*
	Solanum cinereum
	**Solanum mauritianum*
	**Solanum nigrum*
	Solanum prinophyllum
	**Solanum pseudocapsicum*
	Solanum pungetium
	**Solanum spp.*

Family	Species
Stackhousiaceae	*Stackhousia spp.*
Sterculiaceae	*Lasiopetalum ferrugineum*
Stylidiaceae	*Stylidium graminifolium*
Thymelaeaceae	*Pimelea linifolia*
Ulmaceae	*Trema tomentosa var. aspera*
Urticaceae	*Urtica incisa*
Verbenaceae	**Lantana camara*
	**Verbena bonariensis*
	**Verbena officinalis*
	**Verbena spp.*
Violaceae	*Hybanthus monopetalus*
	Melicytus dentatus
	Viola betonicifolia subsp. betonicifolia
	Viola hederacea
Vitaceae	*Cayratia clematidea*
	Cissus hypoglauca
Xanthorrhoeaceae	*Xanthorrhoea media*
	Xanthorrhoea spp.

Appendix F : Fauna species recorded within the BCAA

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Invertebrates				
Meridolum corneovirens	Cumberland Plain Land Snail	End		
Fish				
Anguilla reinhardtii	Longfin eel			
Anguilla sp.	Shortfin Eel			
Gambusia holbrooki	Mosquito Fish			X
Amphibians				
Litoria dentata	Bleating Tree Frog			
Litoria fallax	Eastern Dwarf Tree Frog			
Litoria latopalmata	Broad-palmed Frog			
Litoria lesueuri	Lesueur's Frog			
Litoria peronii	Peron's Tree Frog			
Litoria tyleri	Tyler's Tree Frog			
Litoria verreauxii	Verreaux's Frog			
Crinia signifera	Common Eastern Froglet			
Limnodynastes peronii	Striped Marsh Frog			
Limnodynastes tasmaniensis	Spotted Grass Frog			
Uperoleia laevigata	Smooth Toadlet			
Reptiles				
Amphibolurus muricatus	Jacky Lizard			
Physignathus lesueurii	Eastern Water Dragon			
Chelodina sp.	Long-Necked Turtle Species Unknown			
Cacophis squamulosus	Golden-crowned Snake			
Pseudechis porphyriacus	Red-bellied Black Snake			
Diplodactylus vittatus	Wood Gecko			
Phyllurus platurus	Broad-tailed Gecko			
Ctenotus taeniolatus	Copper-tailed Skink			
Eulamprus quoyii	Eastern Water-skink			
Eulamprus tenuis	Barred-sided Skink			
Lampropholis delicata	Dark-flecked Garden Sunskink			
Lampropholis guichenoti	Pale-flecked Garden Sunskink			
Varanus varius	Lace Monitor			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Bird species				
Acanthorhynchus tenuirostris	Eastern Spinebill			
Acridotheres tristis	Common Myna			X
Aegotheles cristatus	Australian Owlet-nightjar			
Alcedo azurea	Azure Kingfisher			
Alisterus scapularis	Australian King-Parrot			
Anas castanea	Chestnut Teal			
Anas superciliosa	Pacific Black Duck			
Anthochaera carunculata	Red Wattlebird			
Anthochaera chrysoptera	Little Wattlebird			
Aquila audax	Wedge-tailed Eagle			
Ardea pacifica	White-necked Heron			
Artamus cyanopterus	Dusky Woodswallow	Vulnerable		
Cacatua galerita	Sulphur-crested Cockatoo			
Calyptorhynchus lathami	Glossy Black Cockatoo	Vulnerable		
Chenonetta jubata	Australian Wood Duck			
Colluricincla harmonica	Grey Shrike-thrush			
Coracina novaehollandiae	Black-faced Cuckoo-shrike			
Corcorax melanorphamphos	White-winged Chough			
Corvus coronoides	Australian Raven			
Cracticus nigrogularis	Pied Butcherbird			
Cracticus torquatus	Grey Butcherbird			
Dacelo novaeguineae	Laughing Kookaburra			
Dacelo novaeguineae	Laughing Kookaburra			
Egretta novaehollandiae	White-faced Heron			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Eolophus roseicapillus	Galah			
Eurystomus orientalis	Dollarbird			
Falco cenchroides	Nankeen Kestrel			
Falco peregrinus	Peregrine Falcon			
Fulica atra	Eurasian Coot			
Gallinula tenebrosa	Dusky Moorhen			
Geopelia cuneata	Diamond Dove			
Geopelia placida	Peaceful Dove			
Gerygone olivacea	White-throated Gerygone			
Grallina cyanoleuca	Magpie-lark			
Gymnorhina tibicen	Australian Magpie			
Haliastur sphenurus	Whistling Kite			
Hirundo neoxena	Welcome Swallow			
Leacosarcia melanoleuca	Wonga Pigeon			
Lopholaimus antarcticus	Topknot Pigeon			
Malurus cyaneus	Superb Fairy-wren			
Manorina melanocephala	Noisy Miner			
Manorina melanophrys	Bell Miner			
Meliphaga lewinii	Lewin's Honeyeater			
Menura novaehollandiae	Superb Lyrebird			
Neochmia temporalis	Red-browed Finch			
Ninox boobook	Southern Boobook			
Ocyphaps lophotes	Crested Pigeon			
Origma solitaria	Rockwarbler			
Pachycephala rufiventris	Rufous Whistler			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Pardalotus punctatus	Spotted Pardalote			
Phalacrocorax melanoleucos	Little Pied Cormorant			
Phaps chalcoptera	Common Bronzewing			
Platycercus adscitus	Eastern Rosella			
Podargus strigoides	Tawny Frogmouth			
Psephotus haematonotus	Red- rump Parrot			
Psophodes olivaceus	Eastern Whipbird			
Ptilonorhynchus violaceus	Satin Bowerbird			
Rhipidura albiscapa	Grey Fantail			
Rhipidura leucophrys	Willie Wagtail			
Rhipidura rufifrons	Rufous Fantail		Migratory	
Scythrops novaehollandiae	Channel-billed Cuckoo			
Sericornis frontalis	White-browed Scrubwren			
Strepera graculina	Pied Currawong			
Sturnus vulgaris	Common Starling			X
Tachybaptus novaehollandiae	Australasian Grebe			
Threskiornis spinicollis	Straw-necked Ibis			
Trichoglossus haematodus	Rainbow Lorikeet			
Turdus merula	Eurasian Blackbird			X
Vanellus miles	Masked Lapwing			
Zoothera lunulata	Bassian Thrush			
Mammals (non-flying)				
Antechinus flavipes/stuartii	Yellow-footed/Brown Antechinus			
Bos taurus	European cattle			X
Equus caballus	Horse			X
Lepus capensis	Brown Hare			X

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Oryctolagus cuniculus	Rabbit			X
Macropus giganteus	Eastern Grey Kangaroo			
Macropus robustus	Common Wallaroo			
Wallabia bicolor	Swamp Wallaby			
Rattus fuscipes	Bush Rat			
Rattus rattus	Black Rat			X
Petaurus breviceps	Sugar Glider			
Petaurus norfolcensis	Squirrel Glider	Vulnerable		
Trichosurus vulpecula	Common Brushtail Possum			
Phascolarctos cinereus	Koala	Vulnerable	Vulnerable	
Pseudocheirus peregrinus	Common Ringtail Possum			
Vombatus ursinus	Common Wombat			
Vulpes vulpes	European Fox			X
Mammals (flying - megachiropertran and microchripteran				
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	Vulnerable		
Ozimops (*Mormopterus) ridei*	South-eastern Freetail Bat			
Micronomus (*Mormopterus*) *norfolkensis*	Eastern Coastal Freetailed-Bat	Vulnerable		
Austronomus australis	White-striped Freetail-bat			
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Vulnerable	
Rhinolophus megaphyllus	Eastern Horseshoe-bat			
Chalinolobus dwyeri	Large-eared Pied Bat	Vulnerable	Vulnerable	
Chalinolobus gouldii	Gould's Wattled Bat			
Chalinolobus morio	Chocolate Wattled Bat			
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Vulnerable		
Miniopterus australis	Little Bentwing-bat	Vulnerable		
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	Vulnerable		
Myotis macropus	Southern Myotis	Vulnerable		
Nyctophilus spp.	long-eared bat			
Scoteanax rueppellii	Greater Broad-nosed Bat	Vulnerable		
Scotorepens orion	Eastern Broad-nosed Bat			
Vespadelus pumilus	Eastern Forest Bat			
Vespadelus vulturnus	Little Forest Bat			

Appendix G Fauna species recorded by remote movement sensing cameras

Table 29: Results of remote movement sensing cameras that were set at Sites 1 to 8.

Site number		1	2	3	4	5	6	7	8
Camera Number		4743	4743	4632	4742	4749	8961	8579	4631
Species name	**Common name**								
Birds									
Corcorax melanorhamphos	White-winged Chough		X						
Cracticus tibicen	Australian Magpie		X					X	X
Grallina cyanoleuca	Magpie-lark or Peewee		X	X					
Leucosarcia picata	Wonga Pigeon					X			
Manorina melanocephala	Noisy Miner						X		
Menura novaehollandiae	Superb Lyrebird				X	X			
Phaps chalcoptera	Common Bronzewing		X						
Psophodes olivaceus	Eastern Whipbird					X			
Sturnus vulgaris	Common Starling				X				
Zoothera lunulata	Bassian Thrush					X			
Ocyphaps lophotes	Crested Pigeon						X		
Native mammals									
Antechinus stuartii	Brown Antechinus							X	
Macropus robustus	Common Wallaroo	X							X
Tachyglossus aculeatus	Echidna		X		X			X	
Vombatus ursinus	Common Wombat			X	X	X		X	X
Wallabia bicolor	Swamp Wallaby	X	X	X	X	X		X	X
Trichosurus vulpecula	Brush-tail Possum				X	X			
Introduced mammals									
Bos taurus	Cattle		X	X		X	X	X	
Equus caballus	Horse			X					
Oryctolagus cuniculus	Rabbit			X					
Rattus rattus	Black Rat	X							

Vulpes vulpes	European Red Fox	X	X	X	X	X	X		X
Rattus sp	Unknown Rat species		X						
Total number of species recorded		**4**	**9**	**7**	**7**	**10**	**4**	**6**	**5**

Table 30: Results of remote movement sensing cameras that were set at Sites 9 to 16.

Site number		**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Camera Number		**4651**	**4750**	**4745**	**4629**	**9003**	**4748**	**4652**	**4744**
Species name	**Common name**								
Birds									
Cracticus tibicen	Australian Magpie		X				X	X	
Ptilonorhynchus violaceus	Satin Bowerbird			X					
Chenonetta jubata	Wood Duck								X
Native mammals									
Antechinus stuartii	Brown Antechinus			X		X			
Macropus robustus	Common Wallaroo				X	X			
Phascolarctos cinereus[*1]	Koala				X				
Tachyglossus aculeatus	Echidna				X	X	X		
Vombatus ursinus	Common Wombat	X		X	X	X			
Wallabia bicolor	Swamp Wallaby	X	X		X	X			X
Trichosurus vulpecula	Brush-tail Possum			X		X			
Introduced mammals									
Bos taurus	Cattle		X				X	X	X
Equus caballus	Horse								X
Lepus europaeus	European Brown Hare								X
Vulpes vulpes	European Red Fox	X	X	X	X	X	X		X
Rattus sp	Unknown Rat species			X		X			
Total number of species recorded		3	4	6	6	8	4	2	6

* Threatened species listed under TSC Act / [1] Threatened species listed under the EPBC Act

Table 31: Results of remote movement sensing cameras that were set at Sites 17 to 21.

Site number		17	18	19	20	21
Camera Number		**8593**	**4630**	**4746**	**4740**	**9002**
Species name	**Common name**					
Birds						
Corcorax melanorhamphos	White-winged Chough					X
Native mammals						
Macropus robustus	Common Wallaroo				X	
Tachyglossus aculeatus	Echidna	X				
Vombatus ursinus	Common Wombat					
Wallabia bicolor	Swamp Wallaby				X	X
Trichosurus vulpecula	Brush-tail Possum					
*Petaurus norfolcensis**	Squirrel Glider			X		
Reptiles						
Varanus varius	Lace Monitor				X	
Introduced mammals						
Bos taurus	Cattle	X	X		X	X
Equus caballus	Horse	X	X			X
Rattus rattus	Black Rat				X	
Vulpes vulpes	European Red Fox		X		X	X
Total number of species recorded		**3**	**3**	**1**	**6**	**5**

* Threatened species listed under TSC Act

Appendix H : Hair Tube results

No.	Project	Line	Tube size	Hair tube	Species
1	Mt Gilead	1	Large	1	Horse(probable)
2	Mt Gilead	1	Large	3	Cow
3	Mt Gilead	1	Large	5	Fox(probable)
4	Mt Gilead	1	Large	7	No hair
5	Mt Gilead	1	Large	8	No hair
6	Mt Gilead	1	Large	9	No hair
7	Mt Gilead	1	Small	10	Horse(probable)
12	Mt Gilead	Illawarra	Cam	7	*Rattus rattus*
13	Mt Gilead	4	Small	4	No hair
14	Mt Gilead		Arboreal	4749	No hair
15	Mt Gilead	4	Small	2	No hair
16	Mt Gilead	4	Large	1	Fox
17	Mt Gilead	5	Large	9	*Rattus rattus*
18	Mt Gilead	5	Large	7	Cow (probable)
19	Mt Gilead		Cam	4744	Fox
20	Mt Gilead		Arboreal	4	No hair
21	Mt Gilead		Cam	4749	*Antechinus stuartii* (probable)
22	Mt Gilead	9	Large	3	No hair
23	Mt Gilead	8	Large	8 4653	Cow
24	Mt Gilead		Cam	4629	Cow
25	Mt Gilead		Cam	9003	Cow/horse
26	Mt Gilead	6	Small	6	Fox
27	Mt Gilead	2	Small	9	Fox
28	Mt Gilead	2	Small	8	No hair
29	Mt Gilead	7	Large	7	No hair
30	Mt Gilead	7	Large	1	Cow/horse

No.	Project	Line	Tube size	Hair tube	Species
31	Mt Gilead	1	Large	10	Cow/horse
32	Mt Gilead	7	Large	3	Cow(probable)
33	Mt Gilead	10	Large	3	Cow
34	Mt Gilead	6	Small	10	Cow
35	Mt Gilead	?	Large	15	Cow/horse
36	Mt Gilead	9	Large	7	Cow(probable)
37	Mt Gilead	10	Large	5	Cow(probable)
38	Mt Gilead	4	Small	10	Cow
39	Mt Gilead	6	Large	LS	Fox
40	Mt Gilead	6	Large	5	No hair
41	Mt Gilead	6	Large	3	Cow
42	Mt Gilead	2	Large	7	Fox
43	Mt Gilead	Bait station	Cam	4742	No hair
44	Mt Gilead	7	Small	8	Cow(probable)
45	Mt Gilead	11	Large	9	No hair
46	Mt Gilead	11	Large	5	Cow
47	Mt Gilead	11	Small	10	No hair

Appendix I : 2013 Anabat results

Anabat Results – Mt Gilead Stage 2 anabat assessment December 2016 to January 2017

Prepared by Dr Rodney Armistead

Methods

Seven anabat recorders were set at nineteen (19) different locations within the Mt Gilead Stage 2 biocertification study area between in December 2016 and March 2017 (see **Table 33**). The location of anabat survey site, site reference number, anabat number, date each Songmeter was set to record for, number of survey nights in which data was collected and a summary of the habitat at each site is provided in **Table 33**.

The survey effort included fifty (50) anabat survey nights. Surveys were conducted over a three-month period between December 2016 and March 2017. This is considered the optimal time to surveying for microbats in this region.

Data Analysis

Bat calls were analysed by Rodney Armistead in March 2017 using the program AnalookW (Version 3.8 25 October 2012, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW. Available: (http://www.forest.nsw.gov.au/research/bats/default.asp).

Bat calls were analysed using species-specific call profile parameters including call shape, characteristic frequency, initial slope and time between pulses (Reinhold et al 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et al 2006) were followed:

- Search phase calls were used in the analysis, rather than cruise phase calls or feeding buzzes (McKenzie et al 2002). Cruise phase or feeding calls cannot be used for identification purposes and were labelled as being unidentifiable.
- Recorded calls containing less than three pulses were not analysed and these sequences were labelled as unidentifiable as they are too short to confidently determine the identity of the species making the call (Law et al 1999).
- For those calls that were useful to identify the species making the call, two categories of confidence were used (Mills et al 1996):
    - Definitely present – the quality and structure of the call profile is such that the identity of the bat species making the calls is not in doubt

  - Potentially present – the quality and structure of the call profile is such that there is some / low probability of confusion with species that produce similar calls profiles

- Sequences produced by bats but of inferior quality were also labelled as unidentifiable.
- All calls labelled as unidentifiable were retained in the data as they can be used as an indicator of microbat activity at the site.
- *Nyctophilus* spp. (Long-eared bats) are difficult to identify or separate confidently to species level based upon their recorded calls. Therefore, we have made no attempt to identify any recorded *Nyctophilus* spp. calls to species level (Pennay et al 2004). There are two potential Nyctophilus species that could occur in the study area. Both species, *N. geoffroyi* (Lesser Long-eared Bat) and *N. gouldii* (Gould's Long-eared Bat) are relatively common and widely distributed across NSW.
- The Free-tailed Bats (previously referred to as the genus *Mormopterus*) have recently undergone taxonomic revision (Reardon et al 2014) and published reference calls for this group of species (Pennay et al 2004) are believed to contain errors (Greg Ford pers comm.). This report uses nomenclature for Free-tailed Bat species as referred to in Jackson and Groves (2015). The correlation between nomenclature used in this report and that used in NSW State legislation is presented in Table 32 below.
- Sequences not attributed to microbat echolocation calls (e.g. insect buzzes, wind, train and vehicle movement) were dismissed from the analysis.

Table 32: Correlations between current and previous nomenclature for the Free-tailed bats of NSW

Jackson and Groves 2015	Previously known as	Common Name	BC Act
Austronomus australis	*Tadarida australis*	White-striped Free-tailed Bat	
Micronomus norfolkensis	***Mormopterus norfolkensis***	**Eastern Coastal Free-tailed Bat**	**Vulnerable**
Ozimops petersi	*Mormopterus species 3 (small penis)*	Inland Free-tailed Bat	
Ozimops planiceps	*Mormopterus species 4 (long penis eastern form)*	Southern Free-tailed Bat	
Ozimops ridei	*Mormopterus species 2*	Ride's Free-tailed Bat	
Setirostris eleryi	***Mormopterus species 6***	**Bristle-faced Free-tailed Bat**	**Endangered**

Table 33. Site numbers, microbat recording device number, dates and actual survey nights for the anabat surveys at Mt Gilead

Site number	Unit number	Date set	Date collected	Actual survey nights	Location	Habitat description
1	SN81781	12 Jan 2017	13 Jan 2017	2	Illawarra Coal Site	This anabat recorder was set to record microbat activity among the HBTs present in the Illawarra coal site
2	SN81081	12 Jan 2017	13 Jan 2017	2	Illawarra Coal Site	This anabat recorder was set to record microbat activity at the edge of a weed infested woodland with numerous HBTs and pasture n the Illawarra coal site.
3	SN81997	10 Jan 2017	12 Jan 2017	2	Far north east	This anabat recorder was set on edge of a gully that is located among paddock / pasture habitat and a disturbed Large-leaved Privet and *Kunzea* spp. infested creek line. Several HBTs are located nearby.
4	SN81147	10 Jan 2017	12 Jan 2017	2	Far north east	This anabat recorder was set to record microbat activity at a farm dam. The dam has some riparian vegetation, emergent vegetation, dead trees in dams with no hollows and there are HBTs in surrounding area. The open nature of this very likely to support the foraging activities of the Large-footed Myotis.
4	SN82275 and SN82241	1 March 2017	9 March 2017	15 hours from two anabats over three nights	Far north east	This anabat recorder was set to record microbat activity at a farm dam. The dam has some riparian vegetation, emergent vegetation, dead trees in dams with no hollows and there are HBTs in surrounding area. The open nature of this very likely to support the foraging activities of the Large-footed Myotis. These additional survey hours were undertaken while conducting Green and Golden Bell Frog surveys at the dam.
5	SN81081	5 Jan 2017	10 Jan 2017	4	North - west corner of site	This anabat recorder was set to record microbat activity at the edge of paddock / pasture habitat and an area that contains several dead *Angophora floribunda* trees with hollows, dense

Site number	Unit number	Date set	Date collected	Actual survey nights	Location	Habitat description
						understorey vegetation and other living HBTs nearby. The anabat was set to record microbat activity in a fly way located between the dead *Angophora floribunda* trees.
6	SN81781	5 Jan 2017	10 Jan 2017	4	North - west corner of site	This anabat recorder was set to record microbat activity at the row a relatively thin (~50m wide) and 500 m long strip of Ironbark trees. Most of these trees are relatively young and therefore have not developed hollows. The anabat recorder was aimed towards the open paddock / pasture habitat to recording those species using the paddock as a fly way and / or to forage.
7	SN82275	5 Jan 2017	10 Jan 2017	4	North - west corner of site	This anabat recorder was set to record microbat activity at the edge of sandstone gorge. Several dead stags and the odd HBT is also present nearby.
8	SN81147	16 Jan 2017	20 Jan 2017	4	Eastern	This anabat recorder was set to record microbat activity in the eastern conservation zone that is located among heavily grazed area. The habitat is mostly pasture with large hollow bearing paddock trees. There is considerable space among and below the canopies of these trees for foraging bats.
9	SN82441	20 Jan 2017	24 Jan 2017	2	South-western	This anabat recorder was set to record microbat activity at a vegetated creek line. A metal culvert that forms a bridge with rocks and small amount of water is located nearby. The canopy is open above and just downstream of the bridge, but the canopy is closed and the vegetation becomes very dense further downstream. This anabat was set to determine if the metal culvert was being used as roosting habitat.

Site number	Unit number	Date set	Date collected	Actual survey nights	Location	Habitat description
10	SN81147	14 Jan 2017	16 Jan 2017	2	Central	This anabat recorder was set to record microbat activity beneath a sandstone overhang in sandstone lined gorge / gully / creek. At the time of the survey there was little to no flowing water in creek. Some small isolated pools were present. There are numerous caves, crevices, cracks and over-hanging rocks in this gully. This type of habitat continues for through these creek lines / gorges. This anabat was set to determine if Large-eared Pied Bats, Little Bent-wing Bats, Eastern Bent Wing Bats and Eastern Horseshoe Bats.
11	SN81781	16 Jan 2017	20 Jan 2017	4	Eastern	This anabat recorder was set to record microbat activity in a tilled paddock that has been grazed by cattle. There is a rock gully and woodland about 100 - 150m from the site where the anabat was set.
12	SN82241	5 Jan 2017	10 Jan 2017	4	Central west	This anabat recorder was set to record microbat activity at / near a farm dam near western drainage line and irrigation circle. This anabat was set to test for the presence of the foraging Large-footed Myotis at this open disturbed farm dam. There are numerous HBTs located in the western drainage line that could provide roosting habitat for Large-footed Myotis are present in the nearby drainage line.
13	SN81081	14 Dec 2016	16 Dec 2016	3	Central	This anabat recorder was set to record microbat activity near a farm dam that contains relatively clear water, despite the movement of cattle in and out of the dam. This anabat was set to test for the presence of the foraging Large-footed Myotis at this open disturbed farm dam. This anabat recorder was set near some HBTs that could

Site number	Unit number	Date set	Date collected	Actual survey nights	Location	Habitat description
						provide roosting habitat for Large-footed Myotis are present in the nearby drainage line.
14	SN81997	14 Dec 2016	16 Dec 2016	2	Central	This anabat recorder was set to record microbat activity within an open paddock habitat. There is a woodland nearby with mostly young trees that generally lack hollows. Because of the heavy rain that was falling, the anabat recorder was set in large metal pipes as heavy rain had been forecast during the survey period.
15	SN82241	14 Jan 2017	16 Jan 2017	2	Central	This anabat recorder was set to record microbat activity in a paddock / pasture with scattered hollow bearing paddock trees. A sandstone rocky gorge with undercut banks, crevices and small caves is located approximately 100m from this survey site. This rocky gorge is expected to provide habitat that could support the threatened Eastern Bentwing Bat, Little Bentwing Bat, Large-footed Myotis and Large-eared Pied Bat.
16	SN81081	20 Jan 2017	24 Jan 2017	2	South-western	This anabat recorder was set to record microbat activity at the edge of sandstone gorge / creekline that flows in an south to north direction. This rocky / woodland habitat is expected to that could support the threatened Eastern Bentwing Bat, Little Bentwing Bat, Large-footed Myotis and Large-eared Pied Bat.
17	SN81997	20 Jan 2017	24 Jan 2017	2	South-western	This anabat recorder was set to record microbat activity in bushland in the south / eastern corner of site. The anabat recorder was set to record near two large hollow bearing *E. punctata* trees with hollows. This survey site is located near sandstone gorge that could support the threatened Eastern Bentwing Bat, Little Bentwing Bat, Large-footed Myotis and

Site number	Unit number	Date set	Date collected	Actual survey nights	Location	Habitat description
						Large-eared Pied Bat..
18	SN82243	20 Jan 2017	24 Jan 2017	2	South-western	This anabat recorder was set to record microbat activity in Cumberland Plain Woodland, that has been severely under scrubbed and disturbed by grazing. A farm dam, thin strip of relatively young Kunzea spp. and Acacia spp. dominated vegetated strip and a water channel are located nearby
19	SN82275	20 Jan 2017	24 Jan 2017	1	South-western	In southern paddock, some *E. moluccana* HBTS present. Pasture that has been heavily grazed.

Results

There were 9,095 call sequences recorded during this survey. Of these, 5,567 (61.21%) were deemed useful because the call profile was of sufficient quality or length to enable positive identification of the bat species that made the call to genus or species. The remaining 3,529 call sequences were either short or of low quality, thus preventing positive identification of the bat that made these calls (Table 34 and Error! Reference source not found.).

There were at least 16 and up to 19 bat species recorded during this survey (Table 35 to Table 37). The species diversity across the 19 survey sites varied from at least six species at Site 18 through to at least 15 species at sites 2, 4 and 8 (Table 35 to Table 37).

The most widespread species included the common *Chalinolobus gouldi* (Gould's Wattled Bat) which was recorded at all 19 surveys. Whilst, *Austronomus australis* (Yellow-bellied Sheathtail Bat), *C. morio* (Chocolate Wattled Bat), *Mormopterus* (*Ozimops*) *ridei* (Eastern Freetail Bat), *Vespadelus pumilus* (Eastern Forest Bat) and *V. vulturnus* (Little Forest Bat) were recorded at most the survey sites. Thus, showing that these species are broadly distributed across the study area (Table 35 to Table 37). The two *Vespadelus* spp. have been grouped together as they have similar call profiles and it is difficult to separate the calls (see below for further information). However, these two species have broad distributions, occur in forested habitats such as those present within the study area and they are all know to occur in the region.

Eight species listed as threatened under the NSW *Threatened Species Conservation Act 1995* (TSC Act) were recorded during this survey (Error! Reference source not found. **-** Error! Reference source not found. Error! Reference source not found. and Figure 39 **-** Table 35 to Table 37). Of the eight threatened species that were recorded, definite calls were recorded for six species listed as vulnerable and one species listed as endangered, as shown below:

- *Chalinolobus dwyeri* (Large-eared Pied Bat) (vulnerable)
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) (vulnerable)
- *Miniopterus australis* (Little Bentwing Bat) (vulnerable)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat) (vulnerable)
- *Mormopterus* (*Micronomus*) *norfolkensis* (Eastern Freetail Bat)
- *Myotis macropus* (Large-footed Myotis) (vulnerable).

Two other threatened species was recorded as being potentially present within the study area, including;

- *Scoteanax rueppellii* (Greater Broad-nosed Bat) (vulnerable)
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) (vulnerable).

Chalinolobus dwyeri (Large-eared Pied Bat) is listed under both TSC Act and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was recorded during this survey.

The following section outlines the threatened species recorded,

- Large-eared Pied Bat was found to be broadly distributed across the study area. The species was recorded at Sites 3, 4, 5, 7 8, 9, 12. 14 and 17. Generally the species was identified as single calls. However, 42 Large-eared Pied Bats calls was recorded at Site 12. Forty-two (42) calls were recorded from this species at Site 12. Site 12 is in a creek line with steep or vertical sandstone rock walls, sandstone break-aways, rocky crevices and dry rainforest vegetation. Potential roosting habitat for this species was identified across much of the creek line systems present within the study area.

- *Miniopterus australis* (Eastern Bentwing Bat) was found to be broadly distributed across the study area. Indeed, this species was recorded at 14 of the 19 survey sites. Whilst the Large-eared Pied Bat was recorded at nine of the 19 survey sites (Sites 3, 4, 5, 7, 8, 9, 12, 14 and 17) (**Table 34**). This species generally roosts in caves, stormwater drains, abandoned mines and tunnels (Churchill 2008).

- *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat) was recorded in low numbers and only at a few survey sites. This species was recorded at Sites 4, 7, 8, 14 and 19. The low number of records and limited distribution of this species at the study sites reflects its summer migratory patterns. From late Spring to mid-Autumn, this species resides in its maternal caves located in the Great Dividing Range. The individuals recorded during the present survey may not have migratory from the Sydney basis with

- Definite Large-footed Myotis calls were also recorded at nine of the survey sites (Sites 1, 3, 4, 6, 7, 10, 12, 14 and 16) (**Table 34**).

Survey Limitations

The species recorded in this survey with overlapping call profiles include Eastern Coastal Free-tailed Bat and Ride's Free-tailed Bat. The calls of these two species overlap in the range 30 kHz to 32 kHz. Eastern Coastal Free-tailed Bat calls were identified by alternation in call frequency between pulses, a flat shape (initial slope S1 of less than 100 octaves per second) and a characteristic frequency of between 31 – 36 kHz. Calls were identified as Ride's Free-tail Bat if the call shape was flat (initial slope S1 of less than 100 octaves per second) and the frequency was between 28 – 32 kHz.

Gould's Wattled Bat and Ride's Free-tailed Bat also have calls that overlap in the range 28.5 kHz and 32 kHz. Ride's Free-tailed Bat was identified by non-alternating flat pulses in the frequency range of 28 kHz to 31 kHz. Gould's Wattled Bat display curved pulses with up-sweeping tails, a frequency of 27.5 – 32.5 kHz and alternation in call frequency between pulses. Ride's Free-tailed Bat display non-alternating flat pulses usually with a slope below 200 OPS. Calls with intermediate characteristics were assigned mixed species labels.

The calls of Eastern False Pipistrelle, Greater Broad-nosed Bat and *Scotorepens orion* (Eastern Broad-nosed Bat) can be difficult to separate as their call frequencies and some other call characteristics overlap.

- Eastern False Pipistrelle bat calls have a characteristic frequency between 35 and 39 kHz, display curved, often steep pulses without up-sweeping tails and sometimes with down-sweeping tails. The pre-characteristic section is often long. This species can only be separated from Eastern Broad-nosed Bat, as stated above when the characteristic frequency is above 38 kHz.
- Greater Broad-nosed Bats can be distinguished by a frequency of 32 – 36 kHz, lack of a tail or short down-sweeping tail, frequency of the knee greater than 37 kHz, and drop of more than 3 kHz from the knee to the characteristic section.
- Eastern Broad-nosed Bat calls fall between 34 and 37 kHz but can only be separated from Eastern False Pipistrelle when calls are between 34 and 35 kHz, and the frequency of the knee is above 38 kHz.

When calls showed characteristics intermediate between these three species they were assigned mixed species labels.

Eastern Bentwing Bats have call profiles that overlap with other species in this region, including *Vespadelus darlingtoni* (Large Forest Bat) and *Vespadelus regulus* (Southern Forest Bat). Eastern Bentwing Bat calls can be identified by a characteristic frequency of 43.5 – 47.5 kHz, a down-sweeping tail, uneven time between call pulses, uneven pulse shape within a sequence and a drop of more than 2 kHz between the knee and characteristic section of the call. Large Forest Bat calls have a characteristic frequency of 40 - 44 kHz, have no tail or up-sweeping tails. Large Forest Bats often have a long characteristic section which can aid in separating this species from the Southern Forest Bat. Southern Forest Bat calls fall between 43.5 – 46 kHz, are curved and generally have up-sweeping tails but can have down-sweeping tails. Some of the calls recorded during this survey displayed a drop of more than 2 kHz, downward sweeping tails and variability between the pulses leading to an identification of Eastern Bentwing Bat.

The calls of Little Bentwing Bats are generally easily separated from those of Chocolate Wattled Bat by higher frequency falling between 54.5 and 64.5kHz, however both have down-sweeping tails. Chocolate Wattled Bats generally call between 49.5 and 52 kHz in this region but call at frequencies up to 54.5 kHz in other regions of NSW. Calls falling between 54 and 55.5 kHz can be difficult to separate. Little Bentwing Bat calls often display variable shape and time between pulses and rarely call below 58 kHz. When calls with down sweeping tails were recorded at 54 to 55.5 kHz they were assigned mixed species labels.

In this region, calls of Chocolate Wattled Bat, Little Bentwing Bat, *Vespadelus vulturnus* (Little Forest Bat) and *Vespadelus pumilus* (Eastern Forest Bat) can overlap. Both Little Forest Bat calling between 48.5 and 53 kHz and Eastern Forest Bat calling between 50.5 and 58 kHz have up-sweeping tails whilst Chocolate Wattled Bat and Little Bentwing Bat have down sweeping tails. Eastern Forest Bat can be separated from Little Forest Bat when the frequency falls above 53 kHz. When calls fall between 53 and 55 kHz and do not have tails it is very difficult to separate these four species. When distinguishing characteristics are absent, calls are assigned to multi-species groups or characterized as unidentifiable.

The calls of Southern Myotis and the *Nyctophilus* group of species are difficult to separate. Calls can sometimes be identified as *Nyctophilus spp*. when the time between calls (TBC) is higher than 95ms and the initial slope S1 is lower than 300 octaves per second (OPS). Calls can sometimes be identified as Southern Myotis when the time between calls (TBC) is lower than 75ms and the initial slope S1 is greater than 400 (OPS). Southern Myotis calls are often louder and more distinct, recorded in longer sequences and more variable in shape and TBC than *Nyctophilus* spp. calls. In addition, there is often two kinks in the slope of *Nyctophilus* spp. calls. Where the TBC is between 75 and 95ms and the OPS is between 300 and 400 calls are assigned a mixed species label of Southern Myotis / Long-eared Bats (Pennay, Law and Reinhold 2004).

Table 34: Microbat species diversity recorded at Illawarra Coal and Balance Lands between 16 December 2016 and 9 March 2017

Species Name	Common Name	Site 1 SN81871		Site 2 SN81081		Site 3 SN81997		Site 4 SN81147, SN82275 and SN82241		Site 5 SN81781	
		12 to 13 January 2017		12 to 13 January 2017		10 to 12 January 2017		10 to 12 January 2017, 1 to 9 March 2017		5 to 10 January 2017	
		Set to survey among a weed infested *Eucalyptus moluccana* Woodland		Set to survey at the boundary of weed infested *Eucalyptus moluccana* Woodland and pasture		Set to survey among paddock trees, pasture and Kunzea dominated creek line		Set to survey a farm dam that is partially surrounded by trees and pasture		Set to survey among pasture, dead hollow bearing stags, vegetated creek-line nearby	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-Striped Freetail Bat	X		X		X		X		X	
Chalinolobus dwyeri[1]	Large-eared Pied Bat					X		X		X	
Chalinolobus gouldii	Gould's Wattled Bat	X		X		X		X		X	
Chalinolobus morio	Chocolate Wattled Bat	X		X		X		X		X	
*Falsistrellus tasmaniensis**	Eastern False Pipistrelle		X	X			X		X		X
*Miniopterus australis**	Little Bentwing Bat	X		X		X		X		X	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat							X			
Mormopterus (*Micronomus*) *norfolkensis**	Eastcoast Freetail Bat			X		X		X		X	
Mormopterus (*Ozimops*) *ridei*	Eastern Freetail Bat	X		X				X		X	
*Myotis macropus**	Large-footed Myotis	X			X			X			X
Nyctophilus spp. In this region the non-threatened *N. geoffroyi* and *N. gouldii* are	In this region the non-threatened Lesser and Gould's Long-eared	X		X	X			X		X	

Species Name	Common Name	Site 1 SN81871		Site 2 SN81081		Site 3 SN81997		Site 4 SN81147, SN82275 and SN82241		Site 5 SN81781	
		12 to 13 January 2017		12 to 13 January 2017		10 to 12 January 2017		10 to 12 January 2017, 1 to 9 March 2017		5 to 10 January 2017	
		Set to survey among a weed infested *Eucalyptus moluccana* Woodland		Set to survey at the boundary of weed infested *Eucalyptus moluccana* Woodland and pasture		Set to survey among paddock trees, pasture and Kunzea dominated creek line		Set to survey a farm dam that is partially surrounded by trees and pasture		Set to survey among pasture, dead hollow bearing stags, vegetated creek-line nearby	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
likely to be present.	Bats are likely to be present.										
*Saccolaimus flaviventris**	Yellow-bellied Sheathtail Bat	X		X				X			
*Scoteanax rueppellii**	Greater Broad-nosed Bat		X		X		X				X
Scotorepens orion	Eastern broad-nosed Bat		X	X		X		X		X	
Vespadelus pumilus	Eastern Forest Bat		X		X		X	X		X	
Vespadelus vulturnus	Little Forest Bat		X		X		X		X		X
Species Diversity (Positive identification)		**8**		**10**		**7**		**13**		**10**	
Species Diversity (Possible identification)			**5**		**5**		**4**		**2**		**4**

* Threatened species listed under TSC Act

Table 35: Microbat species diversity recorded at Balance Lands between 16 December 2016 and 9 March 2017

Species Name	Common Name	Site 6 SN81781		Site 7 SN82275		Site 8 SN81147		Site 9 SN82441		Site 10 SN81147	
		5 to 10 January 2017		5 to 10 January 2017		16 to 20 January 2017		20 t0 24 January 2017		14 to 16 January 2017	
		Set to survey among a thin row of Ironbark young trees. Mostly pasture		Set survey at the edge of sandstone gorge with many hollow bearing trees located nearby		Set survey among paddock trees in eastern conservation zone		Set survey in creek line, small amount of \water, dense riparian vegetation and metal culvert		Set to survey a creek line with sandstone cracks, crevices and overhanging habitats in gorge/gully	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-striped Freetail Bat	X		X		X		X		X	
Chalinolobus dwyeri[*1]	Large-eared Pied Bat				X	X		X			
Chalinolobus gouldii	Gould's Wattled Bat	X		X		X		X		X	
Chalinolobus morio	Chocolate Wattled Bat	X				X		X			
*Falsistrellus tasmaniensis**	Eastern False Pipistrelle		X		X	X					
*Miniopterus australis**	Little Bentwing Bat	X		X		X					
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat					X					
*Micronomus (Mormopterus) norfolkensis**	Eastern Coastal Freetail Bat	X		X		X		X			
Ozimops (*Mormopterus*) *ridei*	Eastern Freetail Bat	X		X				X			
*Myotis macropus**	Southern Myotis	X					X		X	X	
Nyctophilus spp. In this region the non-threatened *N. geoffroyi* and *N. gouldii* are likely to be present.	In this region the non-threatened Lesser and Gould's Long-eared Bats are likely to be present.	X					X	X		X	
*Saccolaimus flaviventris**	Yellow-bellied Sheathtail Bat	X		X		X					

Species Name	Common Name	Site 6 SN81781		Site 7 SN82275		Site 8 SN81147		Site 9 SN82441		Site 10 SN81147	
		5 to 10 January 2017		5 to 10 January 2017		16 to 20 January 2017		20 t0 24 January 2017		14 to 16 January 2017	
		Set to survey among a thin row of Ironbark young trees. Mostly pasture		Set survey at the edge of sandstone gorge with many hollow bearing trees located nearby		Set survey among paddock trees in eastern conservation zone		Set survey in creek line, small amount of \water, dense riparian vegetation and metal culvert		Set to survey a creek line with sandstone cracks, crevices and overhanging habitats in gorge/gully	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
*Scoteanax rueppellii**	Greater Broad-nosed Bat		X				X				
Scotorepens orion	Eastern Broad-nosed Bat		X		X	X				X	
Vespadelus pumilus	Eastern Forest Bat		X		X	X			X		X
Vespadelus vulturnus	Little Forest Bat		X		X		X		X		X
Species Diversity (Positive identification)		**9**		**6**		**11**		**7**		**5**	
Species Diversity (Possible identification)			**5**		**5**		**4**		**3**		**2**

* Threatened species listed under TSC Act

[1] Threatened species listed under the EPBC Act

Table 36: Microbat species diversity recorded at Balance Lands between 16 December 2016 and 9 March 2017

Species Name	Common Name	Site 11 SN81781		Site 12 SN82241		Site 13 SN81081		Site 14 SN81997		Site 15 SN82241	
		16 to 20 January 2017		5 to 10 January 2017		14 to 16 December 2016		14 to 16 December 2016		14 to 16 January 2017	
		Set to survey pasture that has been heavily grazed horses.		Set survey near dam among pasture with a few scattered paddock trees nearby		Set to survey near a farm dam that is surrounded by trees		Set survey among scattered paddock trees. The understorey vegetation has been severely underscrubbed.		Set survey among large paddock hollow bearing paddock trees. Pasture with sandstone creek nearby	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-striped Freetail Bat	X		X		X		X		X	
Chalinolobus dwyeri[*1]	Large-eared Pied Bat			X				X			
Chalinolobus gouldii	Gould's Wattled Bat	X		X		X		X		X	
Chalinolobus morio	Chocolate Wattled Bat	X		X		X		X		X	
*Falsistrellus tasmaniensis**	Eastern False Pipistrelle		X	X				X			
*Miniopterus australis**	Little Bentwing Bat			X						X	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat										
Mormopterus (*Micronomus*) *norfolkensis**	Eastcoast Freetail Bat	X		X				X			
Mormopterus (*Ozimops*) *ridei*	Eastern Freetail Bat	X				X		X			
*Myotis macropus**	Large-footed Myotis		X	X			X	X			X
Nyctophilus spp. In this region the non-threatened *N. geoffroyi* and *N. gouldii* are likely to be present.	In this region the non-threatened Lesser and Gould's Long-eared Bats are likely to be present.		X	X		X		X		X	
*Scoteanax rueppellii**	Greater Broad-nosed Bat		X		X				X		

Species Name	Common Name	Site 11 SN81781		Site 12 SN82241		Site 13 SN81081		Site 14 SN81997		Site 15 SN82241	
		16 to 20 January 2017		5 to 10 January 2017		14 to 16 December 2016		14 to 16 December 2016		14 to 16 January 2017	
		Set to survey pasture that has been heavily grazed horses.		Set survey near dam among pasture with a few scattered paddock trees nearby		Set to survey near a farm dam that is surrounded by trees		Set survey among scattered paddock trees. The understorey vegetation has been severely underscrubbed.		Set survey among large paddock hollow bearing paddock trees. Pasture with sandstone creek nearby	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Scotorepens orion	Eastern Broad-nosed Bat	X					X	X			
Vespadelus pumilus	Eastern Forest Bat		X		X		X		X		X
Vespadelus vulturnus	Little Forest Bat		X		X		X		X		X
Species Diversity (Positive identification)		**6**		**9**		**5**		**10**		**5**	
Species Diversity (Possible identification)			**6**		**3**		**4**		**2**		**3**

* Threatened species listed under TSC Act / [1] Threatened species listed under the EPBC Act

Table 37: Microbat species diversity recorded at Mt Gilead between December 2016 and March 2017

Species Name	Common Name	Site 16 SN81081		Site 17 SN81997		Site 18 SN82243		Site 19 SN82275	
		20 to 24 January 2017		20 to 24 January 2017		20 to 24 January 2017		20 to 24 January 2017	
		Set to survey over the canopy of a vegetated sandstone gorge		Set to survey a woodland with a small sandstone based creek is nearby. Numerous hollow bearing trees are present in this area		Set to survey in a patch of Cumberland Plain Woodland that is severely underscrubbed and disturbed by grazing. Farm dam and water channel are nearby		Set to survey among hollow bearing paddock trees in the far southern end of the study area.	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-striped Freetail Bat	X		X				X	
Chalinolobus dwyeri[*1]	Large-eared Pied Bat				X				
Chalinolobus gouldii	Gould's Wattled Bat	X		X		X		X	
Chalinolobus morio	Chocolate Wattled Bat	X		X		X			
*Falsistrellus tasmaniensis**	Eastern False Pipistrelle		X		X		X		X
*Miniopterus australis**	Little Bentwing Bat	X		X				X	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat							X	
Mormopterus (*Ozimops*) *ridei*	South-eastern Freetail Bat						X	X	
*Myotis macropus**	Large-footed Myotis	X							X
Nyctophilus spp. In this region the non-threatened *N. geoffroyi* and *N. gouldii* are likely to be present.	In this region the non-threatened Lesser and Gould's Long-eared Bats are likely to be present.	X							X
*Saccolaimus flaviventris**	Yellow-bellied Sheathtail Bat				X				
*Scoteanax rueppellii**	Greater Broad-nosed Bat		X		X		X		X
Scotorepens orion	Eastern Broad-nosed Bat		X		X		X	X	
Vespadelus pumilus	Large Forest Bat	X			X				X

Species Name	Common Name	Site 16 SN81081		Site 17 SN81997		Site 18 SN82243		Site 19 SN82275	
		20 to 24 January 2017		20 to 24 January 2017		20 to 24 January 2017		20 to 24 January 2017	
		Set to survey over the canopy of a vegetated sandstone gorge		Set to survey a woodland with a small sandstone based creek is nearby. Numerous hollow bearing trees are present in this area		Set to survey in a patch of Cumberland Plain Woodland that is severely underscrubbed and disturbed by grazing. Farm dam and water channel are nearby		Set to survey among hollow bearing paddock trees in the far southern end of the study area.	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Vespadelus vulturnus	Little Forest Bat		X		X				X
Species Diversity (Positive identification)		**7**		**4**		**2**		**6**	
Species Diversity (Possible identification)			**4**		**7**		**4**		**6**

* Threatened species listed under TSC Act / [1] Threatened species listed under the EPBC Act

Call profiles

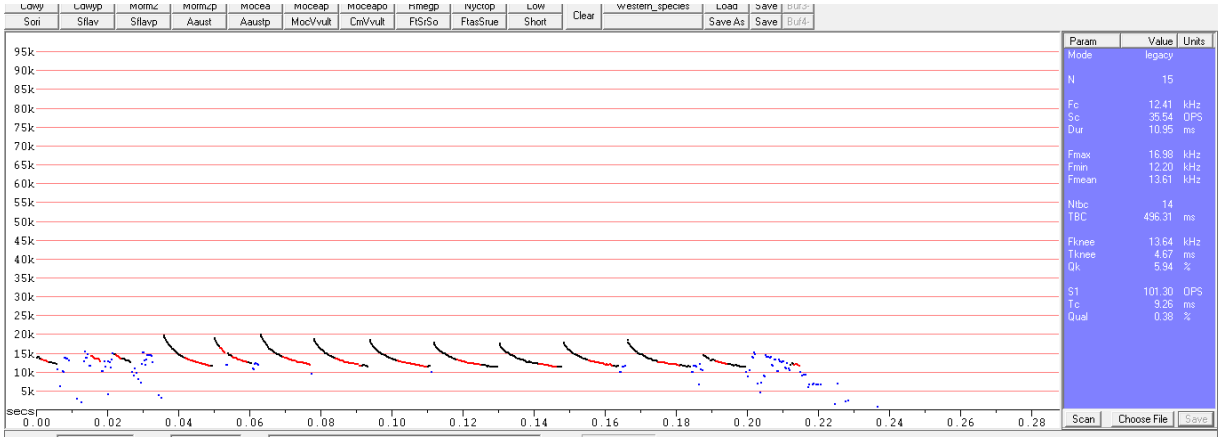

Figure 39: Call profile for *Austronomus australis* (White-striped Freetail Bat)

Recorded at Site 7 which is located on the edge of pasture and directed into vegetated creek (SN82275), at 0315 (03.15 am), 12 January 2017

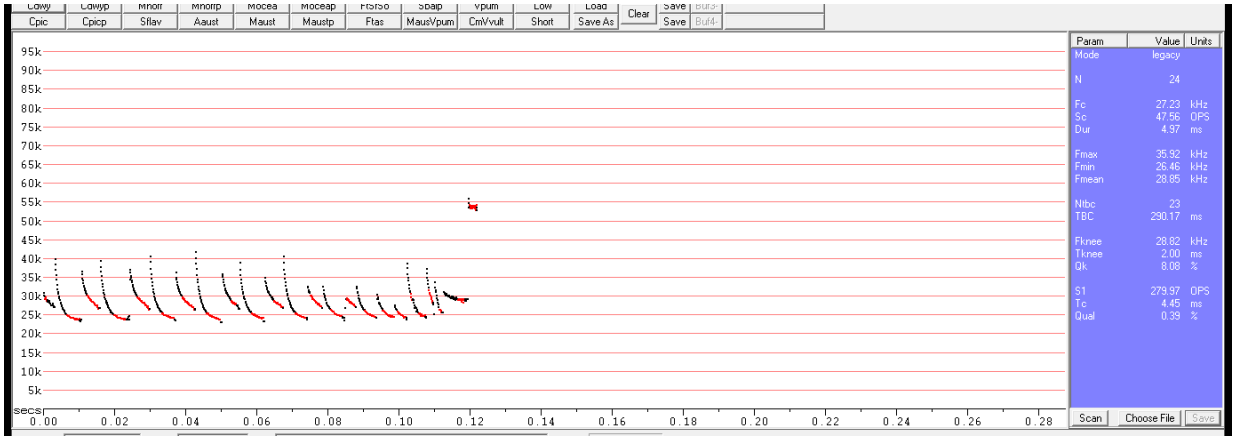

Figure 40: Call profile for *Chalinolobus dwyeri* (Large-eared Pied Bat)

Recorded at Site 6 which was set in a thin Ironbark woodland (SN81781) at 2011 (8.11 pm), 8 January 2017

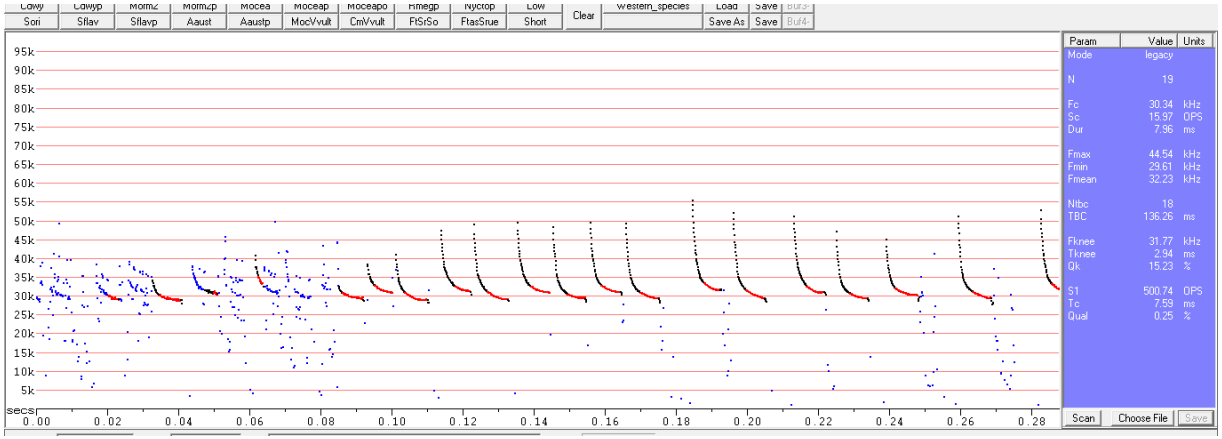

Figure 41: Call profile for *Chalinolobus gouldii* (Gould's Wattled Bat)

Recorded at Site 2 set in the Illawarra Coal land on the edge of paddock/forest edge) (SN81081), at 0231 (2.31 am), 13 January 2017

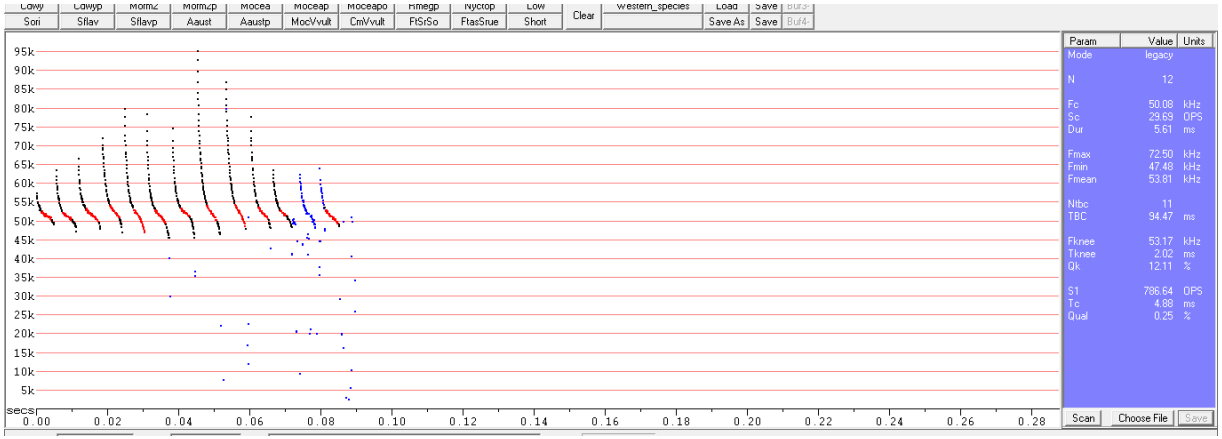

Figure 42: Call profile for *Chalinolobus morio* (Chocolate Wattled Bat)

Recorded at Site 3 which was set on edge of pasture habitat and creek (SN81997), at 0430 (4.30 am) 12 January 2017

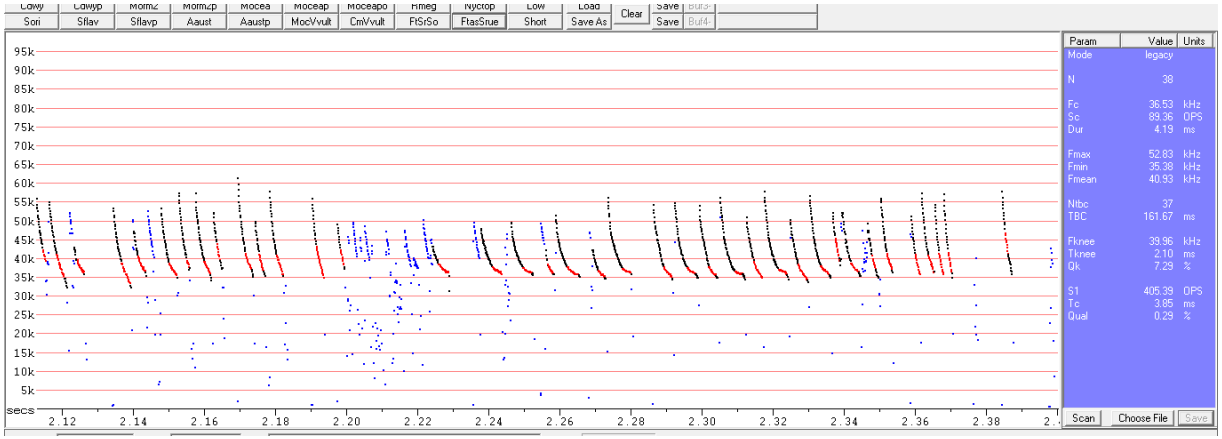

Figure 43: Call profile for *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)

Recorded at Site 7, which is located on the edge of pasture and directed into vegetated creek (SN82275), at 2033 (8.33 pm) 20 December 2016

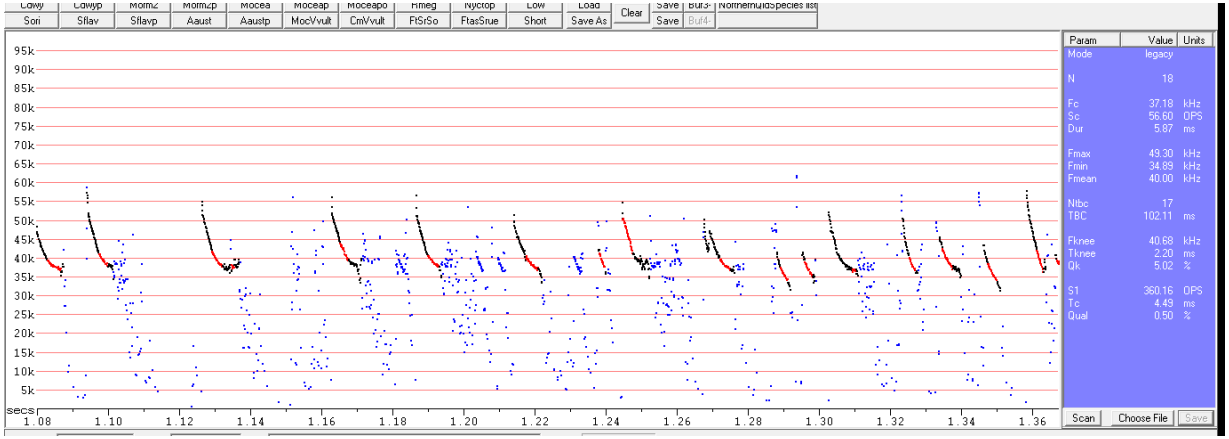

Figure 44: Possible call profile for *Falsistrellus tasmaniensis* (Eastern False Pipistrelle), *Scoteanax rueppellii* (Greater Broad-nosed Bat) and *Scotorepens orion* (Eastern Broad-nosed Bat)

Recorded at Site 1 set among weed infested Eucalyptus moluccana woodland (SN81081) at 2041 (8.41 pm), 12 January 2017

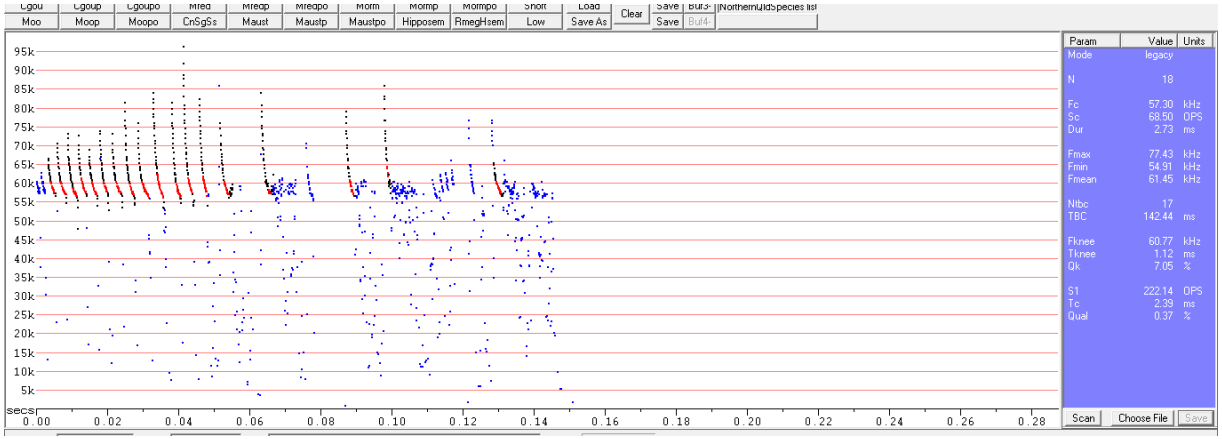

Figure 45: Call profile for *Miniopterus australis* (LIttle Bentwing Bat)

Recorded at Site 12 set near a farm dam a located in pasture and near some paddock trees (SN82241), at 2107 (9.07 pm) 6 February 2017

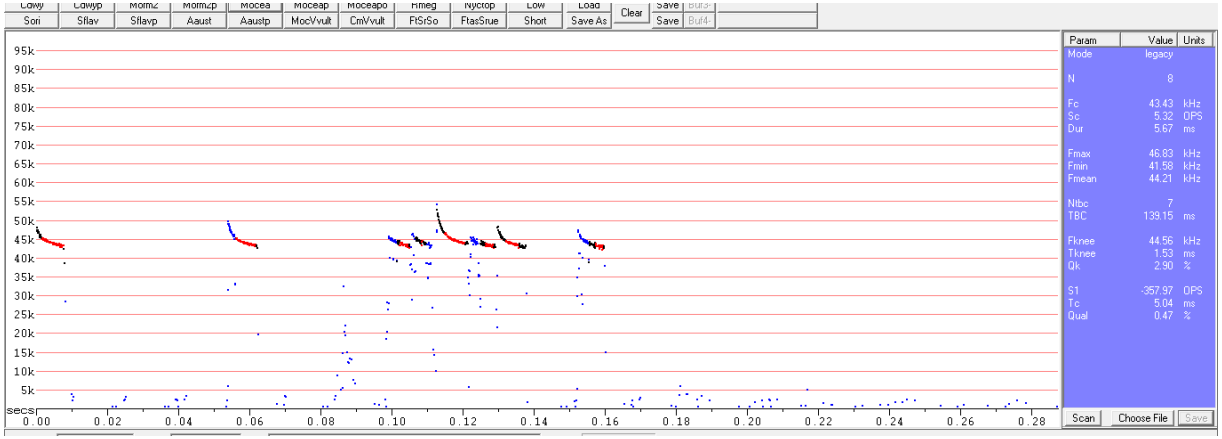

Figure 46: Call profile for *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat)

Recorded at Site 7, which is located on the edge of pasture and directed into vegetated creek (SN82275), at 2213 (10.13 pm) 20 December 2016

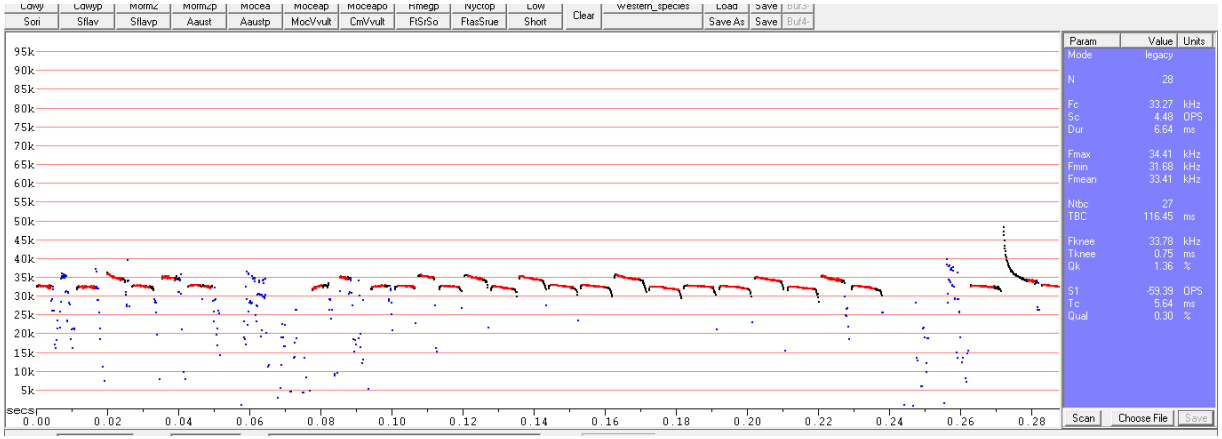

Figure 47: Call profile for *Mormopterus* (*Micronomus) norfolkensis* (Eastcoast Freetail Bat)

Recorded at Site 8 set open woodland among the conservation zone (SN81147) at 2011 (8.11 pm) 16 December 2016

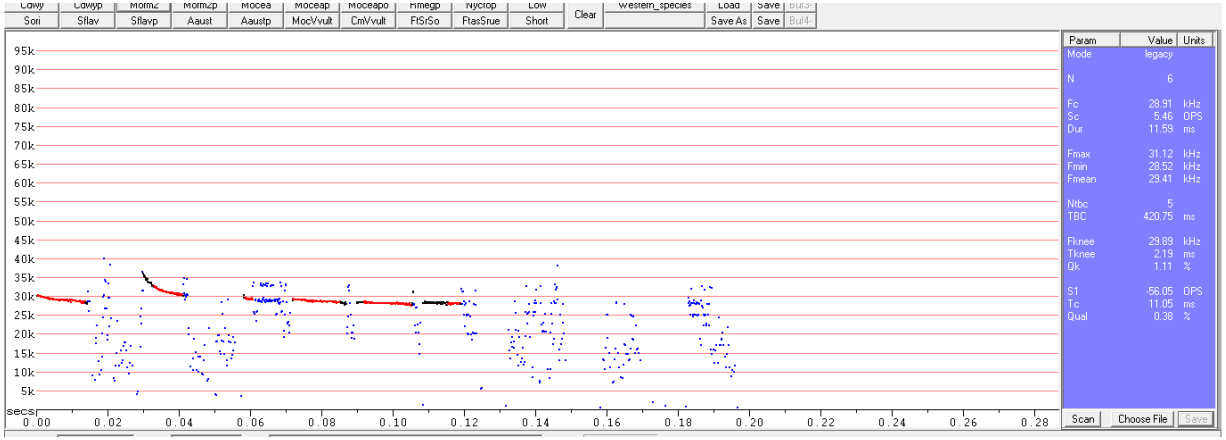

Figure 48: Call profile for *Mormopterus* (*Ozimops) ridei* (Eastern Freetail Bat)

Recorded Site 5 which is located on the north east corner among open vegetation and dead *Angophora floribunda* trees (SN81081), at 2345 (11.45 pm), 5 January 2017

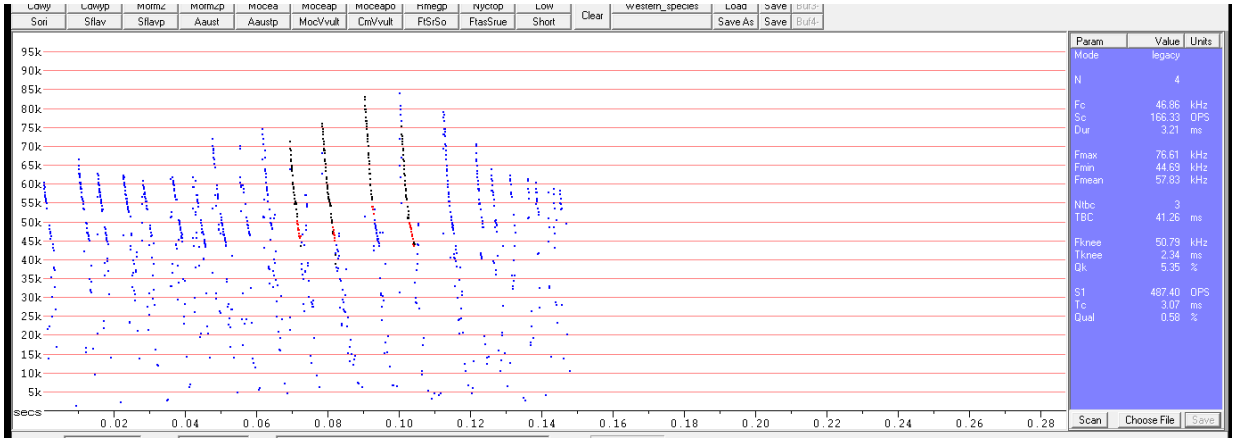

Figure 49: Call profile for *Myotis macropus* (Large-footed Myotis)

Recorded Site 5 which is located on the north-east corner among open vegetation and dead *Angophora floribunda* trees (SN81081), at 0130 (1.30 am), 9 January 2017

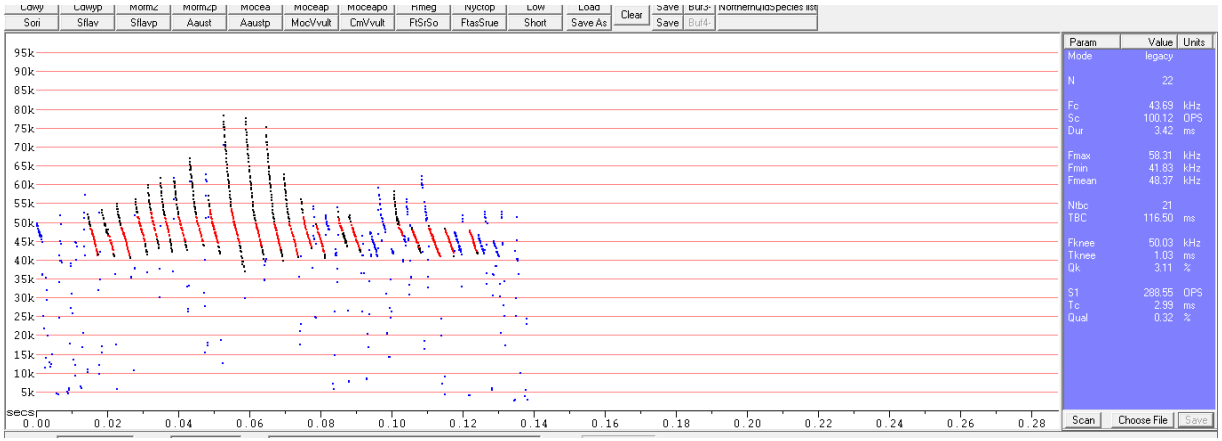

Figure 50: Call profile for *Nyctophilus spp.* (Long-eared Bat)

Recorded at Site 14 set among pasture surrounded by woodland (SN81997), at 2214 (8.14 pm), 14 December 2016

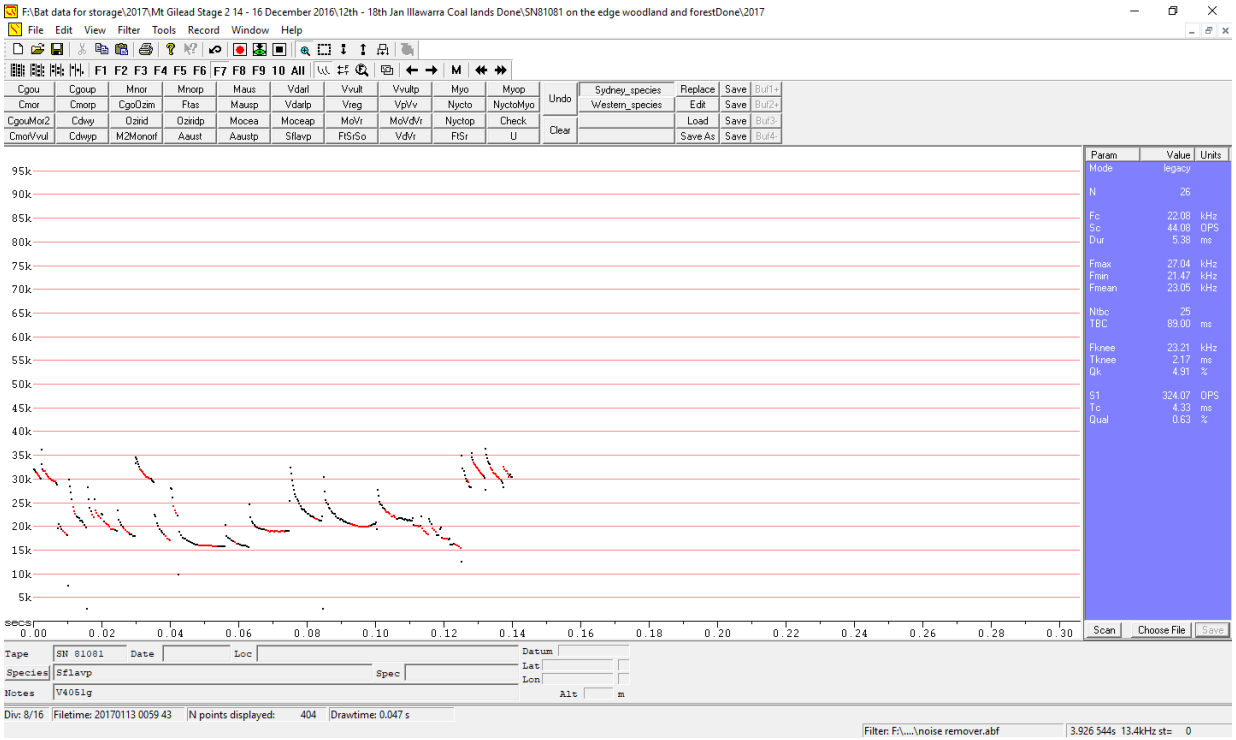

Figure 51: Potential call profile for *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) (lower frequency call) and *Chalinolobus gouldii* (Gould's Wattled Bat) / *Ozimops ridei* (Ride's Free-tailed Bat) call (higher frequency)

Recorded at Site 1 which was set in a Illawarra Coal site (near to a wooded area) (SN81081), at 0059 (12.59 am) 8 January 2017

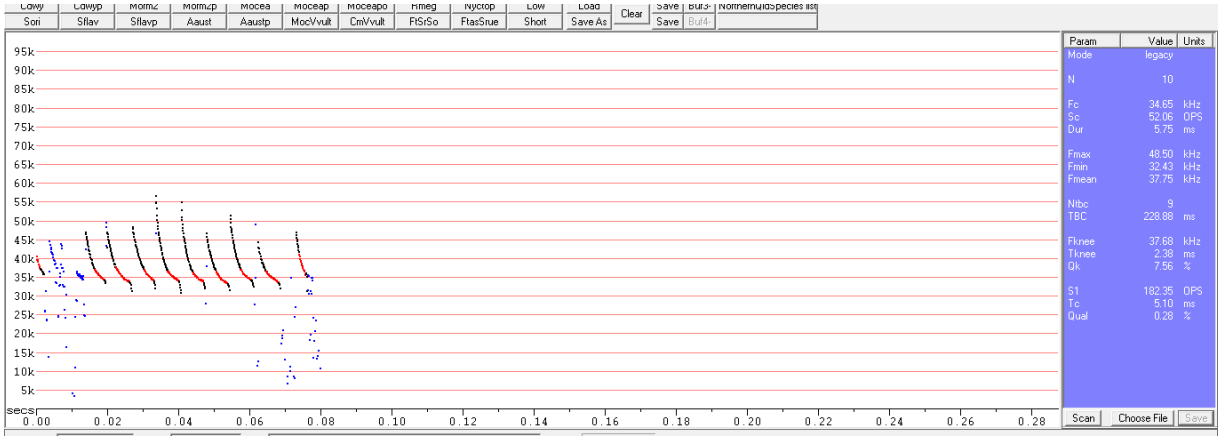

Figure 52: Call profile for *Scotorepens orion* (Eastern Broad-nosed Bat)

Recorded at Site 14 located in pasture that is surrounded by woodland (SN81997), at 2338 (11.38 pm) 14 January 2017

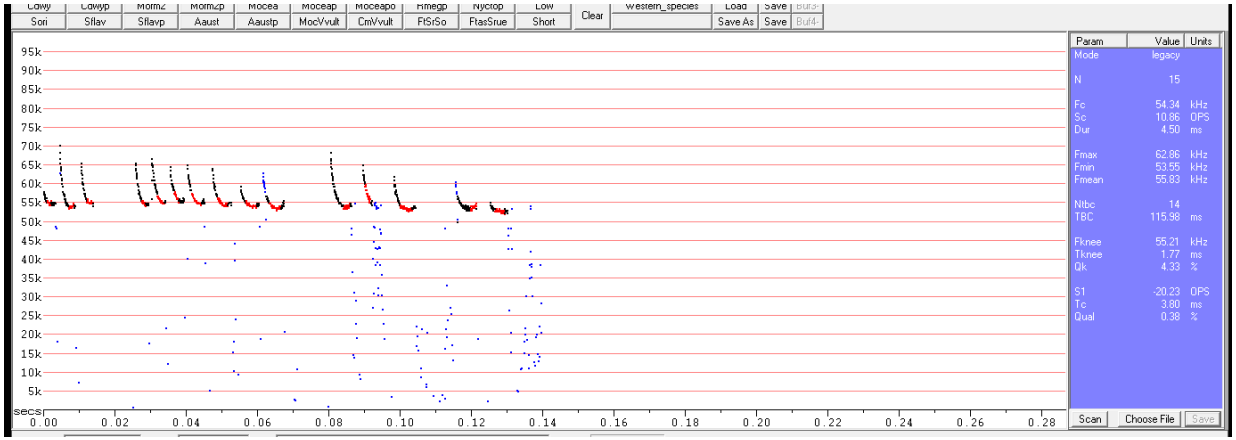

Figure 53: Call profile for *Vespadelus pumilus* (Eastern Forest Bat)

Recorded at Site 5 which is located on the north-east corner among open vegetation and dead Angophora floribunda trees (SN81081), at 2323 (11.23pm), 8 January 2017

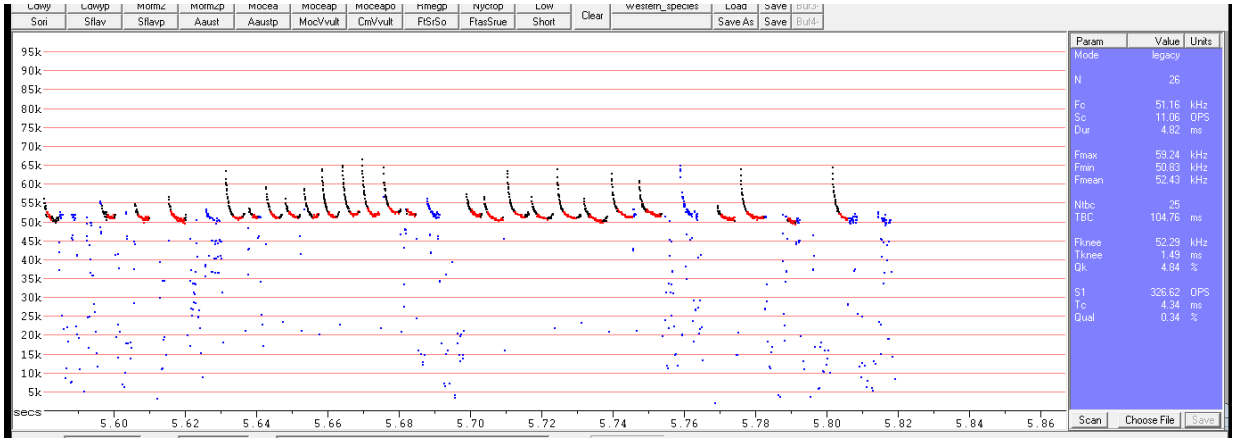

Figure 54: Possible call profile for *Vespadelus pumilus* (Eastern Forest Bat) and *Vespadelus vulturnus* (Little Forest Bat)

Recorded at Site 1 located in the Illawarra Land woodland habitat (SN81781), at 2042 (8.42 pm) 13 January 2017

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Reinhold, L., Law, B., Ford, G., and Pennay, M. (2001). Key to the bat calls of south-east Queensland and north-east New South Wales.. Queensland, DNR.

Appendix J : Transect/plot data

Zone 1: HN526 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Weedy)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG19	17	20.5	1	0	0	0	60	0	0	38	293086	6220188	56
MG20	8	14	3	0	0	12	102	0	0	78	293035	6219584	56
MG21	12	43	0	10	0	2	46	0	0	26	292857	6221254	56
MG22	7	10	0	2	0	0	73	0	0	17	293353	6222095	56

Zone 2: HN526 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Scattered Trees)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG39	15	4.5	8	4	0	0	50	0	0	19	292808	6221120	56

Zone 3: HN526 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Regen)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG37	16	38	8	2	0	0	6	0	0.5	14	292691	6221010	56

Zone 4: HN528 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Pasture improved)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB04	18	30.5	0	28	0	2	48	0	0.6	11	294025	6219552	56
BB09	12	27	0	0	0	30	70	1	0.6	52	295543	6221360	56
BB11	27	17.5	0	58	0	12	52	0	0.6	21	294287	6220184	56
MG06	8	27	0	2	0	2	24	0	0.6	11	293570	6220793	56

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG08	8	25	0	4	0	2	16	0	0.6	68	293446	6221325	56
MG14	15	8	0	12	0	26	12	0	0.6	0	293856	6219770	56
MG25	15	20.5	0	2	0	6	24.1	0	0.6	23	295258	6220445	56
MG30	27	16.5	0	38	8	6	34	2	0.6	19	296689	6222119	56
MG38	14	24	0	6	0	2	12	0	0.6	7	293855	6219554	56
MG44	30	39	4	40	4	10	36	0	0.6	3	296822	6222450	56
MG46	16	11.5	0	28	0	12	4	0	0.6	16	294386	6221949	56
MG47	23	43	0	15	0	4	10	0	0.6	0	295015	6222576	56
MG48	30	39	0	22	0	20	4	1	0.6	21	294489	6222093	56

Zone 5: HN528 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Scattered Trees)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB05	13	33	0	10	0	8	70	0	0.4	8	294155	6220149	56
BB10	3	24	0	0	0	0	74	1	0.4	35	295348	6221287	56
MG16	18	21	0	2	0	2	52	1	0.4	32	293978	6219350	56
MG36	8	27.5	0	0	0	6	28	1	0.4	27	295211	6220584	56

Zone 6: HN528 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (DNG)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB01	18	0	0	94	0	22	74	0	0	0	294399	6220961	56
MG45	11	0	0	44	0	0	38	0	0	0	295191	6222785	56

Zone 7: HN528 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Cleared)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MGCL02	2	0	0	0	0	2	96	0	0	0	295646	6221211	56
MGCL04	2	0	0	16	0	0	100	0	0	0	296918	6222297	56

Zone 8: HN529 - Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (Good)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG32	17	30.5	0	36	0	4	32	4	1	31	293982	6223220	56

Zone 9: HN529 - Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (Weedy)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG33	9	13	0	0	0	2	57	1	0	33.5	293828	6223241	56

Zone 10: HN529 - Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (DNG)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG34	9	0	0	62	0	0	46	0	1	0	293929	6223054	56
MG35	15	0	0	20	0	30	68	0	1	0	293654	6223301	56

Zone 11: HN529 - Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (Cleared)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MGCL01	5	0	0	0	0	2	94	0	0	0	294016	6223174	56

Zone 12: HN538 - Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion (Good)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB02	39	21	40	0	6	28	20	1	0.45	19	294912	6221241	56
MG01	33	76	0	0	0	20	10	1	0.45	37	294712	6221160	56
MG40	36	39	0	2	0	10	5	2	0.45	62	293724	6220247	56
MG41	35	58	6	0	0	2	46	1	0.45	20	293783	6221195	56
MG43	30	62	9	0	0	0	70.5	2	0.45	25	294228	6221150	56

Zone 13: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (Good)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB03	49	23	21	70	10	22	0	0	0.82	28	292932	6220710	56
BB12	37	27	5	30	0	36	0	0	0.82	52	296400	6220725	56
MG02	29	35	0	0	0	10	0	1	0.82	45	293246	6219566	56
MG04	33	11.1	49.5	2	0	2	0	2	0.82	29	294805	6221129	56
MG07	47	49	22	16	2	12	8	3	0.82	77	293191	6220161	56
MG09	31	35	19	24	2	8	0	1	0.82	85	292975	6221450	56
MG17	53	26.5	4.5	10	6	14	0	3	0.82	38	295408	6220523	56
MG18	43	52	9	14	0	2	2	1	0.82	41	295160	6220892	56
MG28	44	19.5	3	56	2	44	0	0	0.82	26	296425	6220974	56
MG29	43	57	9	44	4	30	0	0	0.82	92	296414	6219842	56
MG31	37	36	26.5	22	2	8	0	0	0.82	29	296398	6220176	56
MG42	44	17	24	14	0	0	0	1	0.82	46	293725	6221333	56

Zone 14: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (Thinned/Shrubby)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG11	42	27	42	42	0	6	12	0	0	20	293834	6221881	56
NW05	24	0	7	26	0	40	15.1	0	0	0	293040	6221520	56
NW06	43	0	31	46	2	36	12	0	0	4.5	293928	6221750	56

Zone 15: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (Pasture improved)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB06	43	5.5	0	50	0	40	12	0	0.43	28	294199	6219677	56
BB07	31	23.5	0	46	0	18	6	0	0.43	12	293817	6221003	56
BB13	19	16.6	0	36	0	42	22	0	0.43	24	295440	6221634	56
MG03	13	48	0	4	0	10	22	2	0.43	10	293629	6219598	56
MG12	9	7.5	0	4	0	0	26	0	0.43	14	293832	6220660	56
MG15	25	39	0	10	0	6	10	0	0.43	19	294669	6220866	56
MG23	10	40.5	0	12	0	2	38	0	0.43	40	295462	6220582	56
MG24	11	45.5	0	0	0	6	10	1	0.43	15	294540	6220377	56
MG27	14	12.2	0	34	0	6	26	1	0.43	16	294952	6220606	56

Zone 16: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (Scattered Trees)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
A2_2013	5	15.5	0	16	0	2	100	1	0.43	0	295765	6220555	56
BB08	17	15.5	0	66	0	10	80	0	0	0	294015	6220242	56
MG26	12	35	0	6	0	2	22	1	0	8	295054	6220920	56

Zone 17: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (DNS)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG10	35	0	38	2	4	2	16	0	0.33	9	293247	6221973	56
MG13	43	11	75	28	0	4	1	0	0.33	3	293746	6221565	56

Zone 18: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (DNG)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MGCL05	12	0	0	90	0	0	28	0	0	2	296877	6222420	56

Zone 19: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (Cleared)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MGCL03	7	0	0	0	0	22	94	0	0	17	295182	6221182	56
NW11	30	0	0	30	0	2	82	0	0	0	293842	6221669	56
NW12	22	0	0	26	0	4	66	0	0	3	294195	6221100	56
NS13	2	0	0	0	0	0	98	0	0	0	293163	6221660	56
H11	3	0	0	0	0	0	92	0	0	0	295331	6221021	56

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ISO 14001 Environmental Management

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HEAD OFFICE
Suite 2, Level 3
668-672 Old Princes Highway
Sutherland NSW 2232
T 02 8536 8600
F 02 9542 5622

CANBERRA
Level 2
11 London Circuit
Canberra ACT 2601
T 02 6103 0145
F 02 9542 5622

COFFS HARBOUR
35 Orlando Street
Coffs Harbour Jetty NSW 2450
T 02 6651 5484
F 02 6651 6890

PERTH
Suite 1 & 2
49 Ord Street
West Perth WA 6005
T 08 9227 1070
F 02 9542 5622

DARWIN
16/56 Marina Boulevard
Cullen Bay NT 0820
T 08 8989 5601
F 08 8941 1220

SYDNEY
Suite 1, Level 1
101 Sussex Street
Sydney NSW 2000
T 02 8536 8650
F 02 9542 5622

NEWCASTLE
Suites 28 & 29, Level 7
19 Bolton Street
Newcastle NSW 2300
T 02 4910 0125
F 02 9542 5622

ARMIDALE
92 Taylor Street
Armidale NSW 2350
T 02 8081 2685
F 02 9542 5622

WOLLONGONG
Suite 204, Level 2
62 Moore Street
Austinmer NSW 2515
T 02 4201 2200
F 02 9542 5622

BRISBANE
Suite 1, Level 3
471 Adelaide Street
Brisbane QLD 4000
T 07 3503 7192
F 07 3854 0310

HUSKISSON
Unit 1, 51 Owen Street
Huskisson NSW 2540
T 02 4201 2264
F 02 9542 5622

NAROOMA
5/20 Canty Street
Narooma NSW 2546
T 02 4302 1266
F 02 9542 5622

MUDGEE
Unit 1, Level 1
79 Market Street
Mudgee NSW 2850
T 02 4302 1234
F 02 6372 9230

GOSFORD
Suite 5, Baker One
1-5 Baker Street
Gosford NSW 2250
T 02 4302 1221
F 02 9542 5622

ADELAIDE
2, 70 Pirie Street
Adelaide SA 5000
T 08 8470 6650
F 02 9542 5622

1300 646 131
www.ecoaus.com.au

Appendix C

CS&E's Advice on Protection of the Campbelltown Koala Population - 30 April 2020

NSW GOVERNMENT | Chief Scientist & Engineer

Advice on the protection of the Campbelltown Koala population

Koala Independent Expert Panel

30 April 2020

www.chiefscientist.nsw.gov.au/reports

NSW GOVERNMENT | Chief Scientist & Engineer

The Hon Matt Kean MP
Minister for Energy and Environment

The Hon Rob Stokes MP
Minister for Planning and Public Spaces

Dear Ministers

Advice regarding the protection of the Campbelltown Koala population

In December 2019 you requested expert advice on proposed measures to protect the Campbelltown Koala population, specifically on those measures for the proposed Mount Gilead Stage 2 Development and in the draft Cumberland Plain Conservation Plan, including advice on possible east-west corridors linking the Nepean and Georges Rivers.

This report is submitted in fulfilment of the Terms of Reference. An independent expert panel was established to provide the advice chaired by myself and that included Professor Kathy Belov AO (The University of Sydney), Dr Carolyn Hogg (The University of Sydney) and Professor Jonathan Rhodes (The University of Queensland).

In providing its advice the Panel considered the measures proposed in both the Mount Gilead Stage 2 documents and draft Cumberland Plain Conservation Plan, to provide a holistic and consistent approach in the region.

The Panel advises that access to increased (or retained) koala habitat has prima facie benefits for koalas, however, key is whether the retained habitat in east-west corridors between the Nepean and Georges Rivers can be managed such that koalas are not exposed to increased threats such as traffic and dogs, and whether mitigation measures will separate koalas from these threats. Key to the success of this will be ensuring that koalas are separated from the risks that threaten them.

This report provides recommendations to improve the proposed measures and considers a range of possible scenarios for the mitigation approaches proposed, given constraints including those that are geographic in nature. An adaptive management approach is identified as crucial, with consideration of data collection and monitoring requirements, to ensure and demonstrate the effectiveness of mitigation strategies.

Yours sincerely

Signature has been removed

Dr Chris Armstrong PSM
Deputy NSW Chief Scientist & Engineer
30 April 2020

Chief Scientist & Engineer
GPO Box 5477, Sydney NSW 2001, Australia | Tel +61 2 9338 6786
www.chiefscientist.nsw.gov.au

EXECUTIVE SUMMARY

Urbanisation is one of the main causes of declines in koala populations in NSW. These declines are associated with habitat loss and fragmentation, reduced connectivity or isolation of populations reducing genetic diversity, increasing susceptibility to disease and increasing threats from vehicle strikes and dog attacks.

There is strong evidence that urban development has major impacts for wildlife globally and drives the decline in many species. It then becomes a question of whether the impacts can be mitigated to such a degree so as to reduce them to an acceptable level.

The Macarthur region is host to a historically continuous population of koalas, known as the Campbelltown population. The population of between 250 and 500 individuals is surviving in a landscape that is predominantly native bushland that is connected to rural farmland or peri-urban environment in the vicinity of the Greater Macarthur area. The Campbelltown population is one of the few remaining populations in the Sydney region. The population is considered to be healthy and uniquely Chlamydia free. The main causes of mortality are vehicle strikes and dog attacks. The impact of the widespread 2019/20 bushfires across NSW has increased the comparative importance of this koala population.

The Greater Macarthur region has been declared a growth area to provide homes for Sydney's growing human population. Land use and infrastructure plans for the region are set out in *Greater Macarthur 2040 – An interim plan for the Greater Macarthur Growth Area* (GMGA). There are currently ~3,000 people living between Menangle Park and Appin and with an estimate of another 39,000 new homes the local human population could increase to ~109,000 people over the next 36 years. The development will include new town centres, retail and commercial services, improved transport corridors and schools. A planning principle for the GMGA is the conservation of biodiversity and koala populations.

Biodiversity certification for the GMGA is being sought by two parties: the Campbelltown City Council on behalf Lendlease for a proposed development in Mount Gilead and by the NSW Government for the remainder of the area through the Cumberland Plain Conservation Plan (CPCP). Biodiversity certification identifies, at a regional scale, areas of high conservation values that development should avoid and be protected, areas that can be developed and measures to offset any potential impacts from development.

In December 2019, the Minister for Energy and Environment and the Minister for Planning and Public Spaces requested advice on the protection of the Campbelltown koala population. Specifically, if the (1) the adequacy of the proposed measures for koalas and their consistency with the NSW Koala Strategy and if additional conservation measures are required for the proposed Mount Gilead Stage 2 development and (2) site specific measures required for the CPCP in the GMGA to support the long-term viability of the koala population including an assessment of east-west corridors.

An independent expert panel, chaired by the Deputy NSW Chief Scientist & Engineer, was established to assess the protection measures and provide this advice.

The Panel assessed the adequacy of protection measures proposed in relation to the NSW Koala Strategy, which has the objective of stabilising and increasing koala numbers over the longer-term to ensure genetically diverse and viable populations across NSW. The guiding principles for the Panel were to maximise koala population persistence and abundance, koala habitat amount and connectivity, and minimise contact between koalas and the urban environment to reduce hazards and threats.

Few dense urban new developments in Australia have successfully, over the long term, avoided declining koala populations in the context of rapid growth in urban infrastructure,

dwellings, and the threats that arise from thousands of human residents. Due to the large time lag between new developments and impacts on koala numbers, it may be difficult in the near term to fully understand population impacts caused by urbanisation. Monitoring for population growth may provide a clearer picture of impacts. However, the opportunity presents itself, through forward planning and commitments by parties to protect habitat, mitigate threats and reduce stressors. If this approach is successful, and if it can be monitored, managed and measured, it could show the way for future developments on the rural fringe to minimise the impacts that will arise.

Key to the success of this will be ensuring that koalas are separated from the risks that threaten them, in particular road traffic, and predation by dogs. The proposed high densities for residential and urban development that are proposed makes it unlikely that koalas could persist in the long-term in the urban matrix. Exclusion fencing will be key to keeping them separated from this, as will ongoing observation of the koala population to monitor for disease, indirect stressors such as light and noise, and also to monitor genetic health, population size and distribution.

Habitat and corridor protection in landscapes is not only beneficial to koalas but also other flora and fauna.

The Panel reviewed draft planning proposal information for the MGS2 site and the CPCP area associated with the GMGA. The Panel observes that access to increased (or retained) koala habitat has prima facie benefits for koalas, however, key is whether the retained habitat in east-west corridors between the Nepean and Georges Rivers can be managed such that koalas are not exposed to increased threats such as traffic and dogs, and whether mitigation measures will separate koalas from these threats.

If the removal of key risks cannot be accomplished, then the better management approach would be to monitor the impacts on the koala population and if it declines then consider active management which could include moving koalas between sites for breeding or relocation to safe areas, preferably in the local region. However, if separation from threats can be achieved in the landscape and maintained over the long term, then the better outcome for the koalas, and other flora and fauna, would be to retain the east-west corridors.

Exclusion fencing to prevent koalas accessing Appin Road from the eastern or western side is critical, as is the use of exclusion fencing more broadly to keep koalas separated from dogs and road traffic in the developments. Efforts to sympathetically landscape buffer zones further assists in separating koalas from urban impacts and related stressors, while the approach proposed by the proponents to landscape street scapes and backyards of dwellings so to exclude koala feed trees is welcome, as it removes an attractant for koalas into the urban matrix.

Cooperation, vigilance and participation of the community will be critical, when driving, in checking the integrity of fence lines, in reporting injured or dead animals, keeping dogs enclosed in yards or not taking them into koala areas, maintaining bush regeneration, or even assisting with wildlife counting and monitoring efforts. This is very much in line with the spirit of the NSW Koala Strategy.

This Executive Summary should be read in conjunction with the Findings and Recommendations chapter that follows.

FINDINGS AND RECOMMENDATIONS

Findings

In developing this advice in response to the Review's Terms of Reference, for the proposed developments at the Mount Gilead Stage 2 (MGS2) site and for the draft Cumberland Plains Conservation Plan (CPCP) within the Greater Macarthur Growth Area (GMGA), the Panel has taken a risk-based approach. This advice is based on an assessment of adequacy in terms of the objectives of the NSW Koala Strategy to stabilise and then increase koala numbers over the longer-term, ensuring genetically diverse and viable populations across NSW. In doing so the Panel has considered: hazards and threats to koalas; the benefits of the set of proposed risk mitigation and protection measures; and the costs and disbenefits of measures; residual risks of these measures. The Panel has also considered a range of scenarios to guide its advice on preferred approaches should anticipated outcomes not eventuate.

While the Panel is conscious that it has been asked to provide advice on two distinct development footprints, proceeding under different legislation, at different stages of progress, the Panel is nevertheless keen to highlight the importance of a holistic planning approach. By their very nature, the habitat corridors within the two study areas cross multiple tenures and landscapes, connect internally and with each other. Koalas, in using these corridors, do not recognise lines on maps. Therefore, the Panel report moves between the MGS2 proposal and the CPCP draft planning material fairly freely. While a reader may be interested in one development or another, there is benefit reading them together as a single document. (For the purposes of clarity, the Panel report has adopted a naming convention used in the Figure 5 with six corridors labelled from A to F as you move from north to south, with three corridors A, B, C particularly relevant for MGS2 and four corridors C, D, E and F pertinent for the CPCP planning.)

The Review Terms of Reference seek the Panel's view on the benefit of maintaining an east-west connectivity between the Georges River and Nepean River. The habitat in this region contains high quality feed trees due to the sandstone shale transition forest. The Campbelltown koala population is expanding and therefore, it is essential that this habitat supports the movement of koalas such that dispersing koalas can move through the landscape, can breed to ensure genetic diversity, and can access refugia in times of stress, drought or other threats. Overall, the Panel finds that efforts to increase the availability of habitat while reducing the interface with threats, and maintain genetic and physical health status, are important pillars upon which to plan mitigation measures.

The following findings are laid out corridor-by-corridor, for mitigations and measures in both the sets of north-south and east-west corridors. These are followed by a number of thematic findings of relevance across the landscape.

Georges River Corridor (north south), Mount Gilead vicinity and CPCP planning

The protection of the Georges River corridor, including the creation of the Georges River Koala Reserve, and the replanting of habitat will provide crucial linkage for the koala population of Southern Sydney to the Southern Highlands. While being adjacent to habitat further east in National Parks and Sydney Catchment Special Areas, the habitat in the corridor has a high nutrition value and supports one of the only koala populations in NSW that is thought to be growing and chlamydia free.

The Panel finds the current and proposed efforts to protect and improve the habitat in this corridor to be essential and agrees broadly with the Department's approach. Efforts to protect the habitat and reduce risk to koalas from threats associated with urbanisation using exclusion fencing will be important as the local human population increases with

urbanisation of the region. Regular monitoring and control of predators (such as dogs) within the corridor will be an important ongoing management tool, as will measurements of koala population dynamics.

Arguably, after the establishment of the Georges River Koala Reserve, the most important measure to be delivered for koalas in either the MGS2 plans or the CPCP will be exclusion fencing along Appin Road. Appin Road is currently a hot spot for koala mortality, so the Panel finds the use of fencing to stop koalas entering the road surface from either the east-side or west-side to be a fundamental requirement for the success of protecting koalas in the region.

Crossing structures to traverse Appin Road will also be key if the connectivity to east-west corridors is to be provided, unless intensive active management is to be employed, including translocations for breeding. The crossing infrastructure at locations along the road to facilitate east-west movement could include culverts, underpasses or bridges, while the inclusion of grids and gates will also be necessary to enable the movement of humans and vehicles onto the road while preventing koala access. These crossings are discussed below.

The Panel finds that an additional measure is required in the Georges River Corridor to prevent the development of a koala vehicle collision hotspot. Appin Road crosses the Georges River at Kings Falls Bridge within the corridor east of the Appin township. This location has the potential to create heightened risks for koalas as the number of vehicles increases with urbanisation unless suitable mitigation and crossing structures are developed. An approach using exclusion fencing along this stretch of Appin Road, with the terrain under the bridge modified with appropriate structures to ensure a safe thoroughfare for koalas, would be a valuable pre-emptive measure to prevent road deaths.

Nepean River Corridor (north-south), Mount Gilead and CPCP planning

Koala habitat in river and creek valleys provides important refugia and resilience to warming and drying climates, a characteristic that is likely to become increasingly important with climate change. The majority of the corridors discussed in this Review are riverine, which includes that along the Nepean. This north-south corridor has been identified as a primary corridor by the Department. It contains high quality habitat and connects populations to the south east in the Sydney Catchment and then further to the Southern Highlands.

The habitat associated with the Nepean River has been identified in the draft CPCP material as a strategic conservation area, and possible protections will include Biodiversity Stewardship Agreements (BSA). The Panel agrees with this approach. Additional pockets of habitat that could be replanted or improved have been identified by the Department and the Panel encourages these efforts as well.

The Panel recommends the establishment of exclusion fencing to separate koalas from threats associated with urban development, particularly from dogs and cars. While it is expensive to install and maintain fencing, these costs are small relative to the scale of the development and investment that will occur in the region over the next 36 years.

The Panel notes a particular concern regarding the Nepean Corridor, which is to prevent a functional ‘dead-end’ at its north end. Observing maps and images of the northern reach of the corridor, it appears to end in the vicinity of the MGS2 site where the Hume Highway crosses the Nepean River. Wildlife corridors that end with no connection to other habitat can be a considerable risk, in particular where the habitat exposes wildlife to threats, and in doing so can create population sinks, where wildlife kills occur, causing vacancies in the location which subsequently attract more animals.

Corridor A – Menangle Creek to Noorumba (east west), Mount Gilead development

It is the functional role that habitat in Mount Gilead site plays in connecting the north end of the Nepean Corridor in an easterly direction that means protecting corridor structures at

MGS2 is critical, preventing an isolated population at Nepean. Two corridors are the focus of protection in the MGS2 proponents: Corridor A in the north and Corridor B further south.

The proponents have approval for the protection of habitat in the Noorumba Biobank site to offset the Mount Gilead Stage 1 (MGS1 development). The site is bordered to the north by Campbelltown suburbs, to the south by MGS1 future dwellings, to the east by Appin Road and to the west by dwellings, farmland and a narrow (<85 m) wildlife corridor.

The proponents of MGS2 view the Noorumba site as part of the corridor for koala east-west movement. However, to achieve this an effective koala crossing (one that has been shown to be used by koalas elsewhere) is needed between the two sides of Appin Road. The Panel holds reservations that the proponent's preferred approach for a koala crossing (a tree-top bridge structure) will be used by koalas. Koalas primarily move on the ground between trees, and so crossings that enable this are found by the Panel to be preferred. These could include culverts or underpasses under the road, or wide overpasses or land bridges. The Panel has been informed by the proponent and others that the local topography at Noorumba does not lend itself to having a culvert built under the road.

The Panel has set out scenarios for this corridor given the tree-top bridge may not be functional, including exploring other crossing structures. The Panel finds that if the Noorumba crossing of Appin Road is not feasible, then the site would become functionally fragmented and not perform as an east-west corridor. If this were to occur, the Panel finds that monitoring of the Noorumba site would be required, combined with active management of koalas in that location to avoid genetic bottlenecks and to facilitate movement of young koalas to other areas. Monitoring for predators would also be required with the development of exclusion fencing increasingly needed as the human population increases in the adjacent suburb.

If the Noorumba site can be secured with an Appin Road crossing effective for koalas, then exclusion fencing between habitat and threats would still be required. Efforts to widen the corridors should also be made, while it is acknowledged that there are constraints with corridor widening west of Noorumba due to land use and tenure issues. Narrow corridors with open vegetation, without exclusion fencing place koalas at risk of exposure to threats such as roaming dogs and foxes, so fencing should be pursued. If fencing is not feasible, then buffer zones (~60 m wide) containing non-feed trees, and with monitoring to track predators, and population dynamics to understand these outcomes will be needed. Management decisions regarding the koala population in this area will be informed by those data, and responses could include further active management or even relocation to more suitable habitat.

Corridor B – Woodhouse Creek to Beulah (east west), Mount Gilead development

The proponents of MGS2 have identified the Corridor B route to be important for koalas and other wildlife through the proposed development. A conceptual drawing of a possible Appin Road underpass crossing has been provided to the Panel, with the crossing emerging adjacent to (not within) the Beulah site. The Panel finds that this is a well-conceived structure and is likely to be used by koalas. Should planning activities continue to progress, the Panel believes that discussions with Transport for NSW (TfNSW) should occur to gain more detail of the specific requirements for the site on Appin Road including road uses and utilities associated with the roadway.

The Panel agrees that the protection of habitat along Woodhouse Creek to secure corridors is fundamental to the viability of the corridor. However, the Panel disagrees that post-and-rail fences should be used between the koala habitat and the suburban landscape which includes a range of threats and stressors for koalas. This will not reduce threats at the koala habitat-urban interface. The Panel finds that here, as with other locations in the landscape, exclusion fencing should be used to separate koalas from threats and hazards. Koala exclusion fencing can successfully prevent koalas leaving the corridor and walking onto

roads and meeting neighbourhood dogs. Exclusion fencing will also prevent dogs from entering the habitat.

The Panel finds that the functional roles of Asset Protection Zones (APZ) and of buffer zones to protect koalas are different, and as such need to be differentiated in the design of the interface. APZs serve a role of protecting people and property from bushfire hazard, while buffers associated with koala protection reduce the impact of threats, light and noise on koalas. The goal being to reduce stress on koalas which has general health benefits and impacts on mortality and breeding rates. For this reason, the Panel finds that buffers should be more clearly defined in MGS2 material in terms of their purpose, with buffers being in place on both sides of the corridor and be in addition to APZs (see Figure 10).

As a general rule for this Review, in this region with growing urbanisation and an additional 110,000 human inhabitants, buffers should be at least 30 m wide from the edge of existing corridor habitat, occur on both sides of the corridor, and have exclusion fencing at their edge, with koala feed trees allowed to grow to the fence, with a suitable distance between trees and fencing to prevent fallen boughs creating damage to the fence.

The APZ should be in the development footprint, not the koala corridor/buffer, and the APZ should be on the development side of the exclusion fence. The APZ, unlike the buffer, could accommodate roadways and parks. People would be permitted into the koala buffer, but dogs would be prohibited from entering through the exclusion fence area.

Not all locations will accommodate exclusion fencing, with steep terrain being incompatible. In these cases where exclusion fencing is not achievable, then a wider koala buffer (~60 m) should be established that does not include koala food trees. While the buffer in this case is designed to both discourage koalas from passing through it to reach the development footprint, it is also designed to keep stressors such as light and noise from disturbing and possibly stressing koalas and other threats at a greater distance. Therefore, these buffers should not have roads, playgrounds or picnic areas included in their boundaries, and dogs should not be permitted. The buffer will need monitoring in place to identify incursion by dogs. The APZ (bushfire protection) here, as with other locations, should be considered additional to the buffer, but could include structures such as roads and playgrounds etc. Where a road is passing in the vicinity of a koala corridor where there is no exclusion fencing, then the vehicle speed limit should be reduced to a maximum of 40 km/h, and with the installation of traffic calming devices and signage.

A number of different reports have been produced over time that aim to provide measurements for the scale or width of corridors – these are summarised and discussed in Chapter 2. These analyses tend to calculate the average width of a corridor over an area, and range from 300 m to 425 m. Every opportunity to maintain or increase the width of corridors should be taken and work to understand whether there is a minimum width to make a viable corridor, as well as how this minimum is affected by vegetation density of the corridor and urban density of the surrounding developments. The Panel notes that some stakeholders have recommended a minimum width of 200m. It is noted that within MGS2, in both Corridor A and B, there are locations with narrow widths – including 85 m in Corridor A and 115 m in Corridor B. Efforts to widen the habitat in these areas is important and this could contribute to addressing any koala habitat offset deficits (koala credits) if possible.

It is noted that koalas move through a range of different densities of habitat including between trees in open ground. The Panel notes that due to the range of linear infrastructure running perpendicular to the corridors through the GMGA, for gas and electricity transmission, where vegetation is generally absent, koalas will have to travers these areas. The Panel finds that this could create a location of increased risk from predators, if these easements are not as well fenced as the corridor areas. The Panel would see great merit in proponents looking to options, in discussion with TransGrid (transmission) and Jemena (natural gas) as appropriate, for installing gates in these areas to enable access to pipes and

wires in the corridor while preventing dog incursion. Monitoring in these areas for threats and population response may be required for adaptive management.

As addressed above, the importance of the Mount Gilead site to the east-west movement of koalas is amplified by its location at the north end of the Nepean corridor. Koalas currently can move through the landscape in an easterly direction towards the Georges River. However, once housing development occurs along the western flank of the MGS2 site, the route for koalas to move east or west will be through a narrow strip of habitat at the confluence of the Nepean River and Menangle Creek. However, the Panel notes that planning for future transport corridors (Figure 1) includes an indicative transport corridor to potentially run through this strip of habitat, while the MGS2 biodiversity certification application and conceptual plans illustrate (Figure 2 and Figure 8) this habitat being potentially surrounded by three roads. The biodiversity certification application notes two elevated bridge crossings and possibly a third, designed to maintain vegetation and koala movement. Some clarity needs to be provided as to the vision for this linking habitat, including whether all three bridges would be built at the same time, and some insights into whether koalas would use this area of the landscape with this density of infrastructure. The Panel notes that other wildlife also benefit from corridors. If koalas don't use this connection, options may potentially be needed to confirm the ongoing viability of the link between Corridor B and the northern end of the Nepean Corridor at Menangle Creek.

Corridor C – Nepean Creek to Beulah (east west), Mount Gilead development and draft CPCP plans

Should Corridor B become secured, the relative importance of Corridor C is reduced in terms of its function in connecting the Beulah Biobank site to the northern end of the Nepean Corridor. Notwithstanding this, the biodiversity certification application does identify the koala movement corridor along Corridor C, as well as the Mallaty Creek Corridor D with widths ranging from 100-200 m. However, if koala connectivity at the Nepean River and Menangle Creek confluence is temporarily or permanently broken (during the construction of the bridges, or if koalas do not use them), the role of Corridor C will need to be revisited, as it would provide other possible linkages between Beulah and the Nepean River. It is acknowledged that linear infrastructure currently does, and is further planned to, transect Corridor C, so an assessment would need to be made as to which corridor and infrastructure would be more accommodating to koala habitat. The level of protection offered to Corridor C will depend on its eventual role vis-à-vis a temporary or permanent linkage to the Nepean. However, until that connectivity issue is resolved, the Panel finds it sensible to preserve the habitat in Corridor C, monitor koala population dynamics and threats, and have management actions informed by this monitoring.

This corridor provides an example of where planning considerations across both MGS2 and CPCP need to be considered jointly, as decisions in one footprint impact the relative priority of approaches in the other planning area.

Corridor D – Mallaty Creek to Georges River (east west), CPCP plans

Corridor D is similar to Corridor C in that its potential importance is dependent on connectivity scenarios that will play out in another corridor. Corridor E contains a large area of koala habitat that reaches east toward Appin Road, but where there is nevertheless a potential barrier to linking across Appin Road. Corridor D has fewer barriers to crossing Appin Road and therefore may provide a more achievable crossing. In discussions with Department officials, their preferred approach would be to secure a Corridor E crossing and have that be designated as the koala corridor.

Therefore, the Panel finds that there are benefits to preserving Corridor D as koala corridor until and unless a Corridor E crossing can be guaranteed. This would require an under-road solution at Corridor E under Appin Road such as a culvert, a structure type that koalas are known to use. Once clarity about crossing feasibility and functionality at Corridor E is

decided, then further decisions can be taken on the long-term role of Corridor D for koala movement.

In the event that Corridor D is designated as the koala corridor for east-west movement, then the approach described above should be deployed, with exclusion fencing between the corridor buffer and APZ, where the APZ is outside the exclusion fencing in the development footprint, and koala feed trees can extend to the exclusion fence (with a setback to avoid damage). Where exclusion fencing is not feasible a wider 60 m buffer should be installed, separate to the APZ, where non-feed trees are used in the buffer, and where nearby traffic has a maximum 40km/h speed limit. Monitoring for population dynamics, threats and other attributes to inform management decisions, such as mitigations or active management of populations. Corridor D is narrower than E, and some replanting in D would be needed to increase the width of the corridor, as it only approximately 200 m – 300 m wide, rather than the average 390 m to 425 m proposed by stakeholders. The use of this new habitat as BSA offsets could be explored if this scenario were to play out.

Corridor E – Ousedale Creek (east-west), CPCP plans

Corridor E is the preferred east-west link for the areas in the draft CPCP plans, because it has the most habitat. As discussed above, there are questions about habitat being extended to Appin Road, due to the numerous suburban and rural properties between the habitat edge and road surface, on both the east and west sides. The Panel agrees that discussions with TfNSW on these potential crossings at D and E should occur early in the planning phase before any final decisions regarding primary Corridor designation are made between Corridors D and E.

The Panel agrees that the same approaches to separating koalas from threats should be deployed across the landscape. The team developing the CPCP has mapped the terrain and feasibility of deploying fences, which shows minimal locations where fences are not feasible for Corridor E. The Panel recognises that fencing construction and upkeep is not a trivial cost, so where possible fencing should be laid in a relatively straight line to minimise its length between two points and minimise costs and improve the feasibility of maintenance. As with other locations, the design of buffers should take into account the presence /absence of koala exclusion fencing, and the distance to local roads, and with the APZ outside of the exclusion fence. Monitoring of population dynamics, animal health, threats should be undertaken and inform decision making. Active management of koalas, including to improve genetic health through breeding and relocation/translocation and pest control will also, in combination with habitat protection, connectivity across the landscape and separation from threats provide the koalas with the best chance of their population growing in this corridor.

Corridor F – Elladale Creek and Simpsons Creek to the colliery (east-west), CPCP plans

While Corridor F contains a considerable area of koala habitat that enhances the functionality of the Nepean River Corridor to support koala populations, it does not provide a link towards the east. Therefore, the Panel agrees with the draft CPCP preferred approach for the koalas in this area to be protected from threats using exclusion fencing and buffers, as described above, and could include some replanting efforts to infill habitat in order to reduce the edge:area ratio. Active management would be required here, given the lack of multiple exits to the corridor, so as to prevent it becoming a population sink should predators or fire become an issue within the corridor.

Construction

Early implementation of koala habitat planting can lead to trees being at a more mature stage by the time they are needed for mitigation purposes. The region-wide planning approach occurring at the beginning of the process for the GMGA aids this preparedness.

A Construction Environmental Management Plan (CEMP) and a Koala Management Plan (KMP) should be developed by the proponent and approved through a Commonwealth process. This would include processes to protect koalas during construction and operational phases of the development. Material provided by the proponent indicates that an onsite ecologist would be present through the duration of pre-clearance surveys and clearing works, tree-felling protocols would be used, and education programs for construction workers would be provided etc.

Some complex areas with multiple civil construction developments have been identified in this Review, which interface with the dwelling development footprints and the environmental lands. These areas, such as that described at the Menangle Creek and Nepean River confluence, need to be carefully planned to enable ongoing connectivity to be provided between the Georges River and the Nepean River, some scenario fallback positions have been identified by the Panel. Similarly, the selection of preferred east-west corridors is dependent on securing a suitable connection across Appin Road, as is the role of the Noorumba Biobank site – will it be a part of a functional Corridor A (with an Appin Road crossing) or an enclosed actively managed site (without an Appin Road crossing)? All these issues and their implications need to be considered at a regional scale across the GMGA and over the timeframe for development.

Suburban design

The Panel has also reviewed the approach to urban design to better provide for safe koala habitation. The Panel agrees with the proposed approaches of not including koala food tree species in backyards and streetscapes, as they can be an attractant to koalas to leave their domain and enter higher risk areas (especially for urban development at the densities proposed). The Panel heard of experiences further north in Campbelltown where a small group of three female koalas is understood to inhabit bushland, that is separated from other bush by human residences. However, this site, the Panel understands, is also a location for a high number of koala deaths as young koalas are likely to disperse from this habitat to reach the distant feed trees.

Proposed rules for fences in suburban backyards to prevent escape of dogs and entry of koalas is important, as are other mitigations proposed such as ropes to assist koalas to escape from backyard swimming pools.

MGS2 has proposed speed limits of 50km/h on local roads. The Panel agrees that this would be suitable provided koala exclusion fencing is deployed. For those locations where exclusion fencing is not in place and only buffers are used, then a speed limit of 40km/h should be set and traffic calming (speedhumps, chicanes, signs) be used.

Adaptive and active management

While planning over a large regional area provides a more holistic perspective of how communities, environment and infrastructure will function and interact, the long timeframes and complex interdependencies mean that there is still uncertainty. To manage this uncertainty, as it relates to decisions about protecting koalas and their habitat in the context of the urbanisation of the GMGA, the Panel supports the principle of utilising adaptive management strategies to guide risk management and to improve practice. This is also one of the seven principles for the draft Koala Plan of Management Guidelines as part of the new Koala SEPP. Adaptive management relies on the ongoing collection of information and data that informs future decisions about management, responding to threats as they emerge for acute issues, or changing the direction of management approaches to address longer term threats. This relies on appropriately targeted monitoring activities and the development of thresholds and targets and triggers to guide decisions.

In line with the approach recommended in the NSW Koala Strategy and elaborated in the draft NSW Koala Monitoring Framework, the Panel finds that monitoring efforts ranging from the deployment of monitoring devices to community surveys can all play a role in growing

the information available for decisions. Monitoring should be undertaken at the koala population level, and on a site by site basis. Developers should fund the cost of this activity. The Panel has noted the concept of a 'monitoring trust' for the GMGA to support efforts into the future.

Monitoring informs decision making in the short and long-term, to address acute threats and to improve design and management practices for subsequent rolling construction and development phases for future suburb development stages. Efforts can include: population monitoring (dynamics); genetics sampling; disease monitoring; tests for chlamydia; predator threat monitoring (including at the entrances of bridges and underpasses); infrastructure integrity (holes in fences); movement trackers (predators); location sensors – movement of koalas through landscape; koala counting and surveys; the monitoring of mitigation effectiveness.

These can inform management decisions, including active management programs which are important where a population is isolated in a fragmented patch of habitat. Management decisions can include: vaccinations; fence repair; predator capture; relocation, translocation for breeding and gene dispersal; and education and social engagement programs.

Catch and release efforts with koalas can enable health checks, genetic sampling, vaccination for chlamydia and possibly koala retrovirus (KoRV), and the attachment of sensors to monitor the movement of koalas through the landscape.

Monitoring can also provide insights into how the response of koalas to landscapes change over time and generations, including changes in use of landscape, or whether different character traits of koalas emerge such as being more resilient and less stressed to urban growth. Such information can be used to inform other planning and development proposals into the future.

Reporting data and information once data is collected, and analysed against triggers for adaptive management, should then be reported in the public literature as soon as possible but within three years. Tissue sample collection should be provided to the NSW Koala Biobank.

The recent 2019/2020 bushfires, including in nearby regions to the Campbelltown koala population such as Balmoral, highlight the importance of management of the bushland to reduce the chance and intensity of fires, although it is noted that the close proximity of these corridors to human inhabitants will mean that particular focus on fire prevention will already be in place.

Recommendations

Recommendation 1 – Georges River Koala Reserve

The Georges River Koala Reserve should be protected and revegetated as set out in the draft CPCP, ensuring that revegetation is undertaken in such a manner as to ensure long term sustainability (i.e. species are planted to maintain genetic diversity and minimise kinship to ensure reproduction). Connectivity and threats should be considered within this corridor. Fencing should be placed on Appin Road and a connectivity structure be developed with the bridge over the Georges River.

Recommendation 2 – Connectivity and habitat

East-west corridors within the Greater Macarthur Growth Area can provide connectivity and biodiversity values for flora and fauna species. Not all the identified corridors are suitable to provide connectivity for koalas, but the habitat should be protected for koala habitat, biodiversity values and amenity in the region.

a) Within the proposed Mount Gilead development:
    - The Menangle Creek to Noorumba Reserve corridor (A) should be used for koala movement if:

    - a connectivity structure can feasibly be constructed on Appin Road. The proposed tree-top bridge is not likely to be adequate and would not be used by koalas. A land bridge should be considered to allow koalas and other fauna to cross Appin Road, an example of this is being developed for wallabies at Mona Vale.
    - If the crossing is not feasible, the koala habitat at Noorumba will be isolated and not function as connected koala habitat, therefore should be fenced off at Appin Road. In this case, the koalas within this fragmented area will need to be actively managed.
- The Woodhouse Creek to Beulah Reserve corridor (B) is an important northern connection for the koala population between the Georges River Reserve and the Nepean Corridor and should be retained. The proposed measures to protect the habitat in the corridor are currently not adequate and should be improved with the measures outlined in c). The underpass near Beulah Reserve as proposed by Lendlease should be constructed.
- Close attention should be paid to test the feasibility of the design of the koala connectivity at the confluence of Menangle Creek and Nepean River, near the Hume Highway and possibly under three bridges.

b) Within the Greater Macarthur Growth Area covered in the draft Cumberland Plain Conservation Plan:
    - The Ouesdale Creek to Appin North Corridor (E) should be secured as the east – west corridor to connect the Georges River Reserve and Nepean Corridors. A suitable crossing structure (e.g. culvert) should be constructed at Appin Road.
    - The Mallaty Creek to Georges River Corridor (D) should be fenced if feasible and protected in the event that suitable land cannot be purchased to finalise corridor E. If a crossing at E cannot be progressed, then an underpass across Appin Road should be developed at Corridor D. The measures to protect the corridors as in c) should be applied.
    - If a crossing at Corridor E is secured and crossing at Appin Road for Corridor D not pursued, then a decision would need to be made based on the risk/benefits of maintaining the koalas and mitigation measures in Corridor D without a crossing at Appin Road.
    - The habitat in Corridor F should be protected including with exclusion fencing to minimise risks from threats, and with monitoring of risks to avoid a population sink.
c) Habitat within identified corridors should be:
    - protected (especially from development creep)
    - widened through revegetation (average size 390 to 425 m)
    - include a buffer on either side of the corridor habitat that is at least 30 m wide from the corridor to the exclusion fence with feed trees permitted in this buffer area
    - include, between the buffer area and the urban areas, koala proof fencing to prevent the movement of koalas out of the corridor into urban areas (with trees more than 3 m from the fencing to avoid damage) and the movement of domestic dogs (amongst other potential threats) into the corridor
    - for sites where exclusion fencing is infeasible due to steep terrain, then additional buffer width should be utilised (buffer ~60 m), with a traffic speed limit of 40 km/h and predator / dog monitoring
    - asset protection zone is outside the exclusion fencing, within the development footprint

    Further, connectivity structures within corridors should also be assessed including local roads and other infrastructure (e.g. the Upper Canal).

Recommendation 3 – Monitoring and adaptive management

Monitoring should be undertaken to enable adaptive management of the koala population in the proposed Mount Gilead Stage 2 development and in the draft Cumberland Plain Conservation Plan.

This monitoring should:

- be consistent across the region to ensure data and adaptive management strategy outcomes are comparable
- include trigger levels that enable actions for adaptive management e.g. increased vehicle strikes, increased dog attacks or disease prevalence. (As part of the planning process, targets should be set to gauge success.)
- align with best practice and the NSW Koala Monitoring Framework (as part of the NSW Koala Strategy) and data made available through the SEED portal and any tissue samples provided to the NSW Koala Biobank
- be funded by developers through the establishment of a monitoring trust
- monitor the movement of koalas in the region and understand use of the corridors and connectivity structures, the NSW Government should investigate the development of implantable sensor technologies, such as through the NSW Smart Sensing Network.

Recommendation 4 – disease prevention

Koalas that are captured and/or handled as part of a monitoring program or those that are rehabilitated and released back into the Campbelltown population should be vaccinated against chlamydia. If a joint vaccine for chlamydia and KoRV is available this should be used. Koalas with no microchip or other identifying features that are captured should have a tissue sample taken for genetic analysis, with the tissue samples lodged with the NSW Koala Biobank.

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1 INTRODUCTION

On 9 December 2019, the Minister for Energy and Environment and the Minister for Planning and Public Spaces requested that the Deputy Chief Scientist & Engineer chair an independent expert panel (the Panel) to provide advice regarding the protection of the Campbelltown koala population.

This advice was to include:

- The adequacy of the proposed measures, by the property group Lendlease, for koala conservation on the land referred to as Mount Gilead Stage 2 (MGS2) and the consistency of these measures with the NSW Koala Strategy (the Strategy)
- What, if any, additional conservation measures are considered necessary
- What, if any, site specific measures for koala species should be incorporated into the Cumberland Plain Conservation Plan (CPCP) for the Greater Macarthur Growth Area (GMGA) to support the long-term viability of the koala population.
- Whether east-west corridors linking the Nepean and Georges Rivers can contribute to the conservation of the Campbelltown Koala population; and if so, which east-west corridors and what measures should be taken to ensure their effectiveness.

The full Terms of Reference are at Appendix 1.

This report constitutes the Panel's advice on the Terms of Reference and provides a review of the adequacy of the proposed protection measures for koalas as part of the MGS2 development and the draft CPCP plans viewed by the Panel to date. 'Adequacy' in the Panel's report has been defined in terms of the objective of the NSW Koala Strategy to *"stablise and then increase koala numbers over the longer-term, ensuring genetically diverse and viable populations across New South Wales"*(NSW Government, 2018).

The Panel has assessed the measures to protect koalas in the GMGA considering those proposed in the biodiversity certification application for MGS2 and in the draft CPCP documentation to ensure a consistent approach in the region.

This report provides recommendations to improve the proposed measures and considers a range of possible scenarios for the mitigation approaches proposed, given constraints including those that are financial and geographic in nature. An adaptive management approach is identified as crucial, with consideration of data collection and monitoring requirements, to ensure and demonstrate the effectiveness of mitigation strategies.

This chapter provides an overview of proposed urban development in the GMGA, as well as relevant legislation and guidelines, an overview of the Campbelltown Koala population and a description of threats and impacts to koala populations from urbanisation.

1.1 DEVELOPMENT IN GREATER MACARTHUR

The population of Greater Sydney is growing and is expected to reach 8 million people by 2038, with the population of Campbelltown growing from 740,000 in 2016 to 1.1 million by 2036 to over 1.5 million by 2056 (DPIE, 2020a; GSC, 2020). The *Greater Sydney Region Plan: A Metropolis of Three Cities* (GSC, 2018), developed by the Greater Sydney Commission, provides a vision to support the growing population of Sydney dividing the region into three cities – the Western Parkland City, Central River City and the Eastern Harbour City.

The Western Sydney City Deal, signed in March 2018, is a partnership between the Commonwealth Government, NSW Government and eight local governments (Blue

Mountains, Camden, Campbelltown, Fairfield, Hawkesbury, Liverpool, Penrith and Wollondilly) to deliver the Western Sydney Parkland City (WSCD, 2020). The Deal includes measures to improve transport and connectivity, education, the environment, jobs and housing.

In November 2018, the NSW Department of Planning and Environment (now the Department of Planning, Industry and Environment, 'the Department') released *Greater Macarthur 2040 – An interim plan for the Greater Macarthur Growth Area*, a land use and infrastructure implementation plan for future development in the region (DPIE, 2018). Greater Macarthur 2040 includes a draft Structure Plan and responds to the NSW Government's commitment that land east of Appin Road will be retained as Environmental Conservation and for a koala reserve. The proposed structure plan for the GMGA is at Figure 1.

In 2019, the NSW Government declared Greater Macarthur as a Growth Area and amended the *State Environment Planning Policy (Sydney Region Growth Centres) 2006 to* reflect this declaration (DPIE, 2020b). A planning principle of the *Greater Macarthur 2040* is that *"conservation of biodiversity and koala colonies will be at the heart of the Growth Area"*. The Department is finalising *Greater Macarthur 2040* in response to feedback from the community and proposes to update the Structure Plan to align with the final CPCP and its conservation boundaries.

An estimated 39,000 new homes are proposed in the land release area of Greater Macarthur, (15,000 in North Gilead Precinct (of which, 1,700 is already re zoned), 4,000 in Menangle Park, 5,000 in North Appin and 15,000 in Appin) , and will also include new town centres, retail and commercial services, improved transport corridor and schools (DPIE, 2018). This will change this area from a peri-urban and rural area to urban, with the population increasing from ~3,000 to ~109,000 people when the region is developed (DPIE, 2018).[1]

Under the Western Sydney City Deal, there is a commitment for strategic assessment under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to protect the environment and streamline environmental approvals for development (NSW Government, 2020a). This includes the GMGA as well as the Greater Penrith to Easter Creek Investigation Area, Western Sydney Aerotropolis and the Wilton Growth Area. The CPCP is being developed by the Department to conduct strategic assessment under the EPBC Act as well as identifying the areas within the growth areas that will be certified for development under the NSW *Biodiversity Conservation Act 2016* (BC Act).

The Mount Gilead development has been proposed as two stages – Stage 1 (MGS1) and Stage 2 (MGS2). Lendlease Communities Pty Ltd (Lendlease) has proposed a second stage residential development in Gilead (Stage 2) within the GMGA, and which is the subject of this review. Lendlease's Stage 1 development also known as Mount Gilead, and is already rezoned for urban development, is being marketed by Lendlease as Figtree Hill (Lendlease, 2020a). Within the GMGA, biodiversity certification for Stage 1 Gilead was initiated prior to the start of the strategic assessment. Both MGS1 and MGS2 sites are not within the area subject to the draft CPCP, and due to legislative transitional arrangements will be assessed under the NSW Threatened Species Conservation Act 1995 (TSC Act). Note, both stages of the development are subject to assessment and approval under the EPBC Act.

In July 2018, Campbelltown City Council as the planning authority, applied for Biodiversity Certification of the MGS1 land on behalf of Lendlease and certification was conferred in June 2019. In August 2019, Campbelltown City Council, on behalf of Lendlease, Campbelltown Council applied for Biodiversity Certification of land in MGS2.

[1] This is based on 39,000 homes and an estimated average household of 2.8 people (DPIE, 2020e)

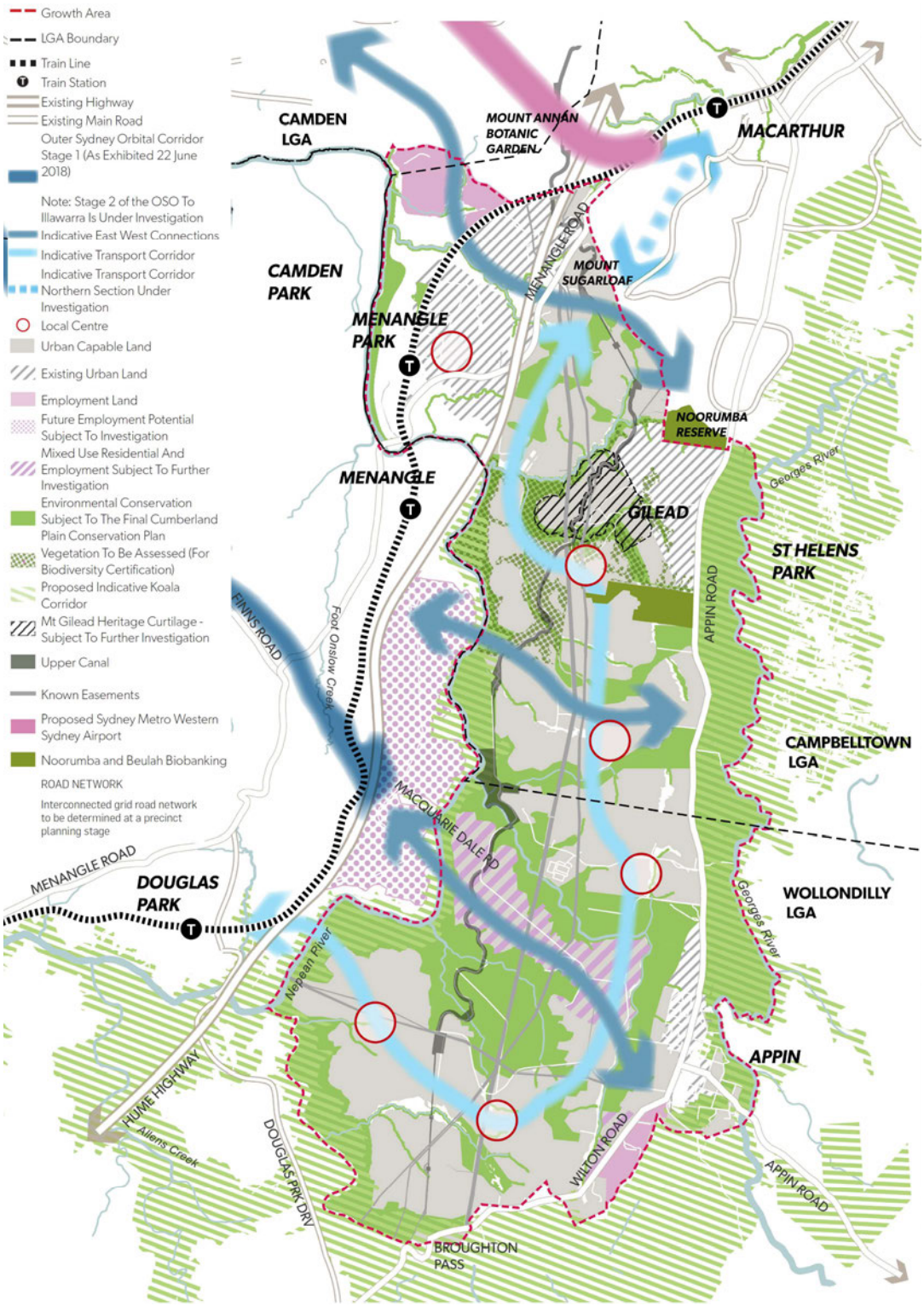

Figure 1: Proposed structure plan for the Greater Macarthur Growth Area
Source: DPIE (2018)

1.1.1 Draft Cumberland Plain Conservation Plan

The Department has undertaken strategic conservation planning to develop the CPCP in response to the rapid growth of Western Sydney. The Plan is being developed to address strategic biodiversity certification provisions under the BC Act and strategic assessment under the EPBC Act, identifying strategically important biodiversity areas within the Cumberland subregion to offset the biodiversity impacts of future urban development. It aims to facilitate the biodiversity approvals required to deliver four Western Sydney growth areas and supporting major transport infrastructure.

Three sub-plans are included to provide details on the implementation of the CPCP, and actions to deliver its commitments. These are:

- Sub-Plan A: Conservation Program and Implementation – the proposed conservation program and its implementation as well as how the Plan will meet its vision and objectives
- Sub-Plan B: Evaluation – the monitoring, evaluation and reporting framework, and how adaptive management will ensure the ongoing effectiveness of the conservation program
- Sub-Plan C: Koalas – protection of the koala population in Western Sydney and how the Plan supports other government initiatives to protect koalas.

A *Cumberland Plain Assessment Report* has been prepared for the Department (Biosis & Open Lines Environmental Consulting, 2020). The report provides the Biodiversity Conservation Assessment Report (BCAR) (in accordance with the BC Act) and a Strategic Assessment Impact Report (under the EPBC Act). It is noted in this report that *"As the proposed development has been determined by the NSW Environment Minister to be considered for approval under a 'strategic biodiversity certification', the offset rules under the BC Regulation do not apply and the Minister can determine any measure to be a conservation measure".*

The Koala Sub-Plan provides a number of specific commitments and actions for protecting the koala population from development in the Wilton and GMGA (NSW Government, 2020c). The conservation program for koalas will:

- establish the Georges River Koala Reserve east of Appin Road from Kentlyn through to Appin protecting up 1,800 ha of koala habitat and movement corridors (including ecological restoration)
- protect vegetation through environmental zoning in potential east-west koala movement corridors between the Georges and Nepean Rivers
- ecological restoration of koala habitat within the CPCP's strategic conservation area
- mitigate indirect and prescribed impacts from urban and transport development on koalas including exclusion fencing
- manage landscape threats e.g. fire, weed and pest management
- building capacity and supporting stakeholders, including leveraging existing programs including the NSW Koala Strategy and SoS to raise community awareness, undertake research and support koala health and welfare

The CPCP also includes a monitoring and adaptive management plan. Specific measures in the draft CPCP are discussed in their relevant sections in Chapter 2.

1.1.2 Mount Gilead Stage 2 development

The proposed MGS2 development is a 332.17 ha urban development project (total area of MGS2, including native vegetation, is 672.57 ha), west of Appin Road and the approved

MGS1 development (Figure 2). Figure 3 shows a master plan for both stages of the development. The site is in the area identified for future growth as part of the GMGA. The proposed development includes low and medium residential development[2] with associated infrastructure, retail, educational facilities, public spaces, active and passive open spaces and conservation lands. MGS2 is expected to deliver 4,500 lots and is proposed to commence from 2024 and take up to 10 years to complete over 7 stages.

The proposed development site is bound by the Nepean River and Hume Highway/ Motorway to the west, rural land to the north and south and the approved MGS1 to the east. The Upper Canal[3] runs through the site as well as easements for electricity and the eastern gas pipeline. The Woodhouse, Nepean and Menangle Creeks flow north and west through the site to the Nepean River. The south east site boundary abuts the Beulah Biobank site and there are several registered Biobank sites to the west as a part of MGS1 and the Noorumba Reserve in the north east.

The site contains remnant patches of native vegetation, heavily vegetated riparian corridors and gullies, and agricultural land that has a long history of disturbance associated with cattle grazing and horse agistments since the 1850's. The site is currently zoned rural and is used for pivot irrigation, cropping, cattle grazing and horse agistment. Despite the history of anthropogenic land use, koalas still persist in this area and use it as a corridor.

The native vegetation communities are comprised of five biometric vegetation types, which include two listed as endangered ecological communities under the TSC Act and the EPBC Act (Cumberland Plain woodland, and Shale Sandstone Transition forest) and one listed as endangered under the TSC Act and is being considered for a listing under the EPBC Act. There are also five flora and fauna species that have been assessed under the BCAM due to impacts on habitat: the koala, squirrel glider, Cumberland Plain land snail, southern Myotis and the hairy-stemmed shrub brown pomaderris (*Pomaderris brunnea*).

A MGS2 Biocertification Assessment Report (BCAR) and Biodiversity Certification Strategy have been prepared for Lendlease by Eco Logical Australia, and is being used to seek biodiversity certification for the proposed development. This was submitted by Campbelltown City Council to the Department in August 2019 and will be assessed using the BC Act transitional arrangements, meaning that it will still be assessed by a BCAM under the TSC Act. The BCAM determines whether biodiversity certification will improve or maintain biodiversity values. i.e. the method to assess loss of biodiversity values on the land proposed for certification and the impact of the proposed conservation measures.

[2] Low density is 15 - 25 dwellings/ha and medium density is 25 - 35 dwellings/ha

[3] The Upper Canal was built in the 1880s and is still the only way of transferring water to Sydney from the four Upper Nepean dams (Cataract, Cordeaux, Avon and Nepean) (WaterNSW, 2020). The system is managed by the Sydney Catchment Authority on behalf of WaterNSW and is listed on the NSW State Heritage Register, which means The Upper Canal is protected by the Heritage Act 1977 and its 2010 amendments (DPIE, 2020g).

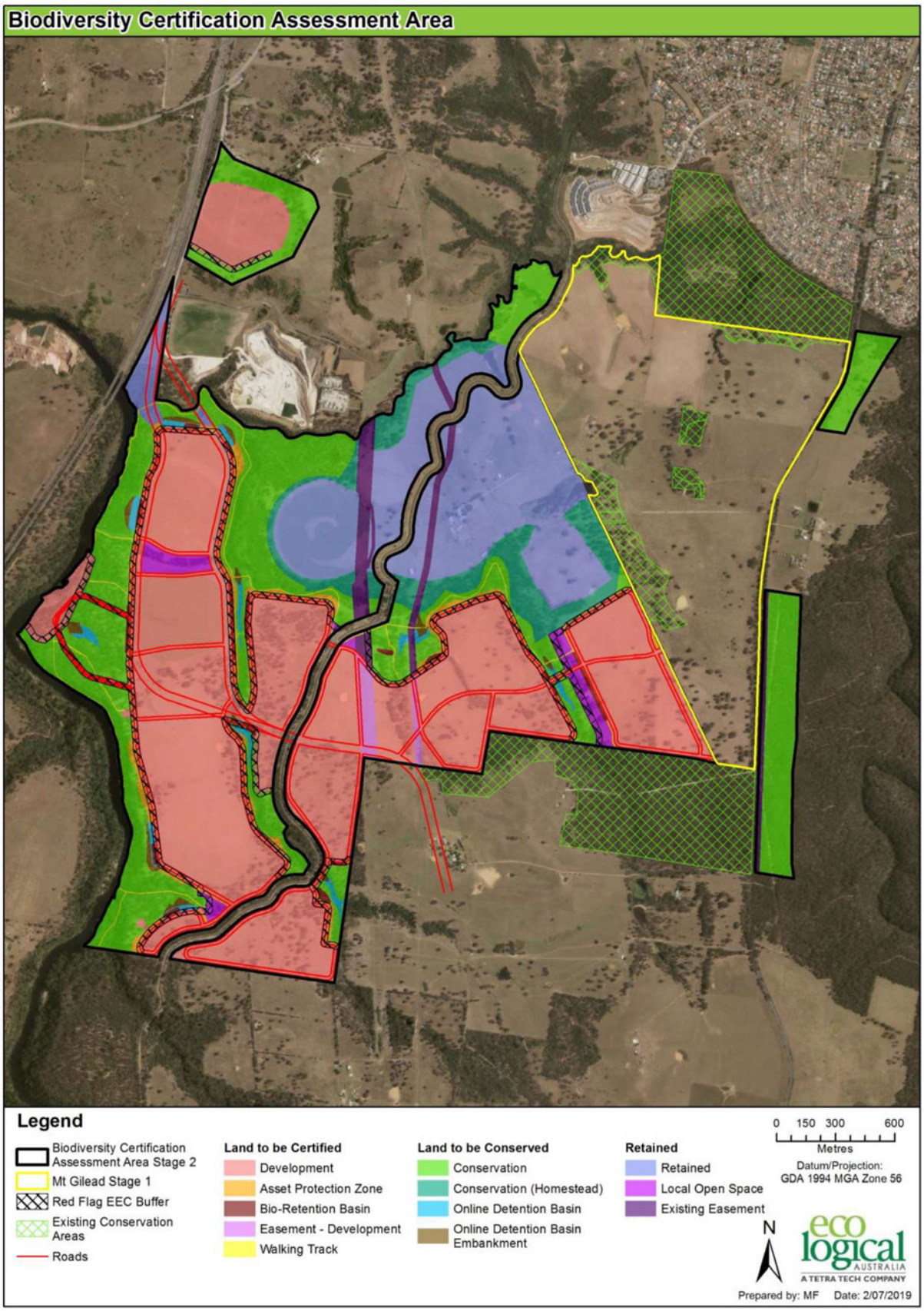

Figure 2: Mount Gilead Stage 2 Concept Plan
Source: Eco Logical Australia (2017)

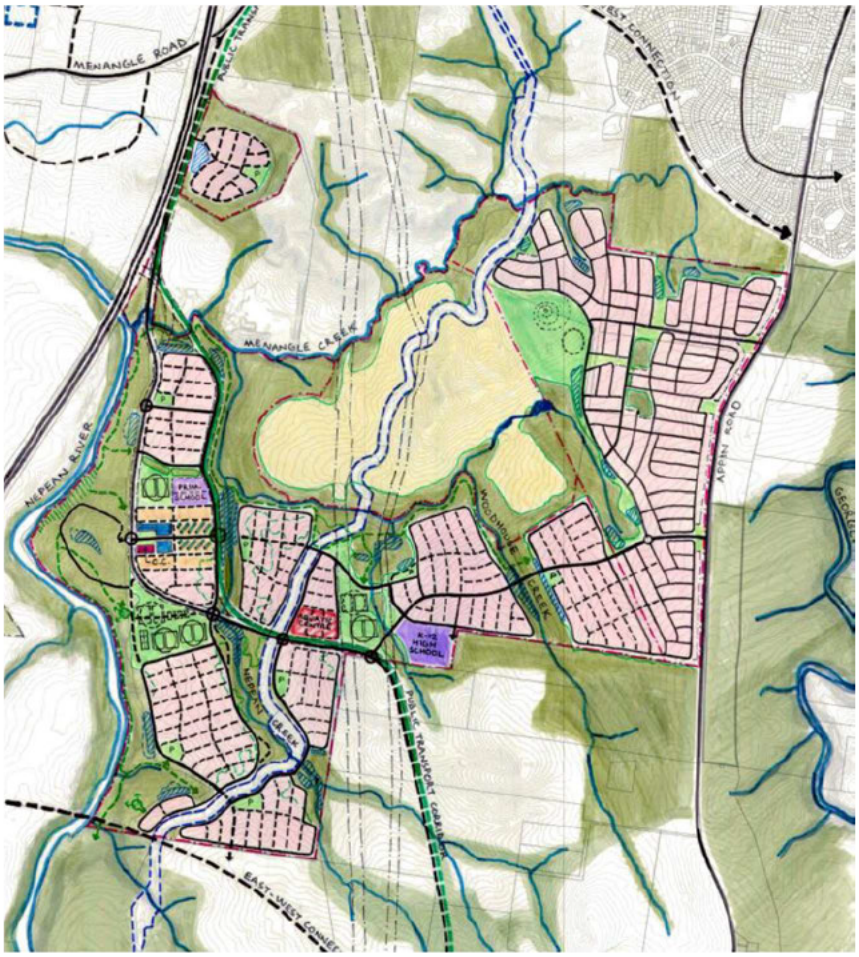

Figure 3: Mount Gilead Stage 1 and 2 Master Plan
Source: Lendlease (2020b)

The BCAR states that there 332.17 ha (~50%) of the assessment area that will be directly impacted, of which 76.89 ha is mapped as native vegetation and threatened species habitat (Table 1). The BCAR has estimated that 72.22 ha of koala habitat will be impacted: 6.29 ha of high, 12.78 ha of moderate and 36.19 ha of low-quality habitat.

Table 1: Mount Gilead Stage 2 BCAR assessment area
Source: Eco Logical Australia (2017) and Lendlease (2020b)

Area	Size
Total land assessed	627.57 ha
Native vegetation	265.81 ha
Exotic vegetation & cleared land	406.76 ha
Total assessed land impacted	332.17 ha (~50% of total area)
Impacted native vegetation & threatened species habitat	76.89 ha
Koala habitat impacted	72.22 ha
Total assessed permanently protected	201.81 ha (~30% of total area)
Generate ecosystem credit (Biobank)	197.46 ha
Red flag vegetation conservation area buffer	4.35 ha

Permanently protected and managed habitat for conservation totals 201.81 ha (197.46 ha of which will generate ecosystem credits (i.e. Biobanks), the remaining 4.35 ha being a red flag vegetation conservation area buffers), with five Biobanks sites to be registered in the area:

Browns Bush, Mount Gilead Homestead, Woodhouse Creek, Nepean and Medhurst biobank sites.

This includes the restoration of native vegetation (200.42 ha), with 38.9 ha fully restored, 37.21 ha enhanced and 124.31 ha of minor restorations (Lendlease, 2020b).[4] Additionally, 138.59 ha of land will be retained as public open space and existing easements. There is a further 16.96 ha that will be used for establishment of detention basins (1.9 ha), wide bush walking track through the koala habitat (1.05 ha), modification of existing habitat to establish bushfire Asset Protection Zones (APZs) (14.01 ha).

Other specific measures to protect koalas as described in the BCAR and supplementary material provided to the Panel are discussed in relevant sections in Chapter 2.

1.2 LEGISLATION, GUIDELINES AND INITIATIVES

There are a number of Federal and State legislative instruments that apply to the conservation of koalas and their habitat in NSW. This section outlines the specific legislation, guidelines and instruments of relevance to the Panel when considering aspects of MGS2 and the CPCP and is not an exhaustive examination of all legislation related to the protection of koalas.

1.2.1 Environment Protection and Biodiversity Conservation Act (1999) [Cth]

The combined koala populations of Queensland, New South Wales and the Australian Capital Territory are listed as 'vulnerable' under the EPBC Act, requiring project proponents to consider whether their project will have a significant impact on important koala populations in these jurisdictions. If a project has or will have a significant impact, the EPBC Act requires the project to be referred for a decision by the Federal Environment Minister on whether the project is a 'controlled action'. If unsure, project proponents may refer the project to the Minister.

1.2.2 Biodiversity Conservation Act 2016 [NSW] and repealed Threatened Species Conservation Act 1995 [NSW]

The BC Act replaced the repealed TSC Act on 25 August 2017. The BC Act lists koalas as 'vulnerable', due to their decline in numbers from multiple threats (i.e. habitat loss, fragmentation and loss; disease; vehicle strike; predation; etc.), resulting in development proposals that impact koalas being more rigorously assessed. The primary purpose of the BC Act is to "*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*" (DPIE, 2019a).

Strategic biodiversity certification (under both the BC Act and repealed TSC Act) identifies, at a regional scale, areas of high conservation value that should be avoided or protected, areas that can be developed (once certified) and measures to offset any potential impact of development. In effect, the strategic biodiversity certification removes the need for site-by-site assessment of the threatened species, populations or ecological communities if any proposed development falls within the biodiversity certified land, as the strategic biodiversity certification examines any biodiversity measures at a landscape scale.[5]

[4] Full restoration – Cleared land/pasture (low quality habitat) fully restored to high quality habitat. Enhanced restoration – Low quality habitat that will be enhanced to create high quality habitat. Minor restoration – High quality habitat that will be subject to weed and feral animal control to improve and maintain habitat quality.

[5] Under Part 7AA of the TSC Act, this relates to; projects under Part 3A, infrastructure under Part 5.1, development under Part 4 and activities under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act); and, the *Native Vegetation Act 2003* does not apply

The biodiversity certification scheme under the repealed TSC Act allowed only planning authorities[6] to apply to the Minister of the Environment to have biodiversity certification conferred to an area where the biodiversity outcomes were improved or maintained, with the Biodiversity Certification Assessment Methodology (BCAM) providing the method of assessment.

In establishing the new biodiversity certification scheme, the BC Act allows both planning authorities and individuals to seek certification using the Biodiversity Assessment Method (BAM) for specific types of development proposals, with the aim to prove adequacy of conservation measures to the Minister.[7]

There are transitional arrangements for previous biodiversity certified land under the TSC Act. As set out in the *Biodiversity Conservation (Savings and Transitional) Regulation 2017*, development applications set out prior to the commencement of the BC Act will be considered under the previous legislation (i.e. the TSC Act).

Biodiversity Offsets Scheme

Under the previous TSC Act biobanking allowed for 'biodiversity credits' to be generated on a voluntary basis and sold to the market in order for developers and landowners to offset their impacts on biodiversity. The BC Act, with the associated *Biodiversity Conservation Regulation 2017*, takes a similar approach in establishing the Biodiversity Offset Scheme[8], a statutory framework to assess the impacts or likely impacts of development and associated native vegetation and habitat clearing activities on biodiversity, moving through a hierarchy of avoiding, minimizing and/or offsetting these impacts (DPIE, 2019b). This Scheme allows for potential adverse impacts on biodiversity at the site of development to be offset by the protection or improvement of the environment at other sites in-perpetuity. Offsets are predicated at both the State and Federal level to be used only when efforts have been made to either avoid or mitigate environmental impacts.

The Scheme establishes biodiversity stewardship sites (via agreements between the landholder and the Minister), the creation of biodiversity credits and a system for these to be traded, prescriptions for biodiversity impact assessments and reports by accredited persons, and the establishment of the BAM.[9]

The BAM provides a consistent method for biodiversity assessment on sites to be developed and/or cleared, guidance on avoiding or minimizing potential impacts on biodiversity, and the residual number and class of credits (either ecosystem or species credits) that are required to be offset to achieve an outcome of 'no net loss' of biodiversity. The BAM is applied by an accredited assessor and is informed by the Biodiversity Assessment Method Operational Manual and the metrics within. This leads to the development of Biodiversity Development Assessment Reports (BDARs), Biodiversity Certification Assessment Reports (BCARs) and Biodiversity Stewardship Site Assessment Reports, depending on the intent of the proponent.

It is the BDAR/BCAR that is submitted as a component of the application for development, with the BCAR usually reserved for larger, multi-staged development proposals.

The BAM is also used to assess the establishment of an area as a biodiversity stewardship site that generates offset credits for the landholder to sell to those who need to purchase credits to offset their impacts. Similar to the BDAR/BCAR, a Biodiversity Stewardship Site Assessment Report is developed that outlines the class (species or ecosystem credits) and

[6] A planning authority under the TSC Act means the Minister for Planning, local councils, a determining authority, the Secretary of the Department of Planning and Environment, or any other person or body declared by the regulations to be a planning authority

[7] Development proposals include those identified in the EP&A Act (Part 4, Part 5), BC Act (Part 5 Activity, Div. 2, Section 7.14(1), 8.2 and 8.7(1)), *Local Land Services Act 2013* (Part 5A, Div. 6), *SEPP (Vegetation in Non-Rural Areas) 2017*

[8] BC Act, Part 6

[9] BC Act, Part 6, Cl. 6.2

number of credits generated if the site is approved under a Biodiversity Stewardship Agreement (BSA).

BSAs have also replaced BioBanking Agreements that were established under the repealed TSC Act. Existing BioBanking agreements, such as those identified in MGS1 and MGS2, remain in place and will be managed as BSAs by the Biodiversity Conservation Trust (BCT_.

1.2.3 State Environmental Planning Policy (Koala Habitat Protection)

The listing of koalas as vulnerable means they must be considered under the NSW *Environmental Planning and Assessment Act (1979)* (EP&A Act) when preparing environmental planning instruments and when undertaking development assessments .The EP&A Act is the legislative tool that sets out how planning occurs in NSW, including environmental planning instruments[10] such as State Environmental Planning Policies (SEPPs).[11]

SEPP (Koala Habitat Planning) 2019 ('Koala SEPP') repealed and replaced the former *SEPP 44 – Koala Habitat Protection* on 1 March 2020, and has two primary aims: to assist in the preparation of Comprehensive Koala Plans of Management (CKPoMs) and to standardize the process for preparing, assessing and implementing development applications for applicants and consenting authorities. The Koala SEPP includes a draft Koala Habitat Protection Guideline, applicable to proponents where land is over 1 hectare and identified on the Koala Development Application Map (if there is no approved council KPoM applying to the land).

1.2.4 Campbelltown Comprehensive Koala Plan of Management

The draft and revised 2018 Campbelltown CKPoM has been prepared in accordance with the NSW Koala Recovery Plan (2008) and SEPP 44 to *"provide for the long-term maintenance of a viable, free-ranging koala population in the Campbelltown LGA"*. The Campbelltown CKPoM aims to enable persistence of a koala population of at least 300 koalas in the area with the increased human population and safeguard the future of the Campbelltown koala population through regulatory and non-regulatory mechanisms (Phillips, 2018). The Panel understands that the Council has submitted the Campbelltown CKPoM to the Department for approval by the Secretary and is currently under consideration, noting that the NSW Government released a new Koala Habitat Protection SEPP March 2020.

1.2.5 NSW Koala Strategy and Saving our Species

The NSW Koala Strategy (the 'Strategy') was released in May 2018. The Strategy responded to the recommendations of the NSW Chief Scientist and Engineer's 2016 *Independent Review into the Decline of Koala Populations in Key Areas of NSW* (CSE, 2016).

The objective of the Strategy is to stabilise and then increase koala numbers over the longer-term, ensuring genetically diverse and viable populations across NSW. The Strategy includes several actions to be undertaken over three years under four pillars: koala habitat conservation, conservation through community action, safety and health of koala populations and building our knowledge.

The Saving our Species (SoS) program in the Department is a statewide program that aims to secure threatened plants and animals in the wild of NSW for 100 years. This program includes the SoS Iconic Koala Project and includes the Southern Highlands Koala Conservation Project to improve habitat and reduce impacts in the region (DPIE, 2020f).

[10] EP&A Act, Division 3.2
[11] EP&A Act, Division 3.3

1.2.6 Inquiry into Koala Populations and Habitat in New South Wales

On 20 June 2019, an inquiry into Koala Populations and Habitat in New South Wales (the Koala Inquiry) was established in the Legislative Council of the NSW Parliament. The Committee aims to report on actions, policies and funding by the NSW Government to ensure the sustainability of koala populations and habitats in NSW. This includes the examination of key habitat, population trends, and threats; resourcing and adequacy of protections; the effectiveness of current legislative conservation measures and the impact of regulatory reforms and programs (particularly around forestry in NSW); and, understanding the impact of climate change on koalas and their distribution. The inquiry will conduct 10 hearings between 16 August 2019 and 8 April 2020 and is accepting public submissions (Parliament of New South Wales, 2020). The Committee is expected to submit its report by 15 June 2020.

1.3 KOALAS IN NEW SOUTH WALES

Koalas are one of Australia's most iconic species, recognisable around the world and a major tourist attraction (DPIE, 2020c). Historically koalas were distributed throughout the woodlands and forests of NSW, however, they are now threatened across their range from impacts such as habitat loss and fragmentation (such as from urban development and agriculture), vehicle strikes, dog attacks (both domestic and wild dogs), drought, bushfires, disease (e.g. Chlamydia), and climate change (CSE, 2016). Most koala populations in NSW now survive in fragmented and isolated habitat and in many cases are subject to intense development pressures (CSE, 2016). Koalas as listed as 'vulnerable' in NSW and needing protection under both state and federal legislation.[12] Koala numbers and distribution have declined over time, with an estimate of 36,000 koalas in NSW (CSE, 2016; Adams-Hosking, 2017).

The 2019-20 bushfires in NSW were unprecedented in their scale and intensity. The extended 2019-20 bushfire season has devastated a significant area of koala habitat (as at 3 February 2020, over 3.5 million hectares or 25% of moderate to highly suitable koala habitat had been affected) and we are yet to fully understand what the impact has been on koala numbers. A recent report by Lane, Wallis, and Phillips (2020), that analysed koala records and the extent of the bushfire, found that over the preceding three koala generations the NSW koala population has declined by at least 28.52% and may be a large as 65.95%. The report also notes that the ongoing threat of climate change and its associated impacts (e.g. more frequent and intense bushfires) will severely affect koala populations and increase the risk of localised extinction events. Further work is underway to provide a picture of the impact of the bushfires on koala numbers, distribution, demographics and condition.

1.3.1 Campbelltown Koala population

The Campbelltown koala population is a historically continuous population of (Hagan, Phalen, & Close, In prep.) which is one of the few remaining populations in the Sydney region (Phillips, 2020). This population includes koalas in the Campbelltown and Wollondilly Local Government Areas (LGAs). The likely extent of the population has been estimated to be east to the coast, south from Holsworthy until it connects with koalas in the Southern Highlands and some distance to the west (it is unknown if the Hume Highway poses a barrier to movement) (Biosis & Open Lines Environmental Consulting, 2020).

1.3.1.1 Koala Population status and health

The population is considered to be stable and increasing (Close, Ward, & Phalen, 2017), recovering from historical impacts. The population is small, between 250 and 500 individuals and is found at low density (~0.1 koalas per hectare) (Hagan et al., In prep.). These

[12] Note legislation and that they are also listed as vulnerable in Queensland and the ACT.

estimates were made prior to the 2019/20 bushfires, however the majority of the region was not affected.

As with many koala populations across Australia, the Campbelltown population is genetically distinct from others. The most closely related population to Campbelltown is the Southern Highlands, showing gene flow between these populations but it is separate from the Blue Mountains population (DPIE, 2020c). Although the Campbelltown population has lower genetic diversity than the Blue Mountains (from 4,606 single-nucleotide polymorphisms, SNPs) it has less inbreeding than the Blue Mountains population indicating gene flow with the Southern Highlands (Kjeldsen et al., 2019).

The population has remained relatively free from Chlamydia infection (Hagan et al., In prep.). However, there is widespread infection in the Southern Highlands population, and it is believed that this infection could move north into the population due to connectivity between the populations. The koala retrovirus, KoRV-A is prevalent in the population, however KoRV-B is found at low (Hagan et al., In prep.).

1.3.1.2 Local koala habitat

The *Conserving Koalas in the Wollondilly and Campbelltown Local Government Areas* (DPIE, 2019c) identified high-quality koala habitat, core koala habitat, koala movement corridors and koala roadkill hotspots in the region (Figure 4). The report found:

- A long-established association between koala presence and vegetation that grows on high fertility soils, such as shale and shale transition soils and the habitat that is present on these soils are considered high quality habitat.
- There are seven preferred food tree species in the region: grey gum (*Eucalyptus (E.) punctate),* white stringybark (*E. globoidea*), woolybutt (*E. longifolia*), forest red gum (*E. tereticornis*), grey iron bark (*E. paniculata*), blackbutt (*E. pilularis*) and green wattle (*Acacia decurrens*).
- The koala habitat in the region is highly fragmented with large patches of core habitat on the eastern edge of the Cumberland Plain.
- The only other core habitat is the remaining areas of Shale Sandstone transition forest along the Nepean River and its tributaries, but this habitat is more limited in extent and in linear in configuration. There are a number of resident koalas in this habitat and it is therefore thought this habitat is important for koala persistence in the region.

This report also identified primary, secondary and tertiary koala movement corridors that have been determined for the region, based on metrics including the area of core koala habitat it contained, width, and level of connectivity (Figure 4). These are described further in Section 2.3.

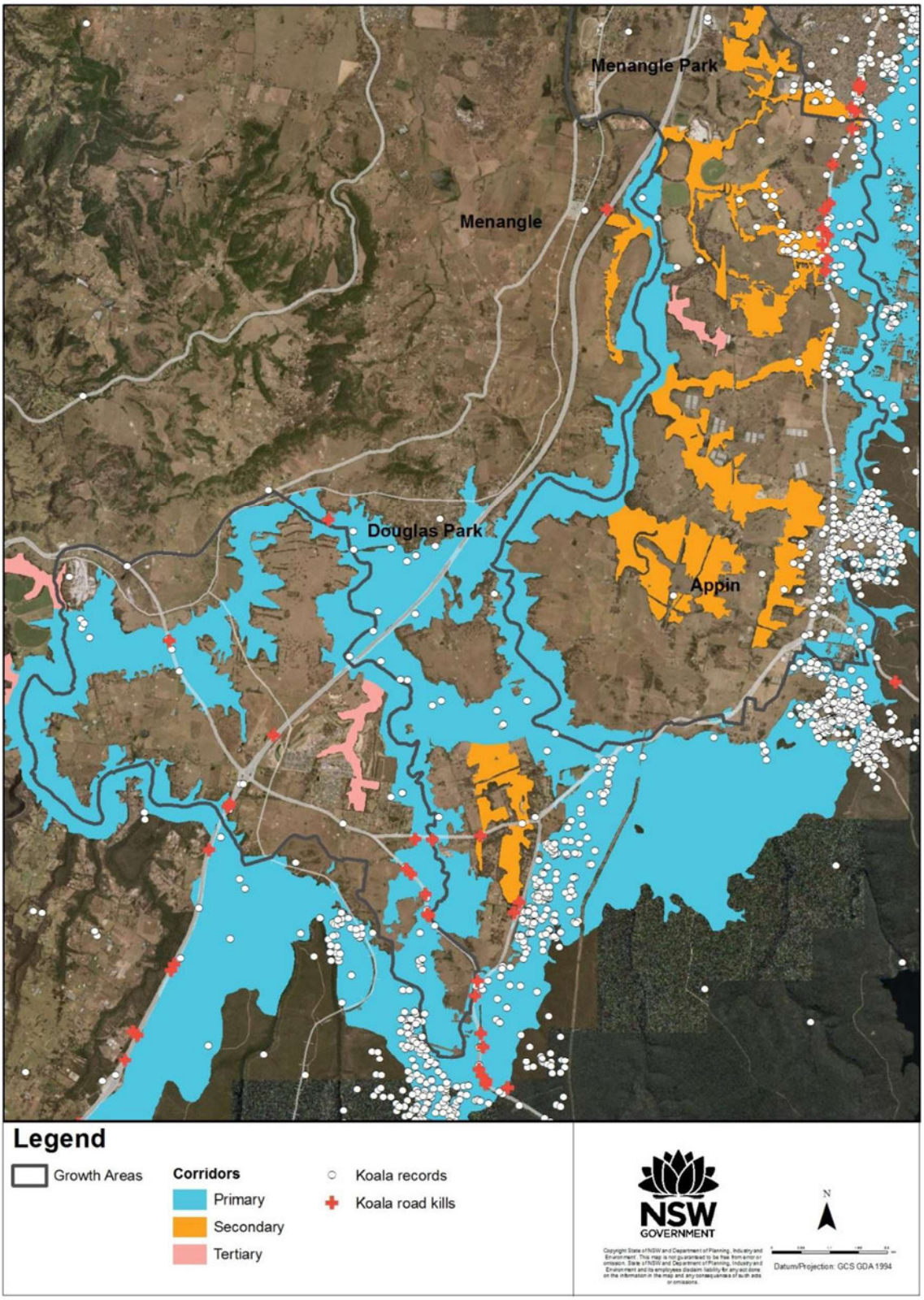

Figure 4: Rankings for koala corridors across the Wilton and Greater Macarthur Growth Areas

Note that koala records shown are sightings and do not indicate koala densities
Source: DPIE (2019c)

Threats and stressors

The current main threats and stressors to the population are:

- **Habitat fragmentation and loss:** Agriculture and urbanisation has led to the loss and fragmentation of habitat across the region. Local core koala habitat is currently maintaining the population and the rural landscape is permitting koalas to move between these core koala habitats. A principal threat to the biodiversity values of the Cumberland subregion is the further loss and fragmentation of habitat from clearing for urban development and agricultural land uses (DECCW, 2011; Biosis & Open Lines Environmental Consulting, 2020), including illegal clearing. High density residential development, as opposed to the current rural landscape, in much of the area between core habitats will place significant pressure on smaller, narrower corridors that link koala populations.
- **Vehicle strike:** Vehicle strike hotspots occur where roads dissect koala habitat, areas of heavy traffic flow and higher speed limits and along koala dispersal routes. There are a number of identified hotspots along Appin Road (Figure 4). This is currently one of the main reasons for admission (41%) to the Avian, Reptile and Exotic Pet Hospital Camden and the main cause of death for koalas in the area (Hagan et al., In prep.).
- **Dog attacks:** Another main cause for hospital admission (11%), with dispersing males and younger (i.e. less than 3 years of age) koalas subject to greater predation risk by domestic dogs (Hagan et al., In prep.).
- **Disease (*Chlamydia*):** The population is healthy and *Chlamydia* infection has not been detected (Hagan et al., In prep.). However, there is widespread infection in the Southern Highlands population, and it is believed that there is the potential for the infection to move north into the Campbelltown population.
- **Stressors:** light and noise can pose indirect threats to koalas by increasing stress levels which in turn can lead to changed patterns of behavior, avoidance of exposed habitat, increased propensity to disease.

1.4 KOALAS AND URBAN DEVELOPMENT

Threats in urban areas for koalas in urban areas include: habitat loss and fragmentation; increased risk of predation by both domestic and roaming dogs; increased risk of vehicle strike mortality, potentially increased risk of disease expression, and backyard swimming pools (with the risk of drowning). Many of these threats are greatest and further exacerbated at the interface between native habitat and anthropogenic land use.

There is good evidence that where urban development interfaces with koala populations and their habitat that this results in declines in koala populations. In particular, rapid declines in koala numbers have been experienced in NSW and Queensland in high-density urban and remnant source populations that have undergone conversions from agriculture to urban environments (McAlpine et al., 2006; Adams-Hosking, 2017).

In South East Queensland populations of koalas have declined rapidly over the past 20 years due to urban development. Rhodes et al. (2015) show that some koala populations in South East Queensland have declined as much 80% over the preceding 20 years, despite attempts to reduce habitat loss through the planning regulation. Rhodes et al. (2011) and Beyer et al. (2018) show that high threat levels from disease, dog predation, and vehicle collisions associated with urban development, on top of habitat loss, are key drivers of decline in these urban environments. In particular, these studies highlight that it is the cumulative effect of multiple threats that drives declines in koala populations. Although, Beyer et al. (2018) show that these populations can be recovered by intensive management

of multiple threats, such intensive management is unlikely to be feasible in the long-term, especially over broader areas.

Research in NSW also shows evidence of declines in koala populations in urban areas (Smith & Smith, 1990; Lunney et al., 2002), but these declines may be potentially mitigated to some extent when urban areas are connected to large areas non-urban occupied koala habitat (Lunney et al., 2010; Lunney et al., 2016).

Threats to koalas inhabiting an increasingly urbanised environment are also further complicated by climate change and extreme climatic events, in particular drought and prolonged high temperatures. Current climate change projections predict hotter and drier climates, and this can limit the koalas current range. The koala's range is predicted to contract east and south to more mesic regions (Adams-Hosking et al., 2011). Riverine vegetation is critical refugia habitat in times of drought and is the source habitat for koala populations post-drought. In landscapes where the primary habitat is limited by habitat loss and fragmentation, population decline is imminent.

From these findings above, we can conclude that there is a need to promote efforts in the GMGA to: maximise habitat area; minimise habitat fragmentation; increase habitat quality and resilience of habitat to climate impacts; minimise edge lengths and interface with threats; monitor and mitigate predation from dogs and threats from roads.

The riverine characteristics of the corridors along the Nepean and Georges Rivers, as well as the creeks running through the landscape are noteworthy and underpin some of the important contribution that this landscape could play to the Campbelltown koala population and their role in future droughts, warming climate and bushfire, with connectivity providing routes of escape from threats. Maintaining connectivity of habitat helps avoid the creation of dead ends where koalas face threats without routes of escape, and thus become population sinks where koalas continue to move into an area but are killed by threats.

1.5 PANEL AND REVIEW PROCESS

An Independent Expert Panel was established to provide advice. The Panel, consisted of some members of the Independent Expert Advisory Panel for the NSW Koala Strategy and included:

- Dr Chris Armstrong PSM, Deputy Chief Scientist & Engineer (Chair)
- Professor Kathy Belov AO, Professor of Comparative Genomics and Pro Vice-Chancellor Global Engagement, School of Life and Environmental Sciences, The University of Sydney
- Dr Carolyn Hogg, Senior Research Manager, Australasian Wildlife Genomics Group, School of Life and Environmental Sciences, The University of Sydney
- Professor Jonathan Rhodes, School of Earth and Environmental Sciences, Faculty of Science, The University of Queensland

The Office of the Chief Scientist and Engineer provided secretariat support.

In providing its advice the Panel has reviewed a number of reports and documents, this has included those listed in the Terms of Reference as well as the draft CPCP, supplementary material and reports provided by Lendlease, the draft Campbelltown CKPoM (Phillips, 2018), draft Koala Habitat Protection Guidelines (developed under the new SEPP Habitat Protection 2019) and other relevant reports and research articles.

On 14 February 2020 the Panel conducted a site visit to the proposed Mount Gilead development site. The Panel also met with representatives from the Department (Biodiversity and Conservation Division, Climate Change and Sustainability group, and the Conservation and Analysis Unit), Campbelltown City Council (including Dr Stephen Phillips

as the author of the draft Campbelltown CKPoM), Lendlease and their consultants including Eco Logical Australia and EMM Consulting.

The Panel would like to thank Associate Professor David Phalen and Jessica Hagan from the Koala Health Hub, School of Life and Environmental Sciences, The University of Sydney for providing background information and data on the Campbelltown Koala population.

An Inquiry into Koala Populations and Habitat in NSW is currently being conducted and is due to report by 15 June 2020 (Parliament of New South Wales, 2020). As part of this, on 25 October 2019 the Committee visited the proposed Mount Gilead development sites and hearings on that day discussed the development (Parliament of New South Wales, 2019). A number of submissions to the Inquiry relevant to the Mount Gilead development were also received. Hearings by and submissions to the Inquiry relevant to the Panels Terms of Reference have been considered.

2 ANALYSES OF MITIGATION APPROACHES PROPOSED FOR KOALAS IN THE GREATER MACARTHUR GROWTH AREA

The Review Terms of Reference requests advice on the 'adequacy' of the proposed measures for koala conservation. The Panel has defined 'adequacy' in terms of the primary objective of the NSW Koala Strategy, which is for protection measures to *"stabilise and increase koala numbers over the longer-term, ensuring genetically diverse and viable populations across New South Wales"* (NSW Government, 2018).

This Chapter sets out the Panel's assessment of the proposed koala protection measures put forward by Lendlease proponents for the proposed MGS2 development, and as set out in the draft CPCP documentation. For clarity of the discussion, the overall assessment and approach is presented first, Section 2.1 provides a wholistic view of the risks, mitigations and a number of possible scenarios to be considered through implementation. This is followed by a discussion and assessment of measures to offset and protect koala habitat, to support koala habitat corridors, connectivity and minimise edge effects as well as monitoring and adaptive management.

2.1 RISK BASED ANALYSIS AND ASSESSMENT OF POSSIBLE SCENARIOS

To promote the longevity and health of koalas in the Campbelltown region, with the goal of maintaining and improving the population (as established in the NSW Koala Strategy), the Panel views it as important to minimise the contact of koalas to hazards and threats, and also to maximise as far as possible the availability of koala habitat.

No matter what approach is taken, a fundamentally important step forward will be to fence off access by koalas to the surface of Appin Road from the east and west side. This stretch of road is a major contributor to koala mortality in the region. Further discussion below assumes that exclusion fencing is used on both sides of Appin Road.

The goal of the biodiversity certification for the MGS2 and CPCP is to enable the koala populations to exist in this increasingly urban environment and deploy a range of habitat of protection and hazard reduction mitigations (See Sections 2.2, 2.3 and 2.4 for more details). Section 2.1.1 illustrates the cumulative benefit of using a range of habitat and connectivity measures, as well as risk management process to reduce threats. Section 2.1.2 goes into more detail on the factors the Panel sees as important for success if koalas are to be kept across the landscape, and Section 2.1.3 provides a scenario framework for mitigations, in the light of possible future outcomes of choices - related to: the securing safe and efficacious crossings across Appin Road; and the implementation of exclusion fencing along corridors.

2.1.1 Approaches whereby koalas remain in east-west corridors

The Terms of Reference for the review, requests in part, that the Panel to provide advice on *"whether east-west corridors linking the Nepean and Georges Rivers can contribute to the conservation of the Campbelltown koala population"*. The identified corridors are shown in Figure 5.

Access to increased (or retained) koala habitat has *prima face* benefits for koalas, however, key is whether the retained habitat is managed in a way that exposes koalas to the increased threats that urbanisation will bring to the region (traffic and dogs), or whether the installation, upkeep and management of mitigation measures will occur so that the koalas are separated from these threats in perpetuity.

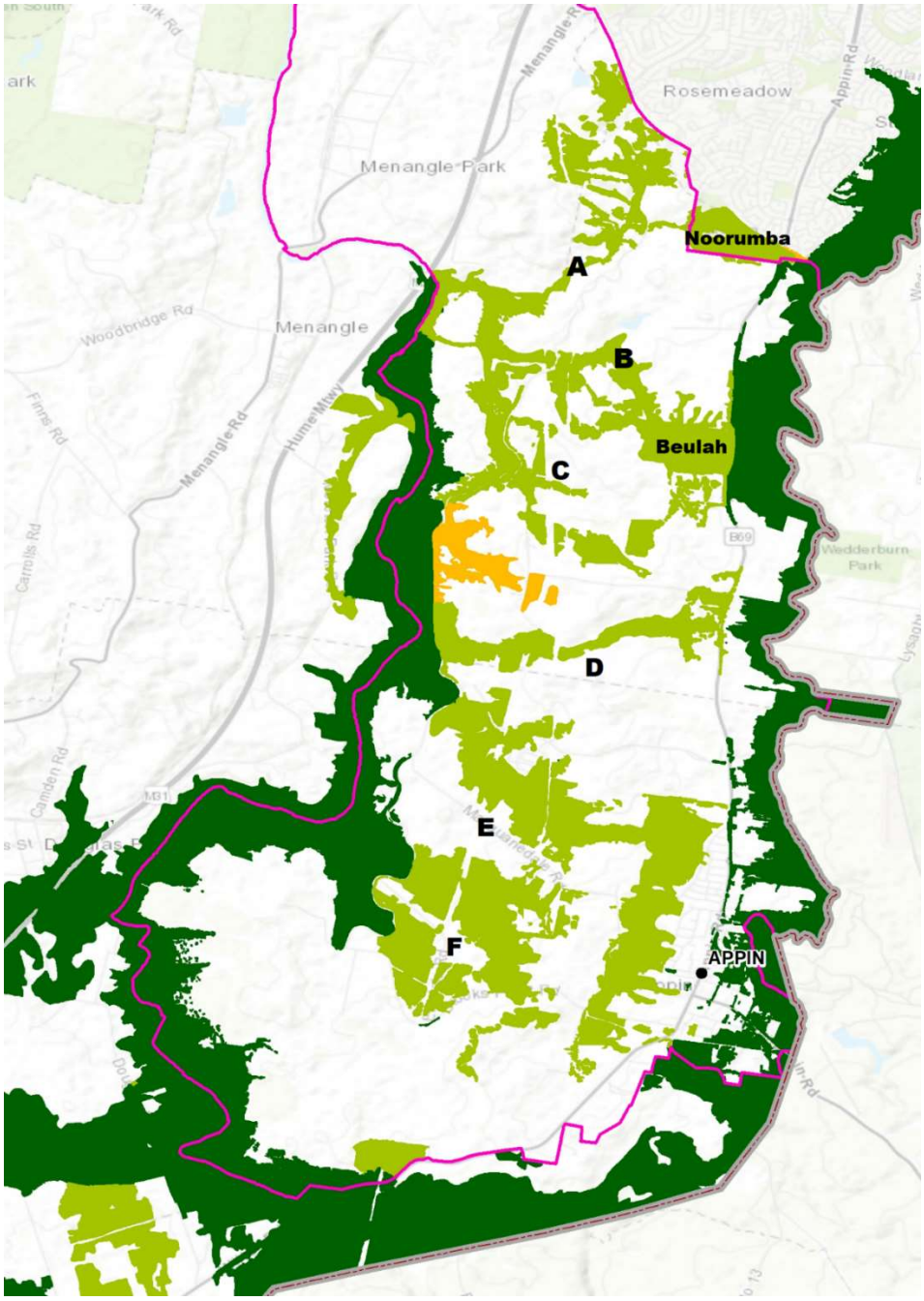

Figure 5: Potential wildlife corridors connecting Nepean River to Georges River

A) Menangle Creek to Noorumba B) Woodhouse Creek to Beulah C) Nepean Creek to Beulah D) Mallaty Creek to Georges River E) Ousedale Creek to Appin North F) Elladale Creek and Simpsons Creek to the colliery

Source: DPIE (2020e)

If the removal of key risks cannot be accomplished, then the better management approach would be to monitor the impacts on the koala population and if it declines then consider active management which could include moving koalas between sites for breeding or relocation to safe areas, etc, preferably in the local region where there are 'safe' places. However, if separation from threats can be achieved in the landscape and maintained over the long term, then the better outcome for the koalas, and other flora and fauna, would be to retain the east-west corridors.

The scenarios in Figure 6 provide options based on the willingness of stakeholders to invest in ongoing threat mitigation infrastructure and management approaches and the likely impact on the koala population.

2.1.1.1 Koalas remain – east-west corridor and north-south corridors

Error! Reference source not found. illustrates the range of planning mitigations that can be deployed with increasing effectiveness. All options assume exclusion fencing on both sides of Appin Road.

- **Pathway 1** - habitat is protected, but there are not crossings over or under Appin Road and corridors are not fenced – as a result koala numbers would decline due to reduced connectivity and increased threats.
- **Pathway 2** - habitat is protected and there are utilised connectivity structures (e.g. underpass) at Appin Road, but there is not exclusion fencing for the corridors. Koala numbers would still decline as dog and car threats are still in place without exclusion fencing within the developments.
- **Pathway 3** - habitat is protected, there are connectivity structures for Appin Road and exclusion fencing protects the corridors. The Panel believes this would maintain koala numbers at approximately current levels.
- **Pathway 4** - includes the interventions for 3, but also includes active management within the fenced koala habitat area, including removing any dogs that enter the fenced area, monitoring and managing disease, identifying and addressing specific stressors in the area from light and noise. The Panel believes that this approach above all would lead to growing koala numbers in the region.

Each of the pathways has certain risks that rise or fall as you move down the figure with increasing efforts. Risks include the cost of fencing installation and upkeep; risks to koalas from dogs and cars; risks that certain pathways across Appin Road cannot be secured. These issues are discussed more in Section 2.1.2 and a high-level adaptive management approach to the implementation of these mitigation choices is set out in Section 2.1.3, with adaptive management of the ongoing operations described in 2.1.4.

The location of the Campbelltown koala population in the GMGA, including within the existing national park and protected areas, the habitat in the proposed Mount Gilead development, biobank sites such as Beulah, habitat in the CPCP area, are all connected. In managing this region, these locations and the movement of koalas needs to be thought of holistically – a koala moving from the Georges River corridor could end up in either the Mount Gilead or CPCP domains, illustrating that in respect of the koala population the areas can be seen as one.

Such holistic management requires planning for connectivity, monitoring that occurs in one area being comparable with that in the other areas, and adaptive management approaches designed and implemented with consideration of the region as a whole.

Understanding the function that corridors, 'stepping-stone habitat'[13] and patches have in enabling koalas to move through the landscape is important. Biolink (2018) undertook an analysis for Campbelltown City Council, using a least-cost modelling approach, to model likelihoods of how koalas would move between the Georges and Nepean Rivers. The use of the modelling assists with planning and management decisions and can be further enhanced when it is underpinned by koala monitoring data.

[13] Discontinuous areas of habitat such as paddock trees, wetlands and roadside vegetation (DIPNR, 2004)

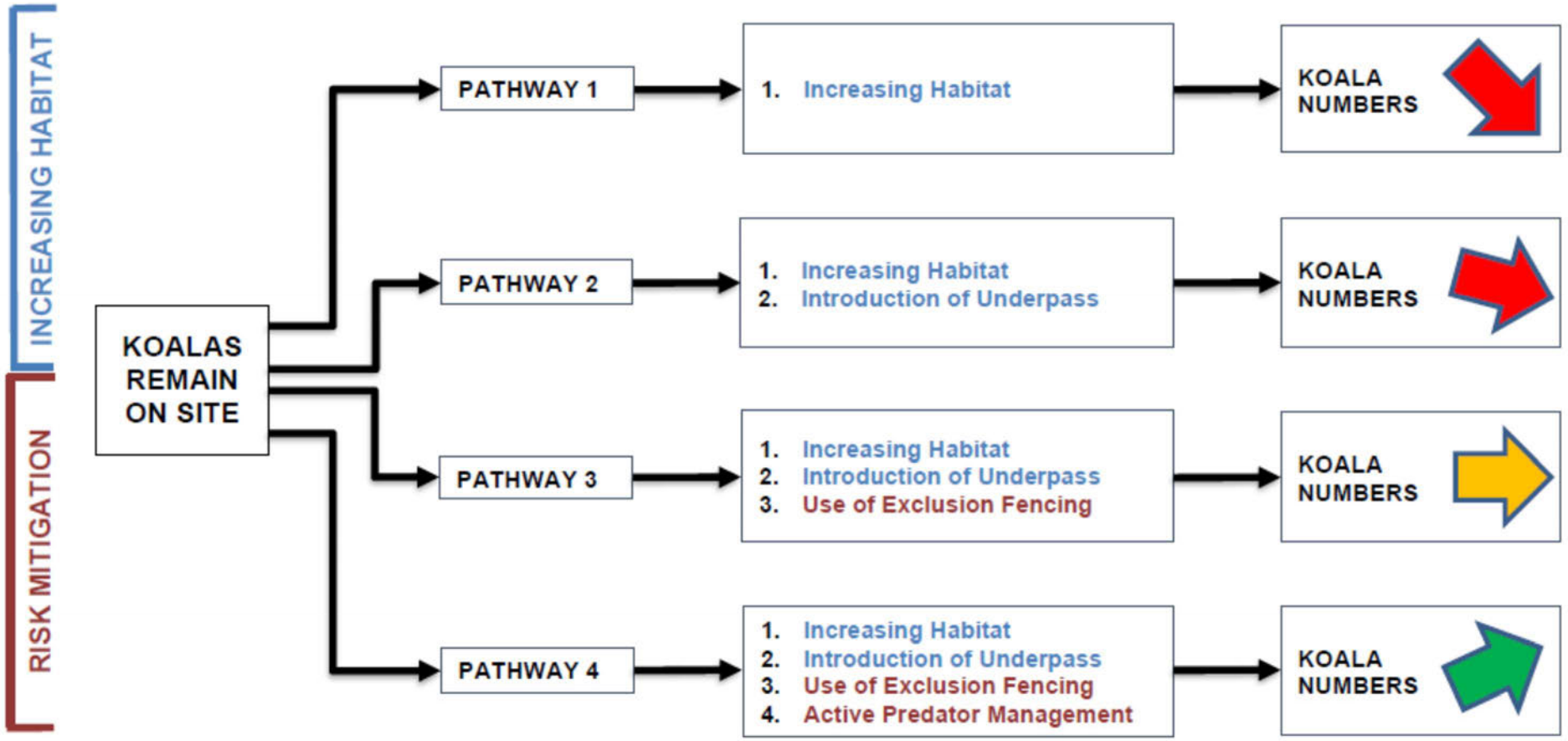

Figure 6: Mitigation options and impact on koala population

2.1.1.2 Preventing the northern end of the Nepean River Corridor from being a population sink

In preserving koala habitat, being mindful of the potential risks of some landscape structures is important in decision making. Ensuring, as far as possible that habitat is connected to other habitat in multiple directions, and that the presence of koalas in the habitat does not expose them to risks. A negative outcome would be for habitat to be preserved as a dead-end, and the dead-end habitat to be open to threats such as accessible roads or predatory dogs; this scenario creates a population sink where koalas continue to move into the habitat, only to be killed by threats, creating a koala vacancy and therefore enticing more koalas to move in.

This illustrates the importance of maintaining the koala corridors through the Mount Gilead site. The Nepean River north-south corridor has been identified in the CPCP as a 'primary corridor' through the landscape, running from the south near Wilton, along the Nepean River in the GMGA, and functionally ending adjacent to or in the Mount Gilead site. Maintaining a functional corridor through Mount Gilead to the Nepean means that koalas moving north along the Nepean River do not reach a dead-end, which can present risks of a population sink, or a lack of escape routes should fire move along the Nepean corridor. Mount Gilead offers an easterly escape route, but also an efficient route to maintaining genetic connectivity with the other members of the Campbelltown koala population near the Georges River corridor (including in the proposed Georges River Koala Reserve).

2.1.2 Planning for the long term, and dealing with uncertainty

The whole program of works and development in the region is scheduled to occur out to 2056, and with cycles of planning of urban facilities, development and construction, habitation and repeating those cycles for different locations and infrastructure. The approach of undertaking regional planning upfront and on the broad scale through the CPCP and for Mount Gilead is beneficial in that it allows restrictions and requirements to be established now in planning policies and approval conditions that can help improve outcomes for natural assets and environmental values across a wide area of land.

However, nothing is guaranteed, and both chronic and acute threats can emerge in a landscape to deteriorate the situation for koalas. There will be uncertainty about what hurdles will emerge in implementing a proposed pathway forward, and unforeseen events are also possible; these uncertainties will present challenges to decision makers and land managers.

Therefore, the Panel recommends using principles of adaptive management for koalas (and other species) in the GMGA, with a program of monitoring (including baseline) of koalas, threats and habitat put in place. Monitoring indicators can serve functions of tracking long-term conditions of the koalas in the landscape (health, demographics, presence/absence) and monitoring leading indicators such as immediate threats that need to be responded to.

The long term and ongoing program of urban development, out to 2056, will result in future unknown events and risks, and possibly opportunities, so scenario planning and mitigation options should be a core component of adaptative planning for preparedness and resilience.

The Panel has been provided with some early conceptual layouts and designs for the proposed development in MGS1 (approved) and MGS2 which is a focus of this report. This includes information such as MGS2 documents, calculations of carrying capacity and illustrations of a koala connectivity structures (Figure 7). The Panel has also been provided with draft CPCP documentation, including the overarching plan, koala subplan, monitoring subplan, etc.

There are a number of definitive findings and recommendations that the Panel has made, and also a set of options that could be considered, depending on the success of a range of proposed approaches. These options are set out in the following Section 2.1.3 for both the

MGS2 and CPCP areas. The section has been developed to inform adaptive management decisions during the planning and implementation phase of the urban developments in the GMGA, including the proposed MGS2. A key factor in which scenario emerges will be whether and where functional connectivity can be secured across Appin Road, and whether exclusion fencing can be widely rolled out to separate koalas from threats in the east west corridors.

Key to minimising interaction of koalas and threats will be the installation of barriers between koalas and the risks from cars and dogs, which can be achieved by using koala exclusion fencing. Connectivity will be ensuring the long-term stability of the koala population and providing for safe crossing structures above or below Appin Road is key to this.

Table 2 sets out a summary of the proposed protections for both the MGS2 development and the CPCP at the early planning and development phase. The Panel is aware that there are constraints (financial, geographic etc.) that are being considered, and these are reflected to some extent by the scenarios presented by the Panel. As described above, minimising the exposure of koalas to direct and indirect threats is a key issue and this will be most effectively enabled through koala exclusion fencing. However, the Panel does note that the installation and ongoing maintenance and replacement of koala fencing is not a trivial expense, with rough estimates by the Panel of $400,000 per kilometre (net present value) for installation and maintenance (Santika et al., 2015; Horsfall, 2017)

2.1.2.1 Adaptive management approaches for the development & construction phase at Mount Gilead

Documents for the proposed MGS2 (Biodiversity certification report and supplementary material) and the draft CPCP present approaches for implementing habitat protection and managing risks. These are summarised in Table 2. A full description of the corridors, protection measures and panel comments are at Table 5. These include protection and improvement of habitat in the local area, deployment of some exclusion fencing for corridors and roads as part of the CPCP, post and rail fencing with buffering for MGS2, and two Appin Road crossings for MGS2, and at least one Appin Road crossing for CPCP.

In relation to the establishment of crossings for Appin Road, preferred methods and locations for crossings have been identified, however the Panel notes:

- there is uncertainty for MGS2 as to whether the koala crossing ridge to Noorumba will be used by koalas, or whether alternative crossing structures at Noorumba can be implemented that koalas may be more likely to use (see Section 2.3)
- for MGS2, further certainty is required about the planned crossing adjacent to Beulah across Appin Road. This is a very important component of the east-west corridor and ensuring the is no sink at the top of the Nepean corridor.

Table 2: Summary of mitigation and protection measures

Corridor	Biodiversity certification area	Current proposals
Georges River Corridor	CPCP	Fencing Appin (East, West), establishment of Georges River Koala Reserve, pre-clearance fauna protocol developed and monitoring of performance measures
Nepean River Corridor	CPCP	Fencing, strategic conservation area, Nepean and Medhurst offset site, pre-clearance fauna protocol developed and monitoring of performance measures
Corridor A **Menangle Creek to Noorumba**	MGS2	Protected by biodiversity offsets; tree-top bridge across Appin; post fence, two creek crossings, possible third across transport corridor, elevated bridge with over 10m clearance, pre-clearance fauna protocol developed and monitoring of performance measures, Noorumba Biobank Site (part of corridor)
Corridor B **Woodhouse Creek to Beulah**	MGS2	Protected by biodiversity offsets; koala underpass under Appin road; post fence east side and west side; multi-use buffer east side, revegetation programs, Woodhouse creek biobank site, pre-clearance fauna protocol developed and monitoring of performance measures, Beulah Biobank Site
Corridor C **Nepean Creek to Beulah**	MGS2/ CPCP	Habitat conserved, fenced on the south side
Corridor D **Mallaty Creek to Georges River**	CPCP	Habitat conserved, fenced to keep out koalas
Corridor E **Ousedale**	CPCP	Habitat conserved; koala fencing for threats; revegetation in some areas, cross Appin Road to be considered, land purchases considered to complete corridor
Corridor F **Elladale Creek and Simpsons Creek to the colliery**	CPCP	Habitat conserved, koala fencing for threats; revegetation in some areas,

2.1.2.2 Panel suggestions

MGS2 Scenarios

MGS2 Scenario 1 is the preferred approach of the Panel.

MGS2 Scenario 1 assumes connectivity structures across Appin Road (facilitating access to habitat) are achievable and are used by koalas (proposed tree-top bridge at Corridor A and the proposed Corridor B underpass as shown in Figure 7 is constructed) and there are no constraints on the ability to deploy and upkeep koala fencing:

- **Georges River Corridor** - koala fencing installed and maintained along both sides of Appin Road, connectivity structure within the corridor (at the bridge over the Georges River on Appin Road)
- **Nepean River Corridor** - koala fencing installed and maintained between Nepean corridor and development to the East; Picnic area with koala fencing
- **Corridor A** – protected habitat; tree-top bridge across Appin Road is feasible and is utilised; koala fencing both sides of the corridor's full length, in particular where adjacent to dwellings

- **Corridor B-** protected and restored habitat; koala underpass under Appin Rd adjacent to Beulah proceeds and is successfully used by koalas; Corridor B should be wider, there should be a 30 m buffer both sides of Woodhouse Creek, and exclusion fencing at the edge of the buffer with the use of grids and gates within fencing to allow people to enter; using koala feed tree planting close to koala exclusion fence with care taken that falling limbs do not damage the fence. The APZ should not be in the habitat buffer, but should be on the development side of the exclusion fence and in the development footprint; Traffic speed limit 50 km/h.

Panel suggestions in Scenario 1 above may not be feasible, if the koala bridge approach across Appin Road at Corridor A is not utilised (there is no evidence that koalas use tree-top bridges), if no other Appin Road crossing at the Noorumba Reserve can be executed, if there are issues with developing a crossing at Beulah Biobank, and also if the CPCP crossing at Corridor E cannot be realised. Scenario 2 presents a potential way forward in response to these challenges.

MGS2 Scenario 2 assumes fencing is unrestricted and can be used where needed, but Appin Road connectivity is not achieved in the north of the Mount Gilead site near the Noorumba Reserve. Connectivity is assumed across Appin Road at Beulah Biobank – although the MGS2 BCAR indicates that this fauna underpass is subject to on-going consultation with the Department and TfNSW, the Panel sees it as vital to maintain an east-west corridor at the northern end of the Nepean Corridor.

- **Corridor A** habitat protected; tree-top bridge across Appin is not utilised by koalas, then the development of an underpass or culvert under Appin Road, or a gantry bridge above Appin Road (see Mona Vale example) should be explored, and these supported by other devises such as grids in the road to stop the movement of koalas around fencing. If a crossing is still not achievable over Appin Road, then the koala population in Noorumba Reserve would be functionally isolated in fragmented habitat, so koala fencing both sides of Corridor A should be installed as far along the corridor as possible, within which the koala population should be actively managed including breeding or relocation of koalas to manage genetic diversity.
- **Corridor B** habitat protected; koala underpass under Appin Rd adjacent to Beulah and koala fencing both sides of corridor B is deployed; koala buffer both sides of corridor: buffer width = 30 m additional to the corridor, with koala feed trees planting in the buffer zone close to the exclusion fence, with care taken that falling limbs do not damage the fence. APZ in the development area. If there are locations along the corridor that cannot be protected with exclusion fencing because of steep terrain, then a wider buffer should be deployed (~60 m) using non feed trees, and with Traffic speed limited to 40 km/h in that area. Extra planting required to the exclusion fencing, including koala buffer would contribute to the additional koala habitat credits required by the proponents (See Section 2.2). If connectivity between the north end of Corridor B and Nepean Corridor (at Menangle Creek) is temporarily closed to koalas or not utilised by koalas in the term, the Corridor C should be considered for connection to Nepean.
- The habitat between Noorumba Reserve and Nepean River is no longer assumed to be useful koala habitat, so the picnic area adjacent to the Nepean would be replanted with koala feed trees to help address this habitat reduction.
- While the BCAR indicates Beulah underpass is being considered, this is such an important crossing that the Panel believes it needs to go ahead for this to be an effective corridor. Otherwise there would need to be a largescale long-term active management protocol for the area.

CPCP Scenarios

Key points

- for the CPCP area, there is uncertainty as to whether an Appin Road crossing is achievable in the vicinity of Appin village (linking corridor E);
- for CPCP, can an alternative location be secured such as corridor D, where there appears to be better access to the roadway;
- further consideration on work to ensure koalas can cross under Appin Road further south within the Georges River Koala Reserve (at bridge over Georges River).

CPCP Scenario 1 assumes Crossing at Appin road as underpass at Corridor E.

- **Georges River Reserve -** Koala fencing installed and maintained along both sides of Appin road; Connectivity structure developed within the corridor at Georges River (Kings Falls Bridge) east of Appin township.
- **Nepean River corridor -** Koala fencing installed and maintained between Nepean corridor and development to the East;
- **Corridor C -** habitat conserved; fence along both sides to keep out threats.
- **Corridor D -** Habitat protected until and unless Corridor E underpass is secured, and linkage is constructed and vegetated and used; koala fencing along Appin road and Nepean keeps koalas out of corridor;
- **Corridor E -** Habitat protected; koala fencing for threats; crossing under Appin Road secured and utilised;
- **Corridor F** protected; koala fencing for threats; replanting undertaken.
- Exclusion fencing both sides of Corridors E and F with koala buffer both sides of corridor use of grids and gates within fencing; buffer width = 30 m each side (total 60m) using koala feed tree planting up to koala exclusion fence, with care taken that falling limbs do not damage the fence. APZ extends from exclusion fence additional into the development footprint. Traffic speed limit 50 km/h.

The Scenario 1 particularly differs from the proposed approaches by the MGS2 proponents and the CPCP drafters including:

- use of exclusion fencing (not post and rail) between development and koala habitat in Mount Gilead;
- differentiation of the concept of APZ (to protect houses from fire), and habitat buffer (to protect habitat and koalas from stressors and threats from development), with the APZ starting at the exclusion fence and in the development footprint;
- monitoring and adaptive management strategy (including the assessment of whether or not installed mitigations are functioning as required)
- in the CPCP Area, Corridor D to be protected until and unless a connection structure across Appin Road for Corridor E can be developed and is used by koalas.

CPCP Scenario 2 assumes Appin Road crossing occurs at Corridor D, and is not feasible in the south near Appin for Corridor E. As with all scenarios, it is assumed that Georges River Koala Reserve north-south Corridor has exclusion fencing installed and maintained along both sides of Appin Road including at Kings Falls Bridge, and there is koala fencing installed and maintained along the Nepean corridor facing development to the East.

Corridors in the CPCP have an equivalent approach to buffers and APZ as occurs in the MGS2, where koala buffer is 30 m wide additional to the corridor reaching to the exclusion fence, and the APZ is distinct to the buffer on the road/development side of the exclusion fence. If there are locations along the corridor that cannot be protected with exclusion

fencing because of steep terrain, then a wider buffer should be deployed (~60m) using non feed trees, and with traffic speed limited to 40 km/h in that area.

- **Corridor C** protects as much habitat connected to Beulah as possible. Corridor C should be re-examined for maintaining connections to Nepean Corridor if the MGS2 connectivity at the Menangle Creek and Nepean River confluence is compromised with road infrastructure.
- **Corridor D** is designated as the main east-west connection in the CPCP and an underpass linkage is constructed and vegetated and used by koalas; fence along both sides of Corridor D to keep out threats.
- **Corridor E** protected habitat; koala fencing for threats; managed population to ensure healthy genetics of the koalas and ongoing exclusion of threats.
- **Corridor F** protected habitat; koala fencing for threats; managed population to ensure healthy genetics of the koalas and ongoing exclusion of threats.

CPCP Scenario 3, where crossings under Appin Road are not feasible; assumes Georges River koala fencing installed and maintained along both sides of Appin Road, and the Nepean Corridor. Koala fencing installed and maintained along the Nepean corridor facing development to the East.

- **Corridor C** protects as much habitat connected to Beulah as possible.
- **Corridor D, E and F** where underpass crossings at corridor D and E are both not feasible (or ineffective if bridge crossings are deployed but not used). In this case the populations in Corridors E and F need to be actively managed for breeding, genetics and population growth using translocation from the Georges River Koala Reserve, and active management to ensure habitat availability and exclusion of threats.

2.1.2.3 Further infrastructure development and property construction

It is understood that over the coming decades, further development of the region is envisaged to deliver housing, town centres, utilities and services to the community, this includes development of roads and transport corridors that may run parallel to corridors, or may cut through corridors (Figure 1).

In the case that lineal infrastructure is planned that runs parallel but outside a corridor, then consideration should be given in the planning, construction and operational phases to increased influence of light and noise. Relevant mitigations should be put in place with suitable time prior to construction along corridors, and monitoring put in place to measure the intensity of the stressor and the impact on the local koala population. The approach to managing koalas during construction will also depend on whether it happens in a graduated way in stages or all at once.

It is noted that the MGS2 proponents are planning the use of best practice guidelines for construction. A construction management plan and a Koala management Plan would be developed and approved through a Commonwealth process

For infrastructure that cuts across corridors temporarily, this should be taken into account in the planning, and mitigations put in place, such as through the building phase. Prior to the construction phase, koalas may be required to be nudged out of the area, or temporarily relocated to another location potentially a sanctuary.

Infrastructure that will cut across a designated corridor should include underpass or overpass structures to enable the movement of koalas along the corridor, with suitable fencing, light and noise barriers put in place early enough through the process so that it is at scale by the time the infrastructure is constructed.

2.1.3 Adaptive management approaches for the operational phase

On-going monitoring of leading and training indicators will be required to understand the success of mitigations, and the response to the koalas of these efforts. Trailing indicators such as koala presence/absence, and koala health (genetics and disease) will to monitor the impact of development on the local koala population.

Some leading indicators can be set up as triggers to inform when further mitigations need to be considered – additional fencing, noise or light barriers, communication to residents, road furniture, or more then consideration should be given to translocating koalas to a dedicated managed location or alternative site.

Performance indicators and triggers can be used to inform when additional mitigations are needed, and expert advice should be sought. Further scenario planning should also occur.

Mitigations such as active management are feasible (described in Section 2.1.4), and potentially lend themselves to the development of a local koala or wildlife sanctuary, which could bring additional tourism and/or research benefits. Translocation of koalas out of the area could also be a long-term option, if the population does not thrive and that becomes the preferred approach. Further discussion of adaptive management approaches in Section 2.1.4.

2.1.4 Active koala management - if koalas are to remain in fragmented patches

A significant threat to isolated or near-isolated populations of koalas could include unforeseen problems of over-browsing (associated with reduced habitat and low dispersal rates) and low genetic diversity leading to inbreeding depression. There may therefore be a greater need for a strategic approach to the management of these potentially isolated koala populations, or those that are at greater risk of becoming isolated due to urban sprawl and development. The active management of koalas in such scenarios may afford for the opportunity to manage populations to ensure genetic diversity and resilience.

An active management approach may involve the monitoring of disease, checking the genetic health of the population, possible relocation of koalas for breeding and the captive management of sanctuaries to provide a long-term insurance population. Here, in this captive management scenario, the koalas would not be able to roam freely and there would be on-ground action for the maintenance and restoration of their enclosed habitat, with breeding by arrangement and informed by genetics. The NSW Koala Strategy is consistent with this approach and suggests the relocation of koalas to unoccupied koala habitat, which may include habitat sectioned as conservation sanctuaries (NSW Government, 2018).

The Mulligans Flat is an example of a strategic active management approach to wildlife conservation. The Mulligans Flat and Goorooyanoo Nature Reserve are two adjacent nature reserves located on the outskirts of Canberra. These reserves are a part of a national effort to conserve endangered woodlands and were set up by the ACT Government to protect box-gum woodlands around Canberra. Together, they total 1,623 ha of land and contain 1,146 ha of Yellow Box – Blackely's Red Gum Grassy Woodland, which represents some the largest protected areas of Yellow Box – Blakely's Red Gum Grassy Woodland in the ACT (Woodlands and Wetlands Trust, 2020).

In 1994, Mulligans Flat was established as nature reserve in a bid by the ACT government to protect the area in response to increasing residential development. In 2002, the Mulligans Flat – Goorooyarroo Woodland experiment arose in direct response to the Woodlands for Wildlife ACT. The Lowland Woodland Conservation Strategy Action Plan was announced that ensured the active recovery and protection for the Yellow Box-Red Gum Grassy Woodland (endangered ecological community) present in the nature reserves (Shorthouse et al., 2012).

The two reserves required restoration interventions to ensure their long-term ecological function and protection of this critically endangered ecological community. The Mulligans Flat – Goorooyarroo experimental restoration project was established as a collaboration between ACT government researchers, ACT government land managers and university researchers. The project was designed to integrate a restoration project with research in a highly accessible way (Shorthouse et al., 2012). The key aim of the project is to restore critically endangered grassy box-gum woodland that has degraded over time. The area has a strong previous history (over 150 years) of livestock grazing, patch cropping, pasture improvement and removal of timber for fencing, firewood and reducing rabbit harbour, which has altered soil condition, contributed to species decline, changed the vegetation structure, introduced weeds and eroded water courses. Furthermore, native plant recovery has been hindered due to grazing pressure by increased eastern grey kangaroo presence in response to urban development within the region. These combined and accumulated effects have led to a declining wildlife population within the nature reserves, and in some cases, local extinctions(Shorthouse et al., 2012).

The research component of the project also provides an opportunity for gaining insight into the efficacy of the range of restoration techniques used in the project and answering some theoretical questions posed. In 2010, baseline data was recorded, and initial treatments implemented. The experiment involved systematic trialling of a range of treatments that could provide insights into the complexities of rehabilitation. By doing so, an adaptive style approach could be taken whereby refinement of management approaches could occur based on the experimental outcomes. In brief, the experimental design involved the identification of 24 areas of vegetation, within which four 1 ha ‘sites’ were established. These 96 sites were subjected to a range of management treatments and contain ‘plots’ where the monitoring is undertaken. The treatments included; exclusion of kangaroo grazing, addition of deadwood, prescribed burning, varied tree and shrub densities and the exclusion of bettong digging in Mulligans Flat (Shorthouse et al., 2012).

The project is ongoing and has made considerable progress to date. There has been a positive response from invertebrates (Barton et al., 2011) and reptiles (Manning et al., 2011). Ground layer vegetation also showed signs of recovery as well as the effective eradication of foxes, cats and rabbits. The successful reintroduction of the first Eastern Bettongs seen in a wild situation on the mainland for over 80 years was undertaken as well as the reintroduction of the New Holland Mouse. Along with the active management of the nature reserves, evidence from the ecological research will continue to inform and exert some influence on the ACT Parks and Conservation Service’s land management policies and programmes (Shorthouse et al., 2012).

2.2 OFFSETS AND PROTECTED HABITAT

Offsets are designed to provide a compensatory mechanism for the negative environmental or biodiversity impacts of development at one site, which cannot be avoided or minimised further, to be offset by positive activities at another site. Offsets otherwise known as biobank sites (TSC Act) or biodiversity stewardship sites (BC Act) are a last resort mechanism to protect, in this case koala habitat, in perpetuity. Based on the area and type of impact an assessment method is used to determine the level of offsetting required. When acquiring species or ecosystem credits under this system, they can be obtained state-wide, and do not need to fall within the locality of the development.

Table 3 provides an overview of the proposed offsetting measures in MGS2 and the draft CPCP and provides panel commentary on those measures.

Table 3: Proposed offset measures in MGS2 and CPCP

Plan	Proposed Measures	Panel comment
Mount Gilead Stage 2 Development	The BCAR states that there would be direct impact to 332.17 ha of the assessment area. 201.81 ha of habitat will be permanently protected and managed for conservation. Of this, 197.46 ha would generate ecosystem credits and the remaining 4.3 ha would be red flag vegetation conservation area buffers. These would be conserved through the five registered Biobank sites on site (Browns Bush, Mount Gilead Homestead, Woodhouse Creek, Nepean and Medhurst sites). 1,901 species credit for the koala are required, the five Biobank sites generate 1,202 credits. This leaves a deficit of 699 koala credits. This would be met by the purchase of additional credits from registered biobank sites in the region or via the Biodiversity Conservation Trust.	Preference for local offsets to ensure protection of koala habitat for the Campbelltown population. However, given the 2019/20 bushfires protection of koala habitat in areas to recover koala populations is also of key importance.
Cumberland Plain Conservation Plan	Establishment the Georges River Koala Reserve. The Office of Strategic Lands owns 60% of the land and is establishing BSAs over some of its holdings. The Office of Strategic Lands will manage the voluntary land acquisition program under the plan and once all land is acquired, will establish BSAs to generate biodiversity credits that will be used to cover costs associated with future management of the reserve. Ownership and management of the reserve will be transferred to the NSW National Parks and Wildlife Service. Around 6,000 ha of important koala movement corridors and habitat have been identified within the strategic conservation are that are candidates for reservation or BSAs.	The strategic certification under the CPCP has no requirement for 'like for like' and provides a flexible offsetting arrangement whereby the proponent can propose an alternative conservation measure, that the Minister agrees *adequately* addresses impacts on biodiversity values. The Panel notes that adequate should meet the objective of the NSW Koala Strategy.

2.3 CORRIDORS, CONNECTIVITY AND MINIMISING EDGE EFFECTS

A wildlife corridor is a stretch of habitat that joins two or more areas of similar habitats. They can be in the form of a sequence of stepping stones across the landscape or as a continual lineal strip of vegetation and habitat (DIPNR, 2004). As habitats are increasingly cut off from each other due to various contributing factors including urban development, corridors play an important role in partially compensating for habitat loss and fragmentation by linking habitats and helping to maintain ecosystem health

It is critical to ensure connectivity between important patches of koala habitat. Large connected areas linking various koala habitats sustain populations by facilitating dispersal of populations, supporting breeding, providing resources for feeding and protecting against localised extinctions (NSW Government, 2020c). Ensuring as far as possible that the habitat has multiple connections can help to prevent the formation of dead ends and population sinks and ensure that koalas (and other species) have routes to escape threats such as bushfires.

Vehicle strike is a major cause of death for koalas in Campbelltown, with hotspots identified on Picton Road between Cordeaux Dam and Wilton, Macarthur Drive, Easter end of Wilton Road, Appin Road between Appin and Campbelltown and the Hume Highway at the Bargo

exit (DPIE, 2019c): These identified hotspots occur where a major road intersects a primary koala corridor, typically at the headwaters of a watercourse.

Factors that make koalas so susceptible to vehicles strikes include their inability to recognise roads and traffic as a potential threat, making them likely to crossroads, even in dangerous environments. Furthermore, koalas are a highly mobile species prone to dispersal, increasing the likelihood of them crossing barrier in search of areas of new habitat and because they are largely nocturnal, their visibility to motorists whilst crossing roads is low (Biosis & Open Lines Environmental Consulting, 2020). The highest proportion of vehicle strikes have been found to be juvenile koalas, with a strong male-bias, indicating their vulnerability from dispersal.

Exclusion fencing and the establishment of underpasses (e.g. Figure 7) or overpasses (e.g. land bridges) are required to protect wildlife and ensures connectivity between habitats and reduces interaction with busy highways. In Australia, the Pacific Highway upgrade in Ballina[14] and the Compton Road widening project in Brisbane[15] are examples where connectivity structures have been utilised to protect koalas and other species of mammals and reptiles. The movement of koalas can also be impeded by other man-made infrastructure (e.g. the Upper Canal, easements along the gas supply line and transport corridors). Although exclusion fences and under passes require ongoing maintenance, they are considered the most effective roadkill mitigation measure on major roads.

[14] The Woolgoolga to Ballina Pacific Highway upgrade includes a Koala Management Plan with commitments from Transport for NSW towards no koala road-kills occurring as a result of the upgrade. The three main mitigation measures resulted in koala-proof fencing along the length of the upgrade, twelve culverts under the upgrade, and koala food tree plantings. Monitoring programs in 2018 and early 2019 indicated that apart from koalas, several species were also using these culverts (Sandpiper Ecological Surveys, 2019)

[15] In 2004, Compton Road that traverses through large bushlands in Brisbane was upgraded from two lanes to four. In order to mitigate the impacts to local fauna, Brisbane City Council constructed infrastructure which included glider poles, rope ladders, fauna-friendly culverts, escape poles and exclusion fencing (Brisbane City Council, 2020). The fences were designed in such a way that it acts as a funnel directing wildlife towards these crossing structures. 18 species of mammals including koalas, kangaroos, wallabies, bandicoots, birds, echidnas, frogs, skinks, snakes, lizards etc. were recorded as having used the connectivity infrastructure (Griffith University, 2020)

Figure 7: Proposed bridge at Noorumba Reserve (top right) and underpass (40 m wide) at Beulah Reserve (bottom right) at Appin Road

Source: Lendlease
Note: The bridge has not been proven effective for koala crossing.

The Division of Environment, Energy and Science, within the Department identified the most important connections of koala habitat in the Campbelltown and Wollondilly region and defined these as primary, secondary or tertiary corridors (Table 4 and Figure 4). The process to identify the corridors and further information on them is in the *Conserving koalas in the Wollondilly and Campbelltown Local Government Areas* report (DPIE, 2019c).

Table 4: Types of corridors defined by the Department

Source: DPIE (2019c)

Term	Definition
Primary corridors	Corridors that contained 'core' koala habitat which were contiguous (gaps between trees less than 100 m) and were greater than 380 ha in size.
Secondary corridor	Corridors that contained 'core' habitat patches and smaller habitat patches or scattered trees that were separated by more than 100 m (were not contiguous) or were narrow or had pinch points less than 50 m wide and contained between 100 ha and 380 ha of 'core' habitat. Secondary corridors sometimes comprised 'core' habitat that totalled more than 380 ha and were wider than 50 m, but where this was the case, they were classified as secondary corridors if they did not connect to primary corridors on both ends.
Tertiary corridor	Corridors that contained patches of high-quality habitat that were poorly linked to primary corridors, contained between 30 ha and 100 ha of high-quality habitat, and did not connect to primary corridors on both ends. Tertiary corridors sometimes contained more than 100 ha of habitat, but where this was the case, they were classified as tertiary corridors if they did not connect to other corridors on both ends.

Biolink calculated the optimal average corridor width for koalas in Campbelltown to be 425 m. This is based on the home range size requirements for female koalas and the region's low carrying capacity (Phillips, 2018).

Eco Logical notes that studies indicate that the 425 m width is an overestimate of the width required for female koalas, and that Biolink has undertaken its calculations based on female koalas having a home range that is circular in shape. Eco Logical notes a study by (Lunney et al., 2010) that identified various home range shapes of koalas in the region including long narrow home ranges. Additionally, with regards to the 425 m corridor width, Eco Logical also notes the Biolink statement that it is *"evident from available studies in CCC LGA that koalas will use areas with a narrower width than this"* (Biolink, 2018).

There are two primary corridors that have been identified, the Georges River and Nepean River corridors. There are six secondary corridors identified in the GMGA that have the potential to provide east-west connectivity between the Nepean and Georges rivers. These corridors are shown in and described in Table 5. Corridors A and B and part of Corridor C are within the proposed Mount Gilead development and Corridors C to F are part of the draft CPCP.

The assessment criteria for these potential movement corridors are (DPIE, 2020d):

- proximity of corridor to current and future infrastructure, and planned urban areas
- threat from other animals including domestic dogs
- corridor's topography and vegetation
- extent of land unattractive or dangerous for wildlife to cross
- minimum width of corridor after setting aside land marked for development
- potential for wildlife crossing to be built across Appin Road.

It is noted in the draft CPCP that regardless of whether potential secondary east–west koala movement corridors are protected for koalas over the long term, native vegetation will be secured and enhanced under the CPCP, benefitting other threatened species and ecological communities. This also supports the possibility of securing and enhancing potential corridors such as Ousedale Creek to Appin North for koalas in the long term.

Urban development in proximity to fauna habitat has increased the potential 'edge effects' that species such as koalas experience. In this context, 'edge effects' has been described as the interaction as a result of a transition between two different ecosystems where the threats to fauna is most pronounced, such as that experienced in the Campbelltown region where clearing of native fauna habitat has created an 'edge' (also often to referred to as the habitat perimeter) with, and interaction between, the anthropogenic land uses (such as agriculture and, increasingly, urban development) (Benitez-Malvido & Arroyo-Rodríguez, 2008).

Edge effects can include both direct (i.e. vehicle strike and dog attacks) and indirect (i.e. light and noise pollution, urban storm runoff) impacts on fauna and flora, and can result in altered behaviour (for example, changes in home ranges or in how species disperse throughout a landscape) that can have longer term repercussions. The magnitude of edge effects and how it impacts fauna residing within the habitat is primarily a factor of the remaining habitat area, and includes factors such as the smoothness of the border (i.e. jagged habitat borders can result in an increased edge:area ratio), the length of the 'edge' and the narrowness of the remaining habitat.

There are a number of strategies and methods that can mitigate the impact on koalas, particularly at the interface of urban and native environments. This includes, but it is not limited to, vegetated buffer zones and managed habitat areas, koala exclusion fencing (includes fencing at the interface to roads, but also around pools and yards), predator and pest management (including weeding programs), vehicle-strike mitigation measures (under- and overpasses, road grids, traffic calming devices and road design, signage, speed limits, etc.), and community awareness programs.

Panel comments

- Specific Panel comments on each of the corridors and proposed koala protection measures is at Table 5.
- With primary corridors along Georges and Nepean rivers, it is important to provide koala populations with the ability to move freely and safely along the east-west corridors to ensure genetic diversity and population dispersal.
- There is only a buffer on one side of the corridor in the MGS2 BCAR (Figure 9). The Panel views this is insufficient as koalas will need to have protection from threats on both sides of the corridor. Buffers, exclusion fences and APZ should be located on both sides of Woodhouse Creek, as the current proposed buffer zone in MGS2 is for the northern side of the Woodhouse Creek corridor only.
- The buffers in the proposed MGS2 development serve the dual purpose as a buffer for the Woodhouse Creek (and other) koala habitat corridor and as an APZ for the development, with infrastructure such as byroads and walking trails including in the outer buffer zone (Figure 10). The Panel sees the design as suboptimal as it permits threatening activities in close proximity to koalas with no barrier to interaction between the koala and the hazard. There is also the inclusion of stormwater retention ponds within the buffer zone.
- Buffer zones provide a mechanism to minimise edge effects – they reduce interactions between koalas and the urban environment. The Panel notes that buffer zones should:
    - provide separation between the built environment and other associated infrastructure (including roads)
    - be wider when it is not feasible to have an exclusion fence at the edge of the buffer
    - not include APZs (as per the SEPP Guidelines), particularly when subject to revegetation
    - not include roads, playgrounds and picnic areas
    - facilitate the complete avoidance of direct impacts (i.e. road strike)
    - mitigate the impact of indirect impacts, such as attenuating noise and light pollution from the urban development, for native species within the environment
    - prevent koalas moving into urban areas and prevent threat such as dog attacks
    - give consideration to the long-term maintenance of the koala habitat and any proposed mitigation strategies (such as fence maintenance in perpetuity)
- If there are not adequate measures to prevent koalas entering the urban environment, revegetation should discourage koalas utilising these buffer zones, this could be achieved by revegetating the buffer with native vegetation that include no koala preferential feed trees. In some locations such as steep terrain, exclusion fencing may not be feasible, and in these cases wider buffers would be required (~60 m), that don't include koala feed trees, and monitor for predators.
- The Panel also recommends that if the preferred method of koala exclusion fencing is used, the buffer zone should be revegetated with preferred koala feed and shelter tree species, with thought given to how far back from the fence line revegetation occurs to ensure that the fence is still effective and that treefall does not pose a risk to its integrity.
- There is also the opportunity to explore dog-free trails and double-gated entry points into the corridor.

Table 5: Primary and secondary corridors

Corridor	Name	Description	Proposed measures	Panel comments
Primary CPCP	Georges River Koala Reserve	• allow koalas to move north-south, from Appin in the South to Kentlyn in the North. • intended to protect and manage approximately 1,800 ha of koala habitat, out of which 800 ha of publicly owned land along the south-eastern edge of the Cumberland Plain has been announced as part of the future reserve.	CPCP • The program aims to deliver an additional 1,050 ha as part of the reserve and restore 250 ha as important koala habitat (NSW Government, 2020c). • The high fertility shale and shale-influenced soils in the region will enable the restoration project to focus on plant community types such as grey box, grey gum, narrow-leaved ironbark trees that are preferred by the Southern Sydney Koala population (NSW Government, 2020c). • Proposed measures to discourage koalas from crossing Appin Road is the instalment of koala exclusion fencing on both sides of the road in identified movement corridors with the aim of reducing fauna mortality. • Measures described in Table 3	• Support fencing both sides of Appin Road to prevent vehicle strike • Connectivity and threats should be considered within this corridor. Fencing should be placed on Appin Road and a connectivity structure be developed with the Kings Falls Bridge over the Georges River. • Support the establishment of the Georges River Koala Reserve is extremely important to safeguard the vital koala population along the Georges River.
Primary CPCP	Nepean	• Contains the remaining areas of Shale Sandstone transition forest along the Nepean River and its major tributaries provide the only other core habitat for koalas in these areas. • This habitat is more limited in extent and linear in configuration. • Supports significant numbers of resident koalas and is therefore vital to the persistence of the regional koala population (NSW Government, 2020c)	CPCP • Identified to be protected as a strategic conservation area	• The corridor should be protected, and connectivity to the east needs to be ensured to stop the development of dead ends/sinks
Secondary A Mount Gilead development	Menangle Creek to Noorumba	• Connects northernmost point of the Nepean riparian vegetation, before passing under motorway and heading west to Razorback • Creek is fourth order below aqueduct, and requires 40 m riparian buffer on each side • Fauna crossing structure on Appin Road will need wide run-	Mount Gilead Development • Tree-top bridge across Appin Road to provide connectivity for koalas • Noorumba Biobank Site (part of corridor)	• This corridor will provide little protection for koalas into the future if it is not fenced as it is very narrow with limited capacity to revegetate the buffer zone • The proposed tree-top bridge is not likely to be adequate and would not be used by koalas. The feasibility of a pedestrian style bridge should be

		up, and will impinge on biobanked land on western side • Menangle Creek main channel (northern stream) is third order below aqueduct and steep on the sides near southern tunnel entrance of the aqueduct • Areas of vegetation are dominated by species other than Eucalypt (instream is *Casuarina*) • After development, vegetated areas at higher elevations likely to be too narrow • Middle section is crossed by two adjacent high-voltage powerlines and a gas main • Addition of busway near gas main route will increase width of hostile land without trees		considered to allow koalas and other fauna to cross Appin Road. • If the crossing is not feasible, the koala habitat at Noorumba Reserve will be isolated and not function as connected koala habitat, therefore should be fenced off at Appin Road. In this case, the koalas within this fragmented area should be actively managed.
Secondary B Mount Gilead development	Woodhouse Creek to Beulah	• Meets Menangle Creek at its western end (Corridor A) to become third order stream • Third order section (north-south) is only 750 m; both streams above this confluence (Nepean and Woodhouse Creeks) are only second order, which means that riparian corridor is 40 m • Remaining east-then-south connection to Beulah is a first order stream and requires only 20 m total width • A gas main, power line and Upper Canal aqueduct cross the stream in close proximity • The future busway may be located nearby leading to a wide hostile area in the crossing • The total width of the riparian zone may be further narrowed by development	Mount Gilead development • buffers to mitigate negative indirect impacts on protected 'red flag' areas from development, including koala habitat and corridors.This buffer zone is broken down into a 15 m outer buffer zone (includes local road, residential dwellings, collector road, managed open space and landscaped stormwater detention basins) and a 15 m inner buffer zone (actively managed vegetated areas for conservation, as part of registered Biobank Agreement sites. The buffer zones will also serve as bushfire APZ and will include infrastructure such as stormwater retention basins and walking/cycling paths. • a fauna underpass on Appin Road at Beulah Reserve. This is intended to reduce significant roadkill in the region. See Figure 7 • two creek crossings (Woodhouse and Nepean Creek) and a possible third across a transport corridor, with each of these crossings having an elevated bridge with over 10 m clearance to ensure connectivity and movement (Eco Logical Australia, 2017).	• Corridor B has been identified as a priority koala corridor within MGS2, linking the primary koala corridor to the east of Appin Road to Nepean River corridor in the west, through Woodhouse Creek, Beulah Biobank site and Menangle Creek. • Corridor B is a continuous corridor that has a mean width of 316 m, a minimum width of 100 m and no part of the corridor separated by more than 220 m (minimum distance between stepping stone habitat areas (Figure 8). It is noted that previous studies identified a minimum width of 200 m, opportunities to widen this corridor should be explored • With appropriate koala exclusion fencing and buffer zones (30 m each side of the corridor) this corridor should provide appropriate east-west movement for koalas at the northern

		An overpass is required at Beulah across Appin Road, with a wide run-up on either side	• Beulah Biobank Site will link to the proposed Browns Bush Biobank site	end of the Nepean River and Georges River corridors. • Ongoing monitoring will be essential to the management of this corridor to ensure koalas are still utilising it and not coming into contact with direct and indirect threats. • The underpass near Beulah Reserve, as proposed by Lendlease, should be constructed. • Particular care needs to be paid to the design and construction of the habitat at the confluence of the Menangle Creek and Nepean River where a number of road bridges are planned, to ensure koalas will use the connection.
Secondary C MGS2/ CPCP	Nepean Creek to Beulah	• Extends in a south-then-east direction, lower confluence to Menangle Creek • Corridor extends southwards and then broad arc in north-east direction (upper end of Woodhouse Creek above Beulah) • Flat topography means that development could create narrow corridor • Power lines, gas line and proposed busway will create reasonably wide hostile area • Very little vegetation over gas main crossing • Difficult to create fauna crossing over Appin Road due to terrain	CPCP • Habitat is to be conserved • Fencing on the south side (CPCP)	• This corridor will have a significant edge effect from the urban development surrounding all aspects of it.
Secondary D CPCP (second most	Mallaty Creek to Georges River	• Mallaty Creek is third order except for the eastern third where it is second order. • At 5 km upstream of the Hume Motorway bridges, the creek meets the Nepean River in a deep gorge section.	CPCP • Habitat is to be conserved • Fencing at eastern and western edges to prevent koala entry	• This corridor is suitable for koala movement and should be protected with exclusion fencing and additional buffer zones • The corridor provides the second-preferred route if Corridor E cannot traverse Appin Road

preferred corridor		• Wide corridors up to 500 m at several points • Northern side of the creek well vegetated • Power lines, gas line and proposed busway will create reasonably wide hostile area • Very wide overpass structure needed at Belltrees Kennels, where Georges River is nearest to Appin Road • Aqueduct at western end crossing the creek will create a strong pinch-point for animals		• While this section is well vegetated and nutritious, particularly at the north, and the corridor widens to 500 m at various points, higher-nutrient vegetation is limited at other areas. • The area is also traversed by power and gas lines, with a proposed busway bisecting the corridor. The western end where the aqueduct crosses the creek is also expected to be a pinch-point for animals (DPIE, 2020d).
Secondary E CPCP: preferred corridor	Ousedale Creek to Appin North	• Fourth order from an upstream confluence with Nepean River; becomes third order upon joining Lily Ponds Creek and therefore 80 m and then 60 m riparian corridor required • Power lines and gas corridors widely spaced, making hostile crossing narrow • Most well-vegetated among all options, with ample vegetation along either side of riparian corridor • Area of corridor considered to be less attractive prospect for development • Designing fauna crossing expected to be easier than other options • Busway is expected to be near the Lilly Ponds-Ousedale creeks confluence, but stream can be bridged easily • Location too far south to be useful for animals moving northwards	CPCP • Habitat conservation and restoration in some areas • Fencing either side • Crossing options across Appin Road are being explored • Land purchases being explored to complete the corridor	• This corridor is suitable for koala habitation and should be protected with exclusion fencing and additional buffer zones as outlined for MGS2. • Suitability as a primary corridor will be contingent on a crossing being secured across Appin Road.

Secondary F CPCP	Elladale Creek and Simpsons Creek to the colliery	• Southernmost corridor • Poorly connects west of Appin village to the east through the vicinity of Brooks Point Road • Corridor has a large area of vegetation that is well populated with fauna and has high-nutrient shale soils • Traffic is light on Wilton Road • Area connecting Ousedale Creek and corridor is forecast to have busway transect it, and possibly a future urban centre • Corridor has poor linkage to east • Originates further south along Nepean Gorge, giving it little advantage over existing Cataract Gorge connection between Appin and Wilton	CPCP • Exclusion fencing • Habitat conservation and restoration in some areas	• This corridor is suitable for koala habitat and should be protected with exclusion fencing and additional buffer zones as outlined for MGS2. • Active management efforts will be required, in formed by monitoring, if threats such as bushfire and predators are identified to avoid a population sink in this corridor

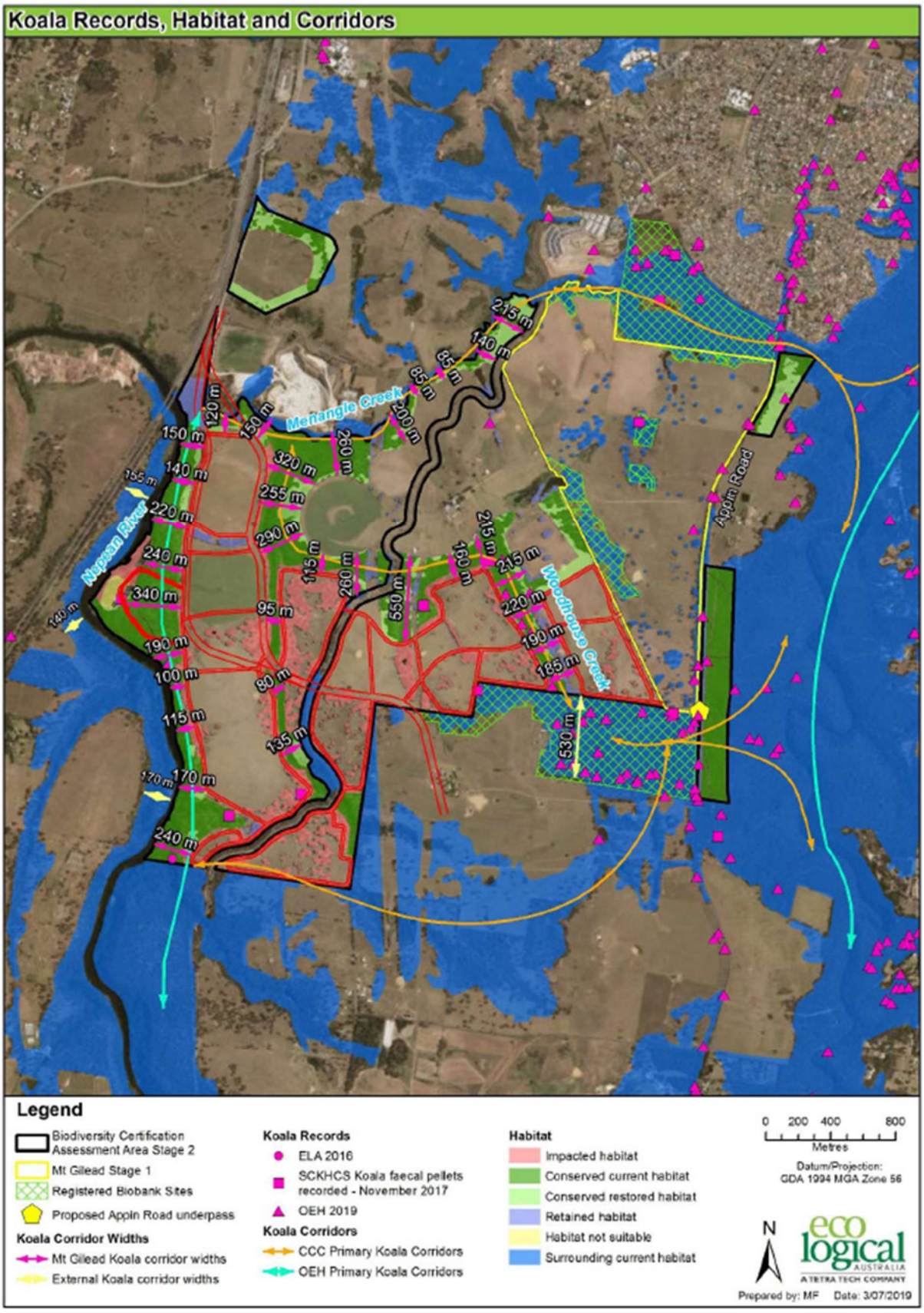

Figure 8: Corridor widths in the proposed MGS2 development
Source: Eco Logical Australia (2020)

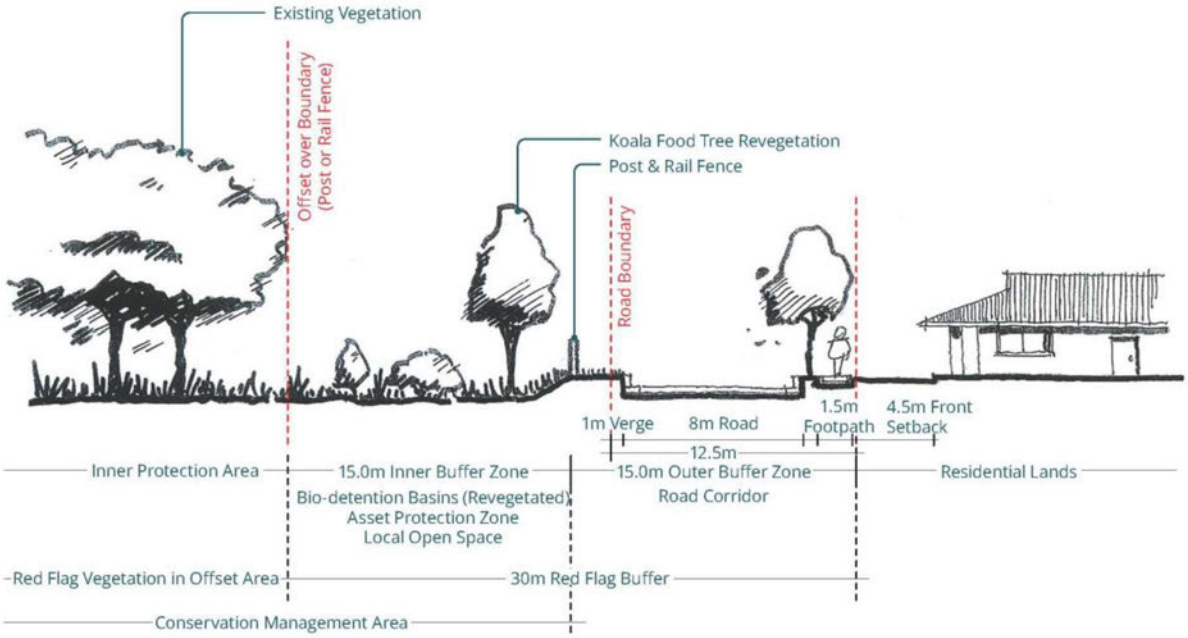

Figure 9: Example of buffer zone at proposed Mount Gilead Stage 2 development
Source: Eco Logical Australia (2020)

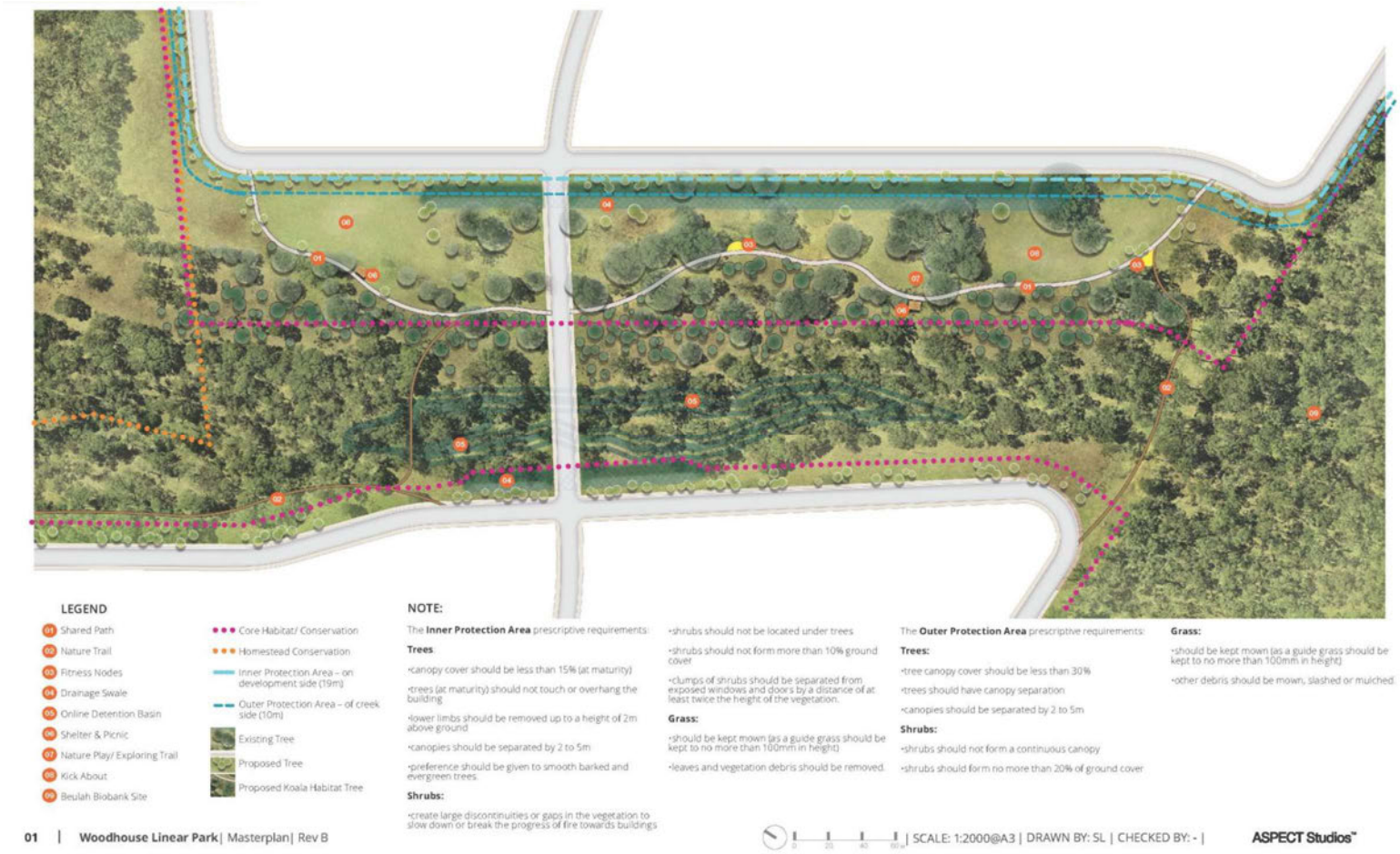

Figure 10: Mount Gilead Stage 2 Woodhouse Creek Koala corridor
Source: Eco Logical Australia (2020)

2.3.1 Mitigation of threats within developments

Without mitigation, the risk of vehicle strike to koalas will increase substantially as development proceeds. There is a number of examples of measures that will minimise and mitigate the impacts from roads and transport projects. These include designing fencing to prevent animal entry to roads or transport corridors, avoid locating new roads in environmentally sensitive areas and ensuring that fauna-sensitive road design elements are employed and maintained during and after road construction.

There are a number of measures proposed for the proposed MGS2 development and the draft CPCP to mitigate against threats within the urban region. These are described in Table 6.

Table 6: Proposed measures to protect koala from threats within developments

Plan	Proposed Measures	Panel comment
Mount Gilead Stage 2 Development	• Development of a Construction Environmental Management Plan to avoid and mitigate potential construction impacts to offset sites. E.g. include temporary fencing around identified conservation areas, pre-clearance fauna protocols, and dewatering plans for existing dams. Pre-clearance Tree Clearing Protocol to achieve the aim of no death or injury to koalas during the construction phase, movement of tree residue that could provide habitat into the retained offsets, and pathogen and weed control protocols. • Identification and avoidance of conservation areas, with permanent protection and management for Biobank sites • Design measures to mitigate the risk of predation by domestic dogs: dog proof fencing on all residential lots, enforced prohibition of dogs within all Biobank sites, alternative dog-friendly open space areas, and community awareness programs (signage, etc.) • Traffic controls (onsite and road): speed limits (50 km/h) on local roads adjacent to conservation areas, signposted (in accordance with specifications set out by various NSW Government agencies and the Council), traffic calming devices and vegetation clearance adjacent to road • Education and awareness, with programs designed for construction and for the Mount Gilead community (process of managing injured koalas, best practice dog ownership, tree planting days, etc.)	Areas of koala habitat should have exclusion fencing, where this occurs a 50 km/h speed limit is suitable. However, if koala fencing is not able to be used, a lower speed of 40 km/h should be observed with traffic calming devices and signage.
Cumberland Plain Conservation Plan	The draft CPCP includes a number of commitments aimed at minimising the impacts from adjacent land-uses on conservation areas and to mitigate the impact from increased road development and movements. Specific actions that are highlighted include the preparation of a Koala Management Area Guideline that would incorporate planning, designing and development controls for the management of the impacts identified, the identification of areas where buffers are critical to protect conservation areas, and increase public awareness of the biodiversity values of the conservation sites. These actions will be undertaken in collaboration with the council and local landholders, as land holders in the area, with the CPCP also establishing a working group to provide advice on koala management and mitigation actions. This working group will also be tasked with reviewing mitigation measures within the Koala Management Area Guideline. The CPCP also identifies the need to amend Growth Centre SEPPs to stipulate adherence to the Koala Management Area Guideline for managing impacts within these areas.	Areas of koala habitat should have exclusion fencing, where this occurs a 50 km/h speed limit is suitable. However, if koala fencing is not able to be used, a lower speed of 40 km/h should be observed with traffic calming devices and signage.

2.4 MONITORING AND MANAGEMENT

The uncertainty around how land and population changes and management actions will impact the koala population (either positively or negatively). This uncertainty can be addressed by: understanding the current koala population including how koalas use the landscape and their population attributes; putting in place a monitoring program to track this population over time; and adopting an adaptive management approach that is informed by real-time monitoring so that amendments and improvements can be made to mitigation measures as needed.

An adaptive management approach informed by monitoring and data capture will help chart a way forward for managing the koala population, at the construction phase as well as through the ongoing management phases. These principles are set out in the SEPP KOALA and in the NSW Koala Strategy. Principle 7 of the draft guidelines released as part of the new Koala SEPP sets out the use of adaptive management of koalas

Adaptative management is an iterative approach that uses ongoing monitoring to adjust or change management actions if they are proving ineffective or, conversely, if one action is having a greater benefit. It allows for the implementation of actions in a structured, yet flexible, manner to achieve a desired outcome. It is, more broadly, a method that ensures risk management is at the forefront on any decisions. It is based on the collection and analysis of data against a set of pre-determined questions/criteria.

An important aspect of adaptive management is the timeframe of actions and the response time to those actions (either positive or negative). For example, there are actions that may take time to be introduce and mature prior to becoming effective, Similarly, the benefits of revegetation on populations potentially would not be seen until several years after.

Linked to this is the need to monitor actions over time and implement strategies to ensure their continual effectiveness. For example, ensuring fence integrity in perpetuity or ensuring that no new predators have entered the habitat.

As part of the NSW Koala Strategy an NSW Koala Monitoring Framework is being developed. This Framework will provide structure to the long-term monitoring of koala populations in NSW, advocating for a consistent, best-practice approach across the functional topics of population dynamics, koala habitat, genetic diversity, disease and reproduction, and threats. At the heart of the Framework is adaptive monitoring, ensuring flexibility in ongoing monitoring that is informed by previous information and sets an overall strategic purpose for monitoring efforts, such as the evaluation of the effectiveness of management actions.

The proposed monitoring in the MGS2 development and in the draft CPCP are at Table 7.

Table 7: Proposed monitoring measures in MGS2 and CPCP

Plan	Proposed Measures
Mount Gilead Stage 2 Development	• fauna assessments and modeling of koala populations have been undertaken as part of the biodiversity certification application process, providing a baseline for the koala population in the proposed development footprint • Monitoring associated with approval and compliance

Cumberland Plain Conservation Plan	• proposed Cumberland Plain Evaluation Program and the monitoring, evaluation, reporting and adaptive management that will support the implementation of the CPCP (NSW Government, 2020b).
	• proposed systematic collection and storage of data relevant to the three identified priorities:
	  ○ koalas at the interface (especially in response to management actions),
	  ○ the identification of threats, and
	  ○ demographic information (including life history and ecology).
	This will also be evaluated to identify potential changes as a result of management actions (adverse or positive) and analyse how these management actions could be improved or if

	there are alternative actions that could be used. This evaluation will occur in the first 15 years of the Plan's implementation. • Proposed monitoring to better understand the threat from Chlamydia, in light of their disease-free status, whilst noting that the SoS program will support this monitoring.

Panel comments

- The Campbelltown koala population should be monitored. Baseline data is required to understand the current status of the population. This should be matched by ongoing and regular survey and monitoring efforts, to compare population trends over time and inform adaptive management approaches (including the development and understanding of appropriate triggers and responses, including timeframes). The site should be designated as one of the dedicated monitoring sites under the NSW Koala Strategy. Supporting these efforts should form part of the landholder, developer or proponents' responsibilities.
- Parameters that should monitored include:
    - population dynamics (including age demographics, fertility and sex ratios, mortality and causation, etc.)
    - the identification, changes and effectiveness of mitigation actions for key threats (predators, vehicles, etc.),
    - tracking how individuals and the koala populations use and disperse throughout the environment (including male movement during mating season, changes in territories, etc.)
    - monitoring for the prevalence of disease, such as Chlamydia and KoRV, which should trigger immediate actions such as vaccination if there is a change in levels detected.
    - monitoring koala generations over time to understand whether offspring are less stressed than their parents and more accustomed to urban edge locations.
- Intrinsically linked to triggers under an adaptive management approach is understanding how monitoring is conducted, and whether there is lag time associated with measurements. For example, trailing indicators such as reduced reproduction may present too late for effective management actions that halt the decline to be implemented. Adaptive management should incorporate leading and lagging indicators appropriately
- Tissue sampling of joeys, along with tagging of the Campbelltown koala population will allow insight into the functional genetics of this koala population and how it could lead to increased resilience in NSW. For any koala monitored, efforts should be made to contribute samples in the ascribed manner to the Australian Museum, as the dedicated NSW biobank for tissue samples. The resulting genetic data can inform translocation strategies that may be required if active management procedures are needed for fragmented enclosed populations as discussed above in CPCP Scenario 3.
- There is an opportunity to use new techniques and technologies to study this population and inform management efforts. For example,
    - new implantable sensor technologies, similar to proximity tags used in marine environments, could be used to understand koala movements when combined with passive sensor stations, and could be investigated further by NSW initiatives such as the NSW Smart Sensing Network. Proximity tagging will identify whether there are areas of the landscape that koalas do not use, or avoid, which will inform future decisions about habitat protection.

    - Drone technology to detect koala presence
- The population has remained relatively free from *Chlamydia* infection. However, there is widespread infection in the Southern Highlands population, and it is believed that this infection could move north into the population due to connectivity between the populations. Animals that are captured and/or handled as part of a monitoring program or those that are rehabilitated and released back into the Campbelltown population should be vaccinated against Chlamydia.

ACRONYMS

Acronym	Full Term
APZ	Asset Protection Zone
BAM	Biodiversity Assessment Method
BC Act	NSW *Biodiversity Conservation Act 2016*
BCAM	Biodiversity Certification Assessment Methodology
BCAR	Biodiversity Certification Assessment Report
BDAR	Biodiversity Development Assessment Report
BSA	Biodiversity Stewardship Agreement
CKPoM	Comprehensive Koala Plan of Management
CPCP	Cumberland Plain Conservation Plan
DPIE	NSW Department of Planning, Industry and Environment (the Department)
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
GMGA	Greater Macarthur Growth Area
LGA	Local Government Area
MGS1	Mount Gilead Stage 1
MGS2	Mount Gilead Stage 2
SEPP	State Environmental Planning Policies
SoS	Saving our Species
TfNSW	Transport for NSW (road authority)
TSC Act	NSW *Threatened Species Conservation Act 1995*

APPENDIX 1 - TERMS OF REFERENCE

Terms of Reference:
Advice regarding the protection of the Campbelltown Koala population

To provide advice to the Minister for Energy and Environment and the Minister for Planning and Public Spaces about:

- The adequacy of the proposed measures for koala conservation proposed by property group Lendlease on land referred to as Mt Gilead Stage 2 (MGS2) and the consistency of these measures with the NSW Koala strategy.
- What, if any, additional conservation measures are considered necessary.
- What, if any, site specific measures for koala species should be incorporated into the Cumberland Plain Conservation Plan for the Greater Macarthur Growth Area to support the long-term viability of the koala population.
- Whether east-west corridors linking the Nepean and Georges Rivers can contribute to the conservation of the Campbelltown koala population; and, if so, which east-west corridors and what measures should be taken to ensure their effectiveness.

In preparing this advice the Chief Scientist & Engineer will review existing science and relevant documentation including;

- NSW Koala Strategy
- Independent Review into the Decline of Koala Populations in Key Areas of NSW, NSW Chief Scientist and Engineer, 2016.
- Conserving Koalas in the Wollondilly and Campbelltown Local Government Areas report, Dept. Planning Industry and Environment, October 2019
- Koala Corridor Project Campbelltown City Council and Wollondilly Local Government Areas: Greater Macarthur Growth Area, Biolink Consultants, October 2018
- South Campbelltown Koala Habitat Connectivity Study prepared for Campbelltown City Council, Biolink Consultants, 2017.
- Fact Sheet CPCP Protecting Koalas on the Cumberland Plain, Dept. Planning, Industry and Environment, September 2019
- Mt Gilead Stage 1 Biodiversity Certification Agreement
- Application for biodiversity certification for Mt Gilead Stage 2, Campbelltown City Council, August 2019
- Biodiversity Certification Assessment Methodology (BCAM). Office of Environment and Heritage, 2011
- Greater Macarthur 2040: An interim Plan for the Greater Macarthur Growth Area, Department of Planning and Environment
- Section 3.25 consultation – Proposed amendments to Growth Centres SEPP to declare Greater Macarthur as Growth Area, Office of Environment and Heritage, March 2019
- Lunney, D. Close, R., Bryant, J. V., Crowther, M. S., Shannon, I., Madden, K., and Ward, S. 2010. 'The koalas of Campbelltown, south-western Sydney: does their natural history foretell of an unnatural future?' *The Natural History of Sydney*. Edited by Daniel Lunney, Pat Hutchings and Dieter Hochuli. Royal Zoological Society of NSW, Mosman, NSW, Australia.
- Phillips, S. and Callaghan, J. 2000. 'Tree species preferences of koalas (*Phascolarctos cinereus*) in the Campbelltown area south-west of Sydney, New South Wales'. *Wildlife Research*. 27: 509-516
- Any other documentation, science and previous reports that are considered relevant.

Reporting timeframe
The advice will be provided in a report by 30 April 2020.

Expert Panel
An Independent Expert Panel, chaired by the Deputy NSW Chief Scientist & Engineer, will be established to provide advice.

Support
Secretariat support will be provided by the Office of the Chief Scientist and Engineer.

The Department of Planning, Industry and Environment will also provide support. The agency contact is Kate Wilson, Executive Director Climate Change and Sustainability, Environment, Energy and Science.

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Appendix D

Department of Planning and Environment response to the OCSE Principles and final Koala corridors in Gilead

Planning, Industry & Environment

IRF21/4944

Ms Ranisha Clarke
Head of NSW Communities
Tower Three, International Towers Sydney
300 Barangaroo Avenue, Barangaroo NSW 2000

Via email: rashina.clark@lendlease.com

Attn: Brendan O`Brien

Dear Ranisha,

Thank you for your letter dated 3 December 2021 relating to the recently published Greater Macarthur update and Koala corridors in Gilead.

The Greater Macarthur update provides a strategic indicative map of Koala corridors in the entire growth area. As you are aware, Lendlease has been working with the Department under the Technical Assurance Panel (assurance panel) pilot program to prepare a draft planning proposal for Gilead Stage 2. An important part of this work has been the investigation of the following Koala corridors in Gilead:

- Corridor A along Menangle Creek,
- Corridor B along Woodhouse Creek, and
- The Gilead component of the Nepean Corridor.

The map at Attachment 1 reflects the outcomes of those investigations and is the current indicative mapping for these corridors. These corridors apply the recommendations and subsequent advice of the Office of the NSW Chief Scientist & Engineer (OCSE) and will provide valuable inputs into the draft proposal to be reviewed by the assurance panel. Please note these corridors also include land within the Cumberland Plain Conservation Plan, however the attached map only shows the corridors in relation to land known as Mt Gilead Stage 1 (Figtree Hill), Stage 2 (subject of the assurance panel program) and the adjacent Noorumba and Beulah reserves. These corridors may be further refined or amended as a result of the assurance panel program or any subsequent statutory rezoning process, however, must continue to apply the recommendations and advice of the OCSE.

I look forward to working with Lendlease and the assurance panel to progress the preparation of a draft planning proposal in 2022. If you have any questions, please contact Naomi Moss, Manager Place and Infrastructure, at the Department of Planning, Industry and Environment on (02) 9228 6351 or via naomi.moss@planning.nsw.gov.au

Yours sincerely

December 2021

Adrian Hohenzollern
Director, Western District
Central River City & Western Parkland City
Department of Planning, Industry and Environment

Indicative Koala Corridors - Gilead

- Nepean River Corridor (*Gilead Component)*
- Woodhouse Creek Corridor (*Corridor B*)
- Menangle Creek Corridor (*Corridor A*)

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Appendix E

Updated Biocertification Assessment report (Eco Logical Australia, 5 September 2022)

Mt Gilead – Stage 2

Biodiversity Certification Assessment Report & Biocertification Strategy

Prepared for
Lendlease Communities (Figtree Hill) Pty Limited

5 September 2022

DOCUMENT TRACKING

Item	Detail
Project Name	Mt Gilead Stage 2 – Biodiversity Certification Assessment and Biodiversity Strategy
Project Number	600-22SUT2256
Project Manager	Robert Humphries (02) 8536 8620 Suite 2, Level 3, 668-672 Old Princes Highway, Sutherland NSW 2232
Prepared by	Michelle Frolich, Brian Towle, Bruce Mullins, Meredith Henderson, Rodney Armistead, Kris Rixon, Robert Humphries
Reviewed by	Meredith Henderson, Accredited BCAM Assessor #0155
Approved by	Robert Humphries
Status	Final
Version Number	6
Last saved on	5 September 2022
Cover photo	Clockwise from top left: *Sarcochilus hillii*, Cumberland Plains Woodland, Grey Myrtle Dry Rainforest, *Pomaderris brunnea* (Rufous Pomaderris)

This report should be cited as 'Eco Logical Australia 2022. *Mt Gilead Stage 2 – Biodiversity Certification Assessment and Biodiversity Strategy*. Prepared for Lendlease Communities (Figtree Hill) Pty Limited.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from Lendlease Communities (Figtree Hill) Pty Ltd

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Abbreviations

Abbreviation	Description
ARA	Adjacent Remnant Area
APZ	Asset Protection Zone
AW	Alluvial Woodland
BAR	Biodiversity Assessment Report
BCAA	Biodiversity Certification Assessment Area
BCT	Biodiversity Conservation Trust
BBAM 2014	Biobanking Assessment Methodology 2014
BC	*Biodiversity Conservation Act* 2016
BCAM	Biodiversity Certification Assessment Methodology
BCS	Biodiversity Certification Strategy
BSA	Biodiversity Stewardship Agreement
BVT	Biometric vegetation type
CCC	Campbelltown City Council
CCPD	Canopy cover projection density
CEEC	Critically Endangered Ecological Community
CMA	Catchment Management Authority
CPAR	Cumberland Plain Assessment Report
CPCP	Cumberland Plain Conservation Plan
CPSWSGTF	Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest (as listed under the EPBC Act)
CPW	Cumberland Plain Woodland
DEC	NSW Department of Environment and Conservation (now OEH)
DECC	NSW Department of Environment and Climate Change (now OEH)
DECCW	NSW Department of Environment, Climate Change and Water (now OEH)
DoTEE	Commonwealth Department of the Environment and Energy
DPE	NSW Department of Planning and Environment (formerly NSW Department of Planning)
DPIE	NSW Department of Planning, Industry and Environment (formerly NSW Department of Planning and Office of Environment and Heritage)
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd

Abbreviation	Description
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
GM2040	Greater Macarthur Growth Area
GMDR	Grey Myrtle Dry Rainforest
IoM	Improve or Maintain
LEP	Local Environment Plan
LGA	Local Government Area
LG Act	NSW *Local Government Act 1993*
Lendlease	Lendlease Communities (Figtree Hill) Pty Ltd
MALD	More appropriate local data
MNES	Matters of National Environmental Significance (EPBC Act)
Mt Gilead	Mt Gilead Pty Ltd
NPW Act	NSW *National Parks and Wildlife Act 1974*
NPWS	NSW National Parks and Wildlife Service (now part of OEH)
NSW	New South Wales
OCSE	NSW Office of the Chief Scientist and Engineer
OEH	NSW Office of Environment and Heritage (formerly DECCW, DECC, DEC)
PCT	Plant Community Type
RF	Riparian Forest
RFEF	River-flat Eucalypt Forest
SCKHCS	South Campbelltown Koala Habitat Connectivity Study
SEPP 44	State Environmental Planning Policy No 44 – Koala Habitat Protection
SHW	Shale Hills Woodland (a component of CPW)
SPW	Shale Plains Woodland (a component of CPW)
SSTF	Shale Sandstone Transition Forest
TSC Act	NSW *Threatened Species Conservation Act 1995 (now repealed by the BC Act 2016)*

Definitions

The following table provides definitions for the terminology used in biocertification assessments. Where these terms have been used in the report they have been included in 'quotation marks'.

Definition	Description
Area of High Biodiversity Conservation Value	As described under Section 2.3 of the BCAM. Areas include critically endangered and endangered ecological communities (CEEC and EEC) not in low condition, threatened species that cannot withstand further loss, areas of vegetation that have regional or state conservation significance, and state and regional biodiversity corridors. Also termed Red Flags.
Biodiversity Certification Assessment Area	As described in the BCAM, it includes land where certification is proposed to be conferred and any surrounding or adjacent land. Surrounding and adjacent land may be proposed for biodiversity conservation, or neither certification nor development (Retained Land).
Conservation Area	Land that is proposed for conservation measures.
Conservation Measures	The range of measures identified in Section 126L of the TSC Act
Credit Discounting	Applies where there are existing legal obligations to undertake conservation management actions on land.
Development Area	Land within the Biodiversity Certification area that is proposed for development
Ecosystems Credit	As described under the BCAM, the class of credit for biodiversity certification that are generated for conservation measures or required for the land proposed for certification. Ecosystem credits are also generated/required? for some threatened species that are assumed to be present based on the location of the site and the vegetation types present.
Low Condition	As described in Section 2.3 of the BCAM. To meet the 'low condition' threshold a number of criteria described in the method must be met, including <50% of the lower benchmark value of over-story percent cover for the relevant vegetation type or native vegetation with a site value score of less than 34 (Site value score is described in Section 3.6.2 of the BCAM).
Managed and Funded Conservation Measure	As described under Section 8.1.1 of the BCAM. Examples include entering into a Biodiversity Banking Agreement with respect to the land under Part 7A of the TSC Act and the reservation of land under the *National Parks and Wildlife Act 1974* (NPW Act).
Managed Conservation Measure	As described under Section 8.1.2 of the BCAM. Examples include entering into a conservation agreement under Division 12, Part 4 of the NPW Act and entering into a planning agreement under the EP&A Act that makes provision for development contributions to be used for or applied towards the conservation or enhancement of the natural environment.
Moderate-Good Condition	As described in Section 2.3 of the BCAM. Any vegetation that is not in 'low condition' is in 'moderate to good' condition
More appropriate local data	As described in 3.4 of the BCAM, the Director General may certify that more appropriate local data can be used instead of the data in the Vegetation Benchmark Database, where local data more accurately reflects local environmental conditions.

Definition	Description
Planning Instrument Conservation Measure	As described under 8.1.3 of the BCAM. Application of this measure requires a number of conditions to be met that are described under the relevant Section of the method.
Biometric vegetation type	A plant community classification system used in BioMetric Tools, including the BioBanking Tool, Biodiversity Certification Tool and Property Vegetation Planning Tool
Red Flags	As described in Section 2.3 of the BCAM. See 'Areas of High Biodiversity Conservation Value above.
Retained Land	Land within the Biodiversity Certification Assessment Area that is not land proposed for biodiversity certification or subject to proposed conservation measures.
Species credit	As described in the BCAM, the class of credits for biodiversity certification that are generated for a conservation measure or are required for the land proposed for certification
Tg Score	Response to Management Score (used to calculate the number of species credits at impact sites)
TSPD	Threatened Species Profile Database (data used by the credit calculator tool)

Executive summary

Eco Logical Australia Pty Ltd (ELA) was commissioned by Lendlease Communities (Figtree Hill) Pty Limited (Lendlease) in 2015 on behalf of Campbelltown City Council (CCC) to undertake a Biodiversity Certification Assessment (BCAR) and prepare a Biodiversity Certification Strategy (BCS) for Mount Gilead Stage 2, a proposed urban development at Appin Road, Gilead. The purpose of the assessment is to obtain '*biodiversity certification*' of land proposed for urban development and associated infrastructure from the Minister for the Environment. Biocertification is conferred by the Minister if the '*conservation measures'* proposed in the biocertification application result in an overall '*improvement or maintenance'* in biodiversity values.

The application was submitted to the Minister for the Environment in August 2019 by CCC under the Savings and Transitional provisions of the *Biodiversity Conservation Act* 2016 and has been revised and updated, as requested by the Minister, following the Chief Scientist and Engineers Independent Report on the Protection of the Campbelltown Koala population in April 2020, February and May 2021 and the release of the Cumberland Plain Assessment Report (CPAR) and the draft and final Cumberland Plain Conservation Plan (CPCP) in August 2020 and August 2022.

The '*Biodiversity Certification Assessment Area'* (BCAA) defined for the study encompasses a total area of 645.75 ha and includes 257.97 ha of existing/remnant native vegetation communities comprising four Biometric vegetation types (BVTs). These BVTs form components of the vegetation communities, Cumberland Plain Woodland (CPW) and Shale Sandstone Transition Forest (SSTF), which are listed as critically endangered ecological communities (CEECs) under the now repealed NSW *Threatened Species Conservation Act 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act) *1999*, and River-Flat Eucalypt Forest (RFEF) which is listed as an endangered ecological community (EEC) under the BC and EPBC Acts. The remaining 387.78 ha of the assessment area is exotic vegetation and cleared land.

Whilst a number of threatened flora and fauna species have been recorded near or within the assessment area, only five species (Koala, Squirrel Glider, Cumberland Plain Land Snail, Southern Myotis and *Pomaderris brunnea)* requires specific assessment under the BCAM for impacts to habitat. These species are classified as '*species credit'* species and impacts to these species cannot be assessed by the vegetation types under the BCAM.

The BCAA and proposed impacts are described in **Section 1**. The biodiversity values of the BCAA are described in the Biodiversity Assessment Report (BAR) in **Section 2**. Explanation for data used in the assessment is provided in **Section 3**. The biodiversity credit calculations and strategy for achieving an 'improve or maintain' outcome are provided in **Sections 4** and **6** respectively.

The application for Biodiversity Certification was publicly exhibited for 64 days by Campbelltown City Council (CCC or Council) between 15 December 2020 and 17 February 2021 in accordance with s126N of the TSC Act. Public Notices appeared in the Sydney Morning Herald and Macarthur Chronicle on Tuesday 15 December 2021 and all reports were available for viewing at Council's Civic Centre, the HY Daley Library and Eagle Vale Central Library and for downloading from Councils website. 626 submissions were received during the exhibition period and a further 53 after the close of exhibition. This assessment report has been updated in light of these submissions.

The application proposes to directly impact 268.72 ha of the assessment area of which 53.50 ha is mapped as native vegetation and threatened species habitat in various condition states, and includes

4.42 ha of a SSTF and 7.75 ha of CPW SPW in 'moderate to good' biometric condition, 2.23 ha of vegetation within riparian buffers, and 2 individuals of the endangered plant *Pomaderris brunnea*, which are categorised as '*red flag areas'* or '*area of high biodiversity conservation value*' by the BCAM.

Impacts to red flag areas that cannot be avoided require a '*variation*' approval from the Minister that addresses specific red flag viability criteria before Biocertification can be conferred. A request for a red flag variation addressing the 'degraded' condition /low viability of these red flag areas is included in **Section 5**. The remaining areas to be impacted are not '*areas of high biodiversity conservation value*', or are cleared of native vegetation.

The application proposes to permanently protect and manage for conservation, 225.76 ha of lands in the BCAA (218.93 ha of which will generate ecosystem credits), 5.7 ha being a red flag vegetation conservation area buffer and 1.13 ha of retained dams, waking tracks and management trails (that will not generate ecosystem credits), which are proposed to be conserved as three registered Biodiversity Stewardship sites (BSAs).

In addition to this proposed conservation measure, 151.27 ha of land within the BCAA will be 'retained' as either rural land (Gilead Homestead), public open space and existing easements which includes 28.53 ha of retained native vegetation, whilst currently cleared areas will be subject to some landscape tree plantings as well as passive recreation to further enhance habitat for koalas.

Collectively, these BSA sites and retained open space, not including the retained rural land around the Gilead Homestead will form an approximately 250 ha fully fenced, dog and vehicle prohibited, Gilead Koala Conservation Reserve. The Gilead Koala Conservation Reserve is consistent with the recommendations of the NSW Office of the Chief Scientist and Engineer's recommendations for the Protection of the Campbelltown Koala population and the Department of Planning and Environment's 24 planning principles for the Greater Macarthur Growth Area, and will be subject to a Gilead Koala Conservation Plan including on-going management and mitigation of threats, community education and involvement and ongoing monitoring.

This Biodiversity Certification Assessment has found that **1,123** biocertification *'ecosystem credits'* are required for direct and indirect impacts to four BVTs (242 credits for CPW SPW, 803 credits for SSTF, 69 for RFEF and 9 for Grey Myrtle Dry Rainforest (GMDR) and **3,668** '*species credits'* are required for impacts to Koala (1,744 credits), Squirrel Glider (993 credits), Cumberland Plain Land Snail (289 credits), Southern Myotis (978 credits) and *Pomaderris brunnea* (29 credits).

The proposed BSA sites in the 'land subject to *conservation measures*' will generate **2,427** ecosystem credits (343 for CPW SPW, 1,800 for SSTF, 198 for RFEF and 86 GMDR), i.e. subject to the approval of the red flag variation requests, all ecosystem credits are met and significantly exceeded by the proposed on-site conservation measures. These same BSA sites will generate **6,344** species credits (1,460 for Koala, 1,347 Squirrel Glider, 1,181 Cumberland Plain Land Snail, 856 Southern Myotis and 1,500 *Pomaderris brunnea* species credits i.e. there will be a deficit of 284 Koala credits and significant surpluses for all other species. The deficit of Koala credits (284) will be met by the purchase of additional Koala species credits from registered Biobank or Biodiversity Stewardship sites in the region (following an application for reasonable equivalence) or via the purchase of biodiversity credits from the Biodiversity Conservation Trust (BCT). Lendlease (Credit ID holder 650) already holds 99 Koala credits from the Campbelltown Koala population purchased from the Noorumba Reserve Biobank site (BA239). The remaining deficit for Koala credits is therefore 185 credits.

All surplus ecosystem (1,304) and species credits (2,960) generated by on-site conservation measures will be retired in accordance with the requirements of the BCAM.

Indirect impacts have been considered in accordance with the BCAM and have been determined to be negligible on the basis that all direct impacts have been assessed on the assumption of complete loss of all biodiversity values, even where impacts are only partial loss as a result of establishing Bushfire Asset Protection Zones (APZ) and all proposed conservation areas have a 30m buffer provided by perimeter roads (15m) and Local Open Space/APZs that will retain biodiversity values, in particular canopy trees that will provide additional foraging resources for Koala.

Subject to the Minister's approval of the request for a red flag variation, the proposal can meet an '*improve or maintain*' outcome and is eligible for biodiversity certification. Upon the Minister conferring biocertification on the requested land, CCC as the consent authority for future development applications is no longer required to assess impacts to 'biodiversity values' as these have already been addressed by the Minister and '*conservation areas*' will be required to be managed in perpetuity for conservation.

1. Preamble

1.1 Project background

Eco Logical Australia Pty Ltd (ELA) was commissioned by Lendlease Communities (Figtree Hill) Pty Ltd (Lendlease), on behalf of Campbelltown City Council (CCC), to undertake a Biodiversity Certification Assessment of proposed urban development over 645.75 ha of land to the west of Appin Road, Gilead (the Biodiversity Certification Assessment area or BCAA), in the Campbelltown Local Government Area (LGA), and to prepare a Biocertification Certification Strategy (BCS) to meet a 'improve or maintain' biodiversity outcome.

The study area is located on five lots accessed from Appin Road (Lots 1 and 2 DP1218887, Part Lot 5 DP1240836, Lot 2 DP603674 and Lot 1 DP603675) and one lot accessed from Menangle Road (Lot 2 DP 249393). The majority of the study area is immediately west of the Mt Gilead Stage 1 urban development that was rezoned in 2017 and biodiversity certified in July 2019 (Figure 1). The lands form part of the North Gilead Priority Precinct in the Greater Macarthur Growth Area for which the former Department of Planning and Environment released a preliminary land use study in 2015 (DPE 2015) and Interim Plan in 2018 (DPE 2018) and an update in December 2021 (DPIE 2021). Additionally, the now Department of Planning, Industry and Environment (DPIE) prepared and exhibited a draft Cumberland Plain Strategic Assessment Report (CPAR) and draft Cumberland Plain Conservation Plan (CPCP) in August 2020 (Openlines 2020 and DPIE 2020), which was approved in August 2022 (DPIE (Figure 2).

An application for biocertification must follow the Biodiversity Certification Assessment Methodology (BCAM) (Department of Environment, Climate Change and Water [DECCW] 2011) and meet the requirements of Section 126K of the *Threatened Species Conservation Act* 1995 (TSC Act), i.e. be accompanied by a BCS.

The BCAM was developed by the New South Wales (NSW) Office of Environment and Heritage (OEH) and was gazetted by the NSW government in February 2011. The methodology may be applied to land for which '*biocertification is sought'* and is conferred by the Minister for the Environment if the '*conservation measures'* proposed in the biocertification application result in an overall '*improvement or maintenance'* in biodiversity values. This is referred to under the methodology as satisfying the '*improve or maintain test*' (IoM).

The methodology provides an equitable, transparent and scientifically robust framework with which to address the often competing demands of urban development and biodiversity conservation. If the Minister for the Environment is satisfied that an IoM outcome has been achieved, the Minister may confer biocertification on 'land'. If the Minister confers biocertification on land, a consent/approval authority does not have to take biodiversity issues into consideration when assessing development applications, i.e. for the purpose of s.5A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), the development or activity is not subject to an Assessment of Significance for threatened species, populations or ecological communities.

This Biodiversity Certification Assessment commenced in 2015 with detailed ecological studies throughout 2015, 2016, 2017 and 2020. In August 2017, the TSC Act was repealed by the *Biodiversity Conservation Act* 2016. At the same time, a Savings and Transition Order was gazetted that allowed this application to continue to be assessed under the 2011 BCAM and TSC Act until 24 August 2019 on the basis that the application was 'significantly advanced'.

The application was submitted to the Minister for the Environment in August 2019 by CCC and has now been revised and updated, as requested by the Minister, following the Chief Scientist and Engineers Independent Reports on the Protection of the Campbelltown Koala population in April 2020, February 2021 and May 2021 and the release of the Cumberland Plain Assessment Report and draft Cumberland Plain Conservation Plan in August 2020 (DPIE 2020) and final Cumberland Plain Conservation Plan in August 2022 (DPE 2022).

Only a '*Planning Authority'* as defined by section 126G of the TSC Act may apply to the Minister for biocertification. Campbelltown City Council (CCC) is a Planning Authority as defined by section 126G. CCC resolved to be the applicant for this application on 11 June 2019.

The field work was undertaken by a number of accredited assessors currently or previously employed by Eco Logical Australia between 2015 and 2017 (Brian Towle, Bruce Mullins, Tammy Paartalu, Rebecca Dwyer Greg Steenbeeke, Bronwyn Callaghan, Alex Gorey, Michelle Frolich, Robert Humphries and Dr Meredith Henderson (Accreditation Numbers 0229, 0156, 0074, 0095, 0110, BAAS20019, BAAS22003, BAAS18064, BAAS 20022 and 0155 respectively) who were supported by other ELA field ecologists (Elizabeth Norris, Dr Rodney Armistead, Alex Gorey, Suzanne Eacott, Dr. John Golan, Mitchell Scott and Jack Talbert) with the credit calculations undertaken by Michele Frolich (BAM Accredited), supervised by Dr Meredith Henderson (Accredited Assessor 0155) in 2019, 2020 and 2022. Brief Cvs for key field staff involved in the project are provided in **Appendix A**. Additional survey data that has covered parts of the BCAA has also been included including Biolink (2018) and WSP in RMS (2018).

1.2 Description of project timelines, management and governance

The application for biocertification of Mt Gilead Stage 2 is being undertaken in parallel with the Greater Macarthur Growth Area land use study (DPE 2015) and the Cumberland Plain Assessment Report (CPAR) (Openlines 2020) being led by the Department of Planning and Environment (DPE) and Cumberland Plain Conservation Plan 2020-2056 (CPCP) (DPIE 2020) but is not part of the Strategic Assessment and is not subject to the proposed land uses in the CPCP. The Minister for the Environment has requested that the assessment be revised to take into consideration the recommendations of the Chief Scientist and Engineers Independent Reports on the Protection of the Campbelltown Koala population in April 2020, February 2021 and May 2021.

Stage 2 is an approximate 269 ha urban development primarily containing low and medium residential development with associated infrastructure, retail & educational facilities, public spaces, active & passive open spaces areas and conservation lands. Development is likely to commence in 2025 and take up to 10 years to complete in eight indicative stages, depending on demand for housing. A summary of the consultations between Campbelltown City Council and DPIE regarding a planning proposal can be found in **Appendix B.**

1.1.1 Strategic Context

This application for Biodiversity Certification is consistent with the DPE structure Plan 2018 as outlined in the NSW Department of Planning & Environment's Greater Macarthur 2040 Interim Plan for the Greater Macarthur Growth Area and the December 2021 update (DPIE 2020 and 2021). This document outlines a 'Vision for Greater Macarthur' which includes Mount Gilead with Menangle Park as a 'Priority Precinct' due to proximity to the Campbelltown-Macarthur regional city and the relatively direct access to existing infrastructure. Additionally, actions for facilitating growth within this Priority Precinct are detailed including upgrades to adjacent roads including Appin Road and the Hume Highway (DP&E 2015, 2018).

1.3 Community Consultation and Stakeholder Engagement

The DPE publicly exhibited the Greater Macarthur Land Release Strategy in 2015 (DPE 2015) and the Greater Macarthur 2040 Interim Plan for the Greater Macarthur Growth Area (GM2040) in November 2018. The GM2040 report included a Structure Plan incorporating the Menangle and Gilead Precinct showing urban capable land, indicative transport corridors, indicative Koala corridors and environmental conservation lands subject to the Cumberland Plain Conservation Plan (Figure 3).

Lendlease have prepared a Concept Masterplan (Figure 4) that addresses the Structure Plan, notes the recommendations from the CPCP including proposed E2 Zoning for retained vegetation/wildlife corridors and have made submissions to DPE regarding the rezoning of the land.

The application for Biodiversity Certification was publicly exhibited for 64 days by Campbelltown City Council (CCC or Council) between 15 December 2020 and 17 February 2021 in accordance with s126N of the TSC Act. Public Notices appeared in the Sydney Morning Herald and Macarthur Chronicle on Tuesday 15 December 2021 and all reports were available for viewing at Council's Civic Centre, the HY Daley Library and Eagle Vale Central Library and for downloading from Councils website.

626 submissions were received during the exhibition period and a further 53 after the close of exhibition. The submissions raised a number of concerns in regards to a lack of a strategic approach, the inadequacy of surveys for threatened species, unacceptable impacts to the Campbelltown Koala population (inadequate Koala corridors) and unacceptable impacts to listed endangered ecological communities. This assessment report has been updated in light of these submissions. The issues raised and responses to these issues are included in a Response to submissions Report **(Appendix C).**

Further, as there are Matters of National Environmental Significance (MNES) (listed communities and species on the schedules of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)) to be affected in the study area, the proposal was also referred to the then Commonwealth Department of the Environment and Energy (DotEE) and was subsequently declared a 'controlled action' under the EPBC Act). A Preliminary Documentation Environmental Assessment Report has been prepared and will be submitted to DotEE.

1.4 Biodiversity certification assessment area and proposal

The Biodiversity Certification Assessment Area (BCAA) encompasses a total area of 645.57 ha and is located close to Campbelltown city centre within the Campbelltown LGA in south-western Sydney. The site is accessed off Appin and Menangle Roads and includes land proposed for biodiversity certification or 'land to be certified' (268.72 ha) and therefore proposed for development, 53.50 ha of which is native vegetation, conservation areas or '*land subject to conservation measures*' (225.76 ha) which includes 176.91 ha of existing native vegetation and regeneration (includes 5.7 ha of red flag buffers) and restoration of 47.72 ha of cleared/degraded land, and '*retained land*' i.e. land that is not proposed for development or subject to conservation measures (151.27 ha which includes 28.53 ha of vegetation on existing rural land and proposed public open spaces that will be enhanced by landscape plantings) (**Table 1** and Figure 5).

Table 1: Proposed biocertification land uses and lots in the BCAA

Development footprint	Area (ha)	% of BCAA	Area of native vegetation (ha)	% of native vegetation
Land proposed for Biodiversity Certification (Urban development and associated infrastructure - roads, bio-detention basins, APZs)	268.72	41.61	53.50 existing vegetation 215.22 cleared land	20.74
Land proposed for conservation (225.76 ha to be registered as 3 BBA sites)	225.76	34.96	176.91 existing vegetation 47.72 to be restored 1.13 tracks/dams	68.58
Retained lands (land excluded from this assessment) includes Mt Gilead Homestead lands, Local Open Space and existing easements.	151.27	23.42	27.56 existing vegetation 123.71 cleared land	10.68
Total	**645.75**	**100**	**257.97**	**100**

The BCAA includes approximately 257.97 ha of existing native vegetation comprising five Biometric Vegetation types, three of which are listed as Critically Endangered Ecological Communities (CEECs) under the TSC/BC Act and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and one of which is listed as an Endangered Ecological Community (EEC) under the TSC Act (**Table 2**). The remaining areas (approximately 387.78 ha) comprise exotic pasture which fits the definition of 'cleared land' as defined by the BCAM (DECCW 2011) i.e. areas where there is no canopy or shrub layer and the ground cover is greater than 50% exotic cover or areas that will be restored to native vegetation within proposed offset areas.

The regional location of the BCAA is shown in Figure 2 and details of the lots that make up the biocertification land uses in the BCAA are shown in Figure 1 and presented in **Table 1**. The areas proposed to be impacted (land to be certified or '*development areas*'), land subject to conservation measures or '*conservation areas*', and '*retained land*' in the BCAA are shown in Figure 5.

Also shown in Figures 2, 4 and 5 are the locations of existing Biobank sites (Beulah, Noorumba Council Reserve, Noorumba-Mt Gilead, Macarthur-Onslow Mt Gilead and the Hillsborough Biobank sites) and the Dharawal National Park.

Table 2: Biometric vegetation types and their conservation status in the BCAA

Biometric vegetation type	Area (ha)	TSC Act	EPBC Act
HN526 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	27.46	RFEF (EEC)	RFEF (CEEC)
HN528 Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion	37.13	CPW SPW (CEEC)	CPSWSGTF (CEEC)*

Biometric vegetation type	Area (ha)	TSC Act	EPBC Act
HN529 Grey-Box – Forest Red Gum grassy woodlands on shale of the Southern Cumberland Plain, Sydney Basin Bioregion	0.38	CPW SHW (CEEC)	
HN538 Grey Myrtle dry rainforest of the Sydney basin Bioregion and South East Corner	8.35	N/A	N/A
HN556 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	184.65	SSTF (CEEC)	SSTF (CEEC)
Cleared land	387.78	NA	NA
Total	**645.75**		

* CPSWSGTF = Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest

1.5 Biocertification Assessment Process and Implications

Under the BCAM, the impact of development and conservation measures on biodiversity values is quantified using '*biodiversity credits*' which are defined by each of the BVTs (ecosystem credits) and threatened species present (species credits). In this regard, the methodology determines the number of credits that are required to offset the adverse impacts of development on biodiversity values and the number of credits that can be generated by undertaking recognised '*conservation measures*' as outlined in s126L of the TSC Act that will improve biodiversity values within the BCAA. Where the number of credits that are created is equal to, or exceeds the number required, the '*improve or maintain*' test described under the methodology is considered to be satisfied, provided '*red flags*' have been avoided, or a red flag variation has been approved by the Director General of the OEH.

'*Red flags*' are regarded as '*areas of high biodiversity conservation value*' in section 2.3 of the BCAM, and include vegetation types that are >70% cleared in the Catchment Management Authority Area (CMA), CEECs and EECs listed under the TSC Act and/or EPBC Act, certain threatened species that are regarded as not being able to withstand further loss in the CMA, and areas that are recognised as biodiversity corridors of state or regional significance.

The BCAA includes three 'red flag' entities as defined by Section 2.3 of the BCAM that will be impacted by the proposal:

1. Impacts to endangered ecological communities in 'moderate to good' biometric condition
    a. 'Shale Sandstone Transition Forest in the Sydney Basin Bioregion' (SSTF) involving impacts to 4.42 ha
    b. 'Cumberland Plain Woodland in the Sydney Basin Bioregion' (CPW) involving impacts to 7.75 ha of CPW
2. Impacts to threatened species classified as species that cannot withstand loss in the Threatened Species Profile Database (TSPD)
    a. *Pomaderris brunnea* (2 plants potentially impacted out of 258 recorded plants)
3. Impacts to areas of vegetation recognised as having regional or state biodiversity conservation significance
    a. Vegetation within a riparian buffer 30 m either side of a minor river or major creek (1.45 ha)
    b. Vegetation within a riparian buffer 20 m either side of a minor creek (0.78 ha)

The measures taken to avoid, minimise and mitigate impacts to these '*red flag*' areas are provided in **Section 5**. As all impacts have not been avoided, this assessment report includes red flag variation requests (**Section 5**).

1.6 Assessment Methodology/Consultation with the OEH

In accordance with the OEH's Biodiversity Certification Guide for applicants (OEH 2015a), CCC and ELA consulted with the OEH prior to and throughout the assessment of the Mount Gilead Stage 1 assessment to ensure that all decisions and assumptions meet the requirements of the BCAM.

This Stage 2 assessment has been prepared consistent with the Stage 1 agreements reached with OEH and other biodiversity certification assessments in the Sydney region, including:

- The version of the Biocertification calculator tool to be used for calculations (Version 1.9_HN556 201216 has been used)
- Amendments to hollow bearing tree and fallen log benchmarks for HN528 and HN556 (1 and 50m have been used respectively)
- There being no State or Regional Biodiversity Links approved by the CEO of OEH for this assessment (there are only local biodiversity links)
- All remnant vegetation mapped as intact, thinned/modified or scattered paddock trees, has been considered as Koala habitat for species credit calculations
- The width of buffers to protect red flag areas (being 30 m including a maximum of 15 m in any perimeter roads, and where possible including open space and Asset Protection Zones between urban areas and conservation lands)
- The consideration of Southern Myotis as a species credit species for potential breeding habitat (breeding habitat assumed to be present within 100 m of a hollow bearing tree that is within 200m of all 'permanent' water bodies greater than 3 m width). However, as the threatened species profile data (TSPD) in Version 1.9_HN556 201216 of the BCAM calculator tool has not been updated since 2012, we have used a Tg value (threatened species response to management) of 0.45 instead of 0.13 consistent with the Tg value in the BBAM 2014 tool and the final version of the TSPD before the repeal of the TSC Act. This TSPD also does not classify Southern Myotis as a red flag species. As Version 1.09_HN556_201216 of the BCAM tool does not recognise these changes, the credit calculations for this species have been calculated using Equation 10 of the BCAM with a Tg score of 0.45.

A site inspection was undertaken with representatives of the Biodiversity Conservation Division (BCD) of DPE on 7 June, to inspect the vegetation type and condition mapping and discuss various aspects of the BCAA.

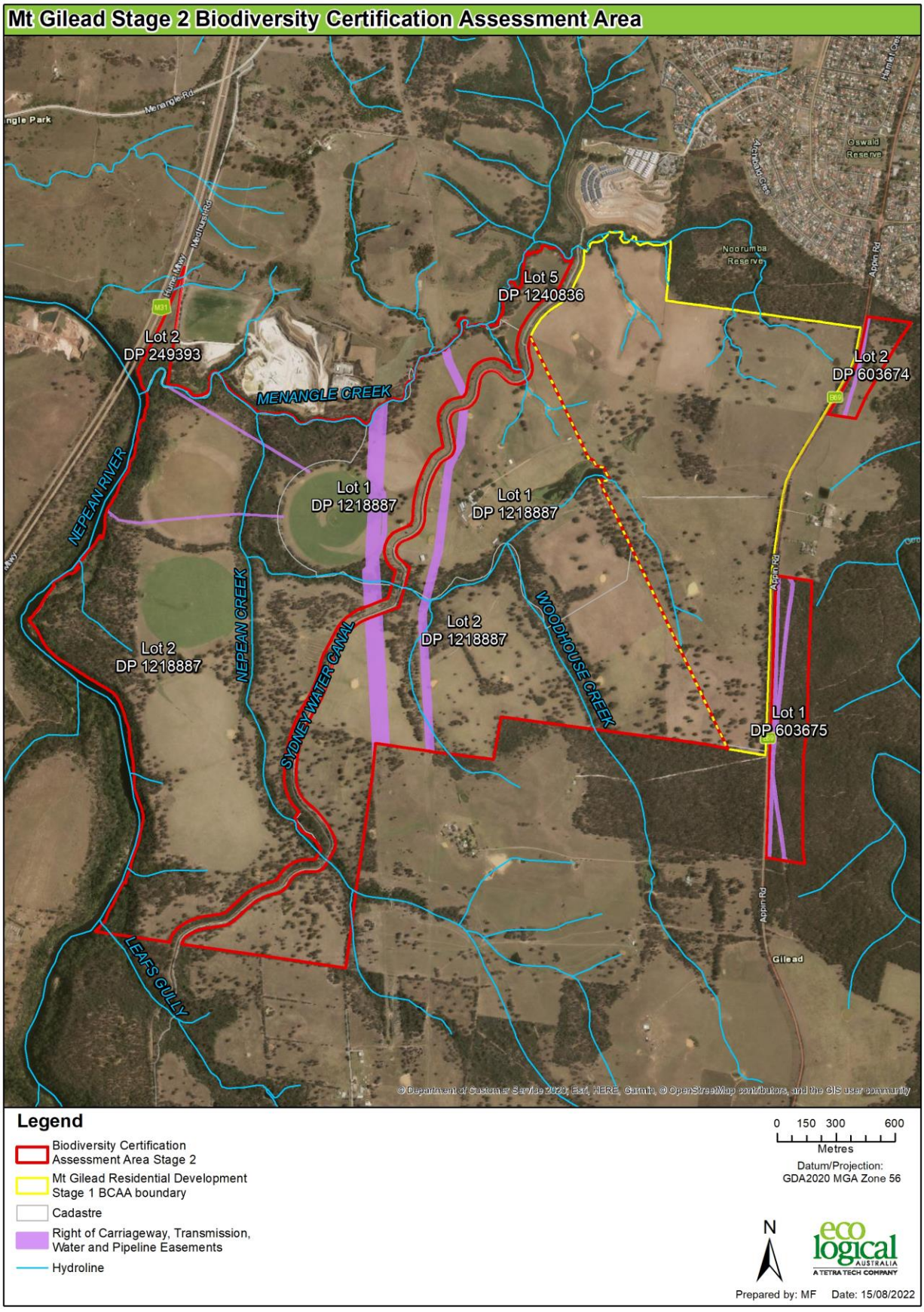


Figure 1: Mt Gilead Stage 2 Biodiversity Certification Assessment Area boundary

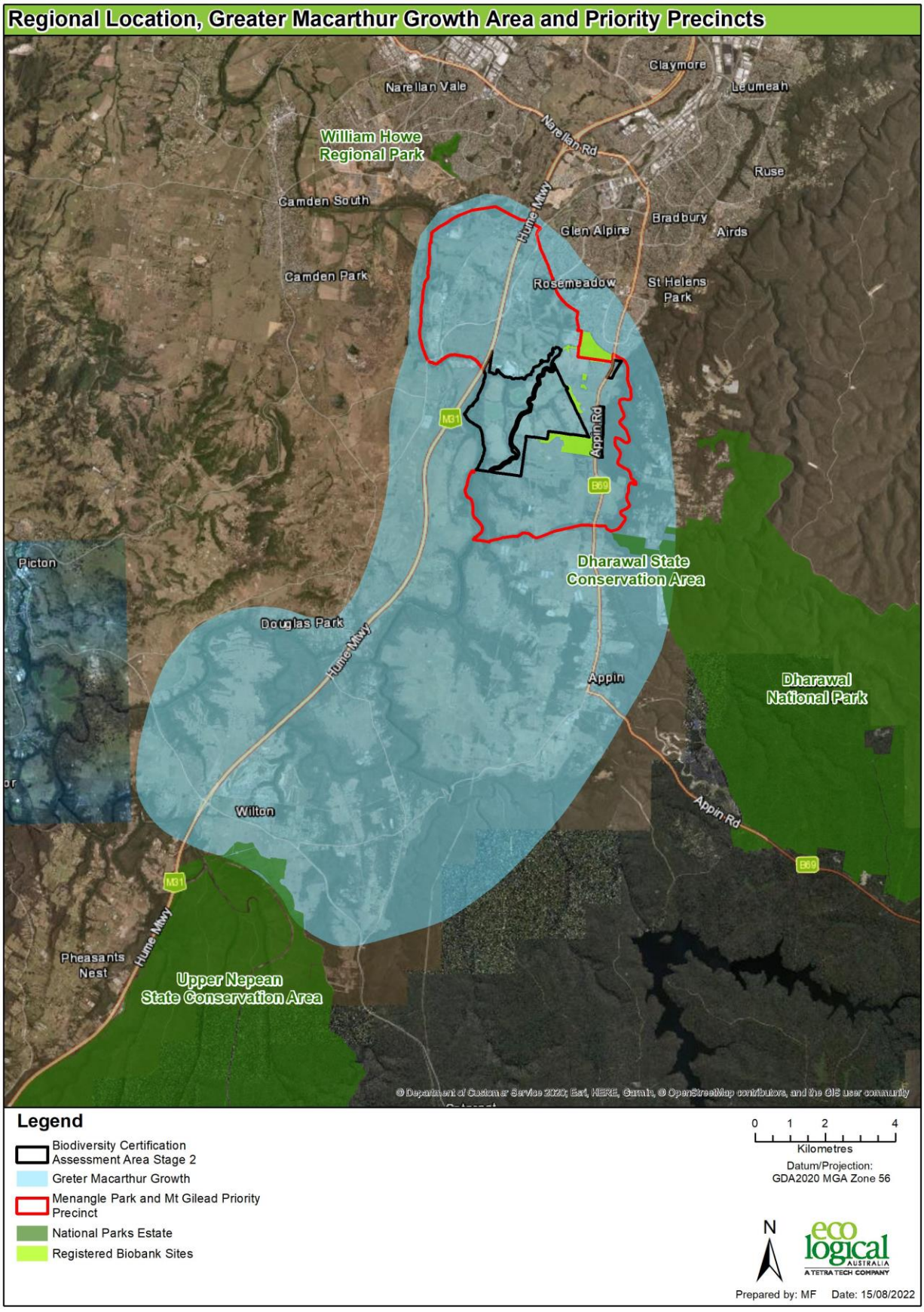


Figure 2: Regional location of the Mt Gilead Stage 2 Biodiversity Certification Assessment Area, Greater Macarthur Growth Area and Priority Precincts

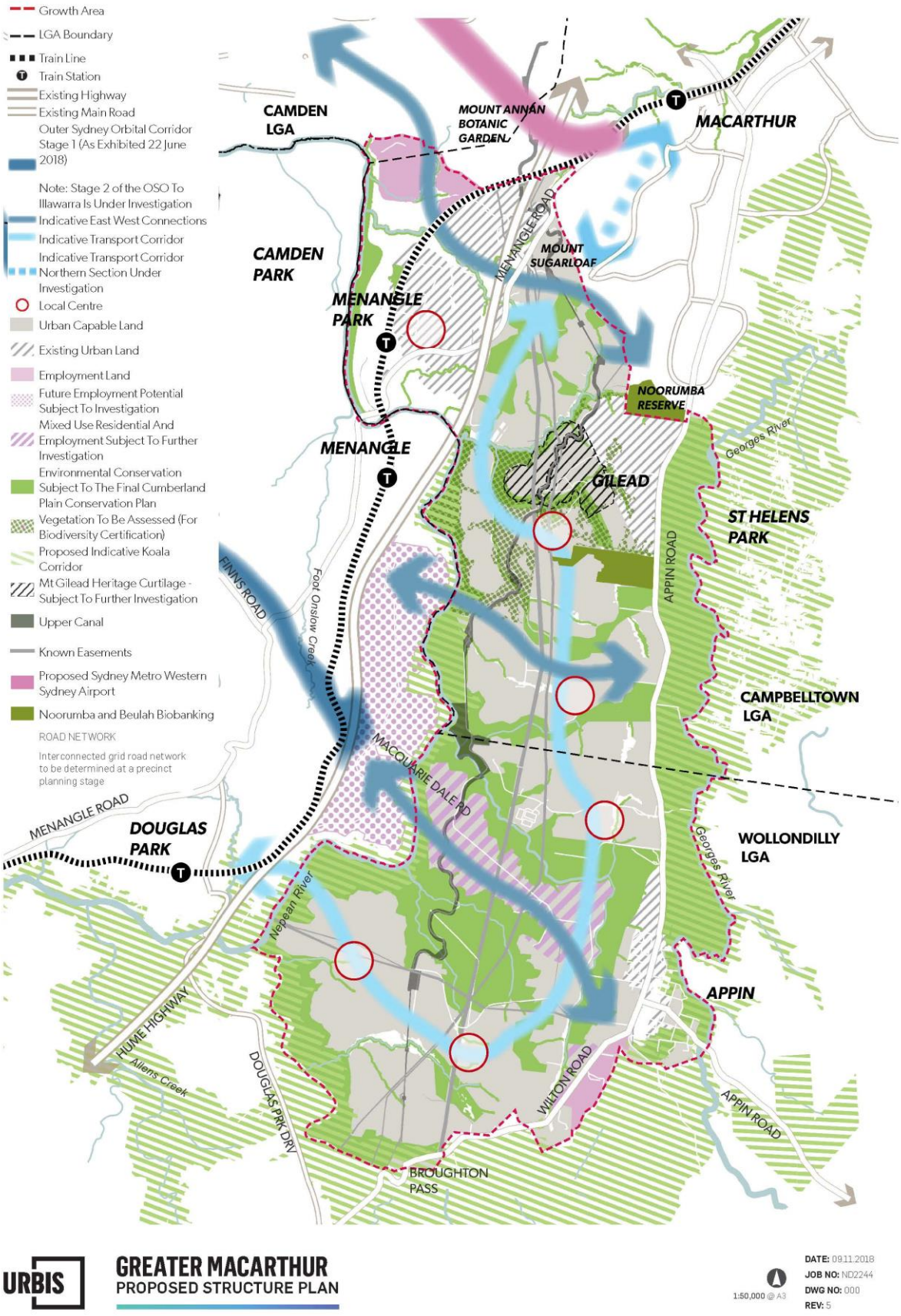


Figure 3: Department of Planning Macarthur Structure Plan (Source DPE 2018)

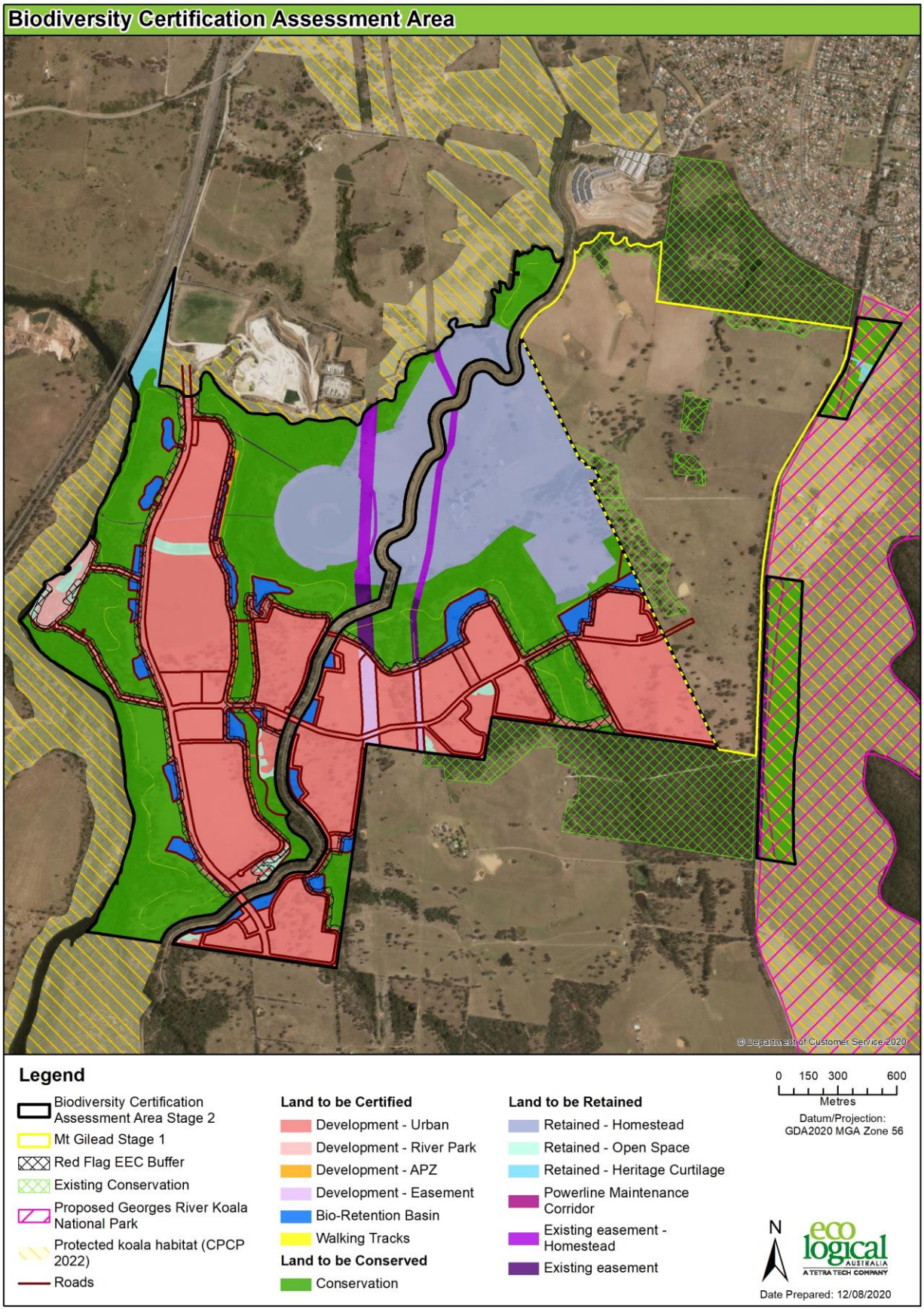


Figure 4: Concept Master Plan

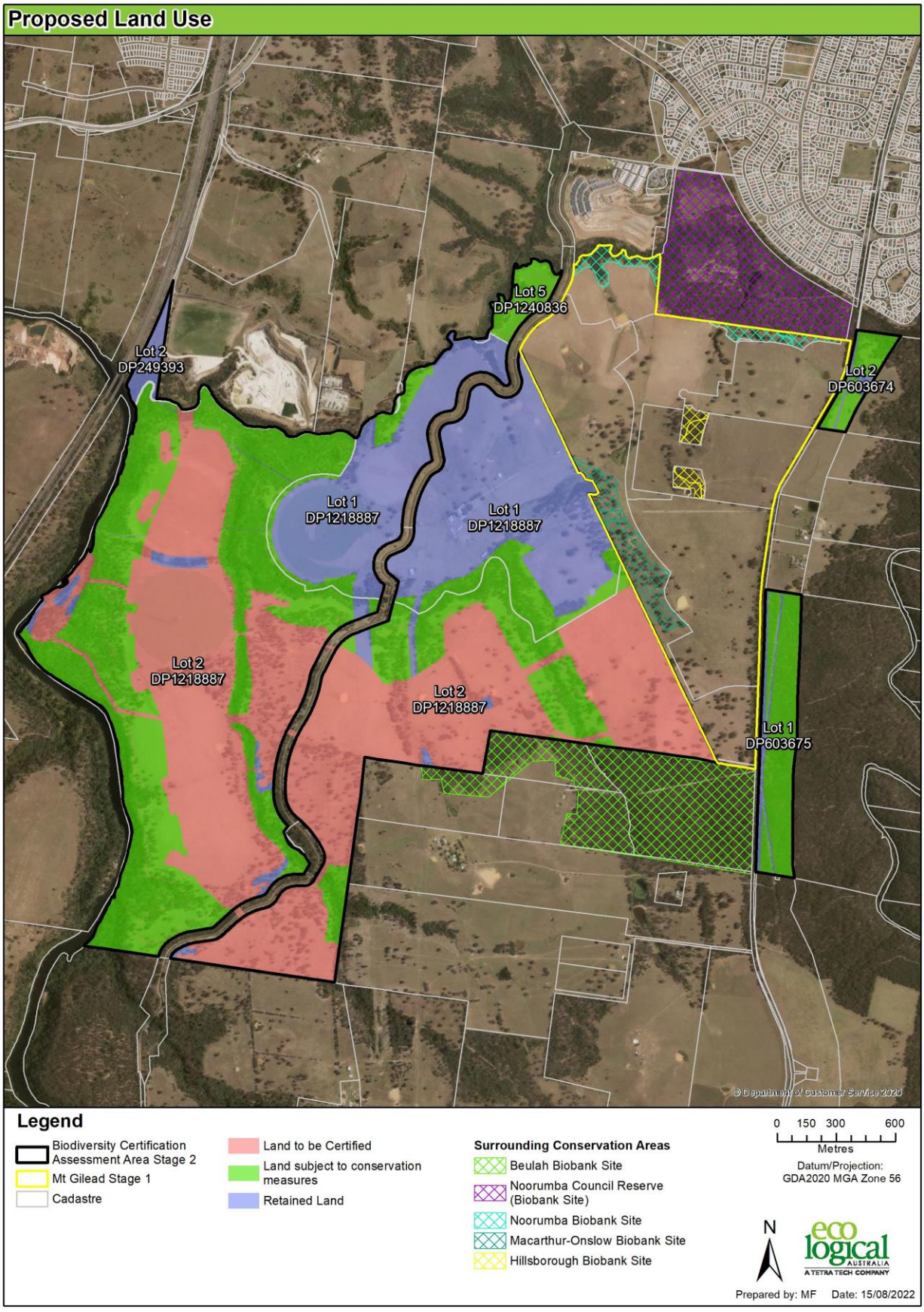


Figure 5: Mt Gilead Biodiversity Certification Assessment proposed land use

2. Biodiversity Values Assessment Report – Methodology and Results

An application for biodiversity certification must include an assessment of the biodiversity values of the BCAA undertaken in accordance with the BCAM. The results of the assessment of ecological values are to be included in a report titled '**Biodiversity Assessment Report**'. This section addresses this requirement.

Assessment of the biodiversity values within the BCAA involved numerous surveys and assessments across multiple seasons. An assessment of the biodiversity values of the BCAA in accordance with the BCAM commenced in January 2015 and built on work undertaken by ELA in 2006 (ELA 2006). All information and data collected by ELA since 2006 and other consultants has been used to prepare this Biodiversity Assessment Report (BAR).

2.1 Literature and data review

Several previous reports were reviewed to identify vegetation types/condition and biodiversity values recorded within the BCAA and surrounding areas (NPWS 2001, ELA 2006). The following sections present a brief summary of the methodology and results for each of these studies, as they relate to the current BCAA.

Additionally, searches of the Atlas of NSW Wildlife and EPBC Protected Matters Search Tool were undertaken to update searches of these databases taken as part of previous reports and ecological assessments (ELA 2006; ELA 2017b). The biocertification credit calculator version 1.09_HN556_201216 was also used to determine ecosystem and species credit threatened species, validating these against the threatened species profile ecological data from the *BioNet Atlas of NSW Wildlife* (see Step 1 in **section 2.2.2**).

Mt Gilead Flora and Fauna Assessment (ELA 2006)

A flora and fauna assessment of the 810 ha Mount Gilead Property (which includes the current BCAA and lands to the east that were certified in 2019) was undertaken by ELA in 2006. ELA completed field surveys between 16 and 28 February 2006 and 1 and 6 March 2006. Surveys were designed to validate vegetation communities and their condition, identify threatened flora species present, map recovery potential, assess fauna habitat features present, including for Koala (feed trees), and assess riparian health. The overall aim of the survey was to determine and document the ecological significance of the area for input into rezoning documentation. No intensive survey methods such as vegetation plots or fauna trapping were undertaken and flora and fauna species were recorded opportunistically. However, some more detailed survey was undertaken for aquatic habitat/health and koalas.

Four vegetation communities were identified within the study area: Alluvial Woodland ; Riparian Forest; Cumberland Plain Woodland (CPW); and Shale Sandstone Transition Forest (SSTF). All four vegetation types were identified as Endangered Ecological Communities under the TSC Act (as listed at the time). The condition of the vegetation communities ranged from poor to good given the history of disturbance in the study area.

A total of 170 flora species were recorded. One threatened fauna species, Brown Treecreeper (*Climacteris picumnus*), was also recorded. Suitable habitat for threatened flora and fauna species was considered to be present. Key habitat features for fauna were:

- Diverse vegetation communities (forest, woodland, grassland).
- Diverse vegetation community structures (forest, shrubby woodland, grassy woodland, grassland, riparian, wetland).
- Large numbers of hollow-bearing trees.
- Woody debris and leaf litter in many remnant vegetation communities.
- Outcropping rock, rock crevices and, significantly, rock on rock.
- Ephemeral and permanent rivers, creeks and tributaries.
- Dams and "wetlands" with open water and emergent vegetation.
- Instream woody debris, rocks and vegetation along river, creeks and tributaries.

Mt Gilead Stage 1 Rezoning F&F Assessment (ELA 2014)

ELA (2014) undertook an ecological assessment of a 210 ha Stage 1 area. Field survey was undertaken over five days on 25 and 26 March, 4 April, 27 June, and 20 September 2013. Survey followed the Biobanking and Biocertification methodologies (DECC 2009; DECCW 2011a). It involved undertaking biometric plots and riparian and aquatic habitat assessments, and also targeted flora and fauna species identified by the biodiversity credit calculator and a review of NSW Wildlife Atlas data as requiring field survey.

Three vegetation communities were recorded: CPW, SSTF, and River-Flat Eucalypt Forest (RFEF). The vegetation communities were highly modified through a long history of grazing, pasture improvement and weed invasion, and erosion was present in places, although some patches of SSTF were in good condition.

A total of 154 flora species, comprising 67 native species and 87 introduced species, and 82 fauna species, were recorded. Fauna species recorded were comprised of 58 birds, 13 microbats, five other mammals, three frogs, one reptile, and two fish. No threatened flora species were recorded, but six threatened bat species and one threatened bird species were recorded. These were *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat), *Mormopterus norfolkensis* (East-coast Freetail Bat), *Falsistrellus tasmaniensis* (Eastern False Pipistrelle), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat), *Myotis macropus* (Southern Myotis), *Scoteanax rueppellii* (Greater Broad-nosed Bat), and *Glossopsitta pusilla* (Little Lorikeet). There was potential for other threatened species, such as Koala, to be present given the presence of food trees in the study area and nearby records. However, for species such as *Meridolum corneovirens* (Cumberland Plain Land Snail), habitat was scant to absent. Targeted surveys did not record this species within the BCAA despite records from Noorumba Reserve (OEH 2014b, ELA 2017) and in remnant Cumberland Plains Woodland on the eastern side of Appin Road.

The majority of the watercourses were considered slightly to substantially modified and erosion was noted in many of the watercourses. Aquatic habitat was limited and where present was marginal. Fringing vegetation where present provided suitable habitat for amphibians, birds and fish. The overall rating of the riparian and aquatic condition varied from degraded to moderate.

Noorumba Reserve Biobank Agreement (ELA 2017a)

A Biobank Agreement Credit Assessment report has been prepared for Noorumba Reserve (ELA 2017a). Three plants community types were identified within Noorumba Reserve, namely:

- 'Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion' (PCT849)
- 'Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion' (PCT850)
- 'Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion' (PCT1395)

These three vegetation types were all identified as components of two critically endangered ecological communities listed under the TSC Act, *Cumberland Plain Woodland in the Sydney Basin Bioregion* and *Shale Sandstone Transition Forest in the Sydney Basin Bioregion*. Additionally, two threatened species credit species were identified, *Phascolarctos cinereus* (Koala) and *Meridolum corneovirens* (Cumberland Plain Land Snail).

Mt Gilead Stage 1 Biodiversity Certification Assessment Report & Biocertification Strategy (ELA 2018c)

A Biodiversity Certification Assessment and Biodiversity Certification Strategy was prepared by ELA (2018c) for lands located immediately to the east of the current BCAA between Appin Road and the current BCAA (Mt Gilead Stage 1, **Figure 1).** This report was heavily informed by the previous ecological assessment of this area undertaken by ELA (2014). The methods and results of these two assessments (ELA 2014 & ELA 2017b) are presented concurrently as follows.

Surveys of the Mt Gilead Stage 1 area followed the Biobanking and Biocertification methodologies including biometric plots, riparian and aquatic habitat assessments and targeted flora and fauna species identified by the biodiversity credit calculator and a review of NSW Wildlife Atlas data as requiring field survey.

Three plant community types, identified as being highly modified through a long history of grazing, pasture improvement and weed invasion were recorded within the Stage 1 BCAA, namely:

- 'Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion'
- 'Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion' (PCT1395)
- 'Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion'

These three plant community types were each identified as comprising an Threatened Ecological Community as listed under the TSC Act and areas of these vegetation communities in 'moderate to good' condition were identified as red flag communities.

No threatened flora species were recorded, but seven threatened bat species and one threatened bird species were recorded, namely:

- *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat)
- *Mormopterus norfolkensis* (East-coast Freetail Bat)
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat)

- *Myotis macropus* (Southern Myotis)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Chalinolobus dwyeri* (Large-eared Pied Bat)
- *Glossopsitta pusilla* (Little Lorikeet)

In addition to the threatened species recorded and listed above, Little Eagle, Swift Parrot, Powerful Owl, Koala, Grey-headed Flying Fox, and some migratory species listed under the EPBC Act were identified as having potential to occur in the Stage 1 BCAA given the presence of suitable habitat.

Of the threatened species listed above species, only one species, Koala, was a species credit species identified as being impacted by the land to be certified.

Appin Road Upgrade, Mt Gilead, Biodiversity Assessment (RMS 2018)

WSP undertook a flora and fauna assessment for the proposed Appin Road upgrade between Ambarvale and Mt Gilead (RMS 2018). The study included vegetation type and condition mapping and targeted threatened flora and fauna survey using parallel line traverses and plots, nocturnal fauna surveys, call playback, diurnal bird surveys and Koala Spot Assessments. The study recorded two vegetation types (CPW and SSTF), Koala, Cumberland Plain Land Snail and Little Lorikeet.

South Campbelltown Koala Study – Biolink 2018

Biolink Ecological Consultants were commissioned by CCC in 2017 to undertake a Koala connectivity study in the South Campbelltown and Menangle areas, which was identified as a strategic Koala linkage area in the draft Campbelltown Comprehensive Koala Plan of Management (Biolink 2016). The objectives of the study were to investigate:-

- Koala usage and occupancy,
- the quality and extent of Preferred Koala Habitat; and
- the feasibility of establishing connections across Appin Road.

The study used Rapid-SAT sampling protocols to determine the presence of diagnostic Koala faecal pellets around the bases of Preferred Koala Food Trees. The study recorded evidence of Koala at 12 of 25 sampling points in the study area and concluded that the area was sustaining a resident Koala population and was therefore 'Core Koala Habitat' for planning (SEPP44) purposes.

In addition to recording Koala, the study also recorded two threatened woodland birds: *Artamus cyanopterus* (Dusky Woodswallow) and *Daphoenositta chrysoptera* (Varied Sittella) within the BCAA.

Mt Gilead Stage 2 Biobank Assessments May-August 2020 (ELA 20120a-d)

Additional BBAM Plots and targeted fauna surveys were undertaken between May and July 2020 for Cumberland Land Snail, Koala and Squirrel Glider to supplement the previous surveys. Fauna survey techniques included a combination of remote cameras, spotlighting, call playback and active searches. The survey techniques, habitat types, target species and survey effort for fauna surveys are outlined in Tables 4, 5 & 6. The locations of targeted surveys are shown in Figures 10 and 11.

2.1.1.1 Database Search – BioNet

NPWS 2001 vegetation mapping is shown in Figure 6. The results of the previous threatened flora and fauna records in the locality from database searches are shown in to Figures 7, 8 and 9 and included in **Appendix C.** These results were used to develop the candidate species list in **Section 2.1.3** for targeted survey.

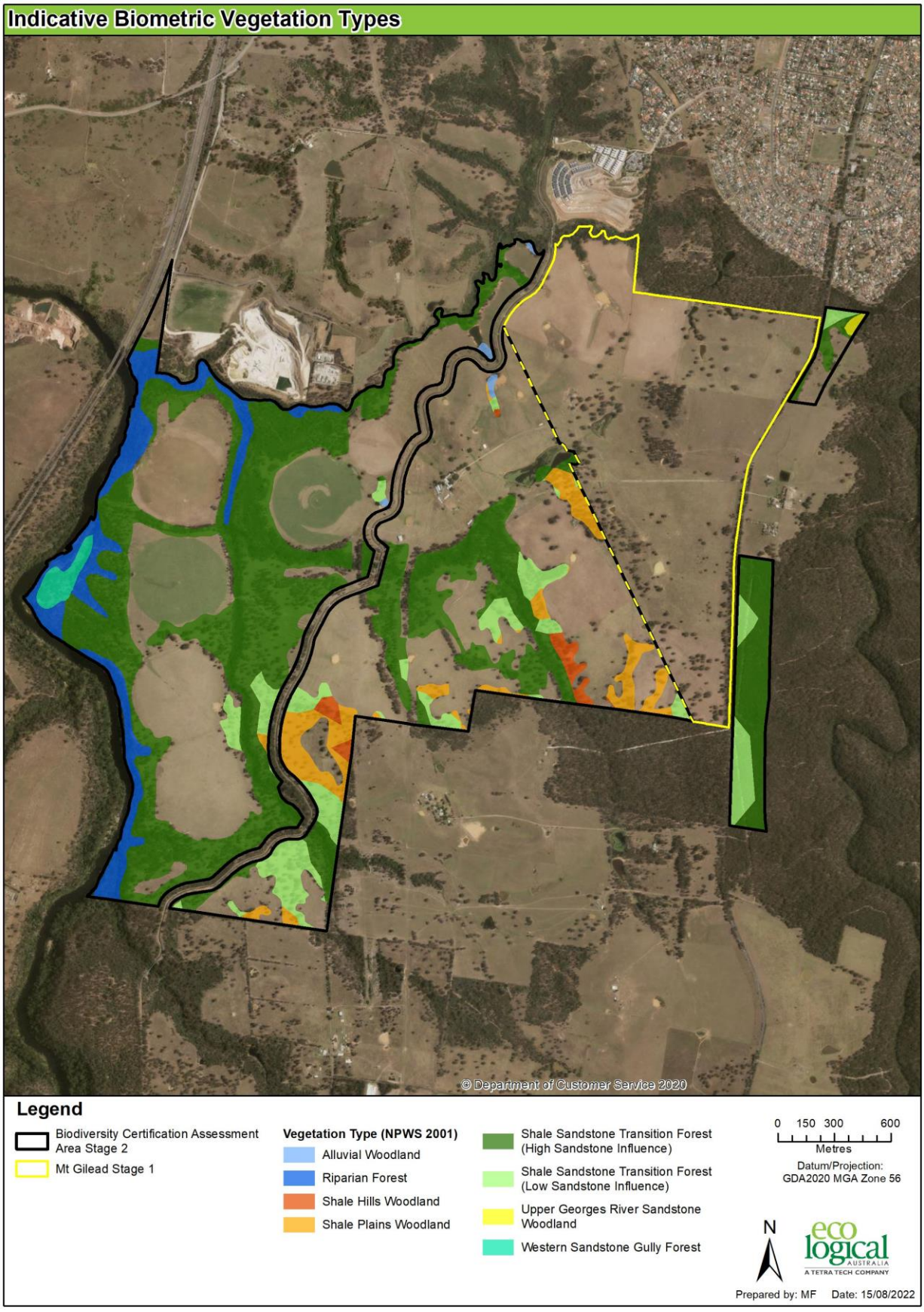


Figure 6: Vegetation units within the BCAA as mapped by NPWS (2001)

2.2 Field Assessment

Field assessment was designed to meet the BCAM requirements for mapping and surveying BVTs and to gather data for use in both this biocertification assessment and the proposed Biobank/BSA sites that will be registered to meet the conservation measures commitments.

Relevant legislation and standard technical resources including the *Threatened Biodiversity Survey and Assessment Guidelines for Development and Activities* (Department of Environment and Conservation [DEC] 2004), Threatened Species survey and assessment guidelines: field survey methods for fauna: Amphibians (DECC 2009), NSW Guide to surveying threatened plants (OEH 2016), Species Credit threatened bats and their habitats – NSW survey guide for the Biodiversity Assessment Methods (OEH 2018) and the *Biobanking assessment methodology* (BBAM 2014) (OEH 2014a) underpinned the survey methodologies and provided background information for the ecological assessment. As such, these resources were also reviewed.

2.2.1 Vegetation mapping and condition stratification

Vegetation mapping and condition stratification within the BCAA was undertaken in accordance with the BCAM including 66 biometric plots to determine the vegetation condition and the number of ecosystem credits required to meet an IoM outcome. Vegetation mapping and condition stratification was undertaken by ELA ecologists Brian Towle, Bruce Mullins, Tammy Paartalu, Elizabeth Norris, Greg Steenbeeke, Suzanne Eacott and Alex Gorey which refined previous iterations of vegetation mapping since ELA (2006).

BVTs within the BCAA were identified based upon expert knowledge of field ecologists with extensive experience in the identification and mapping of vegetation communities across the Cumberland Plain as well as a comparison of the species recorded within biometric plots within the BCAA against published lists of Diagnostic and Characteristic species for select vegetation communities described within southern NSW by Tozer *et. al.* (2010), using the OEH vegetation analysis tool developed by Tim Hager and Greg Steenbeeke (**Appendix D**).

2.2.2 Determination of species credit species requiring survey

'*Species credits'* are the class of biodiversity credit created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. All threatened flora and approximately half to two thirds of all threatened fauna species are classified as species credits by the BCAM. Furthermore, some species credit species are also '*red flag species*' which the BCAM defines as "*a species that cannot withstand further loss in the CMA because it is extremely rare/critically endangered, restricted or its ecology is poorly known*".

The BCAM requires targeted survey for threatened flora and fauna that are considered to be '*species credit'* species on the land that will be impacted by development. Alternatively, species credit species can be assumed to be present. Where a survey or expert report confirms that a species credit species is present or likely to use potential habitat on land proposed for biodiversity certification, then a survey must also be undertaken or '*expert report*' prepared for that species on land to be used as an offset confirming its presence or likely presence. The biocertification credit calculator uses the survey results to calculate the number of credits required to offset the loss of the threatened species on land to be certified and the number of credits generated on land subject to conservation measures to determine whether the '*improve or maintain*' test is satisfied provided a '*red flag species*' is not impacted.

Species that require species credits for the land proposed for biodiversity certification or are being used to generate species credits for a proposed conservation measure were identified and assessed in

accordance with the seven steps outlined in Section 4.3 of the BCAM. The results of the candidate species identification and assessment process are presented in **Appendix D.**

Step 1. – Identify candidate species for initial assessment

A list of candidate species was filtered into the BCAA using biocertification credit calculator version 1.9 and validated against the threatened species profile ecological data from the BioNet Atlas of NSW Wildlife. This list is presented in **Appendix D**.

Step 2. – Review list to include additional species

The list of candidate species was reviewed to include additional species for assessment. This was undertaken using the results of previous surveys of the BCAA (ELA 2006) and surrounding areas (Noorumba Reserve, ELA 2015) and additional database searches undertaken by ELA which included:

- A search of the Atlas of NSW Wildlife database to identify records of threatened flora and fauna species located within 5 km radius of the site. The most recent search of the database was undertaken in July 2019; with previous searches having been undertaken as part of earlier surveys of the BCAA (ELA 2006).
- A search of the EPBC Act protected matters search tool website to generate a report to assist to determine whether matters of national environmental significance (NES) were located within 10 km radius of the site (search performed in July 2019).

All threatened flora and fauna species records within 5km of the BCAA are shown in Figures 7, 8 and 9.

Step 3. – Identify candidate species for further assessment

The list of candidate species was reviewed to identify only those species that required further assessment in the BCAA. The species that were removed and a justification supporting the removal of these species from the candidate list are provided in **Appendix D**.

The following species were identified as candidate species requiring targeted surveys to determine whether they occurred within the BCAA and were subjected to targeted surveys as outlined in **Section 2.2.3**:

Flora species:

- *Acacia bynoeana* (Bynoe's Wattle)
- *Acacia pubescens* (Downy Wattle)
- *Callistemon linearifolius*
- *Cynanchum elegans* (White-flowered Wax Plant)
- *Epacris purpurascens* var*. purpurascens*
- *Eucalyptus benthamii* (Camden White Gum)
- *Grevillea parviflora subsp. parviflora*
- *Gyrostemon thesioides*
- *Haloragis exalata* subsp. *exalata* (Square Raspwort)
- *Hypsela sessiliflora*
- *Marsdenia viridiflora* (Native Pear)
- *Persicaria elatior* (Tall Knotweed)
- *Persoonia bargoensis* (Bargo Geebung)
- *Pimelea spicata* (Spiked Rice-flower)
- *Pomaderris brunnea* (Rufous/Brown Pomaderris)

- *Pterostylis saxicola* (Sydney Plains Greenhood)
- *Pultenaea pedunculata* (Matted Bush-Pea).

Fauna species:

- Australasian Bittern (*Botaurus poiciloptilus*)
- Cumberland Plain Land Snail (*Meridolum corneovirens*)
- Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis*) – Breeding habitat
- Eastern Pygmy-possum (*Cercartetus nanus*)
- Giant Burrowing Frog (*Heleioporus australiacus*)
- Green and Golden Bell Frog (*Litoria aurea*)
- Grey-headed Flying-Fox (*Pteropus poliocephalus*) – Breeding Habitat)
- Koala (*Phascolarctos cinereus*)
- Large-eared Pied Bat (*Chalinolobus dwyeri*)
- Little Bentwing Bat (*Miniopterus australis*) – Breeding habitat
- Red-crowned Toadlet (*Pseudophryne australis*)
- Regent Honeyeater (*Anthochaera phrygia*)
- Rosenberg's Goanna (*Varanus rosenbergi*)
- Southern Myotis (*Myotis macropus*) – Breeding habitat
- Squirrel Glider (*Petaurus norfolcensis*)

Steps 4 and 5. – Identify potential habitat for species requiring further assessment and determine whether species is present

The following species credit species identified in Step 3 were recorded within the BCAA:

Flora species:

- *Pomaderris brunnea*

Fauna species

- Cumberland Plain Land Snail (Meridolum corneovirens)
- Koala (*Phascolarctos cinereus*)
- Squirrel Glider (*Petaurus norfolcensis*)
- Southern Myotis (*Myotis macropus*) foraging, breeding habitat assumed to be present.

While the Grey-headed Flying-fox, Little Bentwing Bat, Eastern Bentwing Bat were also recorded within the BCAA, the identification of these species as species credit species applies only to the breeding habitat of these species. No breeding habitat was recorded for the Grey-headed Flying-fox, Little Bentwing Bat and Eastern Bentwing Bat within the BCAA. The maternity caves of the Little Bentwing Bat and Eastern Bentwing Bat have very specific temperature and humidity regimes and no suitable caves are present within the land to be certified in the BCAA. Grey-headed Flying-foxes roost and breed in conspicuous, often large, communal camps typically in lowland rainforest, swamps forest and gullies. No camps for the Grey-headed Flying Fox were observed within the BCAA. No caves suitable as breeding habitat for the Large-eared Pied -Bat were recorded in land to be certified.

Step 6 – identify the threatened species that trigger a red flag

Pomaderris brunnea is classified as a species in the BCAM credit calculator tool and TSPD "*which cannot withstand further loss within the Hawkesbury Nepean CMA*". *Pomaderris brunnea* is therefore a red flag species. As 6 individuals will be impacted in the land to be certified (5 in APZ areas), a red flag variation request has been prepared (**Section 5**).

Whilst Southern Myotis is classified by the BCAM credit calculator tool as a 'red flag' species – breeding habitat, it is not identified in the TSPD (or BioNet) as a red flag species for breeding habitat. As the TSPD contains updated ecological information for use in a biocertification assessment it is not considered a red flag species for this assessment.

Cumberland Plain Land Snail, Koala, Squirrel Glider are all species identified in the TSPD and BCAM as species which can withstand further loss within the Hawkesbury Nepean CMA and therefore do not trigger a red flag.

Step 7 finalise the boundary of the species polygon and area of impact

Habitat polygons and the number of species credits required was calculated for the species listed below. Habitat polygons were developed based on ELA's expert opinion of the habitat areas and were informed by known records, identification of suitable habitat and published data including biometric vegetation types with which species are associated.

- *Pomaderris brunnea* (Figure 15)
- Koala (Figure 16)
- Squirrel Glider (Figure 17)
- Cumberland Plain Land Snail (Figure 18)
- Southern Myotis (Figure 19 and Figure 20).

For the Koala, all remnant vegetation and scattered trees have been identified as 'habitat' as per the Mt Gilead Stage 1 assessment, as Koalas are a mobile species and will use scattered paddock trees to rest and forage in and will move across open ground to access suitable habitat areas.

For the Cumberland Land Snail, the species was only recorded in the higher quality remnants of CPW and SSTF where a canopy, mid-storey and native understory with fallen logs and litter was present (Vegetation Zones 4, 8, 9, 13 & 14), it was not recorded in the pasture improved/grazed vegetation zones, DNG or scattered trees veg zones. Habitat polygons for the Cumberland Plain Land Snail were mapped based on the presence of records for the species following targeted survey and habitat suitability. The type and condition of the vegetation where individuals were present in the study area, and the connectivity of these patches to other patches was then used to map other areas of potential habitat in the BCAA. Area of existing higher quality vegetation within proposed BSA sites which were adjacent to areas where CPLS was recorded were included as habitat on the basis that these areas will be managed for conservation and habitat suitability will improve. Conversely, degraded areas where the species was not recorded and that will be impacted, have not been included as habitat.

Similarly, the Squirrel Glider was recorded in seven locations across the BCAA, all within intact, higher condition, riparian and adjacent vegetation. Accordingly, and consistent with the ecology/habitat requirements of this species, only the higher quality vegetation was mapped as habitat, isolated individual trees and small patches of vegetation without a mid-storey and greater than 30 m from intact vegetation was not considered suitable habitat.

Areas of potential breeding habitat were identified for Southern Myotis in accordance with previous advice from OEH. Potential habitat for Southern Myotis was assessed as any native vegetation within 100 m of a hollow bearing tree that was within 200 m of a permanent waterbody of at least 3m width. The Nepean River, all 2nd and 3rd order sections of Menangle, Woodhouse and Nepean Creeks, and all farm dams broader than 3 m were mapped as permanent water sources suitable for foraging. The Sydney Water Canal which bisects the BCAA was not included in the potential breeding habitat polygon as the water is

heavily chlorinated by Sydney Water at Broughton Pass and at various points along the route to Prospect Reservoir, therefore not providing suitable foraging habitat.

2.2.3 Flora surveys

Targeted surveys for threatened flora species identified as requiring further assessment (see **section 2.2.2**) have been undertaken over several seasons and years. The timing and effort of these surveys is outlined in **Table 4** with survey locations shown in Figure 10. Targeted surveys for threatened species involved a combination of random meanders to identify suitable areas of habitat and transect based surveys throughout areas identified as suitable habitat as well as any species recorded in the 66 plots.

Targeted flora surveys were undertaken in Summer (2006, 2015, 2016, 2017), Autumn (2006, 2015, 2016 & 2020) and Spring (2015). The surveys were undertaken at a suitable time of year to allow for identification of each of the species requiring further assessment (see **section 2.2.2**) as identified in the Threatened Species Profile Database (**Table 3**).

Table 3: Months in which targeted flora surveys were conducted and months in which "Candidate" species can be surveyed (from Threatened Species Profile Database)

Columns highlighted in green indicate months in which targeted threatened flora surveys were conducted.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acacia bynoeana	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
Acacia pubescens	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Callistemon linearifolius	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
Cynanchum elegans	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Epacris purpurascens var. *purpurascens*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eucalyptus benthamii	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grevillea juniperina subsp. *juniperina*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grevillea parviflora subsp. *parviflora*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gyrostemon thesioides	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Haloragis exalata subsp. *exalata*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hypsela sessiliflora	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Marsdenia viridiflora	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Persicaria elatior	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes
Persoonia bargoensis	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	Yes
Pimelea spicata	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pomaderris brunnea	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pterostylis saxicola	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Pultenaea pedunculata	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No
Thesium australe	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes

Table 4: Flora survey timing and effort

Survey date	Survey methodology / target	Survey Area	Survey effort	Reference
Mt Gilead Due diligence assessment				
16 and 28 February & 1 and 6 March 2006	Random meanders & opportunistic observations	Mt Gilead Property (BCAA & areas to the west)	56 person hours (Steve Ward, Bruce Mullins)	ELA (2006) Mt Gilead Preliminary Flora and Fauna Assessment
Mt Gilead MDP Lands Biocertification Assessment				
25th and 26th March, 4th April, 27th June & 20th September 2013	Floristic plots and targeted threatened fauna survey	Mt Gilead MDP Lands	80 person hours Bruce Mullins, Belinda Failes	ELA (2014) Mt Gilead Rezoning Assessment
29 August 2016	Floristic plots	Stage 1 BCAA	8 hours Bruce Mullins	ELA (2018) Mt Gilead Biocertification Assessment
9-10 April 2015	Floristic plots	Stage 1 BCAA	32 person hours, BCAA Enhua Lee and Mitch Palmer	ELA (2015) Macarthur-Onslow and Noorumba-Mt Gilead Biobank Assessments
Mt Gilead Balance Lands Biocertification Assessment				
28 January & 3, 4 and 9 February 2015	Floristic plots & opportunistic observations	Stage 2 BCAA	110 person hours Bruce Mullins, Brian Towle, John Gollan and Rebecca Dwyer	ELA (2015) Mount Gilead Balance lands due diligence

29 September and 1 October 2015	Targeted threatened flora surveys	Stage 2 BCAA	32 person hours Bruce Mullins, Meredith Henderson	Mt Gilead Stage 2 Biocertification Assessment
21 October 2015	Targeted threatened flora surveys	Stage 2 BCAA	32 person hours (Brian Towle, Tammy Paartalu)	Mt Gilead Stage 2 Biocertification Assessment
February 2016	Vegetation community validation, targeted threatened species surveys	Illawarra Coal and properties immediately north of BCAA.	48 person hours Greg Steenbeeke and Suzanne Eacott	Mt Gilead Stage 2 Biocertification Assessment
15 March 2016	Targeted threatened flora surveys	BCAA	12 person hours	Mt Gilead Stage 2 Biocertification Assessment
9, 10, 12, 16, 18, 19, 20, 23 & 25 January 2017	Floristic Plots and random meanders	Balance Lands	288 hrs Brian Towle, Liz Norris, Suzanne Eacott, Alex Gorey	Mt Gilead Stage 2 Biocertification Assessment
May-July 2020	32 Floristic Plots and random meanders	Lands subject to Conservation Measures (Biobank sites)	128 person hours Bronwyn Callaghan, Katy Wilkins, Alex Gorey, Griffin Taylor-Dalton, Michelle Frolich, Robert Humphries	Mt Gilead Stage 2 Biobank Assessments (ELA 2020a-d)

2.2.4 Fauna surveys

Surveys for fauna species identified as requiring further assessment (**section 2.2.2**) were conducted from December 2016 to March 2017 by ELA ecologists Rodney Armistead, Mitchell Scott, Jack Talbert, Byron Heffernan, and Alexander Gorey. Fauna survey techniques included a combination of remote cameras, hair tubes, nest boxes/hanging baskets, spotlighting, call playback and active searches. The survey techniques, habitat types, target species and survey effort for fauna surveys are outlined in **Table 5**. The locations of fauna surveys are shown in Figure 11.

Table 5: Survey techniques and survey effort for fauna

Previous studies	Survey area	Effort	Results
ELA (2006)	Mt Gilead property (810 ha).	- Four-day survey on 16th and 28th February 2006 and the 1st and 6th March 2006 (total of 56 person hours). - Fauna habitat features were recorded opportunistically. - Targeted Koala searches were undertaken at six sites.	- No threatened fauna species were recorded, but key habitat features were present which could support a range of common and threatened fauna species. - Potential Koala habitat as defined by the State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP 44) was recorded
ELA (2014)	Mt Gilead Stage 1 (210 ha). Rezoning Assessment	- Five-day survey on 25th and 26th March, 4th April, 27th June, and 20th September 2013. - Birds were surveyed over 20-30 minute intervals at four sites over four mornings, depending on whether one or two observers were present. - Microbat surveys were undertaken using two ultrasonic Anabat detectors at three sites (one Anabat at two sites and one Anabat at one site) targeting areas where bats are likely to be present over two consecutive nights over a period of 12 hours between 1800 hours and 0600 hours. - Habitat features for fauna across the study area, such as hollow-bearing trees, rocks and rocky outcrops, water bodies, were opportunistically recorded. As some features were assessed to be unsuitable for the frog target species (*Heleioporus australiacus* (Giant Burrowing Frog) and *Litoria*	- Seven threatened species (six bats and one bird) were recorded: Eastern Bentwing Bat, East-coast Freetail Bat, Eastern False Pipistrelle, Yellow-bellied Sheathtail Bat, Southern Myotis, Greater Broad-nosed Bat, and Little Lorikeet. - One migratory species was recorded: Cattle Egret. - There was potential for Koala to be present, but a low likelihood for Cumberland Plain Land Snail to be present. - The overall rating of the riparian and aquatic condition varied from degraded to moderate.

Previous studies	Survey area	Effort	Results
		aurea (Green and Golden Bell Frog)), targeted survey for these were not undertaken. - Riparian and aquatic habitat assessments included mapping the top of bank using a differential GPS, classifying the condition and recovery potential of steam reaches, categorising each stream using the Strahler method, and identifying heavily degraded streams or areas of overland flow that do not meet the definition of 'river' and are suitable for removal. Assessments were undertaken over one and a half days.	
ELA 2016	Mt Gilead Stage 1 (210 ha). Biocertification Assessment	48 diurnal person hrs, 30 November, 7 & 12 December 2016 24 nocturnal person hours Assessment for presence of *Myotis macropus* and *Litoria aurea* habitat	- No threatened frogs recorded
ELA 2015-2018	Mt Gilead Stage 2	**General / non-specific fauna surveys, searches and / or habitat assessments for threatened invertebrate, birds, reptiles and mammal** General visual searches and surveys for specific threatened species habitats (hollow-bearing trees, koala feed trees, crevice, cracks and caves in rock formations, termite mounds). 133 person hours Searches for direct evidence of the presence or site occupancy of a threatened species (including direct sighting, listening for calls or observations of carcasses). Searches for indirect evidence of the presence or site occupancy of fauna species (tracks, scats and other signs of fauna including foraging digs made by bandicoots and scratches on trees made by Koalas. **General / various sized terrestrial mammals, bird or reptile species**.	- Koala, Squirrel Glider and Cumberland Plain Land Snail recorded

Previous studies	Survey area	Effort	Results
		Remote movement sensing camera trap stations were baited with universal bait (consisting of rolled oats, honey, peanut butter) and sardines. -1085 remote camera survey nights Small sized hair-tubes (opening of tube is 50 mm in diameter) baited with universal bait (consisting of rolled oats, honey, peanut butter) and sardines targeting small sized mammal species (0.01 to 0.150 kg in average body mass) – 3,575 hair tube nights Large sized hair-tubes (opening of tube is 150 mm in diameter) baited with universal bait (consisting of rolled oats, honey, peanut butter) and sardines targeting medium to large sized mammal species (0.150 to 10 kg in average body mass – 3,510 hair tube nights Nest boxes and hanging basket style nest boxes that have been designed to accommodate Eastern Pygmy Possums (opening into nest box >30 mm in diameter) – 14 nest boxes for 910 survey nights **Microchiropteran Bats -** 50 anabat nights Anabat ultra-sonic microbat call recorders **Various nocturnal mammals and birds** Spotlighting and nocturnal searches. Spotlighting was undertaken from moving vehicle and on-foot.	Six species of threatened microchiropteran bats recorded • *Chalinolobus dwyeri* (Large-eared Pied Bat) (vulnerable) • *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) (vulnerable) • *Miniopterus australis* (Little Bentwing Bat) (vulnerable)

Previous studies	Survey area	Effort	Results
			• *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat) (vulnerable) • *Micronomus* (*Mormopterus*) *norfolkensis* (Eastern Freetail Bat) • *Myotis macropus* (Large-footed Myotis) (vulnerable) Two additional potential species were also recorded *Scoteanax rueppellii* (Greater Broad-nosed Bat) (vulnerable) and *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat)
		Cumberland Land Snail - – 38 person hours Searches for CPLS were conducted by searching forest floor debris located at the base of these two tree species. Searches were conducted during or after rainfall.	Cumberland Land snail recorded
		Green and Golden Bell Frog surveys – 14 person hours Random dip netting and visual surveys using polarised sunglasses for tadpoles. Call play back and active searches during optimal climatic conditions (following at least 50mm of rain, warm stormy nights with a forecast for further rain to occur.	Green and Golden Bell frog and Giant Burrowing frog not recorded
		Giant Burrowing Frog Surveys – 60 person hours Nocturnal call play back and active searches on foot along 5 km of waterway. Surveys consisted of moving through creek lines and paddock run off areas. Areas of slow flowing water or large pools were targeted during these surveys Surveys were conducted during optimal climatic conditions (following at least 50mm of rain, warm stormy nights with a forecast for further rain to occur	

Previous studies	Survey area	Effort	Results
RMS 2018	Appin Rd between Noorumba and Beulah	Spotlighting (2 nights x 2 people x 2 hours) call playback (2 nights x 2 people x 2 hours) diurnal bird survey (10, 20 minute surveys, 16 hours opportunistic observations) Koala SAT assessments (2 SAT assessments) Cumberland Land Snail searches (4 person hours), and opportunistic sightings	The following threatened species were recorded in the study area:- • Koala • Cumberland Plain Land Snail • Little Lorikeet • Cattle Egret (EPBC Act migratory species)
Biolink 2018	Mt Gilead Menangle Creek, Woodhouse and Mallaty Creek corridors	21-23 November 2017, 25 Koala SAT sampling sites	- Koala, or evidence of Koala, recorded at 12 of 25 sampling locations across Mt Gilead property - Dusky Woodswallow and Varied Sittella also recorded
ELA 2020	Mt Gilead Stage 2 Biobank Sites	Remote movement sensing camera trap stations were baited with universal bait (consisting of rolled oats, honey, peanut butter) – 23 cameras for 42 nights - 966 trap nights Spotlighting (3 nights x 4 people x 2 hours) Cumberland Plain Land Snail searches (44 person hours), and opportunistic sightings.	The following threatened species were recorded during surveys: • Koala • Squirrel Glider • Cumberland Plain Land Snail
Wild Conservation 2021	Mt Gilead Stage 2 and Beulah and Noorumba Biobank sites	12 nights of infra-red thermal drone surveys between 27 June and 15 July 2021 covering 770 ha	19 Koala detected across study area (18 in existing or proposed conservation areas and 1 in proposed development area)

Table 6: Summary of survey techniques and survey effort for fauna surveys

Target species or guilds	Survey method	General habitat type	Total survey effort*
General / non-specific fauna surveys, searches and / or habitat assessments for threatened invertebrate, birds, reptiles and mammal	General visual searches and surveys for specific threatened species habitats (hollow-bearing trees, koala feed trees, crevice, cracks and caves in rock formations, termite mounds). Searches for direct evidence of the presence or site occupancy of a threatened species (including direct sighting, listening for calls or observations of carcasses). Searches for indirect evidence of the presence or site occupancy of fauna species (tracks, scats and other signs of fauna including foraging digs made by bandicoots and scratches on trees made by Koalas.	Pasture with scattered paddock trees or open and disturbed woodland habitats	75 person hours.
		Woodland habitat	30 person hours.
		Riparian, sandstone creek-line with woodlands and / or rainforest habitats	28 person hours.
General / various sized terrestrial mammals, bird or reptile species.	Remote movement sensing camera trap stations were baited with universal bait (consisting of rolled oats, honey, peanut butter) and sardines	Pasture with scattered paddock trees or in open and disturbed woodland habitats	Total of 697 survey nights at fourteen (14) locations.
		Pasture with scattered trees near to or at farm dam habitats	Total of 66 remote camera survey nights.
		Riparian, sandstone creek-line with woodlands and / or rainforest habitats	Total of 322 survey nights at five (5) locations. Additional 23 cameras for 42 nights - 966 trap nights in May-July 2020
	Small sized hair-tubes (opening of tube is 50 mm in diameter) baited with universal bait	Pasture with scattered trees near to or at farm dam habitats	43 hair-tubes set for 65 consecutive days.

Target species or guilds	Survey method	General habitat type	Total survey effort*
	(consisting of rolled oats, honey, peanut butter) and sardines targeting small sized mammal species (0.01 to 0.150 kg in average body mass)		Total survey effort of 2,795 hair-tube survey nights.
		Sandstone creek-line, riparian vegetation or within woodlands, Swamp She-oak Forest and / or rainforest habitats	12 hair-tubes set for 65 consecutive days. Total survey effort of 780 survey nights.
	Large sized hair-tubes (opening of tube is 150 mm in diameter) baited with universal bait (consisting of rolled oats, honey, peanut butter) and sardines targeting medium to large sized mammal species (0.150 to 10 kg in average body mass)	Pasture with scattered trees near to or at farm dam habitats	42 hair-tubes set for 65 consecutive days. Total survey effort of 2,665 hair-tube survey nights.
		Sandstone creek-line, riparian vegetation or within woodlands, Swamp She-oak Forest and / or rainforest habitats	13 hair-tubes set for 65 consecutive days. Total survey effort of 845 survey nights.
	Nest boxes and hanging basket style nest boxes that have been designed to accommodate Eastern Pygmy Possums (opening into nest box >30 mm in diameter)	Pasture with scattered trees near to or at farm dam habitats	8 nest boxes/hanging baskets for 65 consecutive nights. Total survey effort of 520 survey nights.
		Sandstone creek-line, riparian vegetation or within woodlands, Swamp She-oak Forest and / or rainforest habitats	6 nest boxes/hanging baskets for 65 consecutive nights. Total survey effort of 390 survey nights.
Microchiropteran bats including targeted surveys for *Chalinolobus dwyeri* (Large-eared Pied Bat), *Miniopterus*	Anabat ultra-sonic microbat call recorders.	Pasture with scattered paddock trees or open and disturbed woodland habitats	27 anabat recording nights

Target species or guilds	Survey method	General habitat type	Total survey effort*
schreibersii oceanensis (Eastern Bentwing Bat) and *Myotis macropus* (Large-footed Myotis).		Sandstone creek-line with woodlands and rainforest habitats	8 anabat recording nights
		Pasture with scattered trees and farm dam habitats	15 survey nights and in addition a further 15 hours (over three separate survey nights) were conducted using a hand held whilst conducting other surveys at a farm dam.
Various nocturnal mammals and birds	Spotlighting and nocturnal searches. Spotlighting was undertaken from moving vehicle and on-foot.	All broad habitat types.	One survey night. Additional spotlight surveys were not undertaken after it had been determined that the target nocturnal species, (Grey-headed Flying-fox, Koalas and Squirrel Glider) were present within the BCAA. Additional Spotlighting June/July 2020 (3 nights x 4 people x 2 hours)
General invertebrate – targeting *Meridolum corneovirens* (Cumberland Plain Land Snail (CPLS))	Undertaken during other opportunistic searches within the subject site. Searches for CPLS were conducted by searching forest floor debris located at the base of these two tree species. Searches were conducted during or after rainfall.	Pasture with scattered paddock trees or open and disturbed woodland habitats – focusing in patches mapped as Cumberland Plain Woodland and dominated by *E. tereticornis* and *E. moluccana*.	38 person hours over 4 days. 44 person hours over 6 days in 2020

Target species or guilds	Survey method	General habitat type	Total survey effort*
Targeted *Litoria aurea* (Green and Golden Bell Frog (GGBF)) surveys	Random dip netting and visual surveys using polarised sunglasses for tadpoles.	GGBF survey were conducted at one farm dam and associated creek line only.	4 person hours.
	Call play back and active searches during optimal climatic conditions (following at least 50mm of rain, warm stormy nights with a forecast for further rain to occur.		10 hours over three survey nights.
Targeted surveys for Giant Burrowing Frog and Red-crowned Toadlet	Random dip netting and visual surveys using polarised sunglasses for tadpoles. Surveys were conducting while moving through sandstone dominated creek lines on foot. Dip netting was conducted in any large pools that were encountered.	Riparian, sandstone creek-lines / gorge habitats with woodlands and / or rainforest habitats	28 person hours of daytime searching within sandstone creek lines.
	Nocturnal call play back and active searches on foot. Surveys consisted of moving through creek lines and paddock run off areas. Areas of slow flowing water or large pools were targeted during these surveys Surveys were conducted during optimal climatic conditions (following at least 50mm of rain, warm stormy nights with a forecast for further rain to occur.		32 survey hours.

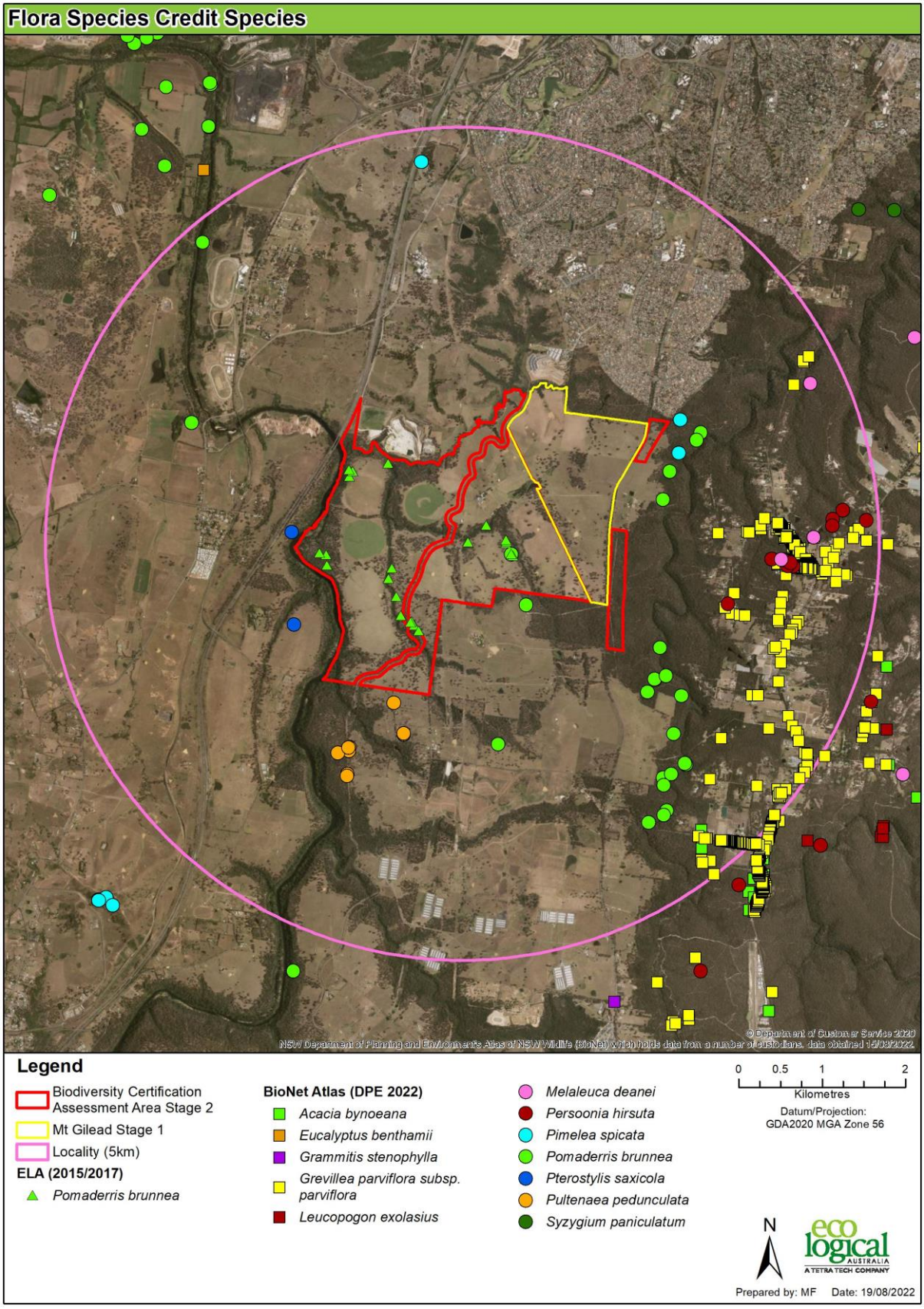


Figure 7: Threatened flora records within 5km of the BCAA (Source Atlas of NSW Wildlife and ELA, unpublished)

Note the precise locations of sensitive species are denatured and locations are not accurate

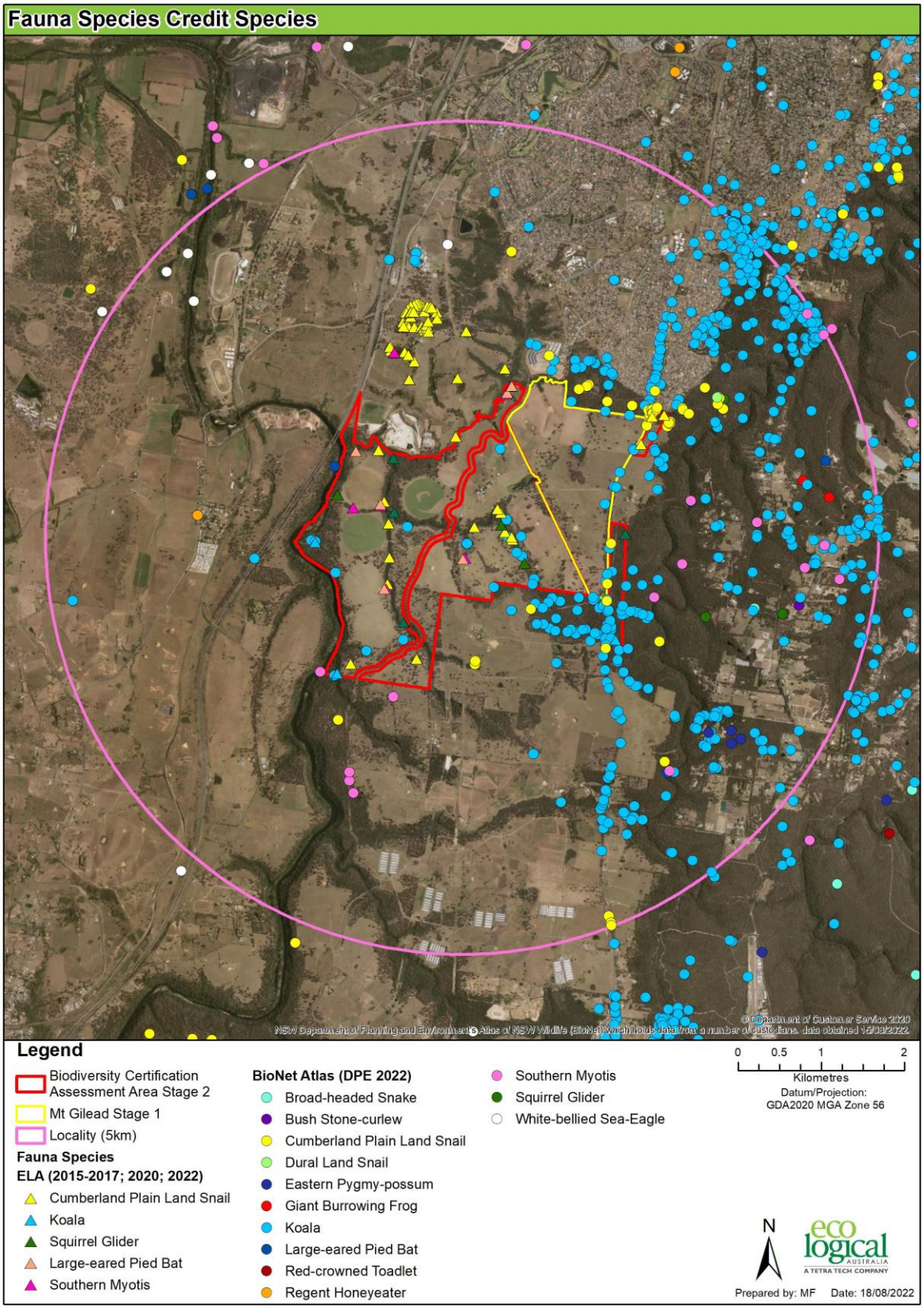


Figure 8: Threatened species credit fauna records within 5km of the BCAA (Source Atlas of NSW Wildlife and ELA, unpublished)

Note the precise locations of sensitive species are denatured and locations are not accurate

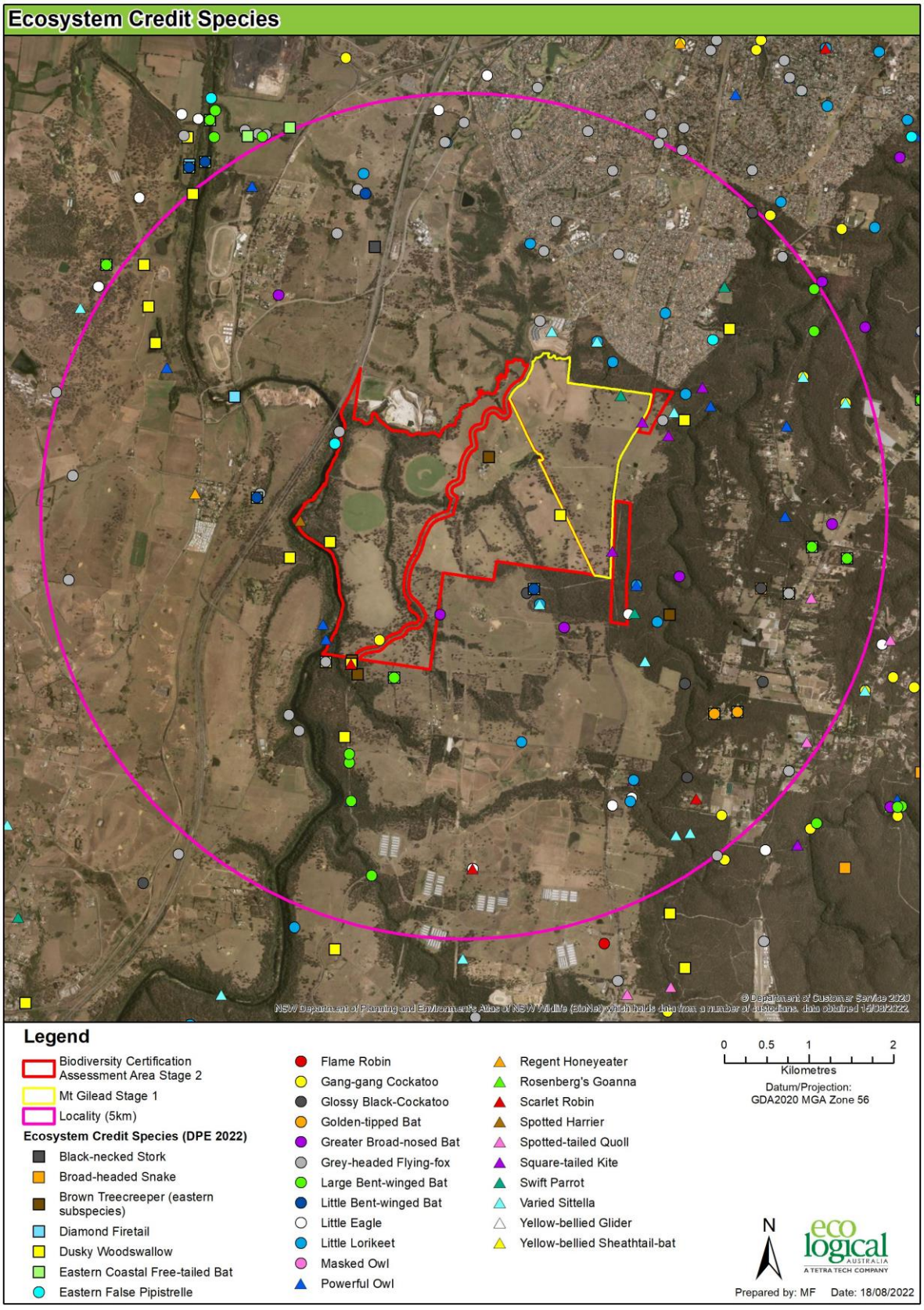


Figure 9: Threatened ecosystem credit fauna records within 5km of the BCAA (Source Atlas of NSW Wildlife and ELA, unpublished)

Note the precise locations of sensitive species are denatured and locations are not accurate

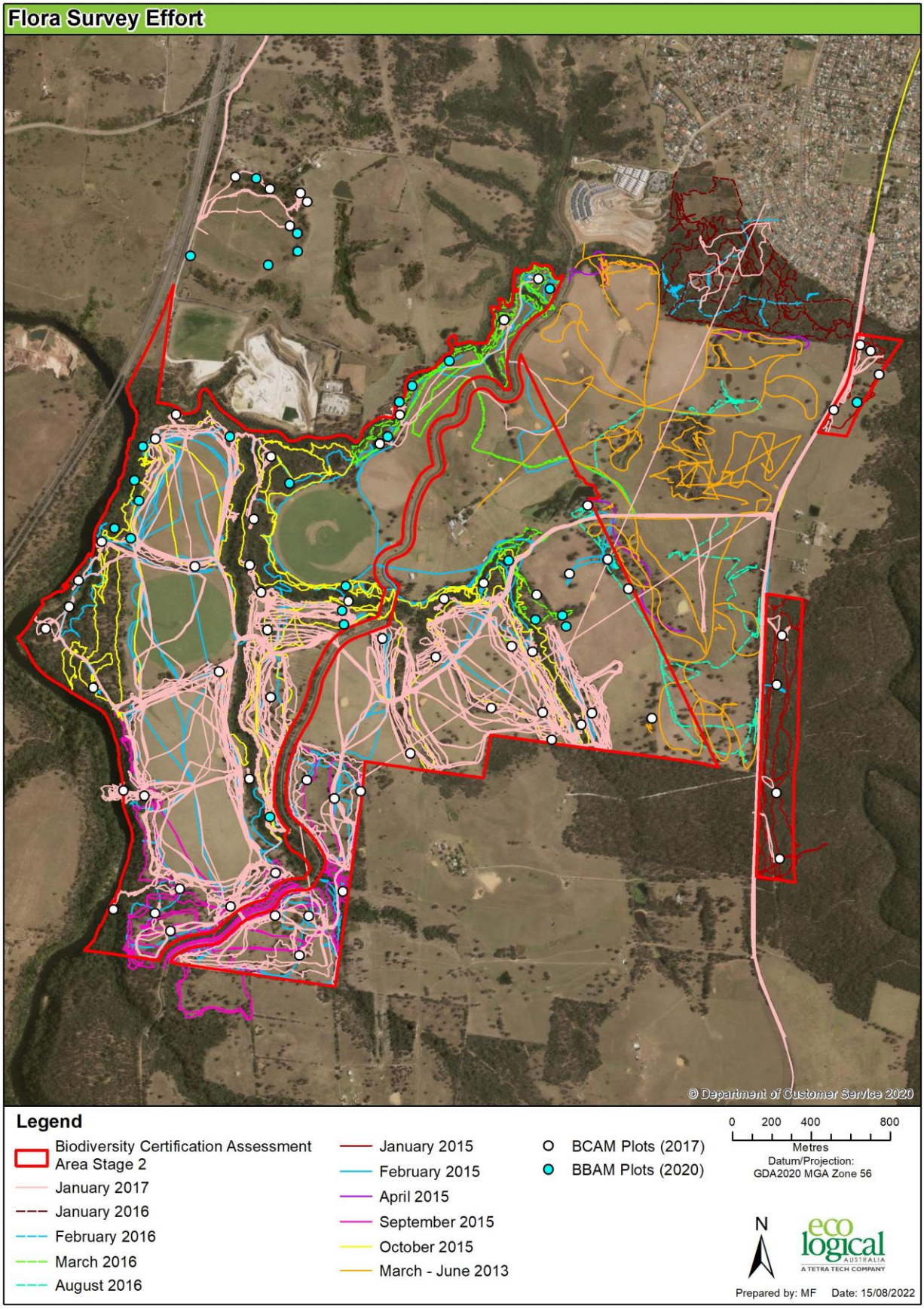


Figure 10: Combined flora survey effort across the BCAA and adjacent properties

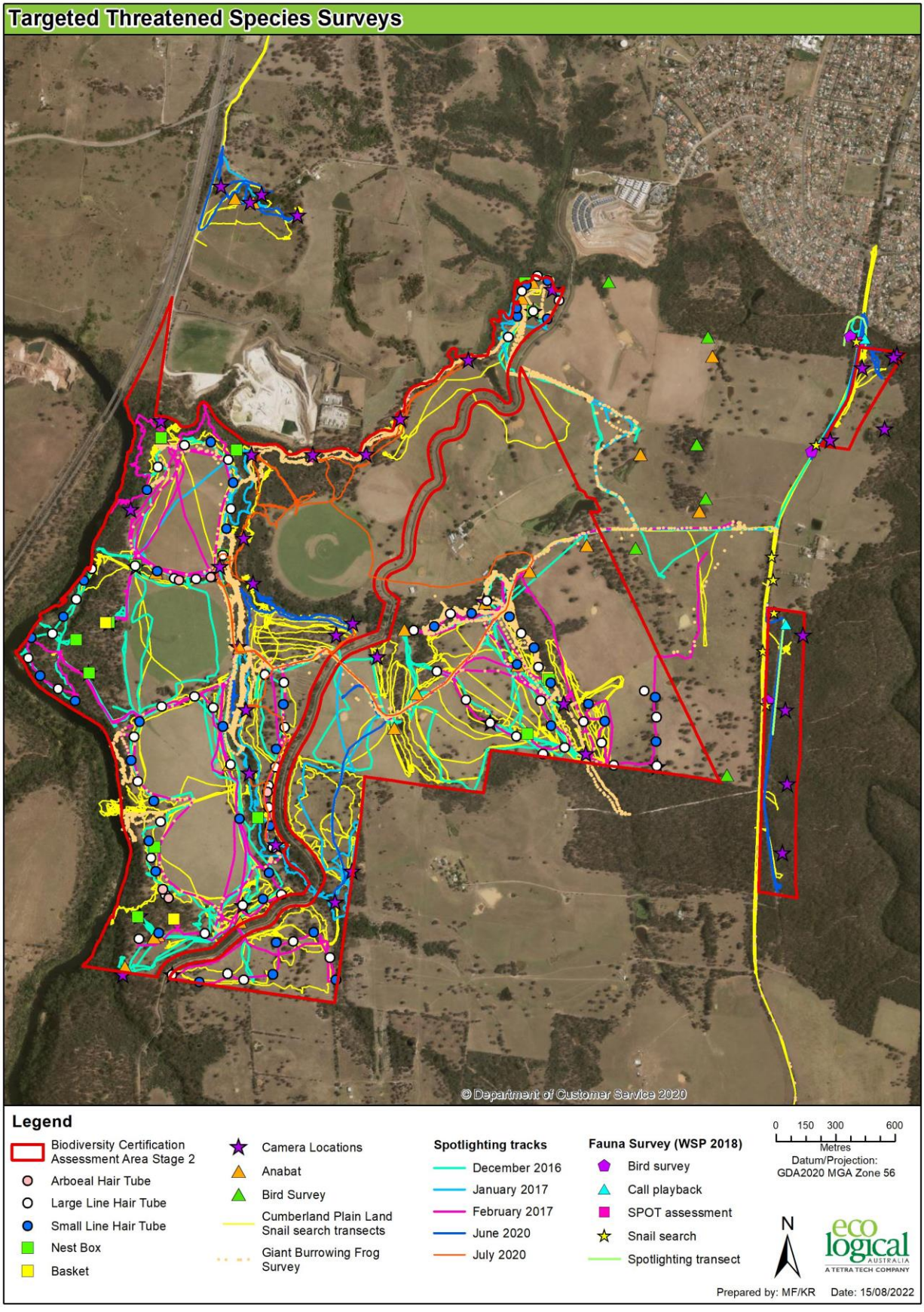


Figure 11: Fauna survey locations within and adjacent to the BCAA

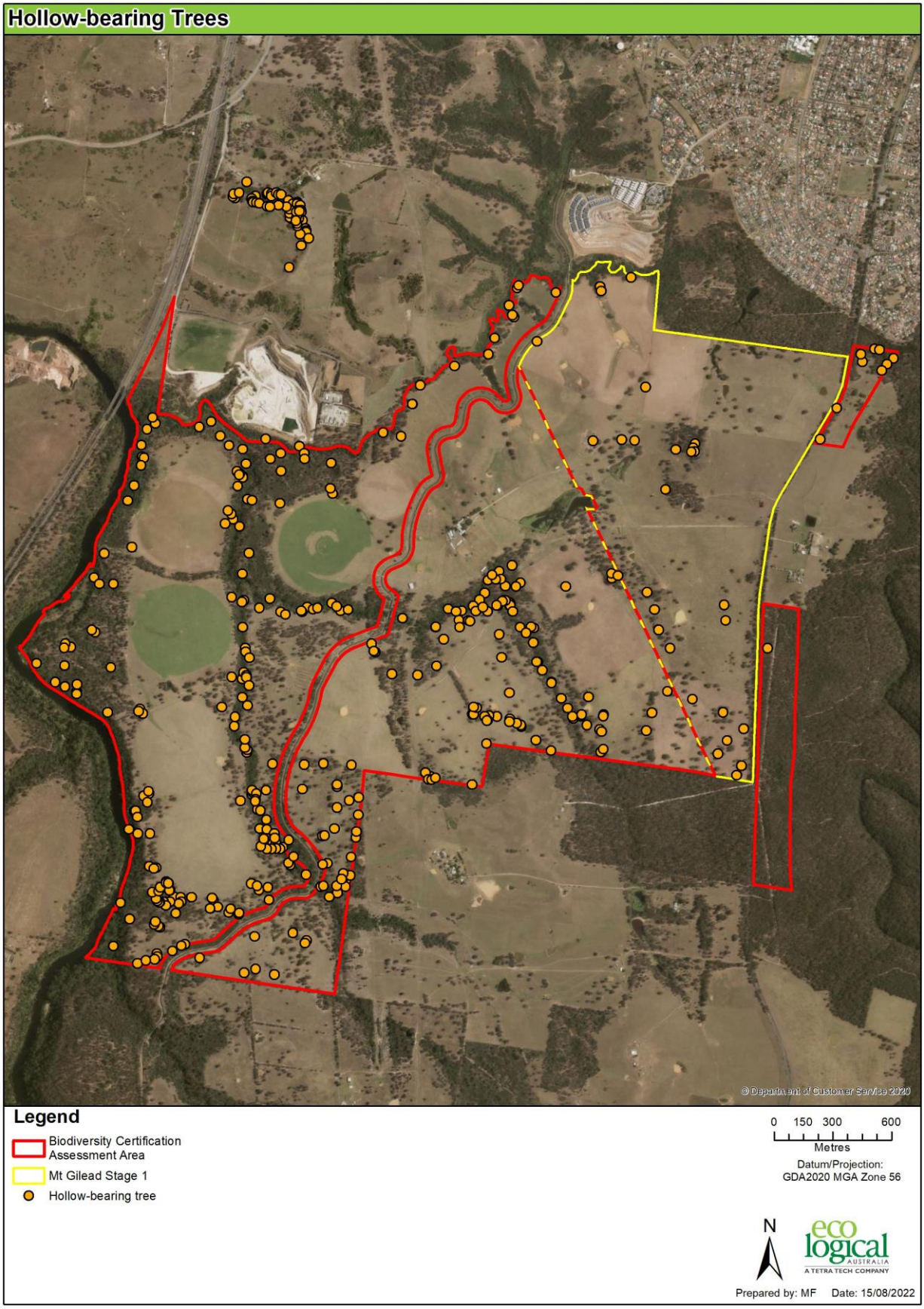


Figure 12: Location of Hollow Bearing Trees across the BCAA

2.3.1 Biometric vegetation types

Field surveys identified five vegetation communities (with names following Tozer *et al*. 2010) within the BCAA, comprising five BVTs. The relationship between vegetation communities, BVTs and TECs are presented in **Table 7**.

Table 7: Vegetation communities (after Tozer et al. 2010), Biometric vegetation types and Endangered ecological communities listed under the *Threatened Species Conservation Act 1995*, within the BCAA

Vegetation community (following Tozer et al 2010)	Biometric vegetation type equivalent (DECC 2008a)	TSC Act
Cumberland River Flat Forest (CRFF)	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
Cumberland Shale Plains Woodland (SPW)	Grey-Box – Forest Red Gum grassy woodlands on flats of the Southern Cumberland Plain, Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion
Cumberland Shale Hills Woodland (SHW)	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	
Cumberland Shale Sandstone Transition Forest (SSTF)	Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	Shale Sandstone Transition Forest in the Sydney Basin Bioregion
Grey Myrtle Dry Rainforest (GMDR)	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	Not listed

The distribution of vegetation communities within the BCAA are shown in Figure 13**.** Within the BCAA two vegetation communities, Grey Myrtle Dry Rainforest (GMDR) and Cumberland River Flat Forest (CRFF), were associated with drainage lines with GMDR occurring along incised sandstone gullies formed by lower order tributaries and CRFF occurring on deep alluvial soils adjoining the Nepean River. Two vegetation communities, Shale Plains Woodland (SPW) and Shale Hills Woodland (SHW) were identified as occurring on clay soils, typically on the upper slopes and crests of the low hills and away from the influence of drainage lines. On the mid to lower slopes and edges of the drainage lines, Shale Sandstone Transition Forest (STTF) was recorded.

Comparison of species lists collected from biometric plots against OEH's vegetation analysis tool was undertaken to compare the field identification of vegetation communities against published characteristic and diagnostic species lists (Tozer *et al.* 2010). Generally, only those biometric plots surveyed within the least disturbed areas of the site (areas classified as 'good' ancillary code, see **section 2.3.2**) where cattle

have been largely excluded, contained the minimum required number of native species in order to make robust statistical comparisons against OEH's vegetation tool. Areas where cattle have been excluded were limited to areas of SSTF and GMDR and only individual plots within these vegetation communities contained the minimum number of native species and diagnostic species for positive confirmation of the vegetation community at the 95% confidence interval. No plots within areas mapped as SPW, SHW or CRFF contained the minimum number of native species required to make an assessment of the number of diagnostic species for these communities. Nonetheless, an assessment of the species lists collected for biometric plots within the BCAA using OEH's vegetation tool was undertaken for the majority of biometric plots (highly disturbed plots with very few native species were not assessed) in order to see which vegetation communities the species lists from individual plots most closely resembled. An assessment of the results for each vegetation community identified within the BCAA is summarised below whilst the detailed analysis is provided in **Appendix E**.

Analysis of species lists from biometric plots within areas mapped as GMDR generally supported the identification of this vegetation community, although select plots within areas mapped as GMDR also showed affinities to other vegetation communities, most commonly Western Sydney Dry Rainforest (WSDR). While species lists from biometric plots show that some areas mapped as GMDR were similar to floristic lists for WSDR, the occurrence of WSDR within the areas was dismissed on the basis of the geology (Hawkesbury Sandstone within areas mapped as GMDR as opposed to Wianamatta Shale in WSDR) and the dominance of *Backhousia myrtifolia* (Grey Myrtle), which although present in WSDR, does not form one of the dominant canopy species.

Species lists collected from biometric plots within areas of CRFF did not align closely with this community when analysed using OEHs vegetation tool, with each plot aligning to different vegetation communities including SPW, GMDR and CRFF. The variability in the predicted vegetation communities when using OEH's vegetation tool is attributed to the highly modified nature of areas identified as CRFF within the BCAA and the relatively few native flora species recorded within biometric plots in those areas mapped as CRFF. Furthermore, one of the more common canopy species within this vegetation community within the BCAA, *Casuarina cunninghamia* subsp. *cunninghamia* (River Oak), is not listed as either a diagnostic or characteristic species for this community by Tozer *et. al.* (2013), although this species is recorded by Tozer (2010) within 'Alluvial Woodland', which forms part of the CRFF vegetation community. The distinct location of CRFF within the BCAA, in association with the banks of the Nepean River and lower stretches of Menangle Creek, on alluvial soils in combination with the floristic patterns observed, were considered reliable indicators of both the presence of this vegetation community and distribution within the BCAA despite the limited floristic diversity.

Analysis of species lists from biometric plots within areas mapped as SSTF generally supported the identification of this vegetation community, although select plots within areas mapped as SSTF also showed affinities to other vegetation communities, most commonly SPW. Generally, those areas with comparatively little disturbance (not grazed, pasture improved or selectively cleared), were strongly aligned with SSTF while more disturbed sites which have been selectively thinned and grazed commonly aligned more closely with SPW. This result is considered to be an artefact of the nature of disturbance within these areas (grazing and selective clearing generally removing the canopy and shrub layer and increasing the cover of groundcover species, particularly grasses).

Species lists collected for biometric plots within areas mapped as SPW consistently aligned with the SPW vegetation community when analysed using OEH's vegetation tool. This result supports the mapping of BVTs for SPW across much of the BCAA. Species lists collected for biometric plot data within areas mapped as SHW also aligned to SPW. Nonetheless, the mapping of SHW follows the identification of BVTs as made during the field assessment, which follows the descriptions of these two communities by

Tozer (2010) with SHW occurring at higher elevations, steeper slopes and more undulating country with a relatively high degree of ruggedness compared to SPW. SHW was thus restricted to the northern part of the BCAA on Lot 1 DP 622362.

The five BVTs identified within the BCAA correspond to three threatened ecological communities listed under the TSC and EPBC Acts (**Table 7**). It is noted that the 'Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion' BVT is identified within the OEH's Vegetation Information System Classification Database as forming part of the Western Sydney Dry Rainforest in the Sydney Basin Bioregion EEC but were not identified as forming part of the EEC listed under the TSC Act due to geology and soil types present as discussed above. The areas of Grey Myrtle Dry Rainforest (GMDR) within the BCAA were restricted to deeply incised drainage lines where underlying Hawkesbury Sandstone bedrock was exposed which formed the parent material for the sandy soils present within areas of this vegetation type. The Western Sydney Dry Rainforest EEC occurs on clay soils derived from Wianamatta Shale. Additionally, the dominance of *Backhousia myrtifolia* (Grey Myrtle) in the GMDR within the BCAA is distinct from the Western Sydney Dry Rainforest EEC which does not commonly include this species.

2.3.2 Vegetation type ancillary codes and threatened status

The BCAM requires that vegetation within the BCAA is divided into vegetation zones delineated by the different vegetation types present within the BCAA and broad condition categories, or ancillary codes. Across all vegetation types within the BCAA eight ancillary codes were identified. The different ancillary codes within each vegetation type and the specific vegetation zones are outlined in **Table 8** and their distribution within the BCAA is shown in Figure 14 together with the plots taken in each zone. A brief description of each of the ancillary codes is provided below.

Vegetation was categorised as 'Good' where all structural layers of the relevant vegetation type were present and there was relatively low cover of exotic species. This generally corresponded to areas where little or no grazing has occurred. Where moderate to high grazing pressure has occurred resulting in a very open or absent mid-storey and moderate to high exotic cover within the ground layer vegetation was categorised as 'Pasture improved/grazed'. Where large scale vegetation clearing had occurred and only isolated canopy trees with no mid-storey and an almost entirely exotic ground layer was present, vegetation was categorised as 'Scattered Trees'. Other ancillary codes recorded included 'Dense Weedy' which occurred in areas with a dense mid-storey of African Olive

Two additional ancillary codes, 'Thinned/shrubby' and 'DNS', were identified within the SSTF vegetation type and corresponded to areas where the canopy had been removed (DNS) or thinned (Thinned/shrubby) and a shrubland (DNS) or dense shrubby open-woodland (Thinned/shrubby) was observed. One ancillary code (DNG) represented a derived native grassland within areas of SPW and SHW where the canopy and mid-storey structural layers were absent, due to past clearing, but a predominantly (greater than 50%) native grassy ground-layer remained. Finally, one area of the CRFF vegetation community had previously been disturbed by sand extraction and was in an advanced state of regeneration, termed 'Regen'.

The number of plots collected for each vegetation zone within the BCAA is shown in **Table 8**. For each zone the number of plots collected met, or exceeded, the minimum number of plots required for each vegetation zone.

Table 8: Ancillary vegetation codes for each BVT including areas and number of plots collected for each vegetation zone

Veg Zone	BVT ID	PCT Name	Ancillary	Condition	EEC	Total Area BCAA (ha)	Plots required	Plots collected	Plot #'s
1	HN526	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Weedy	Low	RFF	24.45	3	4	MG19, MG20, MG21, MG22
2	HN526	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Scattered trees	Low	RFF	0.59	1	1	MG39
3	HN526	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	Regen	Low	RFF	2.42	1	1	MG37
4	HN528	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Pasture improved/grazed	Mod-Good	CPW (SPW)	29.51	3	13	BB04, BB09, BB11, MG06, MG08, MG14, MG25, MG30, MG38, MG44, MG46, MG47, MG48
5	HN528	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	Scattered trees	Low	CPW (SPW)	4.51	1	4	BB05, BB10, MG16, MG36
6	HN528	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	DNG	Low	CPW (SPW)	3.11	1	2	BB01, MG45
7	HN528	Cleared - restore to SPW	Cleared	Low	CPW (SPW)	13.54	2	2	MGCL02, MGCL04
8	HN529	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Good	Mod-Good	CPW (SHW)	0.0	0	1	MG32
9	HN529	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	Weedy	Low	CPW (SHW)	0.38	1	1	MG33
10	HN529	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	DNG	Low	CPW (SHW)	0.0	0	2	MG34, MG35
11	HN529	Cleared - restore to SHW	Cleared	Low	CPW (SHW)	0.0	0	1	MGCL01
12	HN538	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	Good	Mod-Good	WSDR	8.35	1	5	BB02, MG01, MG40, MG41, MG43
13	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	Good	Mod-Good	SSTF	104.38	5	12	BB03, BB12, MG02, MG04, MG07, MG09, MG17, MG18, MG28, MG29, MG31, MG42
14	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	Thinned/Shrubby	Mod-Good	SSTF	10.16	2	3	MG11, NW05, NW06
15	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	Pasture improved/grazed	Low	SSTF	57.50	4	9	BB06, BB07, BB13, MG03, MG12, MG15, MG23, MG24, MG27

Veg Zone	BVT ID	PCT Name	Ancillary	Condition	EEC	Total Area BCAA (ha)	Plots required	Plots collected	Plot #'s
16	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	Scattered trees	Low	SSTF	6.89	1	3	A2_2013, BB08, MG26
17	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	DNS	Mod-Good	SSTF	5.05	1	2	MG10, MG13
18	HN556	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	DNG		SSTF	0.67	1	1	MGCL05
19	HN556	Cleared - restore to SSTF	Cleared	Low	SSTF	35.15	2	5	MGCL03, NW11, NW12, NW13, H11
		Sub-total - Vegetation				**306.66**	**30**	**72**	

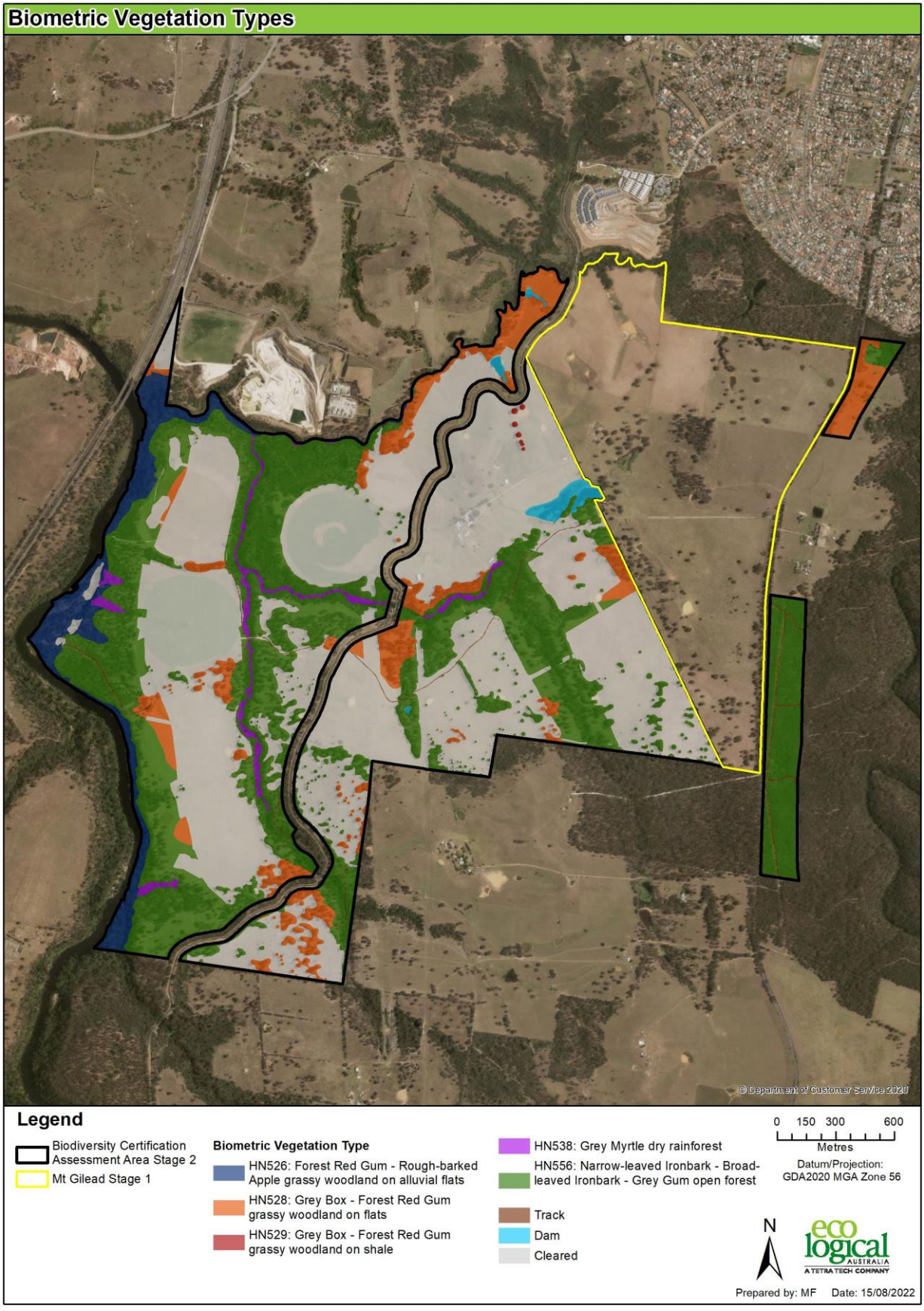


Figure 13: Biometric Vegetation types within the BCAA as mapped by ELA 2015-2020

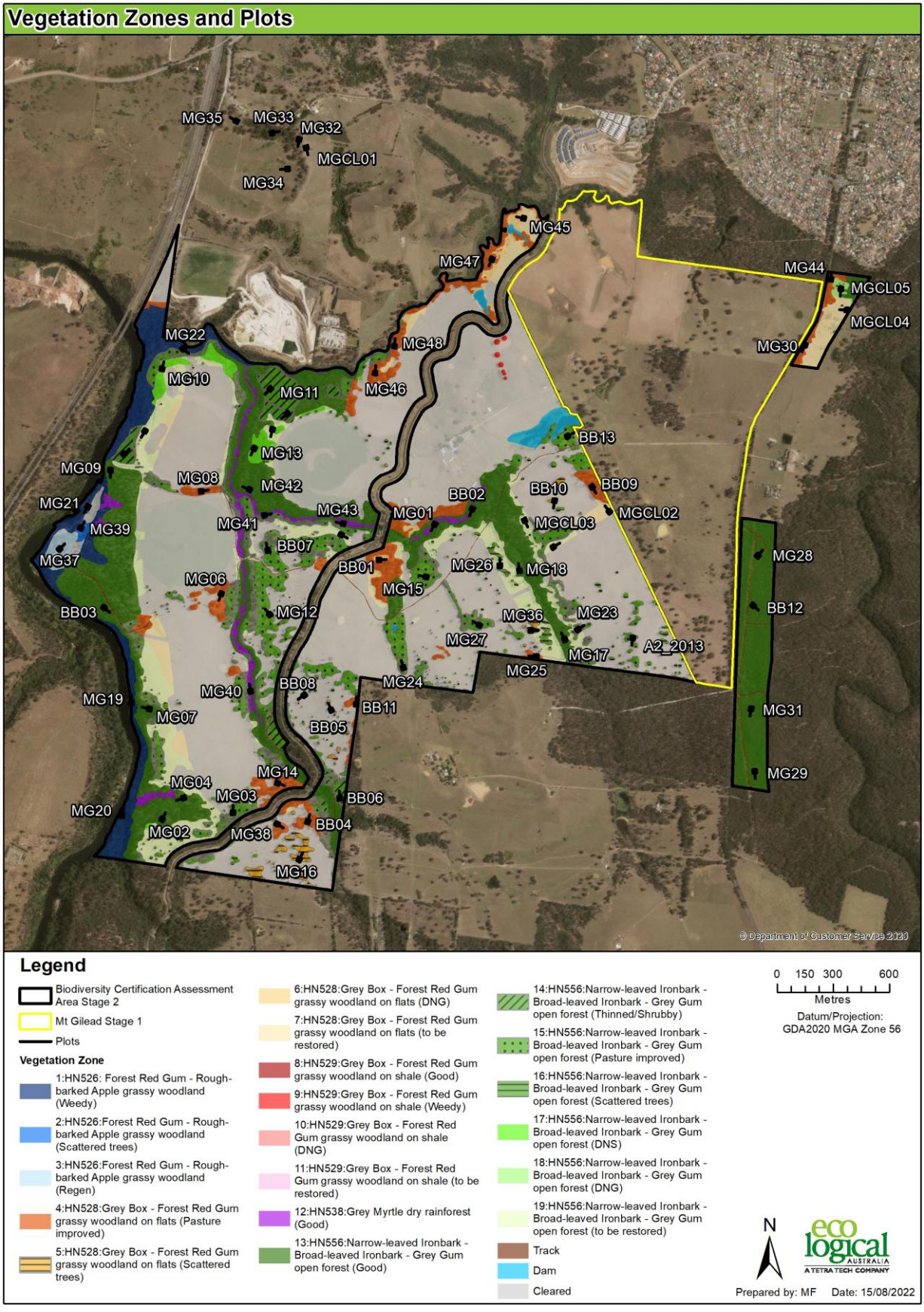


Figure 14 Vegetation Zones and plots as mapped by ELA 2015-2017 and refined 2020

Figure 15: Location of *Pomaderris brunnea* within the BCAA and habitat polygon

2.3.3 Flora species

A total of 287 native and 137 exotic flora species were recorded in the biometric plots used for this assessment. A full list of species recorded in plots is provided in **Appendix F**.

One threatened flora species was recorded by ELA during the current field survey, *Pomaderris brunnea* (Rufous Pomaderris). A total of 253 *Pomaderris brunnea* individuals have been recorded within the BCAA, with an additional five plants recorded outside the BCAA within the Upper Canal corridor which bisects the BCAA. Within the BCAA *Pomaderris brunnea* was restricted to the SSTF vegetation community, or at the ecotone of this community and adjacent vegetation types. The location of records of *Pomaderris brunnea* are shown in Figure 15.

2.3.4 Fauna species

A total of 124 native vertebrate fauna species, comprising 68 birds (two threatened and one migratory species), 17 microbats (including eight threatened species), one megabat (Grey-headed Flying Fox), 11 terrestrial and arboreal mammals (including two threatened species), 11 frogs, 13 reptile, three fish and one threatened invertebrate, were recorded in the Stage 2 BCAA by ecologists). A full list of species recorded by ELA is provided in **Appendix G**, together with a list of species recorded by remote cameras (**Appendix H**), hair tubes (**Appendix I**) and anabats (**Appendix J**.

Threatened and migratory fauna species

Threatened fauna species recorded within the BCAA during targeted surveys and by others are:-

Birds

- Brown Treecreeper
- Dusky Woodswallow
- Glossy Black Cockatoo
- Scarlet Robin (BioNet)
- Powerful Owl (BioNet)
- Square-tailed kite
- Little Lorikeet
- Varied Sittella (Biolink 2018).

Mammals (including micro and macro bats)

- Koala
- Squirrel Glider
- Grey-headed Flying-fox

- *Miniopterus australis* (Little Bentwing Bat)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat)
- *Mormopterus norfolkensis* (Eastern Coastal Freetail Bat)
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat)
- *Myotis macropus* (Southern Myotis)
- *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Chalinolobus dwyeri* (Large-eared Pied Bat)

Other

- Cumberland Plain Land Snail

Of the above species, only Koala, Squirrel Glider, Southern Myotis and Cumberland Plain Land Snail are species credit species and have been identified as being impacted by the land to be certified. The other species that have been recorded or have the potential to occur within the BCAA which are species credits species (Little Bentwing Bat, Eastern Bentwing Bat, Large-eared Pied Bat and Grey-headed Flying Fox) are only species credit species when breeding habitat is being impacted. No breeding habitat was recorded within the land to be certified so these species do not require further assessment as species credit species in this assessment.

Species habitat polygons for these species have been prepared as described in Section 2.2 and are shown in Figures 16-20. The area of habitat entered into the credit calculator tool is provided in Table 17**.**

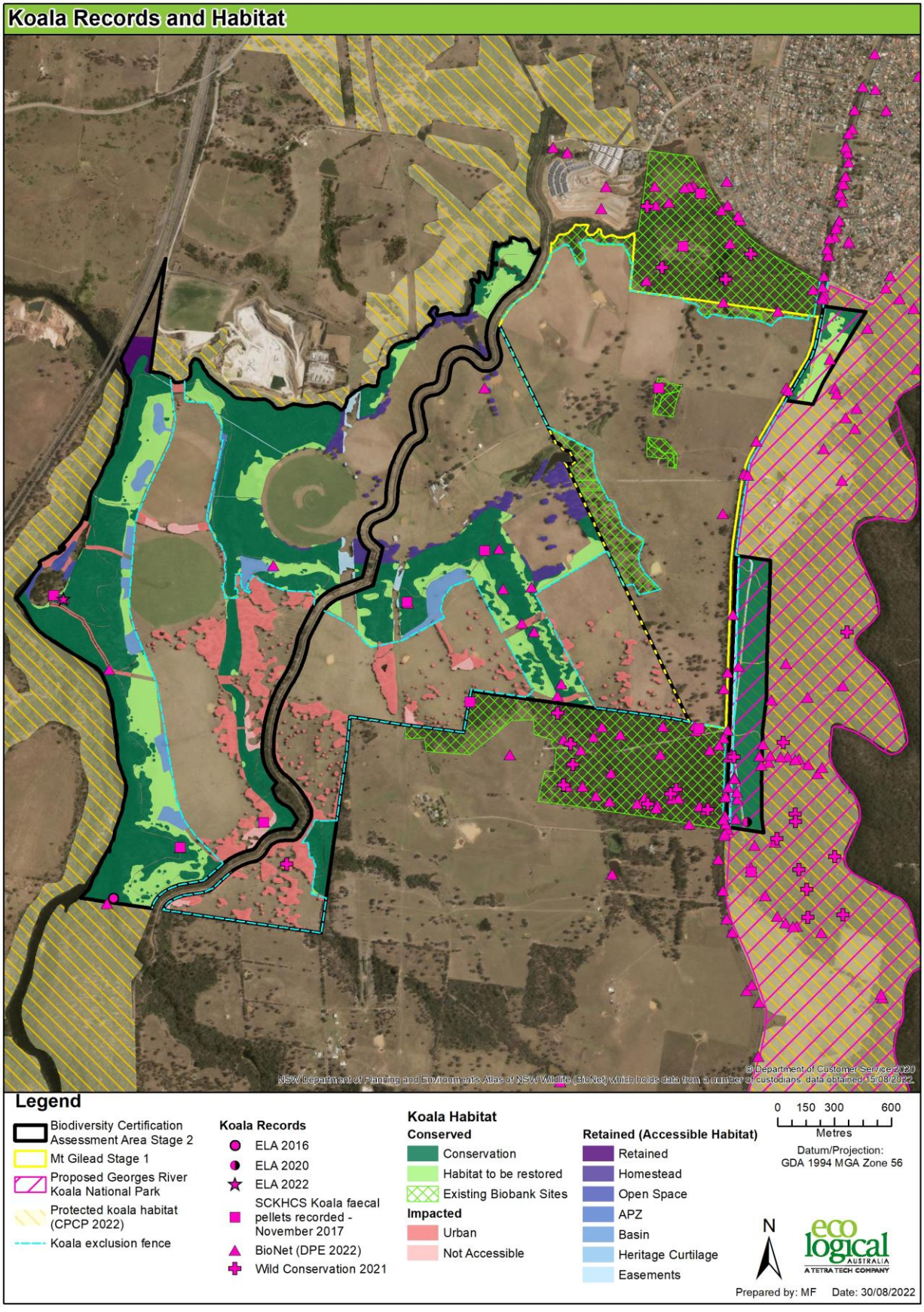


Figure 16 Records and habitat polygon for Koala within the BCAA

Figure 17: Records and habitat polygon for Squirrel Glider

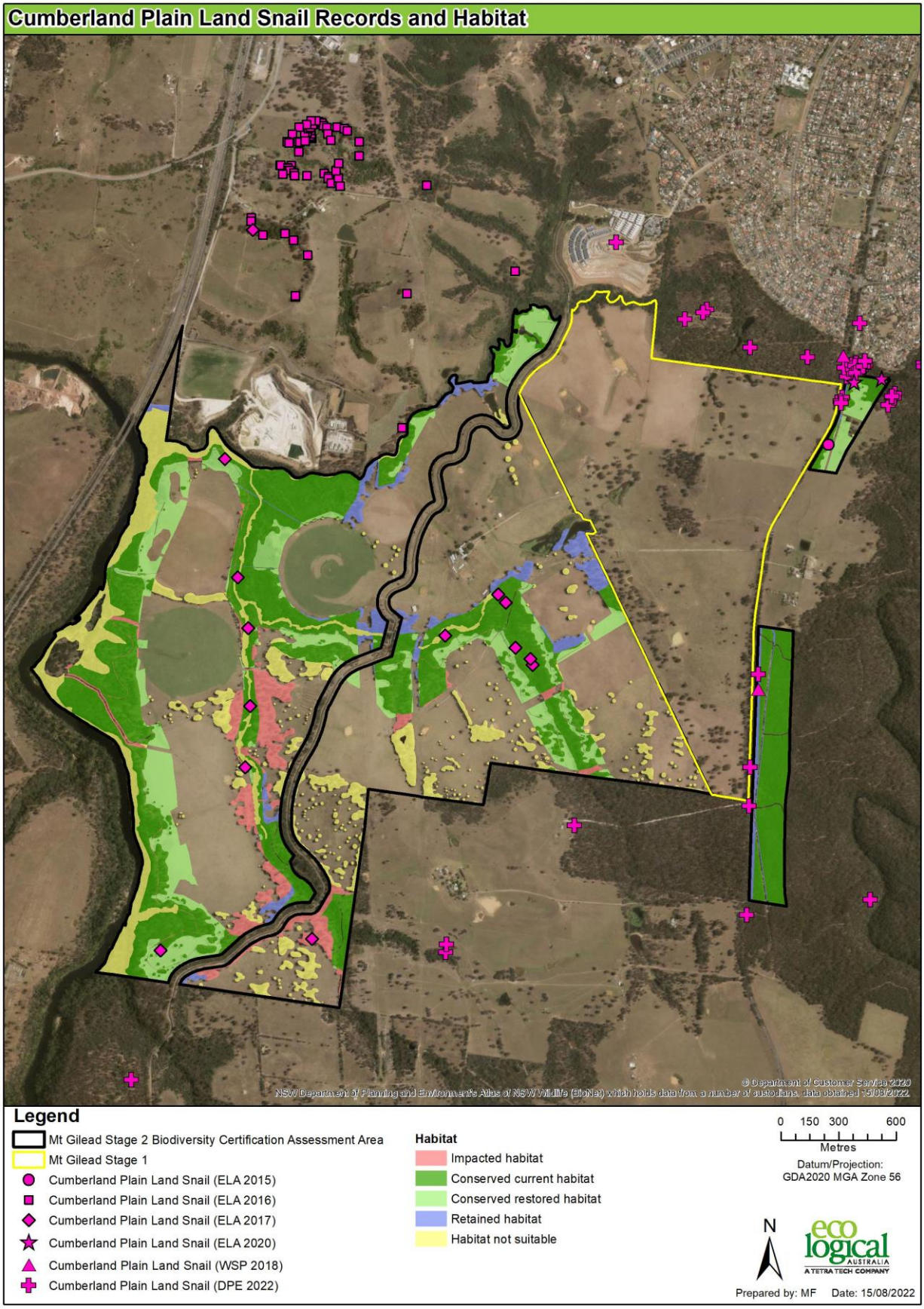


Figure 18: Records and habitat polygon for Cumberland Plain Land Snail

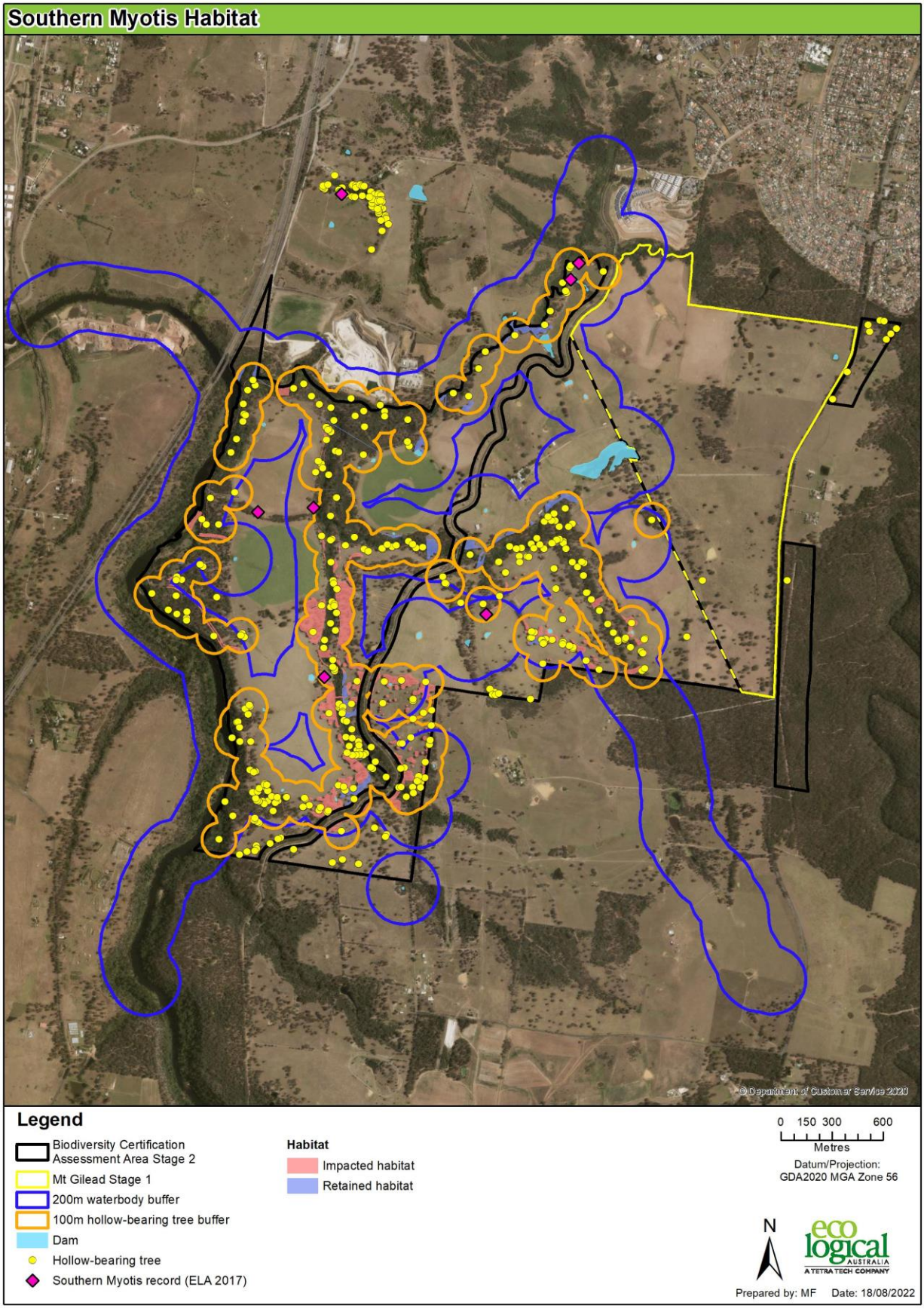


Figure 19: Records and habitat polygon for Southern Myotis prior to impacts and dam-dewatering

Note: Prospect Canal not included as a water body suitable as foraging habitat as water is heavily chlorinated

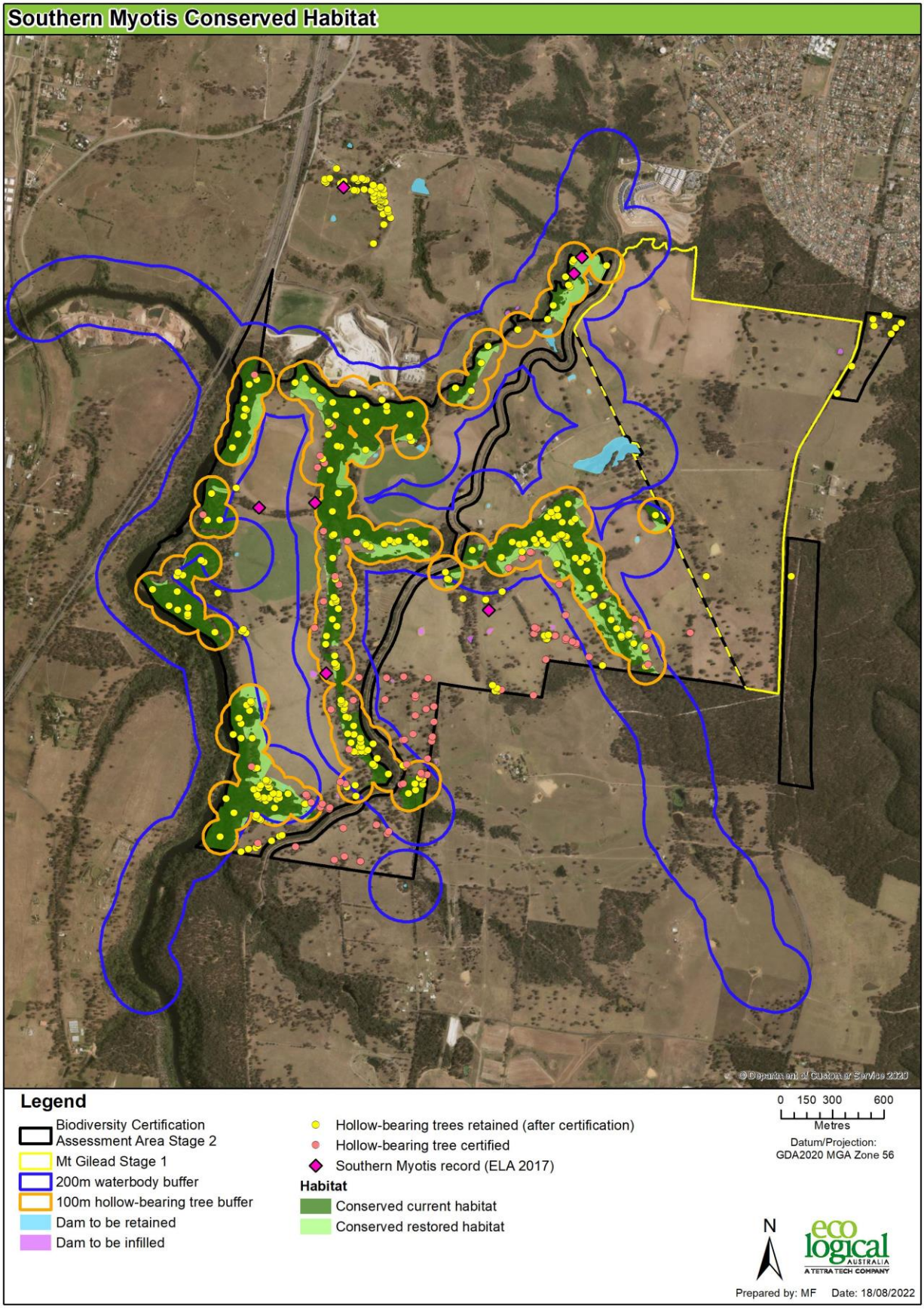


Figure 20: Records and habitat polygon for Southern Myotis post impacts, loss of hollow bearing trees and dam-dewatering

Note: Prospect Canal not included as a water body suitable as foraging habitat as water is heavily chlorinated

2.3.5 Red flag Areas

In accordance with Section 2.3 of the BCAM, a 'red flag area' is an area regarded as having high biodiversity conservation values if it contains one or more of the following:

- a critically endangered or endangered ecological community listed under the TSC Act or EPBC Act, and the vegetation is not in low condition (i.e. it has a site value score of > 34).
- a vegetation type that is greater than 70% cleared as listed in the Vegetation Types Database (that is, has 30% or less remaining of its estimated distribution in the catchment management authority (CMA) area before the year 1750), and the vegetation is not in low condition (i.e. it has a site value score of > 34).
- one or more threatened species identified in the Threatened Species Profile Database that cannot withstand further loss in the CMA area.
- an areas of vegetation recognised as having regional or state biodiversity conservation significance which includes:
  - land that is mapped or defined as a state or regional biodiversity link;
  - a riparian buffer 40 m either side of a major river on the coast and tablelands
  - a riparian buffer 30 m either side of a minor river or major creek on the coast and tablelands
  - a riparian buffer 20 m either side of a minor creek on the coast and tablelands.

Much of the BCAA comprises a red flag area with two of the five biometric vegetation types within the BCAA (SHW and SSTF) identified as a critically endangered or endangered ecological community listed under the TSC Act or EPBC Act and being classified as in 'moderate to good' condition (Table 9). Areas recognised as having regional or state biodiversity conservation significance are present within the BCAA including vegetation within the riparian buffer (30 m) of a minor river (the Nepean River) and within the riparian buffer (20 m) of a minor creek (Woodhouse, Menangle and Nepean Creeks). These areas therefore also represent red flag areas.

In addition, one flora species recorded within the BCAA (*Pomaderris brunnea*) is identified in the Threatened Species Profile Database as a species which cannot withstand further loss in the Hawkesbury Nepean CMA. The threatened fauna species recorded within the BCAA are all identified as species which 'can withstand further loss' within the database and are therefore not regarded as red flag areas.

The distribution of all red flag vegetation (EECs in moderate to good condition), red flag areas (riparian buffers) and threatened species that cannot withstand loss across the BCAA is shown in Figure 21.

Table 9: Vegetation zones that meet the definition of a red flag area (SV score > 34)

Red flag vegetation zones highlighted in red

Veg Zone	Vegetation	BVT ID	Ancillary Code	Condition	Red Flag (Site Value Score ≥ 34)	TOTAL Veg Area
1	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Weedy	Low	20	**24.45**
2	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Scattered trees	Low	21	**0.59**
3	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Regen	Low	32	**2.42**
4	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	Pasture improved / grazed	Mod-Good	39	**29.51**
5	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	Scattered trees	Low	33	**4.51**
6	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	DNG	Low	16	**3.11**
7	Cleared - restore to SPW	HN528	Cleared	Low	7	**13.54**
9	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	Weedy	Low	32	**0.38**
12	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	HN538	Good	Mod-Good	60	**8.35**
13	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Good	Mod-Good	83	**104.38**
14	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Thinned/Shrubby	Mod-Good	41	**10.16**

Veg Zone	Vegetation	BVT ID	Ancillary Code	Condition	Red Flag (Site Value Score ≥ 34)	TOTAL Veg Area
15	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Pasture improved / grazed	Mod-Good	33	**57.50**
16	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Scattered trees	Low	28	**6.89**
17	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	DNS	Mod-Good	35	**5.05**
18	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	DNG		11	**0.67**
19	Cleared - restore to SSTF	HN556	Cleared	Low	8	**35.15**
	Sub-total - Vegetation					**306.66**

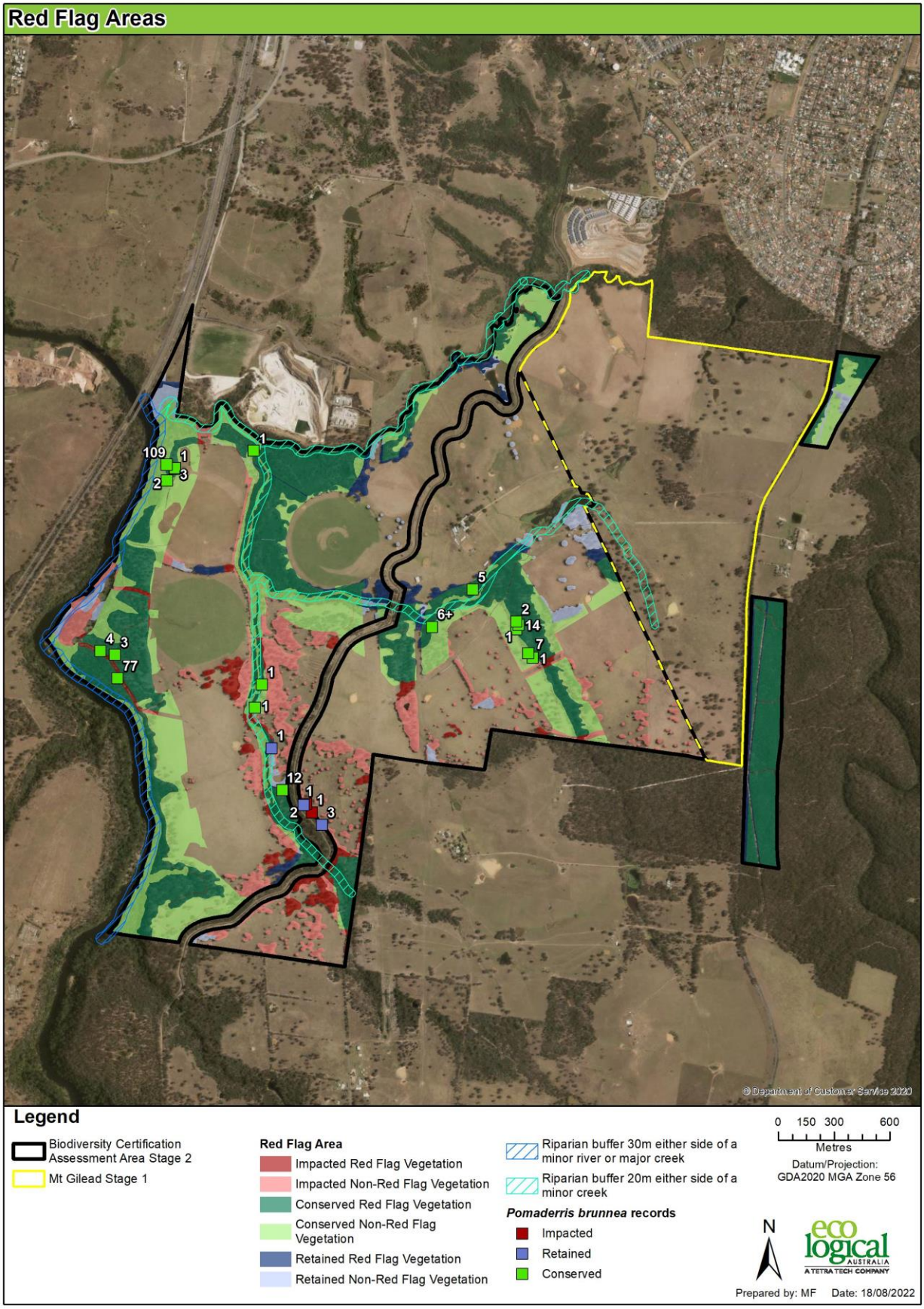


Figure 21: Red flag Vegetation, species and areas within the BCAA

3. More Appropriate Local Data used in the Biocertification Assessment

The BCAM outlines the methods by which general biodiversity values are assessed and measured in the BCAA to determine whether the conferral of biodiversity certification on land, as demonstrated in the application for biodiversity certification, improves or maintains biodiversity values (DECCW 2011a). These methods, along with the methods by which measurements of threatened species, assessments of indirect impacts on biodiversity values, and calculations of ecosystem and species credits are made, were followed in the Biocertification Assessment (Section 4).

According to the methodology, BVTs are used as surrogates for assessing general biodiversity levels. Information on each BVT, including a description, the vegetation class and formation to which it belongs, and percent cleared value, are contained within the Vegetation Types Database held by the OEH. A range of quantitative measures that represent the benchmark conditions for vegetation types are contained within the Vegetation Benchmark Database, also held by the OEH. The Vegetation Benchmark Database is organised by CMA, and as such, information for the same BVTs that may occur across different CMAs are repeated across CMAs, although the range of measures representing benchmark conditions can differ between CMAs to reflect variations in BVTs across their range.

Generally, default data contained in the Vegetation Benchmark Database are used when undertaking an assessment of, and measuring, general biodiversity values. However, the BCAM specifies that the Director General may certify that 'more appropriate local data' (MALD) can be used instead of the data in this database, 'where local data more accurately reflects local environmental conditions' (section 3.4 of the BCAM). Benchmark data that more accurately reflect the local environmental conditions for a BVT may be collected from local reference sites, or obtained from relevant published sources. Data other than benchmark data may also be obtained from relevant published sources. The Director General must provide justifications for certifying the use of local data. The certified local data can then be used in applying the methodology.

ELA considered that some of the benchmark values for 'Grey-Box – Forest Red Gum grassy woodlands on flats of the Southern Cumberland Plain, Sydney Basin Bioregion' and 'Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion', as contained in the Vegetation Benchmark Database, were not accurate reflections of the benchmark condition of these BVTs. This is because the database contained low or benchmark values that were not consistent with the vegetation types i.e. zero values for hollow-bearing trees and length of fallen logs, which would be expected to have some hollows and logs when in benchmark condition.

ELA has previously consulted with the OEH on this matter with regard to 'Grey-Box – Forest Red Gum grassy woodlands on flats of the Southern Cumberland Plain, Sydney Basin Bioregion'. An outcome of a previous discussion between ELA and Tim Hagar of the OEH was that 'local' benchmark data for the number of trees with hollows and for the length of fallen logs could be added for this BVT, with one and 50 m added for the number of trees with hollows and the length of fallen logs, respectively. This was to be consistent with other woodland/open forest vegetation types on the Cumberland Plain, and is consistent with the assessment undertaken for the Brownlow Hill Stages 1 and 2 Biobank Sites and other assessments undertaken by the OEH on the Cumberland Plain.

ELA also consulted with the OEH on this matter with regard to 'Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion' (email

correspondence with Tim Hager and John Seidel on 20 April 2015). The OEH advised that 'local' benchmark data for the number of trees with hollows and for the length of fallen logs could be added for this BVT, with one and 30 m added for the number of trees with hollows and the length of fallen logs, respectively. However, more recently, the Vegetation Information System has been updated and these benchmarks have now been amended to one and 50 m for the number of trees with hollows and the length of fallen logs, respectively.

As this is an error in the Biobanking Tool datasets, it is not considered that a formal application for the use of local benchmark data is required to be submitted to the OEH for approval. Accordingly, the local (or amended) benchmark values for the number of trees with hollows and the length of fallen logs in the two BVTs were used in this Biocertification Assessment (**Section 4**).

4. Biocertification Credit Assessment

This section details the results of the biodiversity certification assessment conducted to the requirements of the BCAM. Information is technical in nature, and relies on a broad understanding of the BCAM to understand the methods applied. Readers should make themselves familiar with the BCAM before reviewing this section of the document.

4.1 Biodiversity certification assessment area

The BCAA and proposed land use is shown in Figure 5 and is comprised of:

- Lands proposed for biodiversity certification – impacts to native vegetation and threatened species habitat in these areas 'requires' biodiversity credits;
- Land proposed for conservation – generates biodiversity credits; and
- Lands where the current land use will be retained (retained lands) – neither requires nor generates biodiversity credits.

The footprint proposed for 'biocertification' is 268.72 ha (53.50 ha of which comprises native vegetation as defined by the BCAM) (Table 10 and Figure 5) which includes APZs and certified open space that is counted as impacted but which will retain some biodiversity values and be managed as open space.

The land proposed for 'conservation measures' totals 225.36 ha (176.91ha mapped as native vegetation and 47.72 ha to be restored to native vegetation (this includes 3.43 ha of the red flag vegetation buffer area that is not part of the of 30 m in the APZ/open space areas that will be managed for conservation but will not generate ecosystem credits (see **Section 6.3 & 6.4**).

151.27 ha of land has been identified as neither impacted nor subject to conservation measures, and has therefore been assessed as 'retained land' (i.e. credits are neither required nor generated). Some of this land includes public open space areas where vegetation will be retained and enhanced amongst passive recreation areas (walking/cycling paths, BBQ areas etc).

Table 10: Land use breakdown

Development footprint	Area (ha)	% of BCAA	Area of native vegetation (ha)	% of native vegetation
Land proposed for Biodiversity Certification (Urban development and associated infrastructure - roads, bio-detention basins, APZs)	268.72	41.61	53.50 existing vegetation 215.22 cleared land	20.74
Land proposed for conservation (25.76 ha to be registered as 3 BSA sites	225.76	34.96	176.91 existing vegetation 47.72 to be restored 1.13 tracks/dams	68.58
Retained lands (land excluded from this assessment) includes Mt Gilead Homestead lands, Local Open Space and existing easements.	151.27	23.42	27.56 existing vegetation 123.71 cleared land	10.68
Total	**645.75**	**100**	**257.97**	**100**

4.2 Vegetation mapping and zones

As outlined in **Section 2.3.1**, five BVTs were identified in the BCAA which has been mapped into 19 vegetation zones (Table 8 and **Table 11**). There was 266.48 ha of vegetation mapped in total, with the dominant vegetation type being '*Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin'* (184.87 ha). The BCAA also supported 36.21 ha of '*Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin*', 8.74 ha of '*Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin*', 27.45 ha of '*Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion*' and 8.33 ha of '*Grey Myrtle dry rainforest of the Sydney basin Bioregion and South East corner*'. The remaining parts of the BCAA are categorised as cleared land (406.92 ha), which in the context of the BCAM includes exotic vegetation.

Table 11: Area of vegetation within the BCAA

Biometric vegetation type	Area (ha)	TSC Act	EPBC Act
HN526 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	27.46	RFEF (EEC)	RFEF (CEEC)
HN528 Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion	37.13	CPW SPW (CEEC)	CPSWSGTF (CEEC)*
HN529 Grey-Box – Forest Red Gum grassy woodlands on shale of the Southern Cumberland Plain, Sydney Basin Bioregion	0.38	CPW SHW (CEEC)	
HN538 Grey Myrtle dry rainforest of the Sydney basin Bioregion and South East Corner	8.35	N/A	N/A
HN556 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	184.65	SSTF (CEEC)	SSTF (CEEC)
Cleared land	387.78	NA	NA
Total	**645.75**		

Table 12: Area of vegetation zones assessed within the BCAA

Veg Zone	Vegetation	BVT ID	Ancillary	BioMetric Condition	Land proposed for certification	Land subject to conservation measures	Retained land	Red Flag Buffer	Total
1	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain	HN526	Weedy	Low	1.80	19.43	3.22	0	24.45
2	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain	HN526	Scattered trees	Low	0.18	0.06	0.35	0	0.59
3	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain	HN526	Regen	Low	2.16	0.25	0.01	0	2.42
4	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain	HN528	Pasture Improved	Mod-Good	7.75	12.86	8.70	0.2	29.51
5	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain	HN528	Scattered trees	Low	3.75	0.44	0.32	0	4.51
6	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain	HN528	DNG	Low	0.06	2.50	0.55	0	3.11
7	Cleared - restore to SPW	HN528	Cleared	Low	0.00	13.54	0.00	0	13.54
8	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain	HN529	Good	Mod-Good	0.00	0.00	0.00	0	0.00
9	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain	HN529	Weedy	Low	0.00	0.00	0.38	0	0.38
10	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain	HN529	DNG	Low	0.00	0.00	0.00	0	0.00
11	Cleared - restore to SHW	HN529	Cleared	Low	0.00	0.00	0.00	0	0.00

12	Grey Myrtle dry rainforest	HN538	Good	Mod-Good	0.27	7.81	0.27	0	8.35
13	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	Good	Mod-Good	3.70	91.99	5.98	2.71	104.38
14	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	Thinned/Shrubby	Mod-Good	0.60	9.14	0.07	0.35	10.16
15	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	Pasture Improved	Low	29.39	18.82	7.02	2.27	57.50
16	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	Scattered trees	Low	3.72	2.56	0.61	0	6.89
17	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	DNS	Mod-Good	0.12	4.68	0.08	0.17	5.05
18	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain	HN556	DNG		0.00	0.67	0.00	0	0.67
19	Cleared - restore to SSTF	HN556	Cleared	Low	0.00	34.18	0.97	0	35.15
	Sub-total - Vegetation				**53.50**	**218.93**	**28.53**	**5.70**	**306.66**

4.3 Transect/Plot data and site value scores

Appendix 4 of the BCAM defines the minimum number of transects/plots required per vegetation zone area (DECCW 2011a). Data from a total of 72 BioMetric vegetation transects/plots were collected across the BCAA. The transect/plot data imported into the credit calculator tool is provided in **Appendix K.**

Current site value and future site value scores were calculated for each vegetation zone using the transect/plot data collected. The BCAM credit calculator was used to produce the current and future site value scores for development and conservation areas (**Table 13**). Note that some changes were made to default settings for future site scores for 'additional management actions'. Additional gains within conservation areas were calculated above default for six site attributes: Native plant species richness, native over-story cover, native mid-story cover, native ground cover grasses, overstory regeneration and total length of fallen logs (vegetation zones 4, 5, 6, 7, 9, 10, 11, 15, 16, 17, 18 and 19), as shown in Figure 37**,** in line with the rules set out in Appendix 4 of the BCAM. This was done as it is proposed that logs with hollows will be brought into the conservation areas from the adjoining development areas and that where required, supplementary planting of over-story, mid-storey species is proposed. This will both increase native over-story and mid-storey cover, increase native plant species richness and decrease native grass cover (through shading which will thin native grass) over time in those vegetation zones that have these attributes in low condition.

Table 13: Site value scores allocated to each vegetation zone

***Indicates vegetation zones where 'additional management actions' (supplementary planting and/or bringing in logs) has been applied

Veg Zone	Vegetation	BVT ID	Ancillary	Condition	Current Site Value Score	Future Site Value Score (after Development)	Future Site Value Score (with Conservation measures)
1	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Weedy	Low	20	0	40
2	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Scattered trees	Low	21	0	41
3	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	HN526	Regen	Low	32	0	54

Veg Zone	Vegetation	BVT ID	Ancillary	Condition	Current Site Value Score	Future Site Value Score (after Development)	Future Site Value Score (with Conservation measures)
4	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	Pasture Improved / grazed	Mod-Good	39	0	70***
5	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	Scattered trees	Low	33	0	59***
6	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	DNG	Low	16	0	40***
7	Cleared - restore to SPW	HN528	Cleared	Low	7	0	30***
8	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	Good	Mod-Good	59	0	82***
9	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	Weedy	Low	32	0	62***
10	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	DNG	Low	19	0	40***
11	Cleared - restore to SHW	HN529	Cleared	Low	7	0	29***
12	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	HN538	Good	Mod-Good	60	0	80
13	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the	HN556	Good	Mod-Good	83	0	100

Veg Zone	Vegetation	BVT ID	Ancillary	Condition	Current Site Value Score	Future Site Value Score (after Development)	Future Site Value Score (with Conservation measures)
	edges of the Cumberland Plain, Sydney Basin Bioregion						
14	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Thinned/Shrubby	Mod-Good	41	0	56***
15	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Pasture Improved / grazed	Low	33	0	72***
16	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Scattered trees	Low	28	0	46***
17	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	DNS	Mod-Good	35	0	59***
18	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	DNG		11	0	36***
19	Cleared - restore to SSTF	HN556	Cleared	Low	8	0	36***

4.4 Landscape Score

The credit calculator calculated a landscape value score of **22** for the land to be certified, and a score of **18.2** for the land subject to conservation measures. The landscape value is calculated from the sum of the scores obtained from the following three attributes:

- percent native vegetation cover in the landscape
- connectivity value
- adjacent remnant area determined according to the Mitchell landscape in which most of the land proposed for biocertification occurs.

Scores for each landscape attribute for 'land to be certified' and 'land subject to conservation measures', as well as an explanation of how the scores were determined, are provided in the sub sections below.

4.4.1 Percent Native Vegetation Cover Score

The percent native vegetation cover calculation was completed within a single 3,000 ha circle (**Figure 22**). The area of vegetation cover was taken from the existing vegetation mapping of the Cumberland Plain (NPWS 2001) and digitised from an aerial photograph at a scale of approximately 1:10,000. The results of the assessment are contained in **Table 14**.

A pre-certification score of **13** was determined with 1,120.62 ha (1120.62/3,000 = 37.4%) native vegetation mapped within the 31-40% native vegetation cover class. Vegetation clearance would result in 1,122.99 ha of vegetation cover (37.4%) remaining in the assessment circle. The post certification score is also **13** because vegetation cover falls within the same 10% increment (31-40%).

Table 14: Native vegetation cover in assessment circle

Circle	Pre-certification			Post-certification		
	Area of vegetation within assessment circle (ha)	Native vegetation cover class (%)	Score	Area of vegetation within assessment circle (ha)	Native vegetation cover class (%)	Score
1 (3,000ha)	1,120.62 (37.35%)	31-40%	13	1,122.99 (37.4%)	31-40%	13

The land subject to conservation measures (post-biodiversity certification) is 225.76 ha, of which 176.91 ha is currently vegetated land, with 47.72 ha to be restored. Therefore (using Table 3 of the BCAM) a gain of **2.2** is recorded for the percent native vegetation score after conferral of biodiversity certification.

4.4.2 Connectivity Value

The current connectivity value of the site was assessed according to Section 3.7.2 of the BCAM. There are three components of connectivity; these are areas approved as a 'state' or 'regional' biodiversity links by the Director General, the hierarchy and riparian zone width of water courses in accordance with Appendix 1 of the BCAM and an assessment of vegetation connectivity. OEH have advised that there are currently no state or regional biodiversity links approved by the CEO of OEH relevant to the BCAA.

'Minor rivers' and 'major creek', defined as a 'regional biodiversity link', with a riparian buffer either side of a minor river or major creek, occur on land to be developed (**Figure 23**: Connectivity). They also occur on land subject to conservation measures. According to Table 4 of the BCAM the score for a regional

biodiversity link is **12**. As a regional biodiversity link is located on land proposed for biodiversity certification and will be impacted it was allocated a score of zero after development (**Table 15**). The vegetation on land subject to conservation is located on land within 30m of the riparian buffer of a minor river. Given this, there is a regional link on land subject to conservation measures, and a score of **12** was allocated post-certification.

Table 15: Connectivity scores allocated for the assessment

Connectivity score	Pre-certification	Post-certification
Land to be certified	12	0
Land subject to conservation measures	12	12

4.4.3 Adjacent Remnant Area

The BCAA predominantly occurs on the Upper Nepean Gorges Mitchell Landscape which is 31% cleared. The vegetation on site is well connected given the areas of moderate to good vegetation are separated by areas of low condition vegetation and cleared land, resulting in an adjacent remnant area (ARA) of 101 ha (**Figure 23**). This receives a score of **10** for Mitchell Landscapes within the 30-70% cleared range.

The land subject to conservation measures also occurs within the same Upper Nepean Gorges Mitchell Landscape with the same ARA of 101 ha. Therefore, the score allocated for the conservation lands is also **10**.

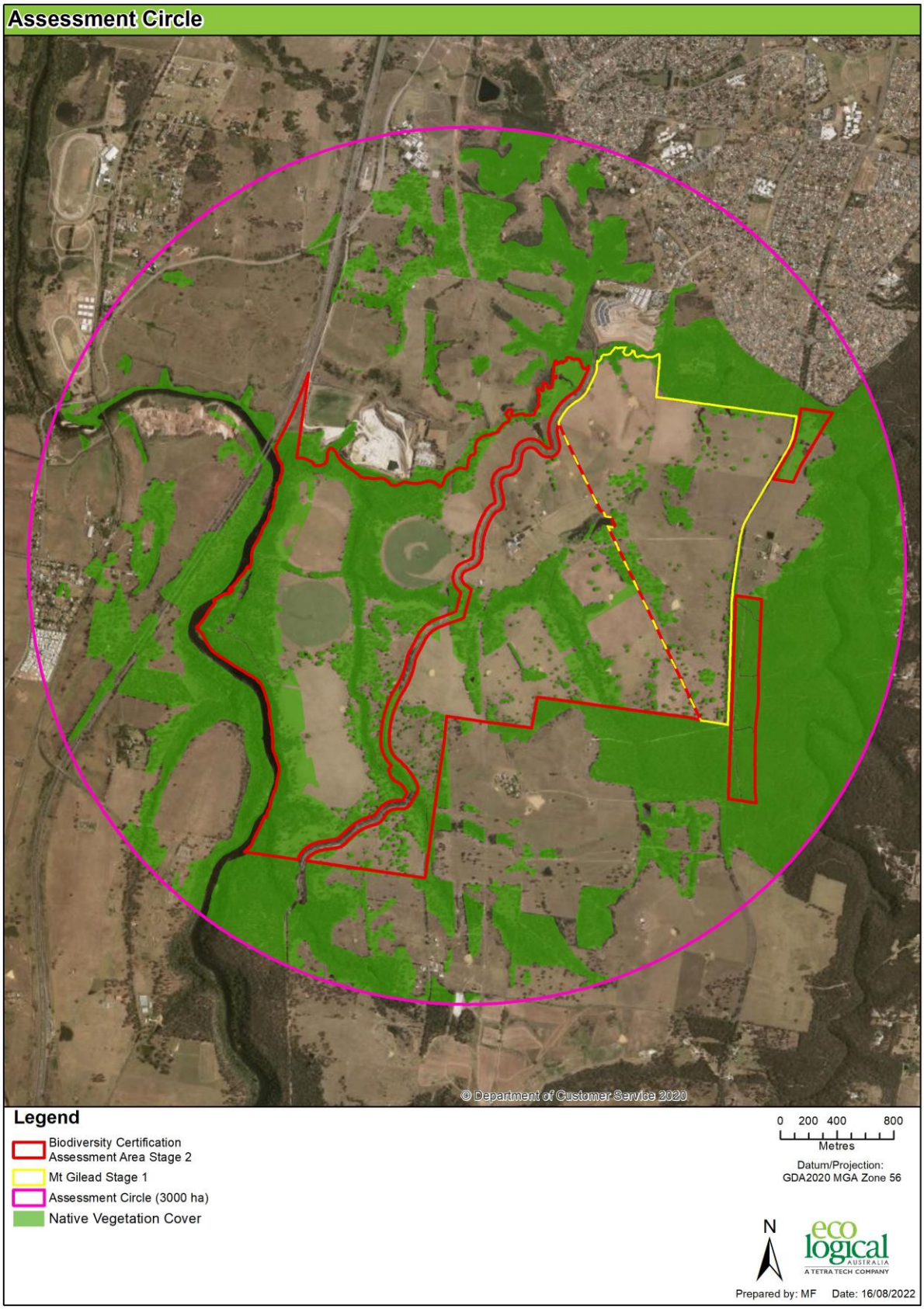


Figure 22: Assessment circle

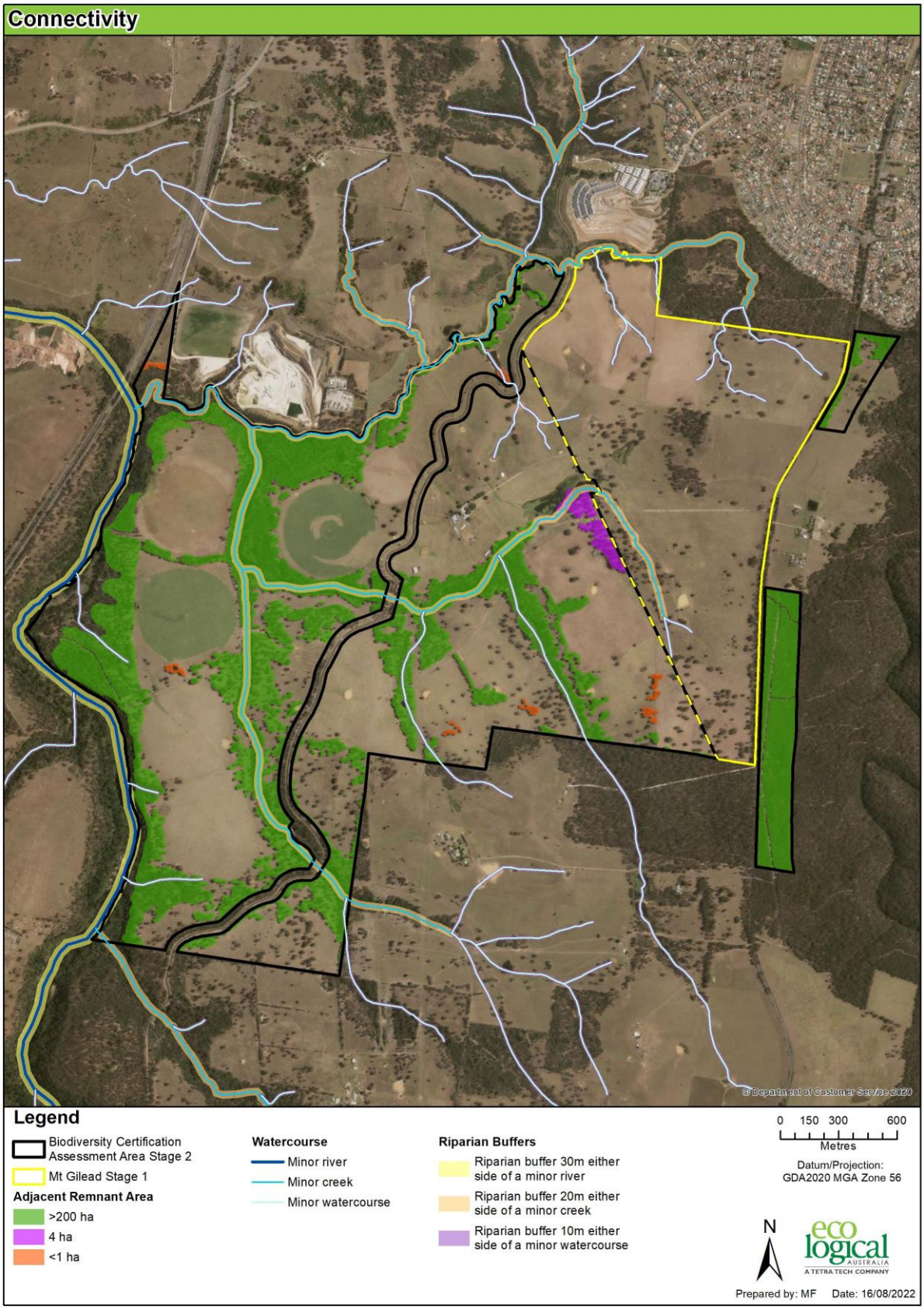


Figure 23: Connectivity

4.5 Red Flags

The BVTs, '*Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion*', *'Grey-Box – Forest Red Gum grassy woodlands on shale of the Southern Cumberland Plain, Sydney Basin Bioregion*' and '*Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion*' have been identified as comprising two CEECs (CPW and SSTF). These vegetation types are therefore 'red-flagged' when in moderate to good condition (a site value score greater than 34/100) under the BCAM (i.e. vegetation zones 4 and 8 for CPW and 13, 14 and 17 for SSTF).

All remaining vegetation zones and vegetation types identified as CEECs/EECs were in 'low' condition because the site value score for these vegetation zones was less than 34/100. Accordingly, these vegetation zones are not red flagged.

The area of impacted red flagged vegetation is shown in **Table 19** and **Figure 28.** Red flag areas should be avoided where possible and can only be impacted in accordance with the variation criteria outlined in Section 2.4 of the BCAM.

A total of 149.10 ha of red flagged vegetation is present within the BCAA of which 7.75 ha of degraded CPW (sv score 39) and 3.70 ha of high condition SSTF (sv score 83) and 0.72 ha of degraded (low condition SSTF, site value score less than 34-41) will be impacted. The majority of these impacts are to 'degraded' (as defined by BCAM) CPW and SSTF woodland that are currently subject to grazing, pasture improvement, firewood/fence post collection and are thus substantially outside of benchmark condition for many of the site attributes.

A red flag variation request prepared in accordance with the criteria set out in Section 2.4.1 and 2.4.2 of the BCAM is provided in **Section 5** for impacts to CPW and SSTF red flag areas. It is noted that a red flag variation request must be assessed and approved by the OEH before biodiversity certification can be conferred.

Pomaderris brunnea is an endangered shrub that is classified in the TSPD as a species that "cannot withstand loss". 2 plants may be impacted in land proposed for certification that are adjacent to the Prospect water canal.

A red flag variation request prepared in accordance with the criteria set out in Section 2.4.1 and 2.4.3 of the BCAM is provided in **Section 5** for impacts to *P. brunnea*. It is noted that a red flag variation request must be assessed and approved by the OEH before biodiversity certification can be conferred.

In addition there is 36.63 ha of vegetation within riparian buffers of minor creeks and rivers of which there will be impacts to 1.45 ha of vegetation within the 30 m buffer area of a minor river (Nepean River) and 0.78 ha of impacts to vegetation within the 20 m buffer area of a minor creek (Menangle, Nepean and Woodhouse Creeks) within the BCAA which are also classified as red flag areas **(Figure 28)**. These impacts are generally associated with three creek crossings in the proposed development footprint, the Nepean River waterfront park and an up to 1.5 m wide bush walking path along these creek lines.

A red flag variation request prepared in accordance with the criteria set out in Section 2.4.1 and 2.4.4 of the BCAM is provided in **Section 5** for impacts to vegetation within riparian buffer areas. It is noted that a red flag variation request must be assessed and approved by the OEH before biodiversity certification can be conferred.

4.6 Buffers on Red flag areas

Where a proposed conservation measure is used to protect land that is a 'red flag area' (i.e. CPW or SSTF in moderate to good condition), the area of the proposed conservation measure must include a buffer to mitigate any negative indirect impacts from development following the conferral of biocertification. The buffer area may be secured via a conservation measure and used to offset the impacts of biodiversity certification, or it may be a retained area in the biocertification assessment area (and not generate any credits) (see Section 6 of the BCAM).

In consultation with OEH for the Stage 1 biocertification assessment, it was determined that an appropriate buffer for the red flag vegetation in the proposed conservation area would be 30 m and this could be partly comprised by any perimeter roads (up to 15 m) separating development from the proposed conservation area and should be classified as a 'retained area' within the BCAA.

The Master Plan (Figure 4) has been designed with perimeter roads, APZs and open space areas providing a minimum 30 m buffer between urban development and conservation areas. These open space/APZs areas have been calculated on the basis of complete loss in the credit calculations, despite retaining biodiversity values (tree canopy). Where the perimeter roads/APZ/open space do not provide a full 30m buffer, the red flag buffer extends into the proposed conservation areas and has been assessed as not generating credits despite the commitment to register and manage these areas for conservation as part of the Biodiversity Stewardship sites (BSAs) as outlined in Section 6.3 and 6.4. Accordingly the credit calculations have included 5.70 ha of red flag EEC buffer within areas proposed for conservation.

The roads surrounding the conservation buffer area will be fully curbed and guttered with piped stormwater management that will not flow into the conservation area of buffer area.

4.7 Indirect Impacts

The BCAM requires that any application for biodiversity certification must demonstrate how the "*proposed ownership, management, zoning and development controls of the land proposed for biodiversity certification is intended to mitigate any indirect impacts on biodiversity values*" (DECCW 2011a).

Indirect impacts have been considered in accordance with the BCAM and have been determined to be negligible on the basis that all 'direct impacts' have been assessed on the assumption of complete loss of all biodiversity values including where these losses are only partial e.g. for Asset Protection Zones (APZs) or may be reduced due to provision of additional local open space in detailed precinct planning.

The Master Plan (Figure 4) has been designed with perimeter roads and open space areas providing at least a 30m buffer between urban development and conservation areas (thus negligible in direct impacts to actively managed, conservation areas). Further, whilst these open space areas provide a dual role (they serve as bushfire APZs and will also include landscaped bio-retention basins, and walking/cycling paths), as the tree canopy cover in these areas is currently well below APZ requirements, they will largely retain existing trees and will include landscape plantings, including preferred Koala browse species (Forest Red Gum, Grey Box, Grey Gum), to further enhance their habitat for biodiversity values (Koala, Squirrel Glider, Southern Myotis). Figures 24-26 show the typical landscaping of bio-retention basins, the urban/conservation area interface and indicative management of these open space areas.

In effect the APZ areas will provide a buffer between the development lands and the adjacent conservation areas, thereby mitigating and buffering any indirect impacts such as increased weeds, run-off, changed noise and light conditions.

All proposed conservation areas, including buffer areas, will be managed in accordance with BSA management plans and their associated reporting, audit and compliance requirements.

4.7.1 Indirect Impacts - Stormwater Management

Inappropriate water, sewer and stormwater management presents potential risks to the integrity of the conservation areas. Water sensitive urban design (WSUD) features will be incorporated in the development. The preferred strategy option for water cycle management includes:

- Vegetated swales incorporated into general streetscape
- Vegetated filter strips located within open areas/parks adjacent and upslope of riparian corridors
- Gross Pollutant Traps strategically located at outlet of stormwater drainage systems
- Bio-retention (filtration) system located at the outlet of stormwater drainage system and off-line from existing waterways (and outside riparian zones where practicable)
- Rehabilitated natural drainage channels incorporating stormwater treatment measures

Stormwater runoff from urban areas will first be treated in off-line bio-retention basins (22.53 ha of the land to be certified containing 3.63 ha of native vegetation) before being discharged to the streams. These basins will treat for water-borne pollutants such as nutrients and suspended solids, and will also reduce discharge rates during small but frequent rainfall events, those which have greater impact on stream erosion.

The detention basins will include appropriate plantings arounds the banks that will provide habitat for birds, frogs and foraging/nesting resources for bats, birds and arboreal mammals, including Koala. This will provide a strong buffer area between the urban development interface and the proposed conservation areas. An indicative design of the bio-retention basins/swales is depicted in Figure 24. The water captured in the detention basins will only be retained for as long as required for it to be released at pre-development flow rates, once discharged (shortly after a rainfall event), the areas quickly dry out as an ephemeral water course. The quantity and quality of the water flowing out of the detention basins into natural watercourses, including through proposed offset areas, will be of a higher standard than pre development rural run-off and no different to the current high and low flow events.

While impacts on vegetation outside those shown on plans will be minimal, there will be some disturbance associated with ancillary works, such as stormwater pipes discharging to streams and sewer mains crossing under vegetated areas. Wherever practicable they will be aligned with proposed or existing disturbances such as road crossings of corridors, existing easements and cleared areas. Impacts outside of this are anticipated to affect less than 1-2% of the vegetated areas and will be re-vegetated.

4.7.2 Indirect Impacts - Koala movement corridors

There is potential for some indirect impacts resulting from the fragmentation of movement corridors or cumulative loss of foraging opportunities for some threatened fauna species. For example, removal of vegetation, including scattered paddock trees, and their replacement with residential housing, could impede the movements/access of the species credit species (Koala, Squirrel Gliders), as well as other fauna species. Albeit any potential minor impact would be significantly compensated through the restoration of pasture areas.

In March 2018, Campbelltown Council prepared a report on the findings of the South Campbelltown Koala Habitat Connectivity Study (Biolink 2018) and recommended establishing "*at least three east west primary natural asset corridors in the Mt Gilead/South Campbelltown urban release area* (i.e. Menangle, Woodhouse and Mallaty Creeks*), with minimum widths ranging from 200m-425m with at least one corridor designed specifically for Koalas that achieves an average width of 425m*".

Further, in April 2020, the Office of the Chief Scientist & Engineer (OCSE) released a report (Chief Scientist NSW 2020) providing advice on the protection of the Campbelltown Koala population prepared by the Koala Independent Expert Panel in which a number of recommendations were made regarding priorities to link the Georges River and Nepean River catchments by protecting certain east-west corridors including average widths of these corridors, safe crossing points for Koalas across Appin Rd, provision of perimeter roads and vehicle speed limits, koala exclusion fencing and management of koala habitat. This report was further clarified and updated by the OCSE in February and May 2021 to include a number of principles addressing habitat connectivity, fauna crossings, threat mitigation, disease management and adaptive management.

The updated Master Plan (Figure 4) has been designed in response to these recommendations and the planning principles for the Mt Gilead land holdings and have identified Woodhouse Creek as a the primary Koala movement corridor within the BCAA between the DPIE Primary Koala corridor to the east of Appin Road, through the Beulah Biobank site, along Woodhouse Creek, to the Menangle Creek and Nepean River corridor and a second corridor is also provided along Menangle Creek (although it is noted that significant parts of this corridor are already impacted by existing development and constraints (bushfires) outside of the Mt Gilead proposal (Gilead Retirement Village) or are landholdings that Lendlease does not have control over (Mt Gilead Homestead and lands to north of Menangle Creek that are subject to the Cumberland Plain Conservation Plan) (Figure 27**)** and **Appendix L**. Further, the Master Plan is consistent with the identified koala corridors in the Greater Macarthur update (DPE 2021) prepared by the DPE's Technical Assurance Panel (**Appendix M).**

Subject to on-going consultation with DPIE and Roads and Maritime Services, a fauna underpass may also be established at Appin to provide two safe crossing point at the upgraded Appin Road in addition to a third crossing point further south outside of the BCAA area.

Lendlease have also prepared an updated Gilead Koala Conservation Plan (Lendlease 2022 **Appendix N**) to serve as a comprehensive conservation management framework to guide the design, planning, construction, habitation and long-term stewardship of the study area. The plan provides a detailed response to the NSW Chief Scientist & Engineers advice on the protection of the Campbelltown Koala population and alignment with CCC Koala Plan of Management. The plan identifies perimeter roads along all boundaries of these corridors, speed limits of 50kph, 1,500mm high koala exclusion fencing and grids to prohibit cars and dogs and the in perpetuity protection, E2 zoning and fully funded management and monitoring of three Biodiversity Stewardship sites protecting 225.76 ha of koala habitat . The larger Gilead Koala Conservation area comprises over 250 ha of fenced and managed koala habitat and includes additional buffer areas of outer APZs and rehabilitated detention basins and compliments the koala habitat protected and restored in Stage 1.

4.7.3 Mitigation measures to reduce direct and indirect impacts

Whilst all impacts within the land to be certified have been calculated on the assumption of complete loss, the following mitigation measures have been included to minimise impacts and address potential indirect impacts to areas proposed for conservation and retained areas:

A Construction Environment Management Plan (CEMP) has been prepared for vegetation clearing within the BCAA (**Appendix O**). The CEMP will guide the development outlined in this biocertification assessment and ensure that all direct and indirect impacts (e.g. APZs, utilities, access, stormwater run-off etc) are contained within the development footprint and appropriate mitigation measures are put in place to minimise indirect impacts to threatened fauna including Koala and Squirrel Glider. Specifically, this will address the management of the land proposed for conservation measures and its buffer such

that surrounding roads will be fully curbed and guttered with no stormwater being discharged into the conservation areas other than that treated within the bio-detention basins.

In addition, the CEMP will include, but not be limited to:

- temporary and permanent protective fencing will be erected around all areas identified for conservation prior to clearing activities to minimise any inadvertent damage
- a fauna pre-clearance protocol
- where trees are removed in the development area, these will be salvaged for fauna habitat values in the proposed BSA sites (i.e. meeting the additional management requirement if importing logs into the conservation area)
- a de-watering plan for any farm dams that are removed
- monitoring of performance measures and non-compliance.

Further, once registered, each BSA site will be required to provide an annual report that will include an audit of the implementation of management actions, monitoring of the condition of vegetation and threatened species.

A bioretention basin showing the transition from open space to vegetated basin, with footpath on farside and fenced off conservation area in the background.

Established native vegetation within a bioretention basin acting as a buffer to the conservation area in the background.

An aerial view of a bioretention basin functioning alongside residential development and conservation areas

Figure 24: Typical design and landscaping of proposed bioretention basins in open space/EEC buffers

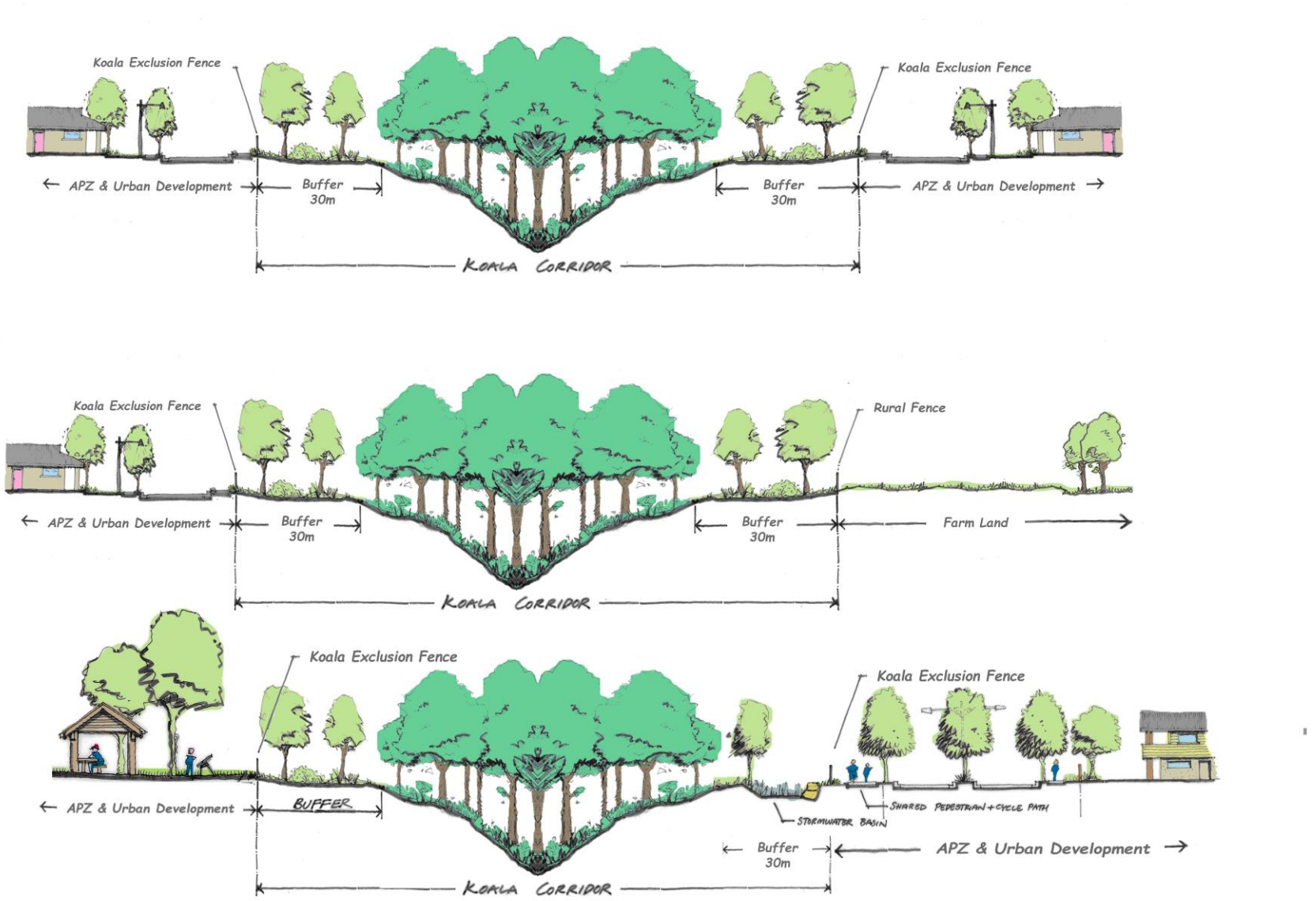
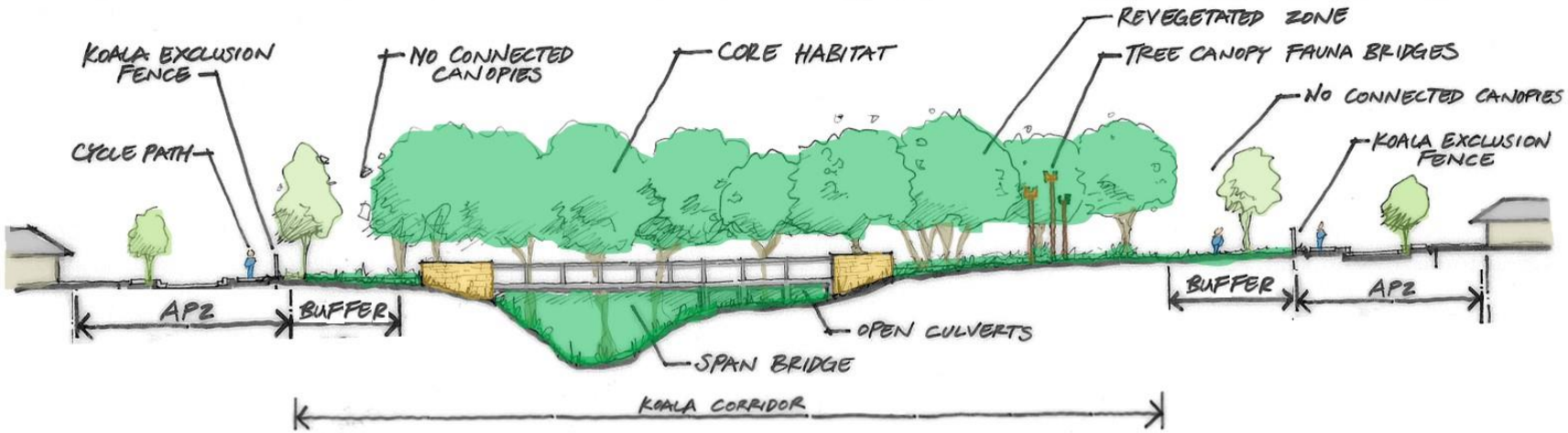


Figure 25: Typical interface of urban development, local open space and offset areas



WOODHOUSE CREEK BRIDGE

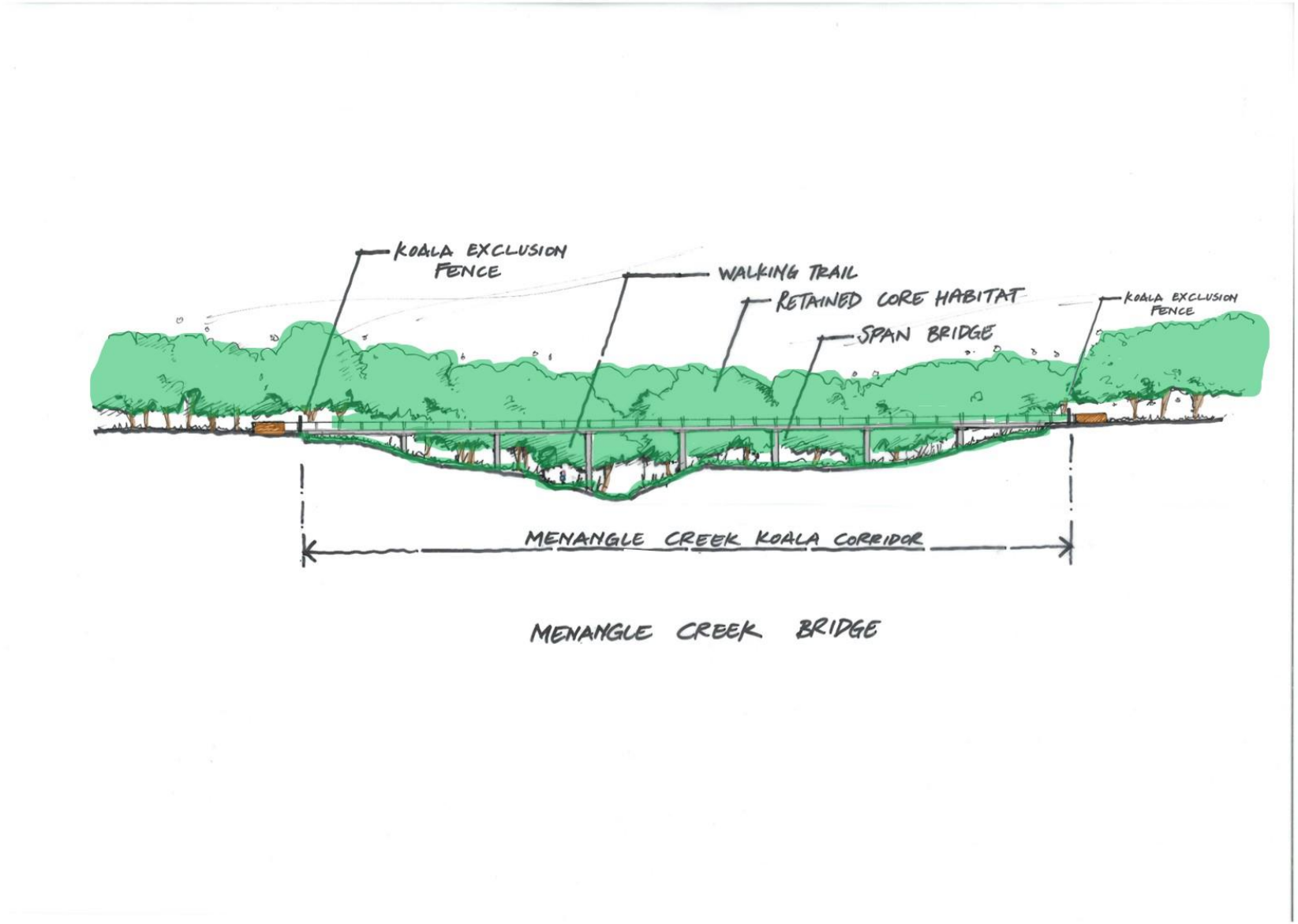


Figure 26: Typical cross section of creek crossing for Koala movement (Woodhouse and Menangle Creeks)

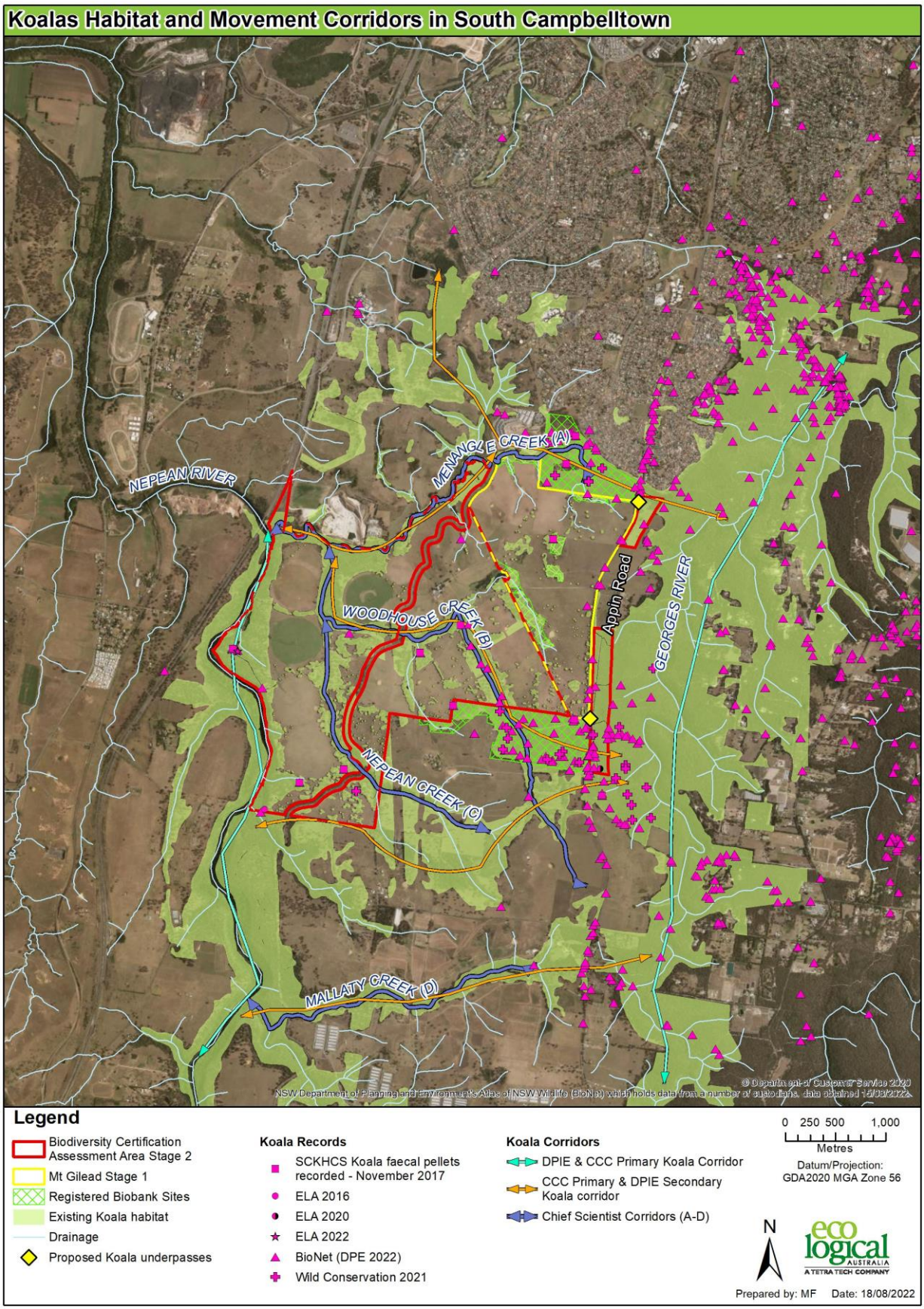


Figure 27 Koala records, habitat and movement corridors in the South Campbelltown Area as identified by CCC, DPIE & Chief Scientist

4.8 Credit Calculations

4.8.1 Ecosystem Credits

Ecosystem credits have been calculated for the loss of vegetation resulting from the proposed development. In total, **1,123** ecosystem credits are 'required' for the proposed development lands within the BCAA, Areas that are managed and funded in perpetuity within the BCAA will generate **2,427** ecosystem credits, all 'surplus' credits generated will be 'retired' as a condition of biodiversity certification.

As defined in the BCAM, different levels of protection and management for conservation lands results in the 'generation' of a different number of credits as outlined below:

- Areas that are managed and funded in perpetuity (i.e. registration of Biobank or BSA sites or gazettal of land as national parks) – 100% credit entitlement – generating **2,427** ecosystem credits;
- Areas that are managed in perpetuity (e.g. classification and management of land as community land 'Natural Area' under the Local Government Act 1993 and adoption of a Plan of Management etc) – 90% credit entitlement – generating **2,184** ecosystem credits - there are no areas to be secured through a Local Government Act Plan of Management as part of this assessment; and
- Areas that are secured through a planning instrument (i.e. environmental zoning) – 25% credit entitlement or **606** ecosystem credits – there are no areas to be secured through a planning instrument as part of this assessment.

All of the land subject to conservation measures within the BCAA will be secured by the registration of three Biodiversity Stewardship sites or BSAs (Browns Bush, Mt Gilead Homestead and Gilead as shown in Figure 38**.** All of the credits generated by the three BSAs will be BAM credits under the Biodiversity Conservation Act 2016 and not BCAM or BBAM credits**,** however a request for 'reasonable equivalence' will not be required as the value of these credits has been calculated by the BCAM credit calculator (as shown in **Table 16** and **Table 17**) and all credits generated by the BSAs will be retired.

All ecosystem credits 'required' are 'generated' by the proposed conservation measures, i.e. there will be no credit deficits. The commitment to register three BSAs actually generates a surplus of 1,304 ecosystem credits, however, all 'surplus' credits generated will be 'retired' as a condition of biodiversity certification.

4.8.2 Species credits

Species credit requirements have been calculated for *Pomaderris brunnea*, Koala, Squirrel Glider, Cumberland Plain Land Snail and Southern Myotis (for which 'breeding habitat' has been assumed to be present for this assessment in the '*land to be certified'* and '*land subject to conservation measures'* as outlined in **Section 2.2**.

A total of **3,668** species credits are required for impacts to *Pomaderris brunnea*, Koala, Squirrel Glider, Cumberland Plain Land Snail and Southern Myotis. The land proposed for conservation measures will generate **6,344** species credits as shown in Table 17 all 'surplus' credits generated will be 'retired' as a condition of biodiversity certification with all species other than koala having a surplus of credits. The deficit of 284 Koala credits will be met by retiring 99 Koala BBAM credits from the Noorumba Reserve Biobank site (BA239) held by Lendlease (Credit ID Holder 650) and the purchase of an additional 185 credits from registered biobank sites outside of the BCAA, or Biodiversity Stewardship sites or the BCT (subject to an assessment of credit equivalency, as outlined in **Section 6** of this report..

Table 16: Ecosystem credits 'required' for impacts and 'generated' by proposed conservation measures within the BCAA

			Credits required			Credits created			
Veg Zone	Vegetation	Area BCAA (ha)	Area certified (ha)	Credits required	Credits Req/ha	Area Offset (ha)	100% Measure	Credits Gen. / ha	Credit surplus / deficit
1	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	**24.45**	1.80	25	13.89	19.43	194	9.96	
2	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	**0.58**	0.18	3	16.67	0.06	1	16.67	129
3	Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	**2.42**	2.16	41	18.89	0.25	3	12.00	
4	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	**28.60**	7.75	168	21.68	12.86	168	13.06	
5	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	**4.50**	3.75	73	19.47	0.44	6	14.29	101
6	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	**3.11**	0.06	1	16.67	2.50	28	10.94	
7	Cleared - restore to SPW	**10.75**	0.00	0	0.00	13.54	141	10.44	
8	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	**2.42**	0.00	0	0.00	0.00	0	0.00	
9	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	**2.59**	0.00	0	0.00	0.00	0	0.00	0
10	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	**3.73**	0.00	0	0.00	0.00	0	0.00	
11	Cleared - restore to SHW	**6.21**	0.00	0	0.00	0.00	0	0.00	
12	Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	**8.33**	0.27	9	33.33	7.81	86	10.95	77
13	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	**104.45**	3.70	150	40.54	91.99	993	10.80	
14	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	**10.18**	0.60	14	23.33	9.14	108	11.78	997
15	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	**57.65**	29.39	573	19.50	18.82	253	13.47	
16	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	**6.85**	3.72	64	17.20	2.56	30	11.76	

			Credits required			Credits created			
Veg Zone	**Vegetation**	**Area BCAA (ha)**	**Area certified (ha)**	**Credits required**	**Credits Req/ha**	**Area Offset (ha)**	**100% Measure**	**Credits Gen. / ha**	**Credit surplus / deficit**
17	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	**5.07**	0.12	2	16.67	4.68	53	11.34	
18	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	**0.67**	0.00	0	0.00	0.67	7	10.45	
19	Cleared - restore to SSTF	**14.09**	0.00	0	0.00	34.18	356	10.43	
	Sub-total - Vegetation	**296.65**	**53.50**	**1,123**	**20.99**	**218.93**	**2,427**	**11.08**	**1,304**

Table 17: Species credits 'required' for impacts and 'generated' by proposed conservation measures within the BCAA

		Credits required			Credits created				
Species	**Area BCAA (ha)**	**Area certified (ha)**	**Credits required**	**Credits Req/ha**	**Offset Area (ha)**	**100% Measure**	**Credits Gen. / ha**	**90% Measure**	**Credit surplus / deficit**
CPLS	217.81	21.7	289	13.35	196.88	1,181	6.00	0	892
Southern Myotis	159.99	27.58	613	22.21	142.74	856	6.00	0	244
Koala***	282.21	66.27	1,744	26.32	243.4	1,460	6.00	0	-284
Squirrel Glider	285.25	44.68	993	22.22	224.42	1,347	6.00	0	354
Pomaderris brunnea	253	2	29	14.70	250	1,500	6.00	0	1,471
Total			**3,668**			**6,344**		**0**	**2,960**

***Of the 66.27 ha of Koala habitat to be impacted, 51.16 ha is direct impacts to koala habitat of which 6.26 ha is partial (APZ and walking tracks) or temporary impacts (bio retention basins) and 15.11 ha is indirect impacts (no access for koala's in retained open space areas).

Of the habitat to be impacted, 6.3 ha is high quality habitat (intact vegetation with a high proportion of preferred browse species), 11.78 ha moderate quality and is 33.12 ha is low quality (modified/thinned vegetation/scattered paddock trees with a low abundance of PKFTs (areas dominated by regrowth Ironbark's).

5. Red Flag Variation Request

5.1 Impact on Red Flagged Areas

The Biodiversity Assessment Report for the ecological values within the BCAA (**Section 2**) identified '*red flags*' as defined by the BCAM, some of which would be impacted by the land proposed for biocertification. The BCAM requires each of the criteria set out in Section 2.4 of the BCAM to be addressed in order for the Director-General to be satisfied that impacts to these '*red flags*' are able to be offset. This section addresses this requirement.

A red flag is triggered under the BCAM when there is an impact on any of the following:

- a vegetation type >70% cleared in the CMA for which it is mapped (not in 'low condition')
- a CEEC or EEC listed under the TSC Act or EPBC Act (not in 'low condition')
- a threatened species that cannot withstand further loss
  - the species is naturally very rare, is critically endangered, has few populations or is a restricted distribution
  - the species or its habitat needs are poorly known
- areas of vegetation recognised as having regional or state biodiversity conservation significance (including vegetation within a riparian buffer 20 m either side of a minor creek, 30 m either side of a minor river or major creek, or 40 m either side of a major river, as defined by Appendix 1 of the BCAM).

The Biodiversity Certification Operational Manual (OEH 2015c) states that each red flag area within the proposed biodiversity certification area should be numbered and listed in a table and shown on a map. Each red flag area impacted will require a separate red flag variation request unless the responses are the same for each entity, i.e. vegetation type is the same, patches are of similar condition, patches have the same connectivity etc.

Four of the BVTs recorded within the BCAA are listed EECs or CEECs

- 'HN526 *Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin* Bioregion' is equivalent to 'River-Flat Eucalypt Forest on the Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregion' (RFEF), which is an EEC listed on the schedules of the TSC Act,
- 'HN528 *Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion*' and 'HN529 *Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion*' are equivalent to 'Cumberland Plain Woodland in the Sydney Basin Bioregion' (CPW) - which is a CEECs listed on the schedules of the TSC Act and EPBC Act
- 'HN556 *Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion'* is equivalent to 'Shale Sandstone Transition Forest in the Sydney Basin Bioregion' (SSTF), which is a CEECs listed on the schedules of the TSC Act and EPBC Act

If these EECs are in 'moderate to good' biometric condition (as defined by the BCAM, i.e. they have a site value score greater than 34/100), they are considered to be 'red flag' vegetation'.

Five out of 19 mapped vegetation zones in the BCAA are in moderate to good condition and have a site value score greater than 34/100 (HN528 Zone 4, HN529 Zone 8, HN556 Zones 13, 14, & 17) (**Table 19** *and* **Figures 28, 29 and 30**). The BCAA contains 149.10 ha of red flag vegetation of which 12.17 ha will be impacted in four of these five zones and 122.10 ha will be protected by proposed conservation measures. There are no other vegetation types >70% cleared in the Hawkesbury Nepean CMA within the BCAA.

In addition to the red flagged vegetation, there is 36.63 ha of vegetation within the riparian buffers of a minor river (Nepean River) and major creek (Nepean, Menangle and Woodhouse Creeks) within the BCAA of which 2.23 ha will be impacted by three creek crossings (Woodhouse, Nepean and Menangle Creeks), the Nepean River Park open space areas and a proposed bush walking track (**Table 18** and **Figure 29**).

In addition, one flora species recorded within the BCAA (*Pomaderris brunnea*) is identified in the Threatened Species Profile Database as a species which cannot withstand further loss in the Hawkesbury Nepean CMA. The threatened fauna species recorded within the BCAA are all identified as species which 'can withstand further loss' within the database and are therefore not regarded as red flag areas (Figure 15)**.**

The distribution of red flag vegetation on land proposed for biodiversity certification is discussed below for each of the red flag variation criteria outlined in section 2.4 of the BCAM, and are shown in **Figure 28**, along with red flag vegetation that will be conserved or retained.

Table 18: Impacts to vegetation in areas defined as having regional or state biodiversity links (Riparian buffers)

Riparian Buffer	Area of native vegetation (ha)			
	Impacted	Conserved	Retained	Total
30m either side of minor river	1.45	9.64	1.15	12.24
20m either side of minor creek	0.78	20.36	3.21	24.35
Total	**2.23**	**30.00**	**4.36**	**36.59**

Table 19: Impacts to red flagged vegetation

Veg Zone	Vegetation Type	BVT ID	Ancillary	BioMetric Condition	Current Site Value Score	Red Flag area within BCAA	Red Flag area to be impacted	Red Flag area to be conserved	Red flag area to be retained	Red flag area within EEC buffers
4	Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion	HN528	Pasture Improved / grazed	Mod-Good	39	**29.51**	7.75	12.86	8.70	0.20
8	Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion	HN529	Good	Mod-Good	59	**0.00**	0.00	0.00	0.00	0.00
13	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Good	Mod-Good	83	**104.38**	3.70	91.99	5.98	2.71
14	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	Thinned/Shrubby	Mod-Good	41	**10.16**	0.60	9.14	0.07	0.35
17	Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion	HN556	DNS	Mod-Good	35	**5.05**	0.12	4.68	0.08	0.17
	Sub-total - Vegetation					**149.10**	**12.17**	**118.67**	**14.83**	**3.43**

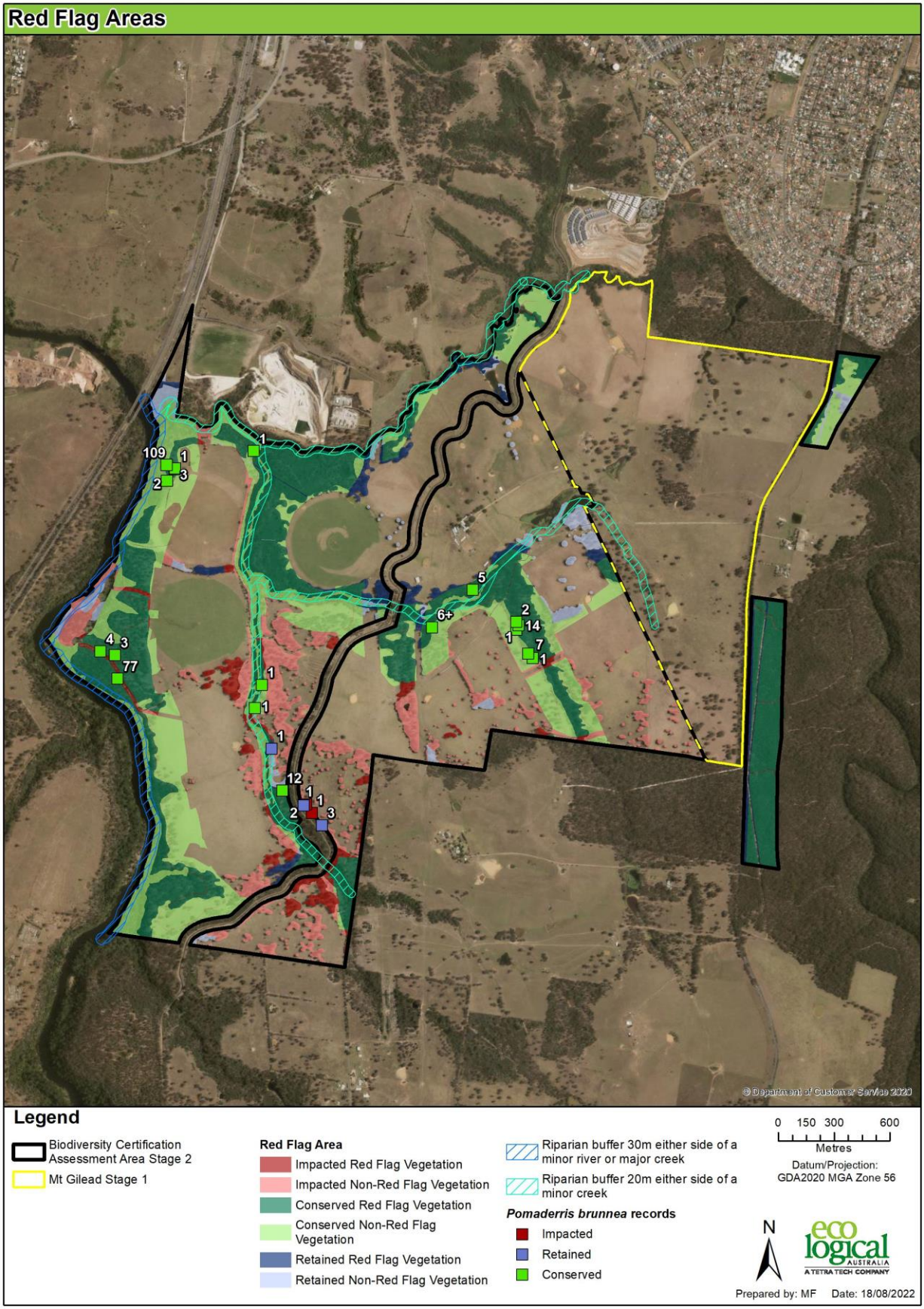


Figure 28: Impacted, conserved and retained red flag vegetation, species and areas of regional or state biodiversity conservation significance

5.2 Red Flag Variation Criteria

The presence of Red Flags within the proposed development area means that Biocertification of the land cannot be conferred unless a red flag variation is granted by the Secretary of the DPE. An application for a red flag variation must satisfactorily address the criteria in Section 2.4 of the BCAM (DECCW 2011a) for a proposal to be regarded as improving or maintaining biodiversity values.

The following criteria must be addressed for a vegetation type which is greater than 70% cleared or is a critically endangered or endangered ecological community:

1. Feasibility of options to avoid impacts on red flag area(s) where biodiversity certification is conferred (Section 2.4.1 of the BCAM)
2. Viability must be low or not viable (Section 2.4.2.1 of the BCAM)
3. Contribution to regional biodiversity values must be low (Section 2.4.2.2 of the BCAM).

The following criteria, as outlined in Section 2.4.3 of the BCAM, must be addressed when the red flag area contains a threatened species that cannot withstand further loss:

1. Viability of the red flag area must be low or not viable (Section 2.4.3.1 of the BCAM)
2. Contribution to regional biodiversity values must be low (Section 2.4.3.2 of the BCAM).

The following criteria, as outlined in Section 2.4.4 of the BCAM must be addressed for areas with regional or state biodiversity conservation significance:

a. The width of a riparian buffer with regional or state biodiversity significance must not be substantially reduced
b. The ecosystem functioning of a state or regional biodiversity link, considering migration, colonisation and interbreeding of plants and animals between two or more larger areas of habitat, must not be substantially impacted,
c. The water quality of a major or river, major or minor creek, or a listed SEPP 14 wetland must not be significantly impacted.

The following sections provide the information required for DPE to assess a red flag variation for the impacts to:

- 7.75 ha of HN528
- 4.42 ha of HN556
- 2.23 ha of vegetation in riparian buffers; and
- Up to 2 individuals of *Pomaderris brunnea*.

5.2.1 Avoiding and Minimising Impacts on Red Flag Areas (Criteria 2.4.1 of the BCAM)

The Director General must be satisfied that the feasibility of options to avoid impacts on red flag areas has been considered in the application for biodiversity certification. An application for biodiversity certification can address this requirement by demonstrating that:

a) all reasonable measures have been taken to avoid adverse impacts on the red flag areas and to reduce impacts of development on vegetation remaining within the biodiversity certification area

b) appropriate conservation management arrangements cannot be established over the red flag area given its current ownership, status under a regional plan and zoning and the likely costs of future management.

a) All reasonable measures to avoid adverse impacts

The land within the BCAA has been identified by the DPE as a Priority Precinct in the Greater Macarthur Growth Area (DPE 2015 and 2018). Following an assessment of the biodiversity values of the BCAA and surrounding lands between 2015 and 2017, Lendlease, have developed a Master Plan that is consistent with the Greater Macarthur Structure Plan and is sympathetic to biodiversity values. The Master Plan shown in Figure 4 has been developed through numerous iterations to avoid the higher quality vegetation/red flag areas and retain and enhance wildlife corridors, in particular for Koala and Squirrel Glider. As a result of these considerations, impacts to 136.93 ha of red flag areas have been avoided with 122.10 ha of this to be permanently protected in proposed BSA sites (**Table 19**).

b) Appropriate conservation management arrangements cannot be established over the red flag area given its current ownership, status under a regional plan and zoning, and the likely costs of future management

The BCAA is private land, currently zoned RU2 Rural Landscape in Campbelltown LEP 2015 and is currently used primarily for agricultural production – cattle grazing/horse agistment and some cropping. Under its current zoning and use, the land is not required to be actively managed for conservation.

5.2.2 Assessment criteria for red flag areas that contain CEECs (Criteria 2.4.2 of the BCAM)

Viability (Criteria 2.4.2.1 of the BCAM)

The BCAM states that:

The application for biodiversity certification must demonstrate to the satisfaction of the Director General that the viability of biodiversity values in the red flag area is low or not viable.

For the purpose of the methodology, viability is defined as the ability of biodiversity values at a site to persist for many generations or long time periods. The ecological viability of a site and its biodiversity values depend on its:

- *condition*
- *the area of the patch of native vegetation and its isolation*
- *current or proposed tenure and zoning under any relevant planning instrument*
- *current and proposed surrounding land use*
- *whether mechanisms and funds are available to manage low viability sites such that their viability is improved over time*

In making an assessment that the viability of biodiversity values in the red flag area is low or not viable, the Director General must be satisfied that one of the following factors applies:

a) The current or future uses of land surrounding the red flag area where biodiversity certification is to be conferred reduce its viability or make it unviable. Relatively small areas of native vegetation surrounded or largely surrounded by intense land uses, such as urban development, can be unviable or have low viability because of disturbances from urbanisation, including edge effects; or

b) The size and connectedness of the vegetation in the red flag area where biodiversity certification is to be conferred to other native vegetation is insufficient to maintain its viability. Relatively small areas of isolated native vegetation can be unviable or have low viability; or

c) The condition of native vegetation in the red flag area where biodiversity certification is to be conferred is substantially degraded, resulting in loss of or reduced viability. Native vegetation in degraded condition can be unviable or have low viability. 'Degraded condition' means substantially outside benchmark for many of the vegetation condition variables as listed in Table 1 of the methodology (s.3.6.2), without the vegetation meeting the definition of low condition set out in section 2.3. Vegetation that is substantially outside benchmark due to a recent disturbance such as a fire, flood or prolonged drought is not considered degraded for the purposes of the methodology; or

d) The area of a vegetation type in a red flag area on land where biodiversity certification is conferred is minor relative to the area containing that vegetation type on land subject to proposed conservation measures.

Impacted Red Flag vegetation within the BCAA has been grouped into four Patches based on the Vegetation Zone and site value scores. Each resulting patch has then been assessed against the four a-d viability criteria in Section 2.4.2.1 of the BCAM. Different criteria/factors (a, b, c or d) are considered in assessing the viability of the separate CEEC red flag areas/patches. Not all CEEC red flag areas are discussed under the different factors given viability is dependent on a number of factors, with some factors at play for some CEEC red flag areas and not others. However, each CEEC red flag area is discussed under at least one of the factors to demonstrate that viability of biodiversity values in red flag areas is low or not viable. **Table 20** summarises the criteria that are satisfied by the CEEC red flag area, with detail provided under each criteria, whilst the distribution of red flagged vegetation across the BCAA is shown in Figures 30 & 31.

Table 20: Red Flag Patches and Variation Criteria satisfied

CEEC red flag areas	Section 2.3.2.2. criteria satisfied
HN528 Veg Zone 4 (Patch 1) 7.75 ha with a sv score of 39 Refer to **Figure 29**	A - current and/or future proposed land use surrounding red flag area reduces viability B – Size and connectedness to other vegetation C - Red flag area is substantially degraded
HN556 Veg Zone 13 (Patch 2) 3.70 ha with a sv score of 83 Refer to **Figure 30**	D – Area of red flag vegetation impacted is minor relative to the area subject to conservation measures
HN556 Veg Zone 14 (Patch 3) 0.60 ha with a sv score of 41	A - current and/or future proposed land use surrounding red flag area reduces viability

CEEC red flag areas	Section 2.3.2.2. criteria satisfied
Refer to **Figure 30**	C - red flag area is substantially degraded
HN556 Veg Zone 17 (Patch 4) 1.12 ha with a sv score of 35 Refer to **Figure 30**	A - current and/or future proposed land use surrounding red flag area reduces viability C - red flag area is substantially degraded

a) Current or Future Land Use surrounding the red flag areas/patches 1, 2, 4 & 5

Lands surrounding these red flag areas are currently used for grazing and irrigation. This long and ongoing history of grazing and associated rural activities (pasture improvement, tilling, fire wood and post collection) have significantly reduced the viability of CPW and SSTF in these areas (in particular Patches 1, 4 and 5 which have site values scores of ≤41 and thus meet the definition of degraded – see Criteria (c).

The red flag areas generally occur as small patches scattered across large open areas of exotic grassland, cropped and/or grazed land with limited connectivity to larger patches in higher condition. Current land use is likely to result in on-going long-term impacts on the edges of the patches.

It is considered that red flag Patches 1, 3 and 4 meet this criterion.

b) Size and connectedness – Patch 1

Red Flag Patch 1 is 7.75 ha of SPW (a component of CPW). The 7.75 ha of Patch 1 comprises 9 smaller patches ranging in areas from 0.04 to 2.61 ha. Each of these smaller patches is either isolated/fragmented from other vegetation and/or adjacent to degraded patches of SSTF.

It is considered that these small patches have limited viability under current management regimes and permitted land uses and therefore Patch 1 meets this criterion.

c) Vegetation substantially outside of benchmark condition – Patches 1, 3 & 4

Patches 1, 3 & 4 are considered to be 'degraded' despite their being in biometric 'moderate-good' condition (site vale score > 34/100) as the site value scores for vegetation within these patches are all at the low end of the moderate to good range (i.e. site values scores of 39, 41 and 35 respectively which are very close to a site value score of 34 which is considered low condition and therefore not red flagged).

'Degraded', as defined by the BCAM means "*many of the vegetation condition variables are significantly outside benchmark*" (score of "0" or "1").

Of the 10 attributes measured in the 14 plots within Patch 1 (Veg Zone 4 – refer to **Appendix K – Plot data**) five, or 50% of the 10 attributes had a current score of "0" or "1" (Native mid-storey cover, Native ground cover grasses, No. of trees with hollows, length of fallen logs and exotic plant cover). Of the remaining five attributes, four have a score of "2" (Native plant richness, ground cover shrubs, ground cover other and over-storey regeneration). The only attribute with a score within benchmark, "3", was native over-storey. This reflects the description of this zone as being remnant tree canopy, lacking a mid-storey with a highly modified ground cover resulting from generations of pasture improvement and grazing.

It is considered that Patch 1 (Veg zone 4) meets this criterion as substantially degraded.

Of the 10 attributes measured in the 10 plots within Patch 3 (Veg Zone 14 – refer to **Appendix K – Plot data**) five of the 10 attributes had a current score of "0" or "1" (Native mid-storey cover, native ground cover grasses, trees with hollows, length of fallen logs and over-storey regeneration). Of the remaining five attributes, three have a score of "2". The only attributes with a score within benchmark, "3", was native plant species richness and native ground cover shrubs where 2 of the 10 plots had a high reading for shrubs. This reflects the description of this zone as being remnant tree canopy, lacking a mid-storey with a highly modified ground cover resulting from generations of pasture improvement and grazing. The overall site condition score for the zone was 41 which is marginally above the 'low condition' threshold of 34

It is considered that Patch 3 (Veg zone 14) meets this criterion as substantially degraded.

Of the 10 attributes measured in the two plots within Patch 4 (Veg Zone 17 – refer to **Appendix K – Plot data**) six of the 10 attributes had a current score of "0" or "1" (Native over-storey and mid-story cover, native ground cover other, trees with hollows, length of fallen logs and over-storey regeneration). Of the remaining four attributes, only three are within benchmark, "3" (native plant species, ground cover grasses and shrubs), but the overall site condition score for the zone was only 35 which is just above the 'low condition' threshold of 34.

It is considered that Patch 4 (Veg zone 17) meets this criterion as substantially degraded.

d) Relative area of red flag vegetation impacted is low compared to area within land subject to conservation measures – Patch 2

There are 3.70 ha of impact to red flag area/Patch 2 (Vegetation Zone, which whilst in high condition (site value score 83), is low, relative to the proportion of this vegetation zone in land proposed for conservation measures (94.70 ha or 3.9%). Of the 3.70 ha of impact, 0.35 ha is within APZ zones and 0.36 is a bush walking path up to a maximum of 1.5m wide that will avoid trees and shrubs.

It is considered that Patch 2 (Veg zone 13) meets this criterion.

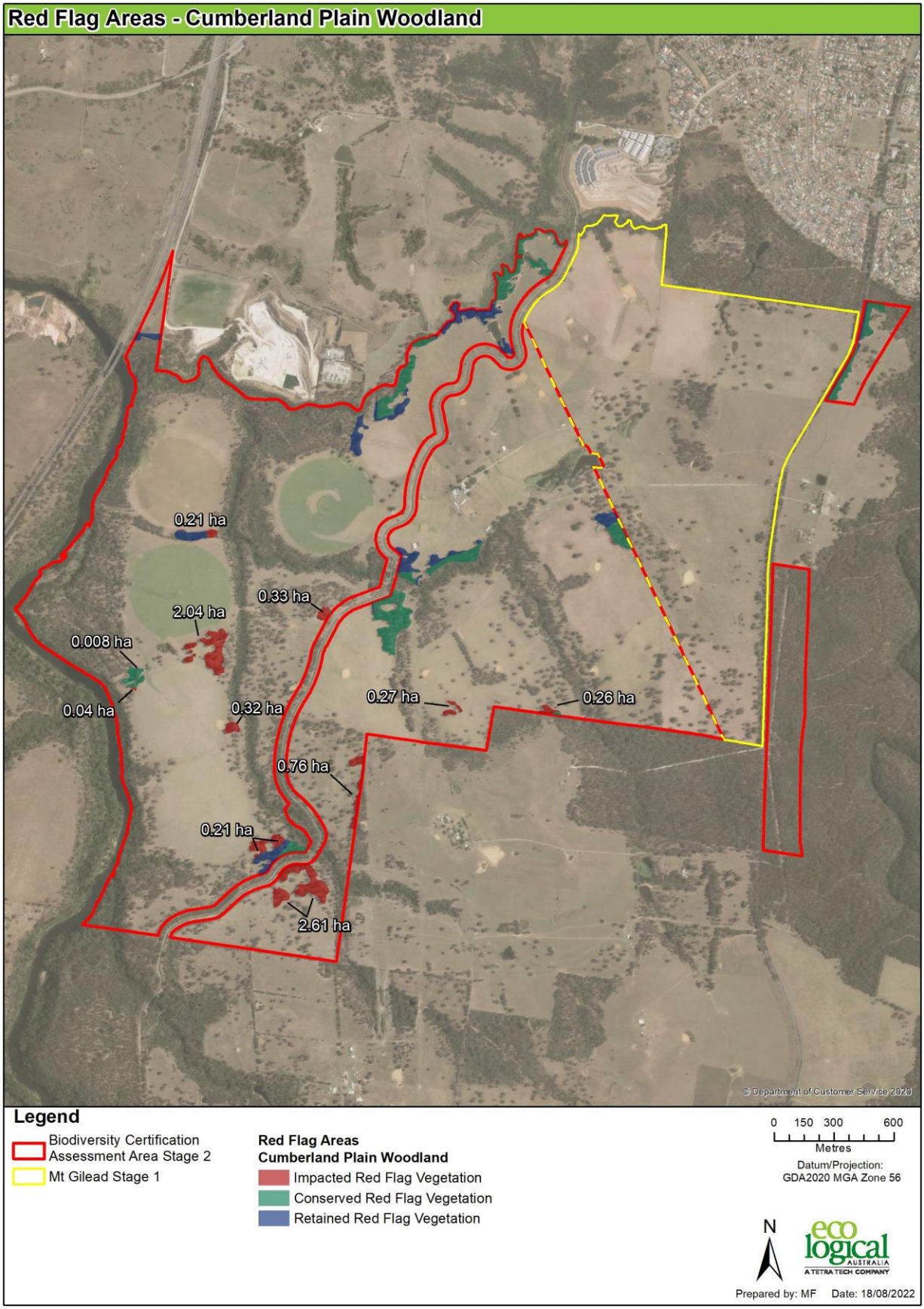


Figure 29: Distribution of impacted and protected Red Flag vegetation Patches 1 (CPW) within the BCAA

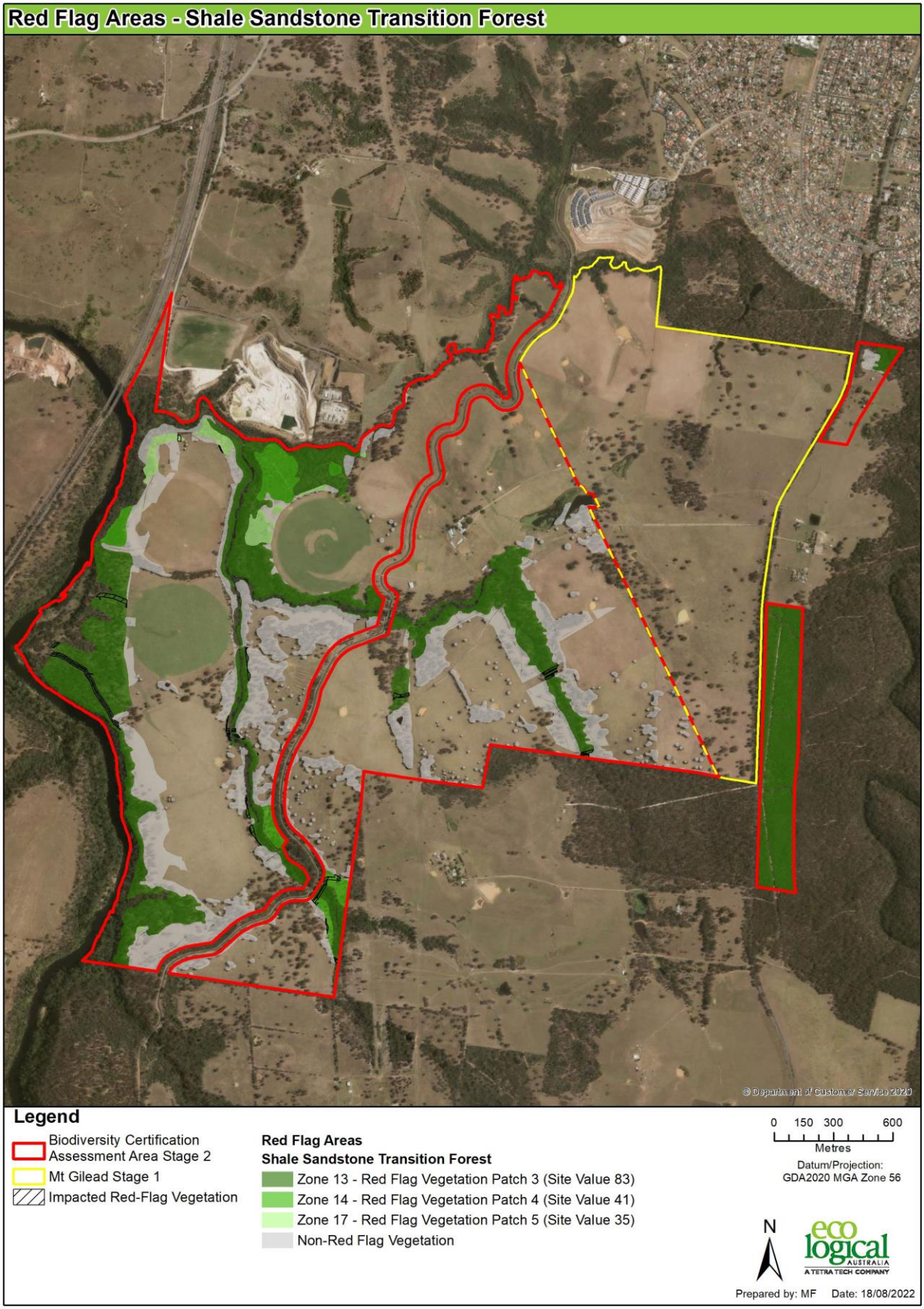


Figure 30: Distribution of impacted and protected Red Flag vegetation Patches 3, 4 and 5 (SSTF) within the BCAA

Contribution to Regional Biodiversity Values (Criteria 2.4.2.2 of the BCAM)

The BCAM states that:

> *The application for biodiversity certification must demonstrate to the satisfaction of the Director General* that *the red flag area on land proposed for biodiversity certification makes a low contribution to regional biodiversity values.*
>
> *In making an assessment that the contribution of the red flag area to regional biodiversity values is low, the Director General must consider the following factors for each vegetation type or critically endangered or endangered ecological community regarded as a red flag area:*
>
> *a) relative abundance: that the vegetation type or critically endangered or endangered ecological community comprising the red flag area is relatively abundant in the region; and*
>
> *b) percent remaining is high: that the percent remaining of the vegetation type or critically endangered or endangered ecological community comprising the red flag area is relatively high in the region; and*
>
> *c) percent native vegetation (by area) remaining is high: that the percent remaining of all native vegetation cover in the region is relatively high.*
>
> *'Region' for the purposes of section 2.4.2.2 means the CMA subregion in which the red flag area is located and any adjoining CMA subregions.*

The contribution to regional biodiversity values was assessed for the red flagged CPW and SSTF in the BCAA, using regional datasets where available. Under the BCAM the 'region' is defined as both the CMA subregion where the red flag area is located (in this case the Cumberland subregion of the Hawkesbury Nepean CMA) and adjoining CMA subregions: the Cumberland (Sydney Metro), Burragorang, Pittwater, Sydney Cataract (Hawkesbury/Nepean), Sydney Cataract (Sydney Metro), Wollemi, and Yengo CMA subregions as shown in Figure 31.

The use of regional vegetation datasets in this assessment, while the best data currently available, does have limitations. The data in some cases is several years old and therefore the extant mapping may require revision.

In addition, most regional vegetation mapping products only map patches greater than a minimum size (for example 0.5 ha) and generally only map vegetation in reasonably good condition. It is highly likely that smaller patches of the red flag vegetation type exist in the relevant regions, however have not been included in this assessment as the patches are too small to map, or the condition is disturbed and therefore has not been mapped.

Information on the contribution to regional biodiversity values, including an assessment of the relative abundance of the red flagged vegetation type, the percent remaining of the vegetation type, and percent native vegetation remaining in the region, is provided below.

a) Relative Abundance

The first measure for the contribution to regional biodiversity values criteria is a measure of relative abundance of the red flagged vegetation types in the 'region'.

Analysis was conducted into the relative abundance of the red flagged vegetation types across the entire 'region'. The associated data layers that were assessed included:

- Sub CMA Cumberland and Yengo (Hawkesbury Nepean) (Cumberland Plain western Sydney vegetation mapping; NPWS 2002);
- Sub CMA Cumberland (Sydney Metro) (Cumberland Plain western Sydney vegetation mapping; NPWS 2002);
- Sub CMA Pittwater (Cumberland Plain western Sydney vegetation mapping; NPWS 2002);
- Sub CMA Burragorang and Wollemi (Hawkesbury-Nepean) (Native Vegetation of the Warragamba Special Area; NPWS 2003a); and
- Sub CMA Sydney Cataract (Hawkesbury-Nepean and Sydney Metro) (Native Vegetation of the Woronora, O'Hares and Metropolitan Catchments; NPWS 2003b).

ELA is confident that the data used capture the majority of the BVTs HN528 SPW and HN556 SSTF as the extent of these BVTs are restricted to the 'region' as defined by the BCAM and is largely incorporated into the mapping used. The results of the analysis can be seen in **Tables 21 & 21** and Figures 32 and 33.

The results for the relative abundance assessment within the region for Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion re summarised below:

- 14,350 ha (of which 5,707 ha is in condition class A, B or C) is recorded within the Cumberland (Hawkesbury Nepean) sub CMA, in which the BCAA is located. The clearing of 7.75 ha of red flagged SPW vegetation represents 0.054% of the total extent of the BVT in the Cumberland (Hawkesbury Nepean) sub CMA and 0.14% in condition A, B or C.

- 17,839 ha (of which 6,745 ha is in condition class A, B or C) is recorded within the region in which the BCAA is located, 7.75 ha to be impacted by this proposal represents 0.043% of the extant 'Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion' or 0.12% of the extent of condition class A, B or C in the region.

The results for the relative abundance assessment within the region for '*Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion*' are summarised below:

- 11,555 ha (of which 5,886 ha is in condition class A, B or C) is recorded within the Cumberland (Hawkesbury Nepean) sub CMA, in which the BCAA is located. The clearing of 4.42 ha of red flagged SSTF vegetation represents 0.04% of the total extent of the BVT in the Cumberland (Hawkesbury Nepean) sub CMA and 0.08% in condition A, B or C.

- 21,769 ha (of which 9,949 ha is in condition class A, B or C) is recorded within the region in which the BCAA is located, 4.42 ha to be impacted by this proposal represents 0.02% of the extant '*Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion'* or 0.04% of the extent of condition class A, B or C in the region.

The above information indicates that the impact to the red flagged vegetation/CEECs from the proposal is 'relatively minor' when compared to the amount mapped in the analysed regions.

Table 21: Relative abundance of red flag CPW (SPW&SHW) vegetation in surrounding regions

Biometric vegetation type	Area impacted (ha)	Vegetation condition#	Area in Sub CMA (ha)								Total area in sub CMAs (ha)
			Cumberland (HN)	Cumberland (SM)	Burragorang	Pittwater	Sydney Cataract (HN)	Sydney Cataract (SM)	Wollemi	Yengo	
HN528 Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion	7.75	ABC	5,707	861	0.29	0	0	4	0	173	6,745
		Cmi & Txs	8,643	2,000	95	0	0	57	22	277	11,094
Total			**14,350**	**2,861**	**95.29**	**0**	**0**	**61**	**22**	**450**	**17,839**

Table 22: Relative abundance of red flag SSTF vegetation in surrounding regions

Biometric vegetation type	Area impacted (ha)	Vegetation condition#	Area in Sub CMA (ha)								Total area in sub CMAs (ha)
			Cumberland (HN)	Cumberland (SM)	Burragorang	Pittwater	Sydney Cataract (HN)	Sydney Cataract (SM)	Wollemi	Yengo	
HN556 Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin	4.42	ABC	5,886	593	977	14	49	485	119	1,826	9,949
		Cmi & Txs	5,420	711	1,113	7	54	466	176	1,436	9,383
		Unknown	249	0	874	0	1,106	0	208	0	2,437
Total			**11,555**	**1,304**	**2,964**	**21**	**1,209**	**951**	**503**	**3,262**	**21,769**

Vegetation condition follows NPWS (2002) with A, B, C being patches >0.5 ha in area and canopy cover projection density (CCPD) > 10%. Cmi, Txs being patches > 0.5 ha and CCPD < 10%.

Figure 31: The BCAA within the 'Region' derived from adjacent CMA subregions

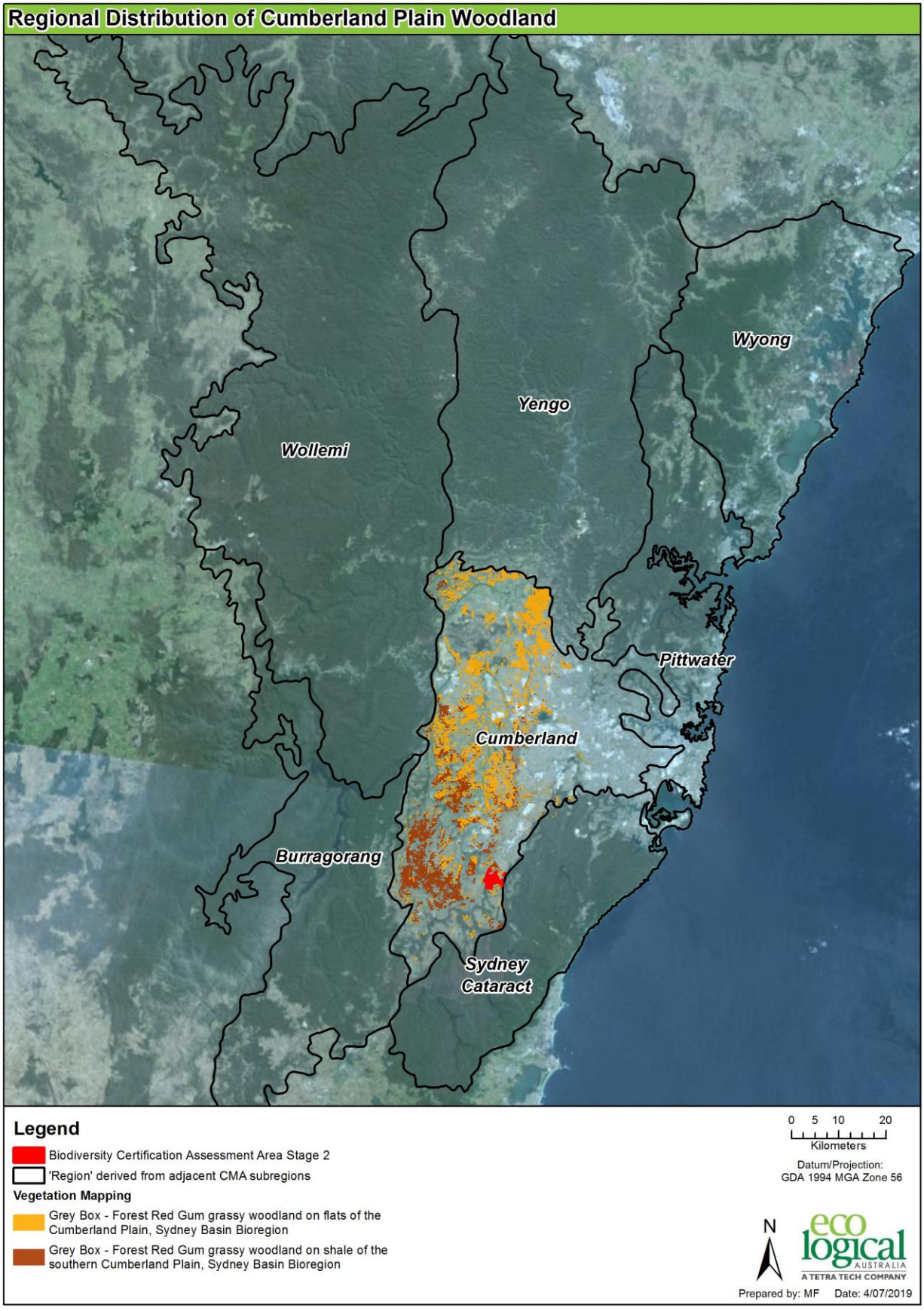


Figure 32: Regional distribution of red flag CPW vegetation

Figure 33: Regional distribution of red flag SSTF vegetation

b) Percent Remaining is high

There are few data sources available to determine the percent remaining of the vegetation type in the 'region'. While the database for BVTs (DECC 2008) has estimates for the percent remaining of each vegetation type, estimates are for entire CMAs, not for individual CMA subregions. Information at the subregion level is required to estimate the percent remaining of the vegetation type in the 'region' given the definition of 'region' includes the CMA subregion in which the BCAA occurs and any adjoining CMA subregions.

Given the lack of data sources to determine the '*percent remaining of the vegetation type in the 'region*', information on the percent remaining of the vegetation type was derived from the former National Parks and Wildlife Service's (NPWS) Cumberland Plain western Sydney vegetation mapping (NPWS 2002), Tozer et al. 2010 Native Vegetation of southeast NSW and the VIS database (OEH 2019). The results of the analysis are shown in **Table 23**.

It is noted that the mapping by NPWS (2002) does not included derived native grasslands in these percent remaining figures, which also meets the biometric condition 'moderate-good' definition or patches less than 0.5 ha in area.

The percent remaining of the red flag vegetation type in the region is not high.

Table 23: Percent remaining of each vegetation type/CEEC

Biometric vegetation type	Area impacted (ha)	% remaining in the Cumberland Plain (ABC condition) (NPWS 2002)	% remaining in the Cumberland Plain (ABC & Tx condition) (NPWS 2002)	Tozer et al. 2010	VIS Data base
HN528 Grey-Box – Forest Red Gum grassy woodlands on flats of the Cumberland Plain, Sydney Basin Bioregion	7.75	7.7%	20.5%	5-25%	7%
HN556 Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin	4.42	22.6%	44.0%	20-40%	20%

c) Percent Native Vegetation (by area) is high

The area of native vegetation was calculated for the region, being the Cumberland (Hawkesbury/Nepean (HN)), Cumberland (Sydney Metro (SM)), Wollemi, Burragorang, Sydney Cataract (HN), Sydney Cataract (SM), Pittwater and Yengo CMA subregions, is shown in **Table 24** and Figure 34. The OEH state-wide vegetation extent layer was used for the assessment (Keith and Simpson 2006) and was intersected with the six CMA subregions to determine the proportion of each region with native vegetation cover.

Table 24: Native vegetation cover of CMA subregions

Native vegetation cover	Burragorang (ha)	Cumberland (ha)	Pittwater (ha)	Sydney Cataract (ha)	Wollemi (ha)	Yengo (ha)	Total (ha)
Cleared	41,567 (18%)	231,218 (84%)	44,079 (35%)	17,095 (12%)	21,260 (4%)	29,613 (9%)	384,831 (24%)
Vegetated	192,769 (82%)	44,200 (16%)	80,915 (65%)	131,254 (88%)	485,884 (96%)	293,273 (91%)	1,228,296 (76%)
Total	**234,335 (100%)**	**275,418 (100%)**	**124,994 (100%)**	**148,349 (100%)**	**507,144 (100%)**	**322,886 (100%)**	**1,613,127 (100%)**

In total, 76% (1,228,296 ha) of the assessment region contains native vegetation cover. The proportion of vegetation cover for five of the CMA subregions is high, with Burragorang containing 82%, Pittwater containing 65%, Sydney Cataract containing 88%, Wollemi containing 96% and Yengo containing 91% vegetation cover. As stated earlier, the vegetation types impacted are predominantly located on the Cumberland Plain, and therefore very little of the vegetation types are likely to extend into the surrounding five CMA subregions. This assessment demonstrates that the majority of the CMA subregions assessed are relatively well vegetated, however when considering the two Cumberland CMA subregions, which are 16% vegetated, native vegetation cover is low.

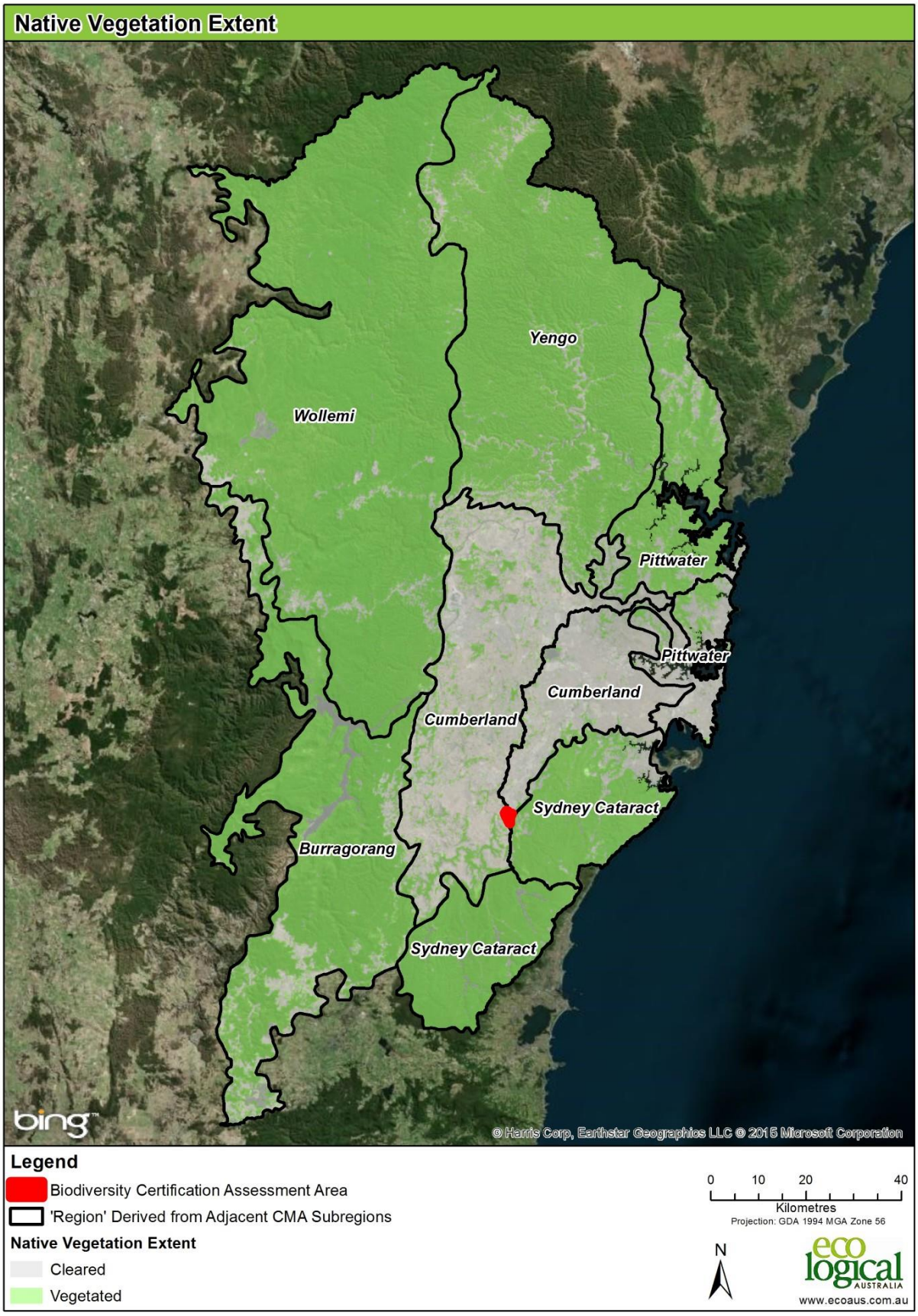


Figure 34: Native vegetation extent

5.2.3 Additional assessment criteria for threatened species that cannot withstand further loss (Criteria 2.4.3 of the BCAM)

Where the red flag area contains a threatened species that cannot withstand further loss as defined in section 2.3 of the methodology, the application for biodiversity certification must demonstrate to the satisfaction of the Director General that:

- the viability of the red flag area must be low or not viable in accordance with section 2.4.3.1
- the contribution to regional biodiversity values of the red flag area is low in accordance with section 2.4.3.2.

Pomaderris brunnea, and endangered shrub was observed at 8 broad locations across the BCAA with 253 plants recorded, and an additional five plants were recorded within the Sydney Water canal (Figure 15). The majority of plants were observed in areas of higher quality, ungrazed SSTF (vegetation Zone 13) or in steep, inaccessible areas along creek lines (Woodhouse and Nepean Creeks) and behind fencing (Nepean River and Sydney Water Canal) where domestic stock had limited access. Outside of these protected areas, plants showed signs of grazing pressure and where regeneration was occurring, plants were noticeably grazed/stunted.

Six locations where the species was recorded, representing 251 individuals, are in proposed conservation areas and a further five individuals are within the Sydney Water Canal corridor and will not be impacted by the proposed development. Two plants are likely to be impacted by earth works associated with the construction of perimeter roads adjacent to the Sydney Water Canal.

Viability (Criteria 2.4.3.1 of the BCAM)

The BCAM states that:

> *The application for biodiversity certification must demonstrate to the satisfaction of the Director General that the viability of biodiversity values in the red flag area is low or not viable.*
> *For the purpose of the methodology, viability is defined as the ability of biodiversity values at a site to persist for many generations or long time periods. The ecological viability of a site and its biodiversity values depend on its:*
>
> - *condition*
> - *the area of the patch of native vegetation and its isolation*
> - *current or proposed tenure and zoning under any relevant planning instrument*
> - *current and proposed surrounding land use*
> - *whether mechanisms and funds are available to manage low viability sites such that their viability is improved over time.*
>
> *In making an assessment that the viability of biodiversity values in the red flag area is low or not viable, the Director General must be satisfied that one of the following factors applies:*
>
> a. *The current or future uses of land surrounding the red flag area (species) reduce its viability or make it unviable. Relatively small areas of threatened species habitat surrounded or largely surrounded by intense land uses, such as urban development, can be unviable or have low viability because of disturbances from urbanisation, including edge effects.*
> b. *The size and connectedness of vegetation in the red flag area to other native vegetation is insufficient to maintain its viability. Relatively small areas of isolated threatened species habitat can be unviable or have low viability.*
> c. *The condition of native vegetation in the red flag area is substantially degraded resulting in loss of or reduced viability. Native vegetation in degraded condition can be unviable or have low*

viability. 'Degraded condition' means substantially outside benchmark for many of the vegetation condition variables as listed in Table 1 of the methodology (s.3.6.2), without the vegetation meeting the definition of low condition set out in section 2.3. Vegetation that is substantially outside benchmark due to a recent disturbance such as a fire, flood or prolonged drought is not considered degraded for the purposes of the methodology.

d. *The area of a red flag area containing a threatened species on land where biodiversity certification is conferred is minor relative to the area containing that threatened species on land subject to proposed conservation measures.*

Viability Criteria 'a' and 'b' are satisfied

a) Current or Future Land Use surrounding the red flag areas

As indicated for the vegetation types assessment, the lands surrounding the red flag areas where *Pomaderris brunnea* will be impacted are currently used for grazing and irrigation. This long and on-going history of grazing and associated rural activities (pasture improvement, tilling, firewood and post collection) have significantly reduced the viability of *P. brunnea* and its habitat within the Mt Gilead BCAA. The majority of individuals observed were on the banks of steep and rocky creek lines that had protection from domestic stock. In areas where regeneration was occurring, the plants were visibly grazed and stunted.

Given the current and continuing land use, it is considered that the persistence of the 2 plants to be directly impacted is not viable, whereas the long term viability of the 251 plants and associated habitat areas proposed for conservation measures will be enhanced through removal of grazing and active conservation management.

d) The area of the red flag area to be conferred is minor relative to the area proposed for conservation measures

The two *P. brunnea* plants to be impacted represent 0.80% of the proportion to be subject to proposed conservation measures (2 impacted and 251 to be conserved = 2/251 = 0.80%).

Contribution to regional biodiversity values is low

In NSW, *P. brunnea* is known from 24 scattered populations in five regions (Walcha, Wollemi and lower Colo, the Upper Hunter Valley, the Capertee Valley) and the Nepean River and associated tributaries around Camden and Bargo (NSW Scientific Committee 2014) (Figure 35 **and** Figure 36**)**. A number of recent records (2018) have been added form Lake Burragorang in the Blue Mountains.

The National Recovery Plan (Sutter 2011) reported a total of 600 plants in NSW and Bremner (in litt June 2012 to Scientific Committee) reported 190 plants in 10 of 18 sites in south-west Sydney.

The 258 plants recorded within the BCAA, an unknown number of plants in the Beulah Biobank site on the southern boundary of the BCAA and further plants recorded at 24 locations east of Appin Road as part of the CPCP (DPIE 2020), are in addition to these earlier estimates. Indeed, BioNet shows 25-30 locations (abundance unknown) between Camden, Camden Park, Elderslie, Menangle, Appin, Wilton, Pheasants Nest and Bargo and southern extensions at Mittagong and Wingello.

Whilst the conservation status of many of these population is unknown, and likely not secure for many, within the Gilead area, the population within the Beulah Biobank site is permanently protected for conservation, the plants east of Appin Road are within a proposed Biodiversity Stewardship site for the

CPCP that will form part of the proposed Georges River Koala Reserve, and a further 225 ha of habitat, known to contain at least 250 individuals, is proposed for permanent protection within the BCAA.

Based on available information, the population within the BCAA is significant in the context of the status of the species in the region, however the loss of up to 2 plants from within the BCAA will not affect the status of the species in the region. The loss of up to 2 plants from the BCAA is low relative to its abundance in the region, which includes the immediate locality of Gilead.

5.2.4 Additional Assessment criteria for areas with regional or state biodiversity conservation significance (Criteria 2.4.4 of the BCAM)

The following criteria, as outlined in Section 2.4.4 of the BCAM must be addressed for areas with regional or state biodiversity conservation significance:

The width of a riparian buffer with regional or state biodiversity significance must not be substantially reduced

> The ecosystem functioning of a state or regional biodiversity link, considering migration, colonisation and interbreeding of plants and animals between two or more larger areas of habitat, must not be substantially impacted,
>
> The water quality of a major or minor river, major or minor creek, or a listed SEPP 14 wetland must not be significantly impacted

Width of riparian buffer with regional or state biodiversity significance (Criteria 2.4.4a)

The width of a riparian buffer with regional or state biodiversity significance (i.e. the riparian buffers on major or minor creeks and rivers) must not be substantially reduced.

The land to be certified includes impacts for a major road (Public Transitway) crossing at the Nepean Creek and use of land in an old rehabilitated sand quarry on the banks of the Nepean River as open space.

Whilst the Nepean Creek crossing will impact some vegetation during construction, a bridge will extend over the creek and allow for continuous vegetation linkages along the length of the creek, the width of the riparian buffer will not be substantially reduced.

Vegetation within the proposed river park is within an area previously used for sand and gravel extraction and comprises low condition RFEF (HN526). A one-way access road will link the urban area to this river frontage but will not impact riparian buffers, the area will be fully landscaped with picnic/BBQ areas and car parking and will retain significant areas of tree canopy. The careful landscaping of this area will ensure that the width of the riparian buffer will not be significantly reduced.

Ecosystem functioning of a state or regional biodiversity link (Criteria 2.4.4b)

The ecosystem functioning of a state biodiversity link or a regional biodiversity link must not be substantially impacted, considering migration, colonisation and interbreeding of plants and animals between two or more larger areas of habitat.

There are no registered state or regional biodiversity links as defined by section 3.7.2 of the BCAM that will be impacted by the application for biocertification therefore the ecosystem functioning of a state biodiversity link or a regional biodiversity link will not be substantially impacted.

Water quality of major river, minor river, major creek, minor creek or a listed SEPP 14 wetland (Criteria 2.4.4c)

The water quality of a major river, minor river, major creek, minor creek, or a listed SEPP 14 wetland must not be significantly impacted.

The BCAA are does not include a SEPP 14 wetland, therefore the water quality of a listed SEPP 14 wetland will not be impacted.

The BCAA includes ‘minor rivers’ and ‘minor creeks’ where 2.23 ha of remnant native vegetation will be impacted by creek crossings, walking paths and use of the river foreshore as public open space.

Stormwater runoff from urban areas will first be treated in off-line bio-retention basins before being discharged to the streams. These basins will treat for water-borne pollutants such as nutrients and suspended solids, and will also reduce discharge rates during small but frequent rainfall events, those which have greater impact on stream erosion. These bio-detention basins are all located outside of the riparian buffers and within the urban footprint.

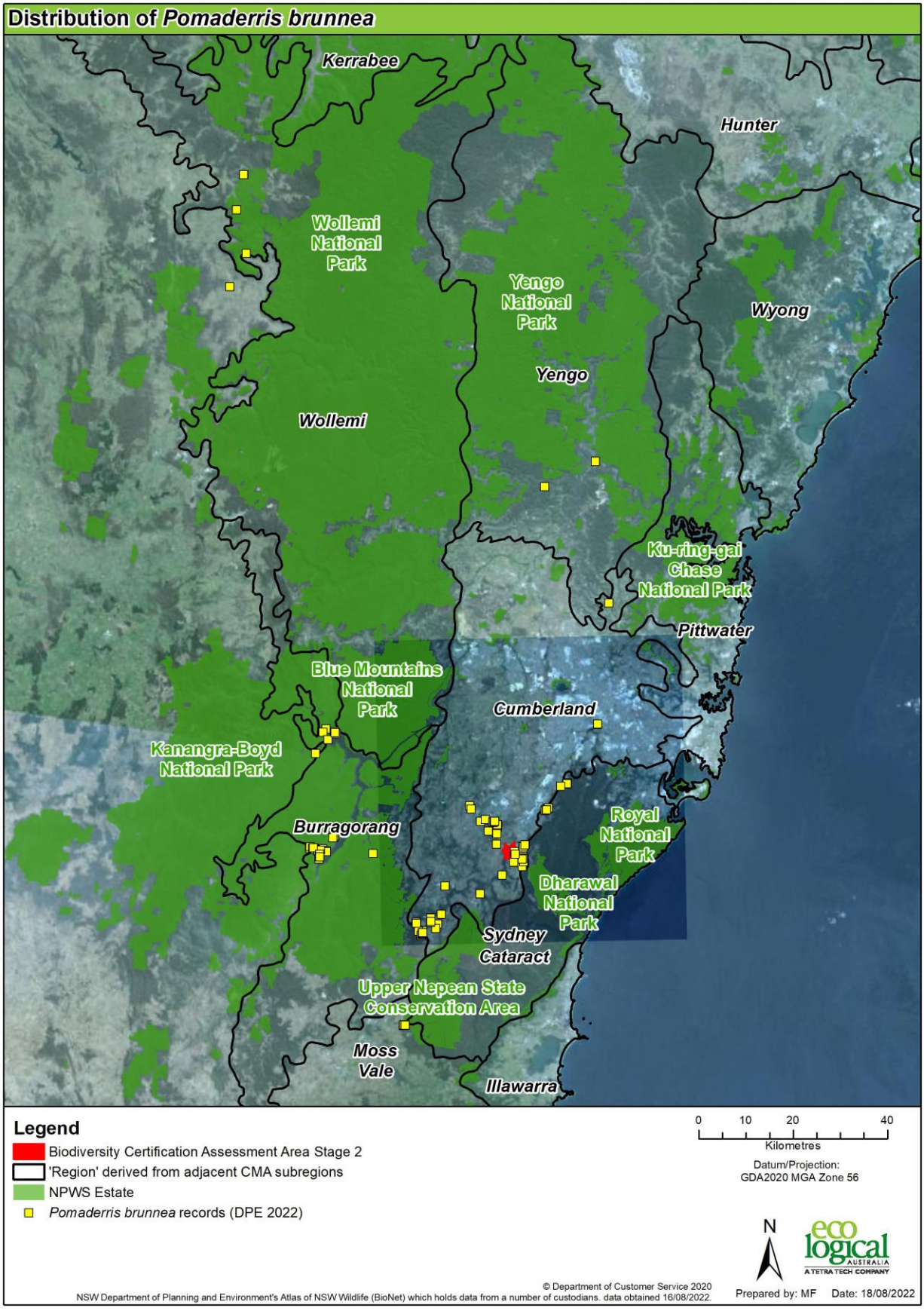


Figure 35: Regional distribution of *Pomaderris brunnea*

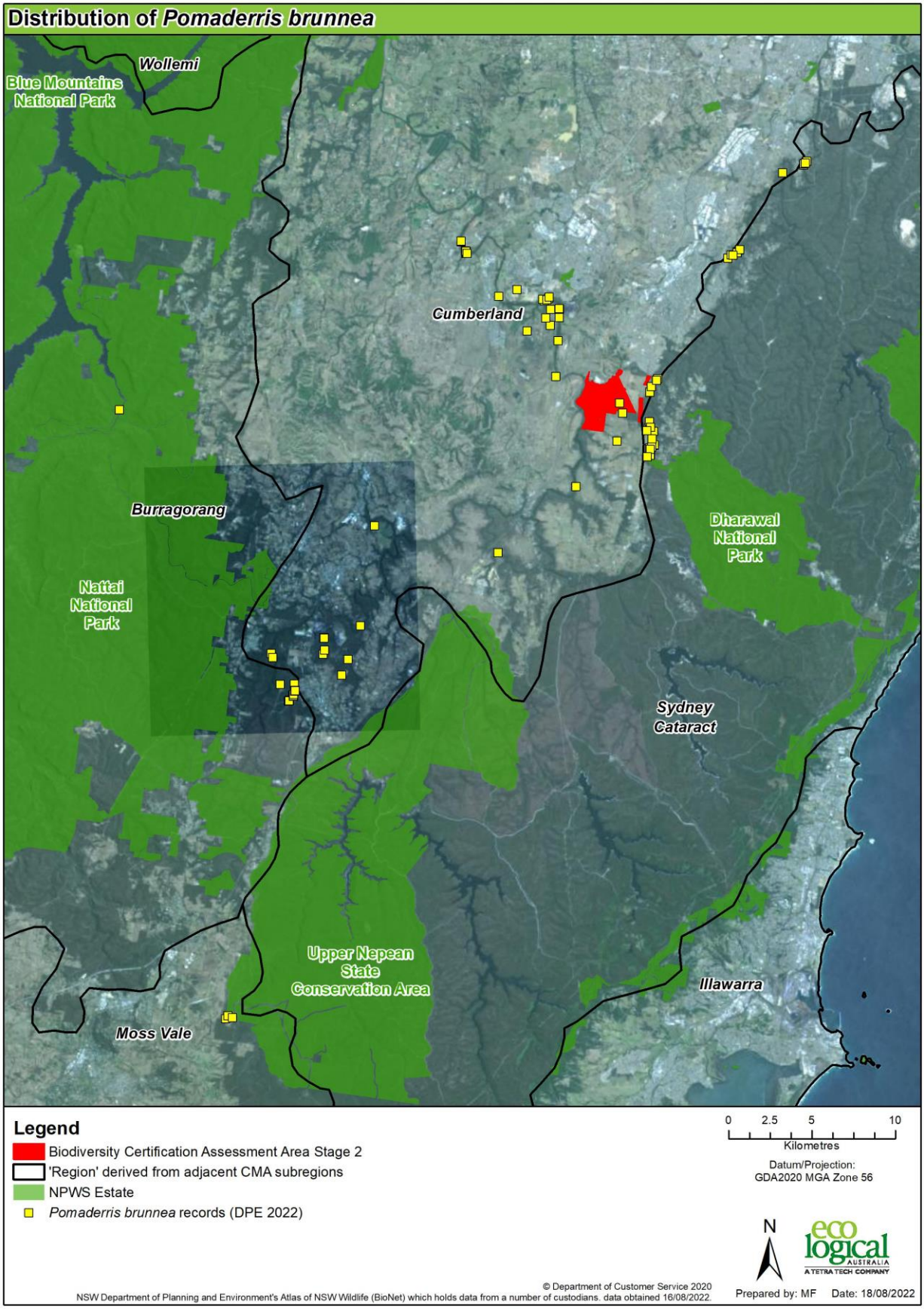


Figure 36: Regional (Camden to Bargo) distribution of *Pomaderris brunnea*

6. Biocertification Strategy

Section 126K of the TSC Act states that biocertification may only be conferred on land by the Minister if the applicant has a biocertification strategy.

Section 126K (2) states that a biocertification strategy is a policy or strategy for the implementation of conservation measures to ensure that the overall effect of biodiversity certification is to improve or maintain biodiversity values. The Biocertification strategy is to be used as the basis for the assessment of the application for biodiversity certification.

A biodiversity strategy is to include the following:

a) the land proposed for biodiversity certification (biodiversity values lost)
b) the land proposed for biodiversity conservation (biodiversity values protected and managed)
c) the proposed conservation measures
d) any person or body proposed as a party to the biodiversity certification

This section addresses these requirements.

6.1 Land proposed for biodiversity certification

The land proposed for biodiversity certification is shown in Figure 5 in **Section 1** of this report.

6.2 Land proposed for biodiversity conservation

The land proposed for biodiversity conservation is shown in Figure 5 in **Section 1** of this report.

Also shown in Figure 5 are areas of '*retained land*' (Existing easements, local open space, Mt Gilead Homestead lands and potential future Public Transit links as identified in the Macarthur Structure Plan.

6.3 Proposed conservation measures

6.3.1.1 Conservation measures within the 'BCAA'

225.76ha of land (including 5.70 ha of retained red flag buffer area) shown in Figure 5 as 'land subject to conservation measures' will be secured by the registration of three Biodiversity Stewardship sites (BSAs) as shown in Figure 38 (Browns Bush, Mt Gilead Homestead, and Gilead BSA sites). Applications to register these three BSA will be submitted to the Biodiversity Conservation Trust (or Credit Supply Task Force) within 12 months of the Minister conferring certification over the land proposed for certification.

BSAs are categorised as 'Permanently managed and funded conservation measures" and are a 100% Conservation Measure as outlined in section 8.1.1 of the BCAM and will generate 100% of the calculated credits as shown in **Table 25** and **26.**

The BSAs will each include a management plan for the conservation area that will include the standard mandatory suite of management actions to improve biodiversity values:

- The erection and maintenance of boundary fencing to prevent in appropriate access (this will be Koala proof fencing to keep dogs out and koalas in the conservation away and away from dogs and cars)
- Implementation of cultural land management practices

- Removal of rubbish
- The active management and reduction of weeds
- The application of fire, where appropriate
- Replanting or supplementary planting where natural regeneration is insufficient to bring back to benchmark condition within a reasonable timeframe - vegetation zones 4, 5, 6, 7, 15, 16, 17, 18 & 19 (Figure 37)
- Addition of logs to supplement the current low level of logs in vegetation zones 4, 5, 6, 7, 15, 16, 17, 18 & 19 (Figure 37)
- Control of rabbits and foxes (as required)
- The retention of regrowth/native vegetation, dead timber, and rocks
- A requirement for annual monitoring, reporting and audit and compliance.

The current land owners, Mt Gilead Pty Limited (Mt Gilead Homestead and Gilead BSA sites) and Lendlease Communities (Figtree Hill) Pty Ltd (Browns Bush BSA site), will be responsible for the permanent fencing of the conservation area (Koala exclusion fencing), establishment of the walking path/ management trail, initial weed and feral animal control, revegetation/supplementary planting and the bringing in of fallen timber from the adjacent development area.

The land subject to this conservation measure will generate **2,427** ecosystem credits and **6,344** species credits as outlined in **Table 25** and **26.**

A Biocertification Agreement will be entered into between Mt Gilead Pty Ltd (the current land owners of the proposed Mt Gilead Homestead and Gilead BSA sites) and Lendlease Communities (Figtree Hill) Pty Ltd (current owners of the proposed Browns Bush BSA sites) and the Minister stating that applications to register the three BSAs will be submitted for registration within 12 months of biodiversity certification being conferred.

The number of species credits generated is less than the credits required for impacts to Koala (284 additional species credits required). These additional credits will be secured by purchasing the credits required from a registered biobank site in the region or from a Biodiversity Stewardship site or the Biodiversity Conservation Trust (BCT), subject to a credit equivalency. Lendlease (Credit ID holder 650) already holds 99 Koala credits from the Campbelltown Koala population purchased from the Noorumba Reserve Biobank site (BA239) so the net deficit of Koala credits is 185.

6.3.1.2 Conservation measures 'outside' the BCAA

Other than the purchase of an additional 185 Koala species credits (284-99), there are no conservation measures required outside of the BCAA.

6.4 Existing management obligations

The land proposed as BSAs are all currently zoned RU2 Rural Landscapes under CLEP 2015. There are no covenants or existing conservation funding arrangements for the land proposed for conservation measures or any existing requirements to actively manage the site for biodiversity conservation. The entire conservation area is to be managed for ecosystem and species credits. Existing easements (electricity, water, gas and Appin Rd upgrade) have all been excluded from the land proposed for conservation measures as shown in Figure 4.

Mt Gilead Pty Ltd and Lendlease Communities (Figtree Hill) Pty Ltd will however, commence interim conservation management of all proposed offset areas from within business 30 days of the date of biodiversity certification being conferred. This will include temporary fencing of offset areas (permanent

fencing will occur as part of the implementation of the BSA Agreements), tree planting in open areas, exclusion of stock and weed control.

6.4.1 Timing of credit retirement

The development is expected to commence in around 2025 and proceed over an indicative 8 stages over 8-10 years as shown in **Figure 39**. All credits will be retired within 6 months of the BSAs being registered.

6.5 Any person or body proposed as a 'party' to the biodiversity certification

As the Conservation measures will not be secured prior to the application for Biocertification being considered by the Minister, a Biocertification Agreement will be entered into between Mt Gilead Pty Ltd, Lendlease Communities (Figtree Hill) Pty Ltd and the Minister stating the following:-

1 Registration of Biodiversity Stewardship Agreements

- Lendlease Communities (Figtree Hill) Pty Ltd will prepare and submit for registration an application to register a BSA over 28.21 ha of land as shown in **Figure 38** as Browns Bush Stewardship site within 12 months of biodiversity certification being conferred
- Lendlease Communities (Figtree Hill) Pty Ltd on behalf of Mt Gilead Pty Ltd will prepare and submit for registration an application to register a BSA over 177.70 ha of land as shown in **Figure 38** as Gilead Stewardship site within 12 months of biodiversity certification being conferred
- Lendlease Communities (Figtree Hill) Pty Ltd on behalf of Mt Gilead Pty Ltd will prepare and submit for registration an application to register a BSA over 19.85 ha of land as shown in **Figure 38** as Mt Gilead Homestead Stewardship site within 12 months of biodiversity certification being conferred

2 Transfer of credits from Mt Gilead Pty Ltd to Lendlease Communities (Figtree Hill) Pty Ltd

Mt Gilead Pty Ltd has committed to making all of the ecosystem and species credits generated by the Gilead and Mt Gilead - Homestead BSAs available to Lendlease Communities (Figtree Hill) Pty Ltd to meet the credit retirement requirements of this Biocertification application as outlined in Section 6.4.1 (i.e. to retire all credits within 6 months of registration of the BSAs

3 Retirement of credits

- A Biocertification Agreement will be entered into between Lendlease Communities (Figtree Hill) Pty Ltd, Mount Gilead Pty Ltd and the Minister stating that all ecosystem and species credits generated by the Browns Bush, Gilead and Mt Gilead – Homestead BSA sites will be 'retired' within 6 months of the BSAs being registered i.e. All 'surplus' credits will also be retired as a condition of biocertification.

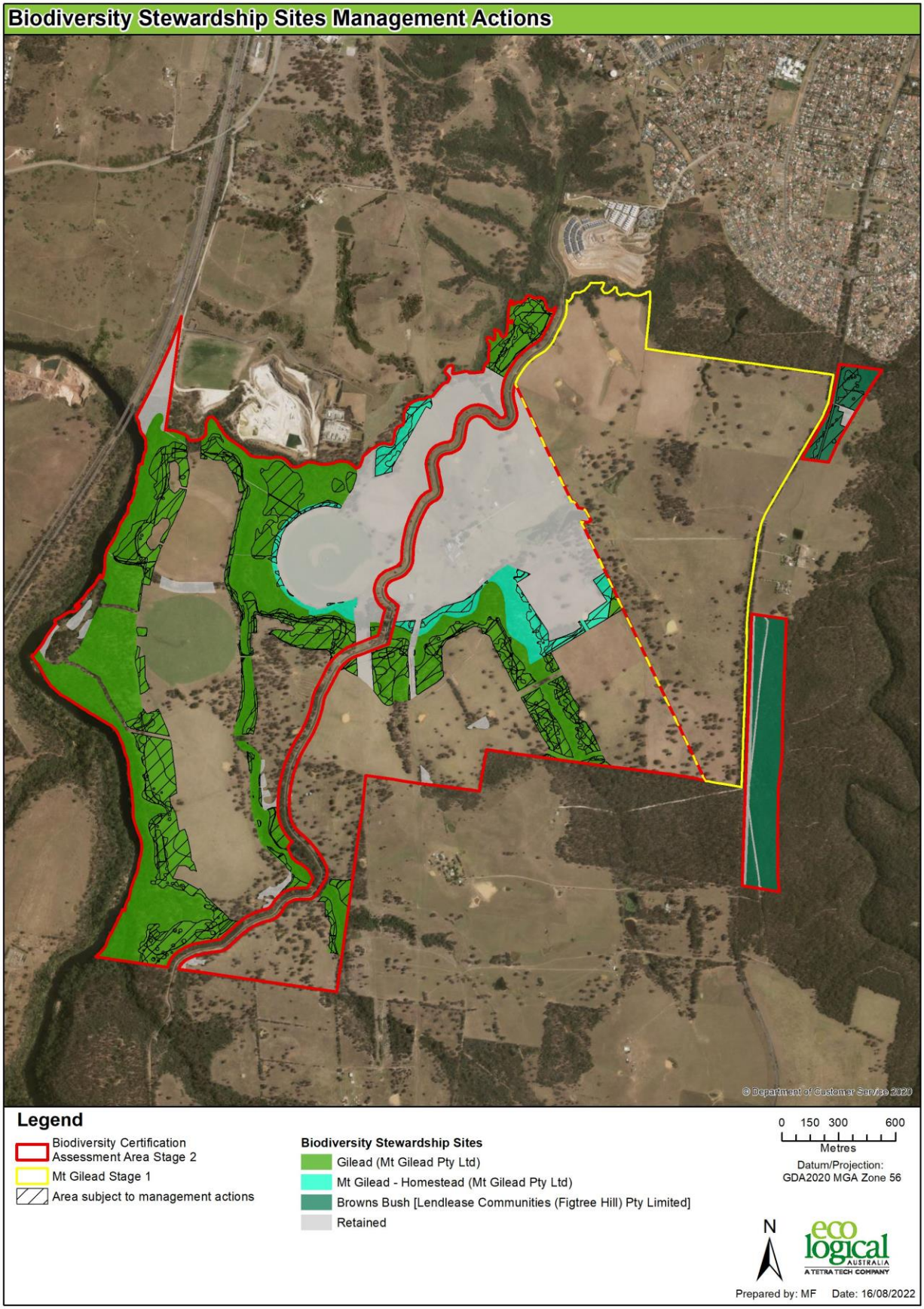


Figure 37: 'Additional' Management Actions (supplementary planting and habitat augmentation) within land proposed for conservation measures

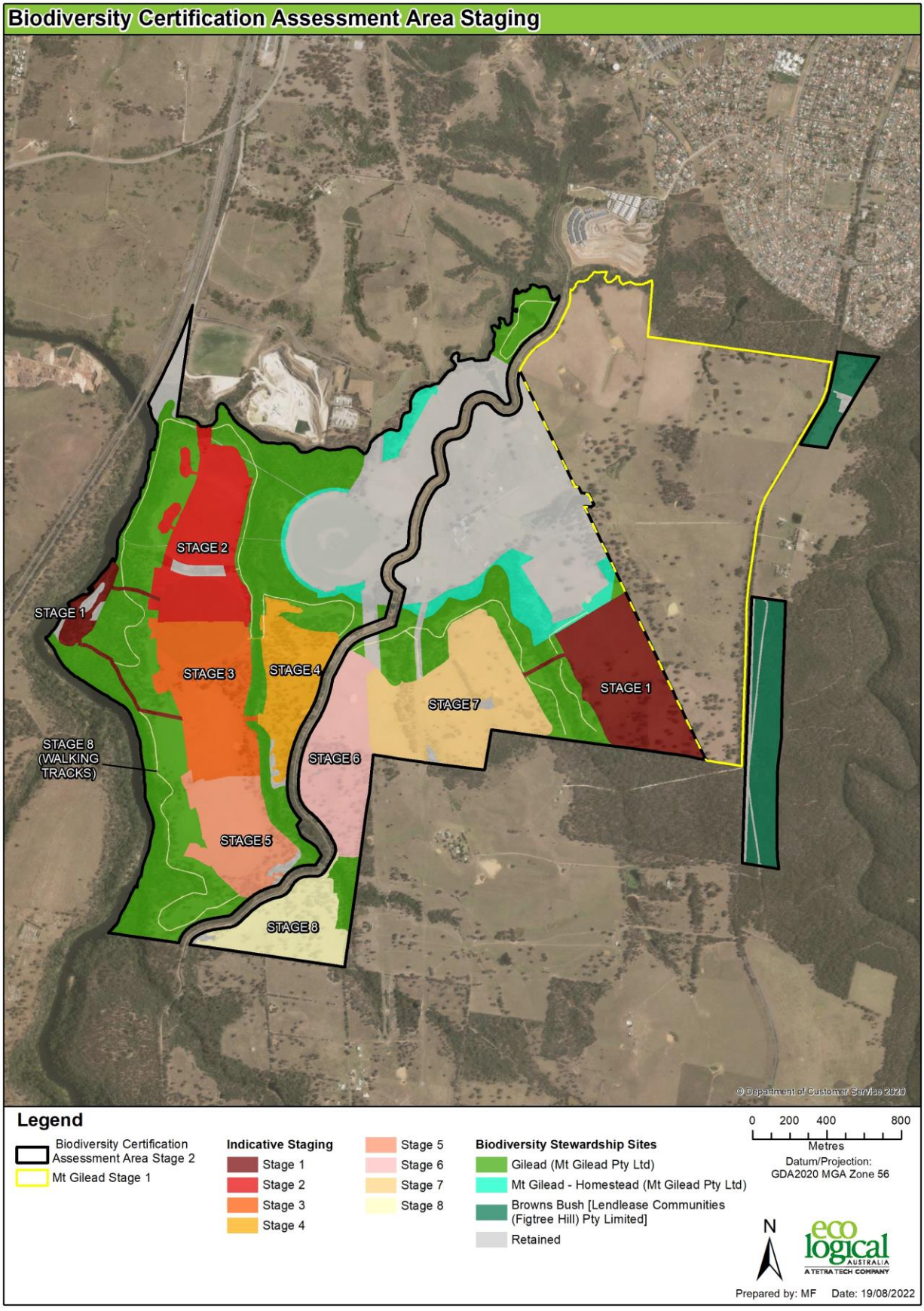


Figure 38:Indicative Staging of development

Table 25: Summary of ecosystem credit surplus/deficit

Biometric Vegetation Type	Credits Required	Credits generated (100% Measure)	Credit Status within BCAA
HN526 Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	69	198	129
HN528 Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin	242	343	101
HN556 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin	803	1,800	997
HN538 Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion	9	86	77
Total	**1,123**	**2,427**	**1304*** **

*** All 1,304 surplus credits will be retired as a condition of biocertification

Table 26: Summary of species credit surplus/deficit

Habitat	Credits Required	Credits generated (100% Measure)	Credit Status within BCAA
Pomaderris brunnea	29	1,500	1,471
Koala	1,744	1,460	-284
Squirrel Glider	993	1,347	354
Cumberland Plain Land Snail	289	1,181	892
Southern Myotis	613	856	244
Total	**3,668**	**6,344**	**2,960*** **

*** All surplus Pomaderris brunnea and CPLS species credits will be retired as a condition of biocertification

6.6 Is an Improve or Maintain Outcome Achieved?

Subject to the Director-General's consideration and approval of the red flag variation requests (**Section 5**), an '*improve or maintain*' outcome can be achieved by the purchase and retirement of all credits from the proposed conservation lands within the BCAA and the purchase and retirement of the additional 185 Koala species credits.

6.7 Statement of commitments

The following is a summary of the commitments made throughout this biocertification assessment:-

1. A Biocertification Agreement will be entered into between Lendlease Communities (Figtree Hill) Pty Limited (the **Developer**), Lendlease Communities (Figtree Hill) Pty Ltd (**Owner A**), Mt Gilead Pty Ltd (**Owner B**) and the Minister stating that the land proposed for conservation measures within the BCAA (225.76 ha) will be submitted for registration as Biodiversity Stewardship sites within 12 months off biodiversity certification being conferred by **Owners A** (Browns Bush BSA site) and **Owner B** (Mt Gilead Homestead and Gilead BSA sites) and all credits generated/created made available to the **Developer** who will retire all of the credits within 6 months of the BSAs being registered prior
2. Within 30 days of the conferral of Biodiversity Conservation, **Owners A and B** will erect temporary fencing around the Conservation Areas to prevent access by stock, and commence interim conservation management (stock exclusion, tree planting and weed control) until the BSA sites referred to in (1) above are registered and credits retired.
3. After the conferral of Biodiversity Certification, and at the written request of the **Developer**, **Owner B** will transfer all biodiversity credits generated to the **Developer**
4. Lendlease Communities (Figtree Hill) Pty Ltd **(Owner A**) will be responsible for the active management of the 'Browns Bush BSA site' in accordance with the BSA Agreement referred to in Point 1 above from the date that all ecosystem and species credits have been retired.
5. Mt Gilead Pty Ltd (**Owner B**) will be responsible for the active conservation management of the 'Mt Gilead - Homestead and Gilead BSA sites in accordance with the BSA Agreement referred to in Point 1 above from the date that all ecosystem and species credits have been retired.
6. Subject to the **Developer** obtaining all required consents, approvals, licences, permits or authorisations for vegetation clearing within the BCAA, the **Developer** will prepare a Construction Environment Management Plan (CEMP) to the satisfaction of Council, prior to clearing in the BCAA to incorporate the Developers Statement of Commitments to guide the development outlined in this biocertification assessment and ensure that all direct and indirect impacts (e.g. APZs, utilities, access, stormwater run-off etc) are contained within the development footprint and appropriate mitigation measures are put in place to minimise indirect impacts to threatened fauna including Koala, Squirrel Glider and microbats. Specifically, this will address the management of the land proposed for conservation measures and their buffers such that surrounding roads will be fully curbed and guttered with no stormwater being discharged into the conservation areas (treated water from the detention basins within the development footprint will flow into existing riparian areas).

   The CEMP will include, but not be limited to:

   i. temporary and permanent protective fencing will be erected around all areas identified for conservation prior to clearing activities commencing in relevant stages to minimise any inadvertent damage

ii. any trees, or parts thereof, that would be appropriate for use as fauna habitat in the Browns Bush, Mt Gilead Homestead or Gilead BSA sites, will be identified and salvaged in accordance with the BSA Agreements

iii. roads surrounding each part of the Conservation Areas will be fully curbed and guttered with piped stormwater management infrastructure to ensure that stormwater will not flow directly into the Conservation Areas

iv. a de-watering plan will be prepared for any farm dams that are removed from the Biodiversity Certification Area

v. a fauna pre-clearance protocol will be prepared for the removal of all trees within the Biocertification Area

vi. lighting around conservation areas designed to minimise impacts to fauna

vii. monitoring of performance measures and non-compliance.

Further, once registered, each BSA site will be required to provide an annual report that will include an audit of the implementation of management actions, monitoring of the condition of vegetation and threatened species.

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Appendix A : Project Staff CVs

The following are brief curriculum vitae's for the key project staff. Please note that since this project commenced in 2013, there have been a number of staff movements, and some of the accredited staff who undertook the field work and prepared parts of this assessment report are no longer with Eco Logical Australia. Meredith Henderson, an accredited assessor familiar with the biocertification assessment process, has however, reviewed and endorsed the assessment report.

Robert Humphries – Project Manager

CURRICULUM VITAE

Robert Humphries

MANAGER, BIODIVERSITY OFFSETS PROGRAMS

QUALIFICATIONS

- Bachelor of Applied Science, Ballarat College of Advanced Education 1983-85.
- Master of Applied Science (Research) University of Ballarat 1986-89.

Robert is an ecologist, environmental planner and project manager with over 30 years experience. Since graduating with Bachelors and Masters Degrees in wildlife management in 1985 and 1989, Robert has worked mainly in the public sector with the Department of Environment and Conservation (Victoria) 1988-1996 and the then NSW National Parks and Wildlife Service, now NSW Office of the Environment & Heritage (OEH) 1996-2006. Robert joined Eco Logical Australia in March 2008 after two years working in the urban development sector.

Robert was the Manager of the Threatened Species Section of the NSW Department of Conservation and Environment for over 10 years and has extensive experience of NSW Threatened Species and Environmental Planning legislation, Government policy, the biodiversity of the Greater Sydney and Hunter Regions and the former biodiversity certification and biobanking provisions.

Robert was a member of the Biobanking Ministerial Reference Group from 2007-2012 and was the lead trainer in the BioBanking and Biodiversity Certification Accredited Assessor Training program that Eco Logical Australia developed and implemented under licence from the OEH for 8 years between 2008 and 2015.

Robert is now actively involved in working with land owners wishing to register Land Stewardship Agreements under the new Biodiversity Conservation Act 2016 and sourcing and securing biodiversity credits for proponents.

RELEVANT PROJECT EXPERIENCE

Biobanking, BioCertification and Major Projects (FBA) offset policy development and preparation of gazetted methodologies

- Engaged by the Biodiversity Conservation Trust to forecast the likely demand for BAM credits under the new Biodiversity Conservation Act 2016 Biodiversity Assessment Method (BCT 2017-18)

- Invited by OEH to participate in developing a framework for Biobank management cost benchmarks (OEH 2017)
- Engaged by OEH in consultation with Taylor Fry Consulting Actuaries to develop the NSW Biodiversity Offset Calculator and provide initial credit prices for all ecosystem and species credits in NSW (OEH 2016)
- Engaged by OEH to forecast the likely demand for offsets under the Major Projects Offset Policy 2014 (OEH 2013)
- Biobanking Ministerial Reference Group (NSW Urban Task Force representative) 2007-2012
- Department Planning Part 3A Biodiversity Offsets Policy Development Workshop (Invited Expert to contribute to development of new policy, 2010)
- Development and Project Management of OEH Biobank/BioCertification and FBA Accredited Assessor Training Course (2008-2015, OEH)
- Contracted by OEH to prepare the BBAM 2014 and FBA Operational Manuals (OEH 2015)
- Engaged by OEH to 'test' versions 1 and 2 of the Biobanking credit calculator tool and prepare Sections 4 and 5 of the revised 2009 Operational Manual (2008-2012).
- Prepared the Operational Manual for BBAM 2014 for OEH 2015
- Prepared the Operational Manual for the Framework for Biodiversity Assessment (Major Projects Offset Policy for OEH 2015
- Development of the Credit pricing calculator for Biobank owners (2008, DECC)
- Contracted by OEH to undertake a regional analysis of the likely demand for offsets required under the Major Projects Offset Policy
- Cost comparison of Biobank Credits and traditional offsets negotiated by the RTA for the M7 Motorway (2009, DECCW).
- Likely demand for Biodiversity Credits in the Lower Hunter, Far North Coast, Western Sydney and South Coast Regions (2008, DECC)

Biocertification Assessments
Robert has completed or is currently undertaking formal Biodiversity Certification Assessments for:-

- Mount Gilead Stage 1 Urban Release Area (Campbelltown City Council) Biodiversity Certification conferred July 2019
- Port Macquarie Airport and Area 13 Urban Release Area (Port Macquarie Hastings Council). Biodiversity Certification conferred October 2018
- El Caballo – Gledswood – Lakeside Residential Estate (Camden City Council). Biodiversity Certification conferred June 2018
- Emerald Hills Urban Release Area (Camden City Council). Biodiversity Certification conferred December 2015
- Maquariedale Road, Appin Urban Release Area (Wollondilly Council) Application being considered by OEH
- Tuncurry State Significant Site (Urban Growth NSW). Application being considered by OEH
- Warnervale Town Centre (Wyong Council). Application approved March 2014
- Broulee and South Moruya Urban Release Areas (Eurobodalla Shire Council). Application approved September 2014

Robert has completed informal Biodiversity Certification Assessments for:-

- Greater Sancrox Area for Port Macquarie –Hastings Council (August 2013)
- Glenning Valley Urban Release Area (Travers Ecology and Glenning Valley Partnership 2011);
- Kings Hill Urban Release Area, Port Stephens LGA (Mondell Property Group and Hunter Land 2011);
- Ingleside Release Area, Pittwater/Warringah LGAs (Urban Growth NSW 2011)
- Darkinjung Local Aboriginal Land Council (North Wyong Structure Area)
- Yallah-Marshall Mount Urban Release Area (Wollongong City Council)
- Whitebridge Investigation Area (Urban Growth NSW 2011)
- Balmoral Urban Release Area, north west Sydney (Urban Growth NSW 2013)

Biodiversity Offset Strategies and Packages
Robert has prepared numerous Biodiversity Offset Strategies and Packages to meet policy frameworks and conditions of approval for Major Projects:-

- Prepared an offset strategy for Coppabella Wind Farm near Yass (Goldwind Australia 2018)
- Prepared an offset strategy for the Bango Wind Farm near Yass (CWP Renewables 2018)
- Prepared an offset strategy for the Taralga Wind Farm (Pacific Hydro 2016-2017)
- Prepared an offset strategy for White Rock Wind Farm near Glenn Innes Stages 1 and 2 (Goldwind Australia 2016-2017)
- Prepared an offset strategy for the West Connex Project (2016-2018)
- Prepared an offset strategy for Queanbeyan-Pallerang Regional Council for the Ellerton Rd project (2017-2018)
- Prepared an offset strategy and secured offsets for the North West Rail Line project in north western Sydney (2014)
- North West & South West Growth Centres Biodiversity Offset Strategy for Sydney Water Infrastructure developments (May 2013)
- Biodiversity Offset Strategy for the proposed extension of the Pine Dale Mine (Enhance Place Pty Ltd, July 2013)
- Biodiversity Offset Strategy for proposed Stage 1 Modification, Moolarben Coal Mine (Yancoal, May 2013)
- Biodiversity Offset Strategy for Crudine Wind Farm (Wind Prospect CWP Pty Ltd – 2012)
- Biodiversity Offset Strategy for Sapphire Wind Farm (Wind Prospect CWP Pty Ltd – 2011)
- Biodiversity Offset Strategy for Boco Rock Wind Farm (Wind Prospect CWP Pty Ltd – 2011)
- Biodiversity Offsets review, Cockatoo Coal NSW & Qld Projects (Cockatoo Coal Pty Ltd, 2011)
- Revised Biodiversity Strategy for Tharbogang Quarry and Landfill (Griffith City Council, 2011)
- Improve or Maintain Biodiversity Offset Strategy for proposed rezoning at Greta, Cessnock LGA (Hardie Holdings Pty Ltd, 2011
- Improve or Maintain Biodiversity Offset Strategy for Kings Hill Urban Release Area, Port Stephens LGA (Mondell Property Group, 2011)
- Preparation of Biodiversity offset strategy for the proposed Narrabri Coal mine (Narrabri Coal Operations Pty Ltd, 2011)
- Preparation of Biodiversity offset strategy for proposed modification to Rocglen Coal Mine (Whitehaven Coal Pty Ltd, 2010)
- Preparation of Biodiversity offset strategy for the proposed Werris Creek LOM Coal Mine (Werris Creek Coal Pty Ltd, 2010)
- Preparation of Biodiversity offset strategy for the South West Rail Link (Transport Construction Authority, 2010)
- Preparation of Biodiversity offset strategy for the Richmond Rail Line duplication (Transport Construction Authority, 2011)
- Preparation of Biodiversity offset strategy for the Camden Valley Way Upgrade (NSW RTA, 2011)
- Biodiversity Offset Strategy for the Oxley Highway Upgrade, Port Macquarie (NSW RTA, 2010)
- Preparation of Offset Strategy and package for the Kingsgrove to Revesby Quadruplication Project (2008/09 K2RQ/TIDC Alliance)

Biobank Site Assessments and Registrations
Robert has prepared and/or project managed through to registration **31** BioBanking Agreements and undertaken numerous feasibility studies for State and Local Government Agencies, Corporate entities and private land holders interested in biobanking, including

- A 25 ha Biobank site west of Camden on the Cumberland Plain (Private landholder) (Agreement No. 3, registered in January 2011)
- A 24 ha site in western Sydney (Western Sydney Parklands Trust). (Agreement No. 70, registered in February 2012)
- A 10 ha site at Belrose (WSN Environmental Solutions) (Agreement No. 55, registered in March 2012)
- A 1,500 ha site near Gunnedah to offset an approved Coal mine (Whitehaven Coal) (Agreement No. 43, registered in August 2012)
- A 51 ha Biobank site west of Camden on the Cumberland Plain (Private landholder) (Agreement No. 88, registered in January 2013)
- A 69 ha proposed Biobank for Shoalhaven City Council at (Agreement No. 101, registered in June 2013)

- A 45 ha proposed Biobank for Lake Macquarie City Council at Belmont (Agreement No. 103, registered in June 2013)
- A 54 ha proposed Biobank at the Oaks on the Cumberland Plain (Private landholder) (Agreement No. 100, registered in September 2013)
- A 31.2 ha site (M7 West) in Western Sydney Parklands (Agreement No. 119, registered August 2014)
- A 19.37 ha site (Kemps Creek) in Western Sydney Parklands (Agreement No. 120, registered August 2014)
- A 29 ha site at Puckey's Estate in the Wollongong LGA prepared as part of OEHs Linking Landscapes project (Agreement No. 163, registered March 2015)
- A 72.64 ha site at Salamander for Port Stephens Shire Council (Agreement No. 148 – registered November 2015)
- A 25 ha site at Emerald Hills in the Camden LGA (Agreement No. 159 – registered November 2015)
- A 25 ha site at Dunmore in Shellharbour LGA for Holcim Pty Ltd (Agreement No. 203 – registered December 2015)
- A 56 ha site at Oaklands (Hardwicke Stage 1) in Wollondilly Shire Council (Agreement No. 168, registered March 2017)
- A 24 ha site west of Camden (Brownlow Hill Stage 3) on the Cumberland Plain (Agreement No 156 Registered October 2017
- A 45 ha site at Gilead (Noorumba Reserve) in Campbelltown LGA for Campbelltown City Council (Registered February 2018)
- A 30 ha site at Brownlow Hill (Brownlow Hill Stage 4) for Brownlow Hill Pty Ltd (Agreement No. 274 registered March 2018)
- A 350 ha site at Crooked Corner (Glenara) for Glenara Pastoral Pty Ltd (Agreement No. 353 May 2018)
- A 150 ha site at Oaklands (Hardwicke Stage 2) in Wollondilly Shire Council (Agreement No. 213, registered November 2018)
- A 20 ha site at Murrays Beach (Murrays Beach) for Roads and Maritime Services
- A 12 ha site at Gilead (Mt Gilead-Noorumba) in Campbelltown LGA for Mt Gilead Pty Ltd (Agreement No. 208, registered January 2019)
- A 8 ha site at Gilead (Onslow-Macarthur) in Campbelltown LGA for Mt Gilead Pty Ltd (Agreement No. 209, registered January 2019)
- A 290 ha site near Glenn Innes (Windemere) for Sapphire Wind Farm (Agreement No. 379, registered January 2019)
- A 600 ha site near Bundarra (Rockview South) for Sapphire Wind Farm (Agreement No. 376, registered January 2019)
- A 300 ha site near Casino (Ermilo) for a private land owner (Agreement No. 449, registered January 2019)
- A 80 ha site at Coal Cliff (Illawarra Coke) for the Illawarra Coking Company (Agreement No. 349, registered February 2019)
- 60 ha site at Berkshire Park (Castlereagh) for Waste Assets Management Corporation (Agreement No. XXX, registered February 2019)
- A 400 ha site at Port Macquarie (Partridge Creek) for Port Macquarie Hastings Council (Agreement No. XXX, registered February 2019)
- A 184 ha site (Tangari) near Glenn Innes for White Rock Windfarm (Agreement No. 453, registered February 2019)
- A 90 ha site at Taralga (Rossvale) for Taralga Wind Farm (Agreement No. 452, registered February 2019)

Applications currently being assessed by OEH

- A 20 ha site at Port Macquarie (Thrumster) for Port Macquarie Hastings Council
- A 40 ha site at Elderslie (Gundungurra Reserve) for Camden Council

Management of Biobank Sites for landholders

Robert has been engaged by Biobank site owners to manage their Biobank sites in accordance with their BioBank Agreement Management Plans and prepare the Annual Compliance reports.

- Brownlow Hill Stage 1
- Hardwicke Stage 1 & 2
- Emerald Hills for Macarthur Developments Pty Ltd
- Onslow-Macarthur and Mt Gilead Noorumba Biobank sites for Mt Gilead Pty Ltd
- Dumore Biobank site for Holcim Pty Ltd

Identification and sourcing of Biodiversity credits for proponents
Robert has been engaged by various proponents to source and secure biodiversity credits to meet approval conditions.

- Holcim to source and secure credits for the Lynwood Quarry

Lendlease Communities to source and secure Cumberland Plain Woodland and Koala credits for the Mt Gilead development at Campbelltown
Sekisui House to source and secure 294 HN528 Cumberland Plain Woodland credits for the El Cabello biocertification area
Frazer's Property Group to source and secure 40 HN528 Cumberland Plain Woodland for the Eastern Creek Business Hub project
RMS to secure various credits for the Growth Centres roads project
West Connex Pty Ltd to source and secure various credits for the WCX project
Sekisui House to source and secure 55 HN528 and 6 HN526 credits for the Spurway Drive project
Pacific Hydro to source and secure 70 HN571 credits for the Taralga Wind Farm
Private land holder to source and secure 10 Green and Golden Bell Frog species credits for a development at Davistown
Ecove Pty Ltd to source and secure 28 Green and Golden Bell Frog species credits for the Opal Tower development at Sydney Olympic Park
Tahmoor Central to source and secure 30 HN56 credits for a development at Tahmoor
McPhails Wollongong – purchase of 224 SR545 credits

Biobank Statements
Robert has prepared and/or project managed through to approval 6 BioBank Statement applications:-

- Biobank Statement for a Commercial Development, Salamander Way, Port Stephens Council (Biobank Statement 46 issued August 2018)
- Biobank Statement for proposed urban development at West Dapto, Wollongong LGA (Biobank Statement 16 issued October 2014
- Biobank Statement for proposed commercial development at Tahmoor, Wollondilly LGA (Biobank Statement 15 issued September 2014
- Biobank Statement for proposed residential subdivision at Davistown in Gosford LGA (Biobank Statement 7 issued January 2013)
- Biobank Statement for proposed retirement Village residential at Beacon Hill, Warringah LGA (Biobank Statement 3 issued May 2011)
- Biobank Statement for proposed residential subdivision at Forrester's beach (Biobank Statement 2 issued December 2010)

Dr Meredith Henderson – Accredited Assessor – Supervision of credit calculations, targeted survey

Dr Meredith Henderson

PRINCIPAL ECOLOGIST

QUALIFICATIONS

- PhD, Victoria University, Melbourne. Vegetation dynamics in response to fire and slashing in remnants of Western Basalt Plains grasslands and the implications for conservation management.
- Bachelor of Science (Honours), University of Wollongong.
- Accredited BioBanking Assessor (#155)
- BAM Accredited Assessor (BAAS 17001)

Meredith is an ecologist with over 24 years of survey and research experience and is Principal Ecologist in Eco Logical Australia's Sydney Metropolitan Region. Meredith has worked in a range of sectors including state government, University, non-government organisations and the private sector. She has a PhD and Honours degree in terrestrial ecology. Meredith has well developed capabilities in terrestrial plant ecology and environmental assessment.

She is experienced in the design and completion of ecological surveys, environmental impact assessment, monitoring impacts of land management change, literature reviews and synthesis. Meredith has highly developed skills in government and client liaison.

Meredith has managed many large and complex projects. She is an accredited BAM and BioBanking assessor and has been led biodiversity certification projects and application of the major projects assessment and offsetting requirements.

CAPABILITIES

Ecological Survey

- Full floristics vegetation surveys for vegetation mapping, Bega Valley, Illawarra and South Coast (NSW NPWS)
- Vegetation mapping of the Holsworthy Military Area (Janet Cosh Herbarium for Department of Defence)
- Vegetation assessment for bushfire planning and assessment in Lower Snowy area of Kosciuszko National Park (Gary Leonard & Associates for NSW NPWS)
- Monitoring *Trachymene saniculifolia* plant populations in Kanangra Boyd NP (NSW NPWS)
- Camden Council Reserves Vegetation Assessment (Camden Council)
- Full floristics, vegetation validation, biobanking plots, and culvert assessments for NorthConnex EIA (Transurban/RMS)
- Full floristics and biobanking plots for proposed Biodoversity Certification (Hardwicke)
- Targeted threatened species surveys (incl. Koala, Green and Golden Bell Frog and number plant species) for a range of infrastructure and residential development clients

Ecological Impact Assessment

- Rezoning in rural residential area in Dural, NSW (Brown Consulting)
- Flora and fauna assessment for outdoor education facility, Wolgan Valley, NSW (Cranbrook School)
- Flora and Fauna Assessments for residential development, Church Point, Bayview, Balgowlah Heights, North Turramurra (variety of clients)
- Ecological Constraints in Sydney Metropolitan (UrbanGrowth NSW)

- NorthConnex ecological assessment EIS (RMS/Transurban)
- WestConnex the New M5 biodiversity technical report for the EIS (RMS/Sydney Motorway Corporation)
- EPBC Act strategic assessment of procedures and guidelines for works on NSW roads (RMS)

Fuel hazard assessment

- Conduct vegetation fuel hazard assessments and ecological assessments for fire planning and management on the Eyre Peninsula, Mount Lofty Ranges, the SA Murray-Darling, South-east and Kangaroo Island (SA DEH)
- Vegetation fuel hazard assessments for fire behaviour analysis in Mt Taylor, New Zealand (for CSIRO and Bushfire CRC)

Research

- Vegetation survey and assessment following experimental burning and grazing exclusion in Guy Fawkes River Wilderness Area (NSW NPWS)
- Vegetation assessment and monitoring in mallee following experimental burning and bushfires – design and conduct full floristics and habitat assessment (SA Department of Environment & Heritage)
- Vegetation fuel hazard assessments and joint project leader for Project FuSE in SA MDB Region (SA DEH and Bushfire CRC)
- Review of environmental information required for impact assessment and approvals (SA Department of Environment, Water and Natural Resources)

Use of BioBanking and related methods

- Conduct field work for BCAM (SouthWest Land Holdings)
- Conduct biobanking plots and vegetation mapping for use in assessing impacts – NorthConnex (Transurban / RMS)
- Conduct biobanking plots, survey and run calculations for additional site for NorthConnex (Transurban / RMS)
- Provide advice to client on biobanking feasibility (Stockland)
- Lead assessor for WestConnex The New M5 using FBA (Roads and Maritime)
- Lead assessor for BCAM in northern Sydney region (Celestino)
- Lead assessor for BioBanking Agreement in the Illawarra (Holcim)
- Conduct field work for proposed major mining project in NSW central tablelands / slopes
- Lead assessor for BCAM at Sydney Science City (Celestino)
- Lead assessor for BCAM at El Caballo, Gledswood and Lakeside (Sekisui House)
- Provide advice on biobanking at Calderwood Valley Stage 3B North (Lendlease Communities)
- Lead assessor F6 Extension Stage 1 BDAR (Roads and Maritime)
- Lead assessor Stage 3C1 Calderwood BDAR (Lendlease Communities)
- Lead assessor Stage 3BN Calderwood BDAR (Lendlease Communities)
- Project Director Stage 3C2 Calderwood BDAR (Lendlease Communities)
- Lead assessor for BioBanking Agreement at Mt Brown (private investor)

Michelle Frolich - Mapping and credit calculations

CURRICULUM VITAE

Michelle Frolich

BIODIVERSITY OFFSETS PROGRAM CO-ORDINATOR

QUALIFICATIONS AND TRAINING

- Bachelor of Science (Marine Science Honours), University of Sydney, 2007
- BioBanking and Bio-Certification Assessors Training Courses, 2010 and 2013
- Biodiversity Offset Scheme and Biodiversity Assessment Method Training Course, 2017
- BAM Accredited Assessor

Michelle is a Biodiversity Offsets Program Coordinator with over 12 years' experience in Geographic Information Systems, BioBanking, Biocertification, ecological impact assessment and ecological surveys. She has a thorough understanding of the BioBanking Assessment Methodology (BBAM), Biodiversity Certification Assessment Methodology (BCAM) and the Framework for Biodiversity Assessment (FBA) for Major Projects. She has also recently completed the Biodiversity Assessment Method (BAM) training course and is a BAM Accredited Assessor under the NSW *Biodiversity Conservation Act 2016*. Michelle also has extensive experience in Geographic Information Systems such as ESRI ArcGIS and MapInfo Professional.

Michelle is an experienced project manager with skills in field surveys, data analysis, mapping, ecological assessments and reporting. She also has highly developed communication and organisation skills, which she applies when dealing with project teams, clients and government agencies.

Michelle has previously worked in other ecological consultancies and NSW Government agencies.

RELEVANT PROJECT EXPERIENCE

BioBanking, Bio-certification and Framework for Biodiversity Assessment

- Biodiversity feasibility assessments under the BBAM for development and biobank sites (across NSW)
- Biobank Agreement Applications using BBAM (Biodiversity Assessment Report, Total Fund Deposit Spreadsheets, Management Action Plan) in the Hunter Valley and Western Sydney
- Biodiversity assessments for Major Projects (State Significant Developments) under the FBA in Western Sydney and Hunter Valley
- Biodiversity assessments under BCAM for mines in the Hunter Valley for the Upper Hunter Strategic Assessment

Ecological Impact Assessment

- Flora and fauna assessments for proposed developments in the Greater Sydney region
- Species Impact Statements for proposed developments in Western Sydney and the Lower Hunter Valley

Ecological Surveys

- Botanical surveys in the Greater Sydney, Upper and Lower Hunter Valley, and Central West regions
- Feral animal monitoring for a mine within the Hunter Valley
- Targeted surveys for threatened flora and fauna species in the Hunter Valley and Greater Sydney regions
- Pre-clearing and clearing supervision

Bruce Mullins – Senior Field Ecologist – Vegetation Mapping and threatened flora (moved to Eco Planning Pty Ltd, December 2016)

CURRICULUM VITAE

Bruce Mullins

ASSOCIATE - MANAGER, ECOLOGY AND ASSESSMENT - PRINCIPAL ECOLOGIST

QUALIFICATIONS

- Master of Science, University of Technology, Sydney. Factors affecting the vegetation of mined and unmined areas in a montane forest.
- Bachelor of Science, University of Technology, Sydney
- Accredited Biobanking Assessor

Bruce is an ecologist with over twenty years post-graduate experience and is Eco Logical Australia's Senior Ecologist and Manager of the Ecology and Assessment team. Following the completion of a Master of Science thesis examining patch dynamics and plant ecophysiology at an abandoned mine site in the central tablelands of NSW, Bruce has been working as a researcher and environmental consultant. For seven years he managed the environmental consulting activities of Charles Sturt University, principally through the Johnstone Centre, after which time he joined Eco Logical Australia.

Bruce has highly developed skills in research and consulting. He is experienced in the design and execution of ecological surveys, environmental impact assessment, the development of management plans, literature reviews and all aspects of project management.

RELEVANT PROJECT EXPERIENCE

- Parramatta Escarpment shared path and boardwalk, Options study, Parramatta City Council
- Jerrabombera wetlands, vegetation mapping project.
- Plains-wanderer, survey and habitat assessment 2015, OEH
- Floristic Value Score advice, Riverina grasslands, OEH
- Mt Gilead Biocertification Assessment
- Bingara Gorge, Ecological surveys
- Western Sydney Dieback project, bird surveys and advice, Goodman.
- Metropolitan Colliery Vegetation Monitoring Program 2008 - present
- Ecological Assessment, Proposed Hume Highway Duplication, RTA
- Flora and Fauna Impact Assessment, Roadside Vegetation Maintenance, Old Princes Highway, Bulli Tops to Waterfall, Wollongong City Council
- Goodnight Island Ecological Assessment, Studio Internationale
- Research and Monitoring Program, DEFCOMMSTA Morundah, Dept of Defence
- Ecological Expert, Land and Environment Court, Booralie Rd, Warringah, Northern Beaches Council.
- Superb Parrot Surveys, selected sites in ACT 2014 and 2015
- Eastern Highlands Vegetation Surveys, (Kosciusko NP and ACT), DECCW and ACT government.
- West Dapto and Adjacent Growth Areas, Part 3A Assessment, Sydney Water Corporation
- Tharbogang Landfill Biodiversity Offset Strategy, Griffith City Council
- Ecological Equivalence Assessment, Carmichael Mine, central QLD.
- Rapid vegetation assessment, mid to lower Murrumbidgee (Griffith to below Balranald), OEH
- PAS expert advice (Plains-wanderer, *Brachyscome muelleroides* and *Leptorhynchos orientalis*), OEH

- Council Appointed Expert, terrestrial ecology, Proposed Subdivision Hampton Cres Blacktown
- Council Appointed Expert, terrestrial and aquatic ecology, Rooty Hill
- Box-Gum Woodland Mapping and Monitoring Plan for Kapooka Military Area, Dept of Defence
- Monitoring the Impacts of Kangaroo Grazing in the Kapooka Military Area, Dept of Defence
- Monitoring the Impacts of Kangaroo Grazing in Latchford Barracks, Dept of Defence
- North Bandiana Landscape Management Plan, Dept of Defence
- South Bandiana Landscape Management Plan, Dept of Defence
- Vegetation Condition Assessment, South West Slopes, DEWHA
- Flora and Fauna Assessment, Proposed Bayswater 2 Powerstation, Part 3A, AECOM
- Rapid weed assessments, Wilderness areas (Kosciusko, Deua, Monga, Mummel Gulf National Parks), OEH
- Hargraves to Windeyer Powerline Ecological Assessment, Barnson Pty Ltd
- Moolarben Coal Mine Preclearing Survey, Moolarben Coal Operations
- Vegetation Mapping, Mulwala Explosives Facility, Mulwala, Dept of Defence
- Native Grassland Condition Assessment, Tubbo Station, Tubbo Farming.
- Wagga Wagga Linepack Extension, Environmental Licencing Professionals
- Ecological Assessment, Cooktown, QLD, Airservices Australia
- Assessment of Irongrass Natural Temperate Grassland, Tailem Bend, SA, Airservices Australia
- Moorlaben Coal, Flora and Fauna Monitoring 2010-2011, Moolarben Coal Operations
- Tralee Station proposed rezoning, environmental assessment and constraints analysis, Queanbeyan, Urbis.
- Ecological Surveys, Nymagee, Triako mines with Charles Sturt University.
- Ecological Surveys, Cobar, Endeavour mine with Charles Sturt University.
- Ecological assessment, piping Llanillo Bore Drain, Lightning Ridge
- Ecological Assessment, proposed upgrade to Lake Brewster, near Hillston, State Water
- Ecological Assessment, Muggabah and Merrimajeel Creeks, Booligal, Dept Commerce
- Flora survey, Coleambally Irrigation Area, Australian Museum.
- Towra Point Artificial Bird Roosts REF, DECCW
- Southern Highlands Transfer, Identification of Flora and Fauna Constraints, Dept Commerce
- Shoalhaven Water Transfers, Terrestrial Ecology and Wetlands, Dept Commerce
- Wetland Vegetation Surveys for LiDAR comprising the Gwydir Wetlands, DECCW
- Wetland Characterisation and Management, Port Stephens Council
- EPBC Box Gum woodland survey and mapping, Molonglo region, ACT
- Tallawarra Local Environment Study, TRUenergy
- Shellharbour Hardrock Extraction Flora and Fauna Assessment, NSW Dept of Planning
- Campbelltown Biodiversity Study, Campbelltown City Council
- Native Vegetation Guide for the Riverina, Greening Australia
- Buckingbong State Forest Environmental Assessment, Dept of Defence
- Wagga Wagga Planning Studies, Willana Associates
- Historical distribution of Native Grasses through Parkes, Forbes and Lachlan Shires, Western Research Institute
- A review of the ecological health of the Murrumbidgee River, Living Murray
- Systematic Vegetation Surveys, Upper Hunter Valley
- Environmental investigations and vegetation mapping, DEFCOMMSTA properties, Dept of Defence
- Vegetation Condition Assessment, Woodlands Historic Park, Melbourne, Parks Victoria
- Flora survey, Riverine Plain (62 sites), DLWC
- Flora survey, Jingellic, Bogandyera and Clarkes Hill Nature Reserves, NPWS
- Flora survey, Wagga Wagga LGA, DEC
- Googong Environmental Investigations for Local Environment Study, Willana Associates
- Gum Swamp Management Plan and Operation and Maintenance Manual, Gum Swamp, DLWC
- Evaluation of 1750 mapping of vegetation by the Riverina Vegetation Committee, NPWS
- Edwin Land Parkway, Queanbeyan, GHD
- Vegetation validation - Narrandera, Ardlethan, Barmedman and Coolamon 1:100,000 Map Sheets, DECCW
- Scoping Report for the Development of a Biodiversity Strategy and Plan for the Rice Industry, Rice Growers Association

Brian Towle Senior Field Ecologist – Vegetation Mapping and threatened flora (moved to Eco Planning Pty Ltd, December 2016

CURRICULUM VITAE

Brian Towle

SENIOR ECOLOGIST

QUALIFICATIONS

- Bachelor of Environmental Science (First Class Honours). The impacts of recreational vehicle use on vegetation and soils of a Sydney Sandstone Ecosystem. University of New South Wales – 2005.
- Accredited Biobanking Assessor

Brian is a senior ecologist with over 10 years' experience as an environmental consultant. During this time he has worked primarily as a botanist undertaking a range of projects including registered BioBanking agreements, applications for Biodiversity certification, vegetation monitoring programs, large scale vegetation mapping projects, targeted surveys and a range of impact assessments.

Brian has conducted surveys in a range of ecosystems across NSW, and in parts of QLD (Bowen Basin), from the coast to the far western plains including arid woodlands, shrublands and grasslands, wet sclerophyll forests, rainforests and coastal swamps. This experience has exposed him to a diversity of flora and fauna distributed across these ecosystems. Brian has also undertaken research into the ecology of native plants co-authoring publications within peer-reviewed journals.

Brian has a sound knowledge of environmental and planning legislation, and has applied this understanding and his ecological expertise to a range of projects including as an expert witness for the Land and Environment Court. Brian has worked for a range of clients ranging from Local Councils, to state agencies and private industry. This has required him to communicate effectively with a range of professionals and the general public in both written and oral form.

RELEVANT PROJECT EXPERIENCE

Ecological impact assessment

- Macdonaldtown Gasworks remediation (Incoll Management Pty Ltd)
- Southern Sydney Freight Line, Glenfield to Cabramatta (John Holland Pty Ltd)
- Impacts of Pacific Highway Upgrade on Koalas, Bonville (Roads & Maritime Services)
- Powerline corridor widening, Cordeaux (AAJV Pty Ltd)
- Tallawarra Part 3A Ecological Assessment
- Powerline Maintenance works, various locations (Integral Energy)
- Darkes Forest Powerline, Ecological Assessment, central NSW
- Proposed Sewer alignment El Cabello Blanco, Gledswood and Lakeside properties (Sekisui House)
- Threatened Species Impact Statement for proposed residential subdivision at Menai, Sutherland LGA, NSW (Landcom, 2009/10).
- Bald Hill carpark and lookout redesign (Wollgong City Council)
- Lucas Heights Stockpile Assessment (WSN Environmental Solutions)
- Mount Ousley Heavy Vehicle Checking Station REF (Roads & Maritime Services)
- Woodford sewer line extension, (AAJV Pty Ltd)
- Sublime Point Water Treatment Plant Upgrade (Wollongong Council)
- Pinedale Coal Mine Ecological assessment report
- Threatened Species Impact Statement Beacon Hill, Warringah LGA, NSW
- Yallah-Marshall Mount Ecological Sensitivity Analysis (Wollongong Council)

BioBanking and Biocertification Assessments

- Biodiversity Certification Application for 600ha property in south-west Sydney (Lendlease Communities)
- Biodiversity Certification Application for North Tuncurry Crown Land (UrbanGrowth NSW).
- Vegetation mapping and assessment of 54 ha Biobank site on the Cumberland Plain (Private landholder) (Agreement No. 100, registered in September 2013)

Ecological inventory & monitoring

- Monitoring impacts to vegetation associated with longwall mining, Illawarra Coalfields
- Offset sites vegetation monitoring and Landscape Function Analysis (Moolarben Coal Pty Ltd)
- Field validation and mapping of Endangered Ecological Communities (Ku-ring-gai Council)
- Updated vegetation mapping and biodiversity conservation options for the West Dapto urban release area (Wollongong City Council)
- Vegetation community mapping project, Mulwala Defence Facility
- Mapping of vegetation communities of the Darling River Floodplain (Murray-Darling Basin Authority)
- Environmentally Sensitive Land Map update Camden LGA (Camden Council)
- Validation of wetland mapping across the Lachlan River catchment (NSW Office of Environment and Heritage)
- Validation of Groundwater Dependent Ecosystem mapping across the Lachlan River catchment (NSW Department of Primary Industries)

Management Plans

- Black Fellows Hands Reserve Biodiversity Management Plan, Mingaan Aboriginal Corporation
- Biobanking Assessment and Plan of Management, Kempsey & Deerubbin LALCs
- Cooper Park Management Plan (Woollahra Council)

Ecological Review

- Expert Witness Statement, Groundwater Extraction, Bilpin
- Ecological Review, UTS Ku-ring-gai Campus Development, Ku-ring-gai

Publications

Bower, C. **Towle, B** and Bickel, D. (2015). *Reproductive success and pollination of the Tuncurry Midge Orchid (*Genoplesium littorale*) (Orchidaceae) by Chloropid Flies*. Telopea 18: 43-55.

Liz Norris Senior Field Ecologist – Vegetation Mapping and threatened flora (moved to Eco Planning Pty Ltd, December 2016

CURRICULUM VITAE

Elizabeth Norris

SENIOR ECOLOGIST

QUALIFICATIONS

- Bachelor of Science, Macquarie University, Sydney. Biology/Ecology and Palaeontology major, 1983.
- Post Certificate in Electron Microscopy, Sydney Technical College, Transmission and Scanning Microscopy, 1986.
- Master of Science, Macquarie University, Sydney. Thesis entitled: 'A study of the soil and vegetation patterns within part of the Pilliga Forests, and an evaluation of the impact of European settlement on the vegetation', 1997.

Liz has 25 years botanical and ecological research in the New South Wales: Sydney Basin, Coastal New South Wales, Hunter Valley, North and South Western Slopes and Plains, often to remote areas. She has a Bachelor of Science, a post graduate certificate in electron microscopy and a Master of Science (Thesis) "*A study of the soil and vegetation patterns within part of the Pilliga Forests, and an evaluation of the impact of European settlement on the vegetation*".

Liz is a senior botanist/ecologist at Eco Logical Australia (permanent part time). During this time, she has been involved in a large number of systematic floristic surveys, targeted flora surveys, vegetation monitoring, the development of strategic conservation plans, other ecological assessments and an ecological expert to the NSW Land and Environment Court. She has been an employee at the National Herbarium, Royal Botanical Gardens from 1982 – 2009 and has undertaken a range of duties including various research projects and curation of the herbarium collection. Liz has extensive experience as a field botanist, has written species descriptions for the Flora of NSW, and provided technical advice at flora workshops.

RELEVANT PROJECT EXPERIENCE

Ecological Constraints / Impact Assessment

- Ingleside Biodiversity Strategy
- Pre-clearing Assessment for APZ development
- Calderwood Urban Development Ecological Survey
- South Cecil Hills Ecological Constraints Analysis
- Crudine Ridge Wind Farm Ecological Assessment (Wind Prospect)
- Ecological Impact Assessments – various (Integral Energy)
- Biobanking Pilot Assessments (DECC)
- El Caballo Blanco and Gledswood Rezoning Ecological and Bushfire Assessment (Landcom)
- Ballanagamang Biobanking Assessment (Ecotrades)
- Blacktown Olympic Park Site Expansion Flora and Fauna Impact Assessment (Blacktown City Council)
- Marsden Park Industrial Precinct Ecological Assessment & EPBC Surveys (APP)
- Alex Avenue Ecological Assessment (Landcom)
- Area 20 Ecological Assessment (GCC)
- Shoalhaven LGA Rural Residential property Flora survey
- Vegetation survey and targeted orchid survey for SEPP 5 development in Wyong LGA.
- Vegetation surveys for Integral Energy and the NSW Road & Traffic Authority and other authorities

- Raymond Terrace and Medowie Wastewater Transportation System, Hunter Water.
- Flora survey and assessment for proposed water pipeline - fennel Bay to Toronto, Hunter Water.
- Flora survey and report including assessment under EPBC and TSC Acts, Kiama LGA.

Targeted threatened species survey

- Targeted orchid survey, Buckingbong State Forest
- Various targeted flora surveys, Cumberland Plain
- Targeted flora surveys, Maroota State Conservation Area (DECCW)
- Hawkesbury City Council's Council and Crown Reserves Vegetation survey

Vegetation Survey and Mapping

- Vegetation Survey for South-east Corner Biometric Benchmark Project
- Systematic Vegetation Surveys, Upper Hunter Regional Environmental Management Strategy
- Marra NP and Muogomarra NR NPWS flora surveys
- Wetland Vegetation Surveys for LiDAR, Lowbidgee and Gwydir wetlands (DECC)
- Vegetation Survey, Durness Station, Tea Gardens, Great Lakes LGA
- Vegetation Survey, Camerons Gorge Nature Reserve, DECCW
- Vegetation Survey, Maroota State Conservation Area, DECCW
- Wingecarribee LGA Flora survey and targeted threatened species survey
- Baulkham Hills Shire Natural Assets Mapping
- Hawkesbury City Council's Council and Crown Reserves Vegetation survey

Ecological Monitoring

- Systematic surveys of long term monitoring plots within Upland Swamps, Newnes Plateau
- Systematic surveys of long term monitoring plots within Upland Swamps and Riparian communities, Metropolitan Colliery Vegetation Monitoring Program

Ecological Reviews

- EPBC Conservation Advice (DEWHA)
- Review of Threatened Species Nominations (DECCW)

Other

- Vegetation Condition Assessment, South West Slopes, DEWHA
- EPBC Referral - Cumberland Plain Woodland, Wivenhoe

Tammy Paartalu Senior Field Ecologist – Vegetation Mapping and threatened flora (moved to Eco Planning Pty Ltd, December 2016

CURRICULUM VITAE

Tammy Paartalu

SENIOR ECOLOGIST

QUALIFICATIONS

- Bachelor of Environmental Science (First Class Honours), Macquarie University. Thesis title: *Assessing the feasibility of nutrient removal at stormwater outlets using biomass: experimental and comparative studies*
- AusRivas Certification, University of Canberra
- Accredited Biobanking Assessor

Tammy is a senior ecologist with over fourteen years experience conducting and managing a diversity of ecological projects for a variety of clients including local government, the Department of Defence and the private sector. She has worked in a number of large environmental consultancies and prior to joining Eco Logical Australia.

Tammy has experience in the preparation of environment impact assessments in both terrestrial and aquatic environments, constraints and opportunities reporting, fauna monitoring and survey, vegetation and conservation management plans, Part 3A and Section 5A Assessments under the EP&A Act, Local Environment Studies, Review of Environmental Factors, Referrals, Species Impact Statements, Biocertification studies and AusRivas aquatic assessments.

Tammy is experienced in plant identification, vegetation mapping and classification, aerial photograph interpretation and detailed fauna assessments. Tammy has worked on numerous projects in a variety of locations throughout NSW, QLD, VIC and the ACT.

Tammy has undertaken numerous assessments for infrastructure projects including linear infrastructure such as powerlines / energy generation, pipelines road, rail, and wind farms. Some of her key project experience within the infrastructure sector is outlined below.

RELEVANT PROJECT EXPERIENCE

Biobanking / Biocertification

- Tahmoor Biocertification
- Ingleside Chase Biobanking Assessment
- Warringah Biobanking Assessment
- Belrose Biobanking Investigation

Wind farms

- Sapphire Wind Farm, Ecological Assessment (EA), Glen Innes, NSW (includes Biobanking Assessment) (2008-2015)
- Boco Rock Wind Farm, EA, Monaro, NSW (includes Biobanking Assessment) (2008 – 2010)
- Crudine Ridge Wind Farm EA, Sofala, Central West, NSW (includes Biobanking Assessment) (2008 – ongoing)

Vegetation Mapping

- Warringah Natural Areas Survey – Vegetation Mapping Update

- Molonglo Box Gum Woodland Mapping
- Great North Walk Natural Areas Survey
- Mapping of Endangered Ecological Communities on Council Managed Lands (Shoalhaven LGA)

Monitoring
- Metropolitan Colliery vegetation monitoring, Peabody
- Wilpinjong Mine vegetation monitoring, Peabody
- Ulan Vegetation Monitoring and Landscape Function Analysis, Ulan Coal
- Vegetation survey and monitoring, Metropolitan Colliery
- Murrumbidgee (SWS) Vegetation Monitoring Project
- Latchford Barracks and Kapooka Military Area Box Gum Woodland monitoring
- Manildra to Parkes nest box monitoring

Offsets
- Taralga Wind Farm
- Narrabri Offset Site, Ecological Assessment
- Williamsdale Offset Site Assessment – Box Gum Woodland mapping and targeted surveys for *Aprasia parapulchella* and threatened flora
- K2RQ Offset Strategy
- M2G pipeline vegetation offset monitoring

Powerlines / Power generation
- Hargraves to Windenmyer Powerline, Ecological Assessment, central NSW
- Bamarang Gas-fired Power Facility Ecological Assessment
- Integral Energy substation flora and fauna assessments throughout western Sydney

Rail
- North West Rail Link Ecological Assessment
- Kingsgrove to Revesby Rail Quadruplication Offset Strategy
- Cronulla Line Upgrade and Duplication Project

Roads
- Hume Highway Upgrade Ecological Assessment (2007)
- Ulan Road Upgrade, Mudgee flora and fauna assessment (2010)
- Richmond Road Upgrade, Western Sydney (2010)

Impact Assessment
- Tallawarra Part 3A Ecological Assessment
- Narrabeen Lagoon Multi-user Access Trail Ecological Assessment
- Numerous Part 5 Assessments throughout Western Sydney
- Vincentia Ecological Assessment
- Glossy Black Cockatoo Breeding Site Surveys, Vincentia

Rezoning
- Koompahtoo Rezoning Assessment
- Threatened Biodiversity Survey and Assessment Nowra Bomaderry Structure Plan (NBSP) Area
- Threatened Biodiversity Survey and Assessment Rezoning Assessment, Woollamia

Infrastructure / Mining
- Ulan Coal Mine Pre-clearance survey
- Ulan Coal Mine Biodiversity Management Plan and Offset Management Plan
- Pre-mining surveys numerous mines in the Hunter Valley
- Hume Highway Upgrade Environmental Assessment
- Ravensworth Mine Ecological Assessment

Aquatic Assessments
- Morwell River Diversion
- Warringah Creeks Assessment
- Hornsby Shire Council Macroinvertebrate and Diatom Monitoring
- Aquatic habitat assessments for a variety of projects including rail and road projects.

Greg Steenbeeke, Senior Field Ecologist – Vegetation Mapping and threatened flora (seconded form OEH Jan 2016 to January 2017

CURRICULUM VITAE

Greg Steenbeeke

SENIOR ECOLOGIST

QUALIFICATIONS

- Bachelor of Science, University of Sydney. Honours in vegetation mapping and analysis, 1990.
- Post-graduate Diploma in Education, secondary education, University of Western Sydney, 1991.
- Master of Environmental Management, University of New England, 2006.
- Certificate IV in Project Management
- Accredited BioBank, Major Projects FBA and Biocertification Assessor

Greg has more than 25 years of botanical and ecological research experience in New South Wales and southern Queensland: Sydney Basin, North Western Slopes and Plains, New England and Central Tablelands, NSW North Coast and South-east Queensland, often to remote areas. He holds a Bachelor of Science with Honours in vegetation mapping and analysis, a Masters of Environmental Management and has also obtained a graduate Diploma in Education as well as a number of certificate-level courses. Greg's primary expertise is in environmental assessment – in particular in vegetation assessment, monitoring and plant identification in both dry land and wetland habitats. He has been involved in regional and state-scale vegetation mapping projects, as well as intensive site assessments for ecological attributes. He has accreditation in Biobanking and Property Vegetation Planning and was involved in developing and refining both systems within the NSW Office of Environment and Heritage and its predecessors. Apart from life sciences he also has a strong background in geology, governance and policy, and environmental restoration and rehabilitation, as well as community and adult education.

Greg has gained his experience working in NSW government as an ecologist or vegetation expert in their environmental management agencies. Greg recently joined Eco Logical Australia as a Senior Ecologist specialising in vegetation work. He brings to the role a significant involvement with a large number of systematic floristic surveys, targeted flora surveys, vegetation monitoring, development of management and implementation plans at scales from the single property to regional assessments. He has also received training as an expert witness. Greg has extensive experience as a field botanist, has provided significant technical expertise to the development of environmental assessment systems and provided technical advice at environmental management workshops as well as authoring books and guides in the subject. He maintains an active role in botanical taxonomy and has been an author for newly-described species.

RELEVANT PROJECT EXPERIENCE

Ecological Constraints / Impact Assessment (including BioBank Assessments)

- Departmental reviewer role for submissions through legislative instruments within OEH/DECCW
- Undertook Biobanking Pilot Assessments as part of development of BioBanking Scheme (DECC 2006)
- Preliminary BioBank Assessment for "Grasstrees" property, Capertee Valley (Eco Trades Pty Ltd, 2007).
- BioBank Assessments: Noorumba Reserve, Campbelltown City Council (2016); Brownlow Hill (stage 4, 2016); Windemere (2016); Rockview South (2016); Tangari (2016); Taralga (2016); Arcadia (2016); Waitara Creek (2016) and others as required
- Constraints assessments: Luddenham Road corridor (2016); Huskisson West (2016); Mount Gilead west (2016)
- Flora and Fauna Assessments: Kiama (2016); Royalla (2016) ; Vineyard pipeline (2016)

Targeted threatened species survey

- Various targeted flora surveys, Cumberland Plain, Blue Mountains and North Wests Slopes regions
- Targeted threatened species surveys in Capertee Valley, Burragorang Valley, Northern Tablelands and SE Queensland.

Vegetation Survey and Mapping
- Kowmung Valley Vegetation Mapping
- Lower Macquarie Valley floodplain and associated lands surrounding Macquarie Marshes
- Native Vegetation Mapping Project – northern regions: Moree – Kaputar; Nandewar; Brigalow Belt South
- Vegetation Mapping – Western Blue Mountains region

Ecological Monitoring
- *Micromyrtus minutiflora* long-term monitoring sites establishment and baseline as part of the Saving our Species project
- Team leader, Wildcount monitoring for NPWS, 2013, 2015.
- Central Hunter Woodland Vegetation Assessments (2016)
- Metro Colliery upland wetlands monitoring (2016)

Ecological Reviews
- EPBC Conservation Advice (DEWHA) and involvement as state expert in teams developing Recovery Plans for Sydney Turpentine Ironbark Forest, Blue Gum High Forest and the multi-entity Cumberland Region Multispecies Plan (in development).
- Review of and provision of expertise to Threatened Species Nominations (EPBC and NSW TSC) for the relevant Scientific Committees.
- Growth forms and lifeform categorisation for NSW flora species (2005-2016)

Technical Review
- Member of the Technical Working Group for Border Rivers-Gwydir CMA.
- Member of the Technical Working Group for the Western Regional Assessment – Bioregional Assessment of the Brigalow Belt South bioregion.
- Member of the Technical Review Panel for Threatened Species assignments and projects in the NSW Government Saving Our Species program.

Training and Education
- Coordinated and assisted with presenting the Roadside Environment Environmental Assessment workshops for Border Rivers-Gwydir CMA.
- Delivered training on taxonomy and nomenclature, and on simple environmental impact recognition for certificate students in Conservation and Land Management.
- Training workshops in *Plant Propagation* and *Identifying Plants*.
- Trainer / Presenter for *Environmental Assessment* units within Property Planning courses for Border Rivers-Gwydir CMA
- Trainer / Presenter in *Part 5 - Review of Environmental Factors* training for Local Government.

Other
- Review and maintenance of the NSW Vegetation Survey database with NSW DECCW.
- Assisting students (in a supervisor-assistance capacity) on research into vegetation on serpentine and ultramafic soils.
- Editor for the journal *The Orchadian* (2012-2015).
- Various peer reviews for technical and scientific journals including *Cunninghamia*, *Ecological Management and Restoration* and *Telopea*.

Publications
- 2014 – *Thismia megalongensis* (Thismiaceae), a new species of *Thismia* from New South Wales (in *Telopea*)
- 2013 - *Managing and Conserving native Vegetation* (Border Rivers – Gwydir Catchment Management Authority) as co-editor and author of several chapters.
- Various short articles to grey-literature journals including The Orchadian

Trade and other certifications
- Construction Induction (White Card) – Number CGI0129696SEQ01
- Maritime / Boat Driver's Licence 744062
- UWS Contractor – Issued 14 / 11 / 2011
- Class C drivers Licence
- PADI Open Water Diver
- Apply First Aid 03/04/2013

Dr Rodney Armistead – Senior Field Ecologist – threatened fauna

CURRICULUM VITAE

Dr Rodney Armistead

ECOLOGIST

QUALIFICATIONS

- PhD in Conservation Biology from Murdoch University, Perth Western Australia. The impact of Phytophthora Dieback on the Mardo or Yellow Footed Antechinus (*Antechinus flavipes leucogaster*).
- Bachelor of Advanced Science (Honours), Deakin University, Geelong. A phylo-genetic assessment of Swamp Antechinus (*Antechinus minimus*).

Rodney is an ecologist with a Doctor of Philosophy in Conservation Biology with 14 years' experience in environmental research and consulting. Rodney has considerable experience conducting flora, Phytophthora Dieback, terrestrial and aquatic fauna assessments across a variety of desert, alpine, coastal, woodland, tall forests, aquatic and urban habitats in Western Australia, Victoria, Tasmania and New South Wales. He has particular experience in establishing and conducting large broad scale mammals, reptile, frog as well as bird population, biodiversity and presence-absence surveys. He has had the pleasure of surveying such threatened and iconic native fauna species as the Green and Golden Bell Frog, Growling Grass Frog, Spotted Tree Frog, Striped Legless Lizard, Grassland Earless Dragon, Guthega Skink, Grey-headed Flying-foxes, Western and Northern Quoll, Pilliga Mouse, Southern Brown Bandicoots, Brush-tailed Phascogale, Brush-tailed Bettong, Platypus and the Mountain Pygmy Possum.

RELEVANT PROJECT EXPERIENCE

Impact assessments and large scale flora and fauna surveys

- Moxham Quarry, Flora and Fauna Assessment at Moxham Quarry, Northmeade, NSW.
- Bong Road, Flora and Fauna Assessment, West Dapto, NSW
- The Crescent, Flora and Fauna Assessment Helensburgh,
- Bringelly Rd, Flora and Fauna Assessment, Bringelly
- Bingara Gorge, Flora and Fauna Assessment
- Shellharbour wetlands, Flora and Fauna Assessment
- Yennora, Ecological Constraints Assessment
- Calvary, Ecological Constraints Assessment, Victoria Road, Ryde

Targeted Species Surveys and Ecological Monitoring

New South Wales

- Migratory shorebirds and Waders at Cronulla and Kurnell.
- Green and Golden Bell Frog Surveys at Cronulla, Kurnell, Enfield, Port Kembla and Sydney Olympic Park.
- Long-nosed Bandicoot, Inner Western Sydney threatened Population
- Guthega Skink Surveys. Perisher
- Pilliga Mouse surveys in the Pilliga State Forest
- Spot-tail Tiger Quoll surveys in Pilliga State Forest
- New Holland Mouse Surveys in the Pilliga State Forest
- Spot-tail Quoll, Eastern Pygmy Possum, Southern Brown Bandicoot, Giant Burrowing Frog and Broad Headed Snake surveys at Coalcliff

- Grey-headed Flying-fox camp static and fly-out population assessments at Kareela, Cannes, Parramatta River, Burnt Bridge Creek (Manly) and Wolli Creek Camps
- Grey-headed Flying-fox - preparation of management plans for Kareela, Cannes, Parramatta River, Burnt Bridge Creek (Manly) and Wolli Creek Camps
- Grey-headed Flying-fox – assistance and guidance with the preparation of the dispersal plan for the Kareela GHFF camp
- Grey-headed Flying-fox – Vegetation Management Plan for the Centennial Park Flying-fox Camp
- Microchiropteran bat harp-net live capture at Lake Keepit and a Kellyville culvert
- Microchiropteran bat anabat recording and data interpretation at Sydney, Wollongong, Lake Keepit, Mudgee and Newcastle

Western Australia

- Dibbler surveys on Boulanger and Whitlock Islands (University of Western Australia)
- Woylies or Brush-tail Bettong surveys in the southern Jarrah Forest and Dryandra Woodlands (Murdoch University)
- Southern Brown Bandicoot and Brush-tail Phascogale surveys in urban Busselton
- Northern Quoll, Pebble-Mound Mouse and Mulgara surveys in the central and southern parts of the Pilbara (Fortescue Metals and BHP)
- Mulgara, Sandhill Dunnart, Long-tailed Dunnart and Marsupial Mole surveys in the Great Victoria Desert (ecologia, Western Australia Museum and Department of Environment and Sustainability (DSE))

Victoria

- The distribution of Swamp Antechinus in the eastern Otway Ranges. (Deakin University)
- The distribution of Swamp Antechinus on Greater Glennie Island, Bass Strait (Deakin University)
- The distribution of New Holland Mouse at Anglesea and Wilson's Promontory
- The distribution and status of Mountain Pygmy-possums on Mount Buller, Mount Hotham and Bogong High Plains. (Parks Victoria).
- Spotted Tree Frog surveys in north-eastern Victoria (Parks Victoria).
- Platypus surveys in Melbourne's urban Melbourne's urban waterways (Melbourne Water)
- Modified gill net platypus surveys in the Wimmera region. (Project Platypus and Wimmera Catchment Management Authority)
- Platypus surveys in the Mackenzie River, Grampians National Park. (Wimmera Catchment Management Authority)
- Growling Grass Frog surveys in the urban growth areas of Werribee, Cranbourne and outer Melbourne.
- Plains Wanderer surveys in the urban growth areas of Werribee.
- Golden Sun Moth surveys in the urban growth areas of Werribee, Cranbourne and outer Melbourne.
- Micro-bat anabat recording surveys in the urban growth areas of Werribee, Cranbourne and outer Melbourne
- Striped Legless Lizard surveys in the urban growth areas of Melbourne.
- Grassland Earless Dragon surveys in the urban growth areas of Werribee
- Dwarf Galaxias surveys in urban waterways of the Mornington Peninsula, Melbourne.
- Dwarf Galaxias relocation surveys in urban waterways of the Mornington Peninsula, Melbourne.
- Broad Toothed Rat surveys in areas impacted by the Black Saturday Fires
- The distribution of Shearwater and Little Penguin nests and reproductive success on Phillip Island (Phillip Island National Park)

Publications

Western Australia

- Dunstan, W. A., Rudman, T. Shearer, B. L., Moore, N. A., Paap, T., Calver, M. C., Armistead, R. Dobrowolski, M. P., Morrison, B., Howard, K., O'Gara, E., Crane, C., Dell, B., O'Brien, P., McComb, J. A., and Hardy, G. E. St J. (2008) Research into natural and induced resistance in Australian native vegetation of Phytophthora cinnamomi and innovative methods to contain and/or eradicate within localised incursions in areas of high biodiversity in Australia. Eradication of *Phytophthora cinnamomi* from spot infections in native plant communities in Western Australia and Tasmania. Prepared by the Centre for Phytophthora Science and Management for the Australia Government Department of the Environment, Water, Heritage and the Arts.

Victoria

- Cahill, D. M., Wilson, B. A., and Armistead, R. J. (2001). Dieback assessment at Fairhaven Ridge, Ganghook – Lorne State Park, Victoria. A report to Parks Victoria.
- Cahill, D. M, Wilson, B. A., and Armistead, R. J. (2001). Assessment of *Phytophthora cinnamomi* (cinnamon fungus) at Coalmine Road, Anglesea Alcoa lease, Victoria. As report for Alcoa World Alumina, Anglesea.
- Cahill, D. M., Wilson, B. A., and Armistead, R. J. (2001). Assessment of Phytophthora dieback, *Phytophthora cinnamomi* in the Otway National Park, Victoria. A report for Parks Victoria for the Great Ocean Walk.

- The distribution of platypus in waterways in greater Melbourne: spring 2008 and autumn 2009 survey results. A report prepared by Dr. R. Armistead and Dr. A Weeks for Melbourne Water (2009).
- The distribution of platypus in waterways in greater Melbourne: spring 2009 and autumn 2010 survey results. A report prepared by Dr. R. Armistead and Dr. A Weeks for Melbourne Water (2009).
- The distribution of platypus in waterways in the McKenzie River, Grampians National Park 2008 and 2009 survey results. A report prepared by Dr. R. Armistead and Dr. A Weeks for Wimmera Catchment Management Authority (2009).
- The Mount Hotham Mountain Pygmy Possum Recovery Plan (Biosis Research, Mount Buller and Mount Stirling Alpine Resort Management Board and Parks Victoria)

New South Wales

- Eco Logical Australia (2012). Cannes Reserve, Avalon – Grey-headed Flying-fox camp Management and Species Impact Statement. A report to Pittwater Council
- Eco Logical Australia (2013). Kareela Grey-headed Flying-fox camp management plan. A report to Sutherland Shire City Council
- Eco Logical Australia (2013). Parramatta River Grey-headed Flying-fox camp management plan. A report to NPC Consultants
- Eco Logical Australia (2015). Wolli Creek - Grey-headed Flying-fox camp management plan. A report to Rockdale City Council
- Eco Logical Australia (2015). Burnt Bridge Creek - Grey-headed Flying-fox camp management plan. A report to Manly City Council

Memberships

- Australasian Bat Society.
- Foundation for Australia's Most Endangered Species Ltd

Jack Talbot – Field Ecologist – threatened fauna (left ELA 2017)

CURRICULUM VITAE

Jack Talbert

ENVIRONMENTAL CONSULTANT

QUALIFICATIONS

- Bachelor of Environmental Science (Honours): Major in Land Resources University of Wollongong – 2012
- Rail Industry Safety Induction (RISI)/Rail Industry Work Training – 2014
- OEH approved Grey-headed Flying Fox expert – 2015
- National OHS Construction Induction Training (White Card) – 2010

Jack is an Environmental Consultant who joined Eco Logical Australia in 2013. Jack has over 6 years' experience in the environmental science and consulting sector with a primary focus on planning and approvals and ecological assessments. As a requirement of this role, Jack is well versed in Australian environmental legislation, including the EPBC Act, TSC Act, EP&A Act, FM Act and WM Act.

During his time at ELA Jack has managed numerous large project approvals and referrals under the Commonwealth EPBC Act, as well as Biocertifcation Strategic Assessments under the NSW TSC Act. His clients include some of Australia's largest and most well respected community developers and government departments. He has conducted an array of ecological assessments, both terrestrial and aquatic, across a large portion of NSW and the ACT. His experience includes flora and fauna assessments, riparian assessments, controlled activity approvals, vegetation community mapping, nocturnal surveys, hollow bearing tree assessments and felling supervision, as well as more specialised services including Grey-headed Flying Fox camp management and Green and Golden Bell Frog management plans. He also has highly developed technical skills that can be successfully applied to undertake high quality map production and spatial data analysis using Geographic Information Systems (GIS).

Jack completed a Bachelor of Environmental Science (Honours) at the University of Wollongong in 2012. Jack's honours thesis involved a retrospective analysis of beach morphology incorporating photogrammetric data with LiDAR data to assess the movement of sediment within selected beach embayments along the Wollongong coastline. This helped to inform the Wollongong City Councils' Plan of Management for their coastline. Recommendations were adopted by the council and implemented in a subsequent dune reprofiling project in the Illawarra.

Previously Jack has worked within a Hydrogeological and Environmental Consultancy specialising in groundwater resource definition, testing, assessment certification and associated environmental management extending over a large part of NSW and ACT.

Jack is currently working as an Environmental Consultant, within the planning and approvals discipline, located at the Wollongong office of Eco Logical Australia.

RELEVANT PROJECT EXPERIENCE

Planning and Approvals

- South Campbelltown – Rezoning Strategic Assessment (Mir Group of Companies)
- Mt Gilead – EPBC Act Referral (Lend Lease)
- Mt Gilead Dwzonniks Property – EPBC Act Referral (Lend Lease)
- Mt Gilead – Sydney Water Advice and Constraints (AECOM)
- Sydney Science Park – EPBC Act Referral (Celestino)
- Bingara Gorge Residential – EPBC Act Referral and Preliminary Documentation (Lend Lease)
- Port Macquarie Airport – EPBC Act Referral (Port Macquarie Hastings Council)
- Tamala Park Regional Council/Satterly – EPBC Act Approvals and Advice, Compliance Reporting (Catalina Residential Community)
- Site 68 Multi-story Development - EPBC Act Referral and Advice(Sydney Olympic Park Authority)
- Sutton Road Driver Training Centre – EPBC Act Referral (Canberra Institute of Technology)
- Jacaranda Ponds – EPBC Act Referral (Celestino)
- Riverstone, Vineyards, Leppington, Marsden Park - Biodiversity Consistency Reporting (Department of Planning and Environment)
- Eastern Creek Business Hub - EPBC Act Approvals and Advice (Western Sydney Parklands Trust)
- El Caballo Blanco, Gledswood, Lakeside Residential - EPBC Act Approvals and Advice (Sekisui House)
- Emerald Hills Estate - EPBC Act Approvals and Advice (Macarthur Developments)
- Harrington Grove Residential - EPBC Act Approvals and Advice, Compliance Reporting (Harrington Estates)
- Caval Ridge Mine - EPBC Act Approvals and Advice (BMA)
- Gregory Hills Road Extension – Controlled Activity Approval (Dart West Developments)
- Gregory Hills South Creek – Controlled Activity Approval (Dart West Developments)
- Brickpit Referral - EPBC Act Approvals and Advice (Austral Bricks)
- Narrabri Operations - EPBC Act Approvals and Advice (Santos)

Ecology

- Rydalmere Kirby Street – Flora and Fauna, Riparian, and Bushfire Assessments (Mecone)
- HMAS Creswell – Hyams Beach – Flora and Fauna Assessment (Spotless Facilities)
- Gregory Hills Road Extension – Pre-construction Ecology Works (Dart West Developments)
- Batemans Bay – Grey-headed Flying Fox Active Dispersal (Eurobodalla Shire Council)
- Bulli Hospital Hill – Ecological Constraints Analysis (Alex Urena Design Studio)
- Kareela – Grey-headed Flying Fox Active Dispersal (Sutherland Shire Council)
- Leumea Residential – Koala Nocturnal Surveys (Michael Brown Planning Strategies)
- Kentlyn – Weed Management Plan and Koala Management Plan (Neil Singh)
- Manooka Valley – Gregory Hills – Hollow Bearing Tree Assessment and Nest Box installation (TRM)
- Quakers Hill – Westlink M7 – Constraints Analysis – (AAVJ)
- Swan St Wollongong, Forest Rd Gymea – Sydney Water Validation Assessments and Arboricultural Assessments (Diona)
- El Caballo Blanco Sewer – Flora and Fauna Assessments (Sekisui House)
- Mt Ousely – Tree Felling Supervision (Burnett Trees)
- Bingara Gorge – Weed Management Plan (Cardno)
- Barry Road, Kellyvilles – Clearance Supervision (Design + Planning)
- Warrawong – Green and Golden Bell Frog Management Plan (Kennards Self Storage)
- Oran Park Sewer Main – Clearance Supervision
- Mardsen Park, Townsen Road – Weed Management Plan (Arcadis)
- Cobbity – Biocertification Letter
- Gregory Hills Upper Canal – Pre-clearance and Clearance Supervision (Dart West Development)
- Arncliffe Train Station – Pigeon Nest Removal (NSRU Alliance)
- Rossmore Minh Giac Buddhist Temple – Flora and Fauna Assessment (Formacon Building)
- Berkeley Vale Stage 1 – Hollowing Bearing Tree Assessment (Investa Land)
- Hillview Kellyville all stages – Hollow Bearing Tree Assessment
- Bald Hill Reserve – Flora and Fauna Assessment (Wollongong City Council)
- Moolarben Coal Operations – Spring Fauna Monitoring (Moolarben Coal Operations)
- Moolarben Coal Operations – Hollow Bearing Tree Assessment (Moolarben Coal Operations)
- Ulan Surface Operations – Tree felling supervision (Glencore/Xstrata)
- Pilliga State Forest – Flora and Fauna Surveys (Santos)
- Caval Ridge – Offsets Management Plan (BHP)

- McPhails Residential Development – Species Impact Statement (Don Fox Planning)
- El Caballo Blanco – Flora and Fauna Surveys, Federal Approval of Offsets (Sekisui House)
- Eastern Creek Business Hub – Federal Approval of Offsets (Western Sydney Parklands)
- Emerald Hills Estate – Federal Approval of Offsets (Macquarie Developments)
- Ashlar Golf Course – Green Star Rating Report and Nocturnal Surveys
- Parramatta Park – Flying Fox Population Assessment

Aquatic Ecology

- Moolarben Coal Operations – Stream Stability Assessment (Moolarben Coal Operations)
- HMAS Creswell – Creswell Foreshore – Aquatic Ecology Assessment (Jirgens Civil)
- Rouse/Box Hill – Aquatic Ecology Assessments (Private Developer)
- Caledonia Edgelands – DPI Water Headwater Reclassification (Saturday Studio)
- Grays Point – Aquatic Ecology Assessments (Chris Parkhill Developers)
- Wollongong City Council – Continental Swimming Pool Aquatic Ecology Assessment
- McPhails North – Dam Dewatering and Fauna Relocation (Stocklands)
- Port Hacking Aquatic Surveys – Dredging assessment for Fishing Management Act (Sutherland Council)
- Lime Kiln Bay Wetland – Water Quality Assessment (Hurstville Council)
- El Caballo Blanco – Microbat and Green and Golden Bell Frog Nocturnal Surveys (Sekisui House)
- The Ponds Wetland Restoration – Aquatic Fauna Translocation
- Port Kembla Green and Golden Bell Frog Translocation Plan
- Western Sydney Grown Precinct Riparian Assessment and Top of Bank Mapping
- Department of Planning and Infrastructure Riparian Assessment (Riverstone, Ingleside, Vineyards)
- Wollondilly Council – Top of Bank Mapping

Hydrogeology and Contaminated Sites

- Invincible Colliery Lithgow – Annual Groundwater Monitoring
- Mt Kosciusko National Park – Underground Storage Tank Decommissioning and Soil Validation
- Southern Highlands Coal Action Group Hydrogeological Assessment – Berrima region/Boral Colliery
- Southern Highlands Coal Action Group Hydrogeological Assessment – Sutton Forest region
- Cabonne Council; Canowindra, Cudal, Eugowra –Sewerage Treatment Plant Groundwater Monitoring
- Palerang Council; Bungendore Town Water Supply – Hydrogeological Assessment
- Mt Penny – Quarterly Hydrogeological Assessment and Groundwater Monitoring
- Jerrabomberra Wetlands, ACT – Hydrogeological Assessment
- Tyco Water Sydney – Environmental Monitoring
- Shoalhaven City Council – Landfill Environmental Monitoring
- Wollongong City Council – Coastal Zone Study
- Boggabri Coal - Hydrogeological Assessment and Pump Tests
- Black Wattle Bay – Phase 1 Site Investigation
- Fairfield Council – Phase 1 Site Investigation and Targeted Soil Sampling
- S&Q Projects Leichhardt – Phase 1 Site Investigation
- Australian Enviro Services – UST Validation, Targeted Soil Sampling, Installation of Monitoring Bores
- Burrill Lake – Soil Validation Sampling & Analysis
- Various Residential – Soil Validation Sampling and Reporting
- Boggabri Coal Hydrogeological Assessment and Pump Tests

Mitchell Scott– Field Ecologist – threatened fauna (left ELA 2018)

CURRICULUM VITAE

Mitchell Scott

ENVIRONMENTAL CONSULTANT / ECOLOGIST ***(UPDATED MAY 2018)***

QUALIFICATIONS AND PREVIOUS POSITIONS

Bachelor of Science (Biology, and Environmental Studies) - Honours (Class I - Ecology)
University of Sydney 2012
Research Assistant – Macquarie University, Sydney 2013
Research Assistant – Australian National University (ANU), Canberra 2014
National OHS Construction Induction Training (White Card) 2016
Lyssavirus immunized - July 2016
Rail Industry Safety Induction (RISI) Card – 2017

Mitchell is an Environmental Consultant and Ecologist with over 4 years post-graduate experience in environmental consulting and ecological surveys. He has been with ELA since 2015, working with variety of clients at the local (Property Development; Engineering Firms), state (Office of Environment and Heritage [OEH]; NSW Department of Planning & Environment) and federal levels (Department of Environment and Energy).

Mitchell has worked clients from an urban context (UrbanGrowth) and a rural context (Biodiversity Stewardship Sites; Transgrid). He has worked with a variety of stakeholders, including government, private groups, landholders, universities, Indigenous communities and Traditional Owners. He may be utilized in any given stage of a project, from proposal scope, field work, data analysis, use of GIS, report writing, client consultation, and project management.

Mitchell is experienced in assessments under the NSW *Biodiversity Conservation Act 2016* (BC Act) (including BAM methodology and the preparation of BDARs) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Prior to joining ELA, he worked with the Indigenous Yugul Mangi Rangers in southeast Arnhem Land conducting cross-cultural ecological research.

RELEVANT PROJECT EXPERIENCE - SELECT PROJECTS

Project Management

- **Waterloo State Significant Precinct (SSP):** Redevelopment, urban ecological strategy, impact assessment, and community consultation (UrbanGrowth)
- **Flora and Fauna Assessment (FFA) and Biodiversity Management Plan (BMP):** Supporting a Development Application (Aveo Group)
- **Flora and Fauna Assessment (FFA)**: Supporting of rezoning application (Southern Metropolitan Cemeteries Trust)
- **Environmental Planning Advice:** Western Sydney development (Northrop Consulting Engineers Pty Ltd.)

Ecological Surveys

- **Biodiversity Development Assessment Reports (BDAR) using the Biodiversity Assessment Methodology (BAM):** Developments within Greater Sydney Region
- **Mine annual Biodiversity Monitoring, including monitoring of flora and fauna species, and stream stability:** Projects in the Hunter Valley and Central West
- **Nest box monitoring and assessment** (Transgrid: Parkes, New South Wales)
- **Cross-cultural Biodiversity Surveys:** with Yugul Mangi Rangers, SE Arnhem Land, NT.
- **Fauna survey and monitoring:** Operation Wallacea, Buton Island, Sulawesi, Indonesia
- **Fauna survey and monitoring:** Kakadu National Park, NT.

Examples of threatened flora species detected from targeted surveys

- ***Ammobium craspedioides* (Yass Daisy):** Crookwell, NSW, Biobank Site Assessment (Private Landholder)
- ***Darwinia biflora***: Kellyville, Development Application (Group Development Services)
- ***Grevillea juniperina* subsp. *juniperina*:** Blacktown, NSW, Ecological Assessment (Blacktown City Council)
- ***Pimelea spicata* (Spike Rice-flower)**: Camden, NSW, Biobank Site Assessment (Private Landholder)
- ***Prostanthera marifolia**:* Manly, NSW, Saving Our Species (SOS) Project, OEH
- ***Pterostylis ventricosa:*** Jervis Bay, Biobank Site Assessment (Private Landholder)

Examples of threatened fauna species detected from targeted surveys

Amphibians

- ***Litoria aurea* (Green and Golden Bell Frog):** primarily Western Sydney developments (Sydney Olympic Park Authority [SOPA]; Celestino Developments; Orion Consulting Engineers)
- ***Pseudophryne australis* (Red-crowned Toadlet):** Glenorie, NSW, Development Application (Group Development Services).

Mammals (not including microbats)

- ***Cercartetus nanus* (Eastern Pygmy Possum):** Jervis Bay, Biobank Site Assessment (Private Landholder)
- ***Macrotis lagotis* (Greater Bilby):** Tanami Desert, NT (Infrastructure Project)
- ***Petaurus norfolcensis* (Squirrel Glider):** Crookwell, NSW, Biobank Site Assessment (Private Landholder)
- ***Sminthopsis leucopus* (White-footed Dunnart):** Jervis Bay, Biobank Site Assessment (Private Landholder)
- ***Petaurus volans* (Greater Glider):** South Coast NSW, Biobank Site Assessment (Private Landholder)
- ***Phascolarctos cinereus* (Koala):** South Coast NSW, Biobank Site Assessment (Private Landholder)
- ***Pteropus poliocephalus* (Grey-headed Flying-fox):** Monitoring / Dispersal Program - Eurobodella Council, South Coast NSW.

Microbats from Anabat analysis and harp trapping (Impact Assessments; Biobanking; Mine Monitoring):

Non-threatened:

- ***Nyctophilus geoffroyi (Lesser Long-eared Bat); Vespadelus vulturnus (Little Forest Bat); Scotorepens balstoni (Inland Broad-nosed Bat); Mormopterus (Ozimops) planiceps (Southern Freetail Bat).***

Threatened

- ***Falsistrellus tasmaniensis (Eastern False Pipistrelle)***
- ***Myotis macropis (Southern Myotis)***
- ***Saccolaimus flaviventris (Yellow-bellied Sheathtail Bat)***
- ***Scoteanax rueppellii (Greater Broad-nosed Bat)***
- ***Vespadelus troughtoni (Eastern Cave Bat)***

Birds

- ***Pomatostomus temporalis* (Grey-crowned Babbler):** Mine annual fauna monitoring (Mudgee Region)
- ***Polytelis swainsonii* (Superb Parrot):** Mine annual fauna monitoring (Mudgee Region)
- ***Daphoenositta chrysoptera* (Varied Sittella):** Mine annual fauna monitoring (Mudgee Region)
- ***Neophema pulchella* (Turquoise parrot):** Biobanking Project, Crookwell (Private Land Holder)
- ***Climacteris picumnus* (Brown Treecreeper):** Mine annual fauna monitoring (Mudgee Region)

- ***Ninox strenua* (Powerful Owl):** Biodiversity Management Plan for Ingleside, Sydney
- ***Callocephalon fimbriatum* (Gang-gang Cockatoo):** Flora and Fauna Assessment, ACT
- ***Calyptorhynchus lathami* (Glossy Black Cockatoo):** Flora and Fauna Assessment, South Coast NSW

Invertebrates

- ***Meridolum corneovirens* (Cumberland Plain Land Snail):** Western Sydney developments, NSW.

Reptiles:

- ***Hoplocephalus bungaroides* (Broad-headed Snake):** Research Projects with University of Sydney and NSW Parks and Wildlife Services.
- ***Ergernia kintorei* (Great Desert Skink):** Tanami Desert, NT (Infrastructure Project)

ACADEMIC PUBLICATIONS

Putting Indigenous conservation policy into practice delivers biodiversity and cultural benefits.
Ens, E., **Scott, M.L.,** Yugul Mangi Rangers, Moritz, C., and Pirzl, R. (2016) *Biodiversity and Conservation.* DOI:10.1007/s10531-016-1207-6. Accessible here: http://link.springer.com/article/10.1007%2Fs10531-016-1207-6

Multilocus phylogeography reveals fractal endemism in a gecko across the monsoonal tropics of Australia.
Moritz, C., Fujita, M., Rosauer, D., Agudo, R., Bourke, G., Doughty, P., Palmer, R., Pepper, S. Potter, R. Pratt, M., **Scott, M.L.** Tonione, M., & Donnellan, S. (2015) *Molecular Ecology,* DOI: 10.1111/mec.13511

Territoriality in a snake.
Webb, J.K., **Scott, M.L.**, Whiting, M.J. and Shine, R. (2015) *Behavioural Ecology and Sociobiology*, 69:1657-1661

Chemoreception and mating behaviour of a tropical Australian skink.
Scott, M.L., Llewelyn, J., Higgie, M., Hoskin, C.J., Pike, K. and Phillips, B.L. (2015) *Acta Ethologica*, 18(3):283-293.

Chemosensory discrimination of social cues mediates space use in snakes, *Cryptophis nigrescens*.
Scott, M.L., Whiting, M.J., Webb, J.K., and Shine, R. (2013), *Animal Behaviour*, 85(1493-1500).

Alex Gory – Field Ecologist – threatened fauna

CURRICULUM VITAE

ALEX GOREY

ECOLOGIST

QUALIFICATIONS

- Master of Sustainability: University of Sydney – 2015.
- Bachelor of Science: Double major in Environmental Science and Geography, University of Sydney – 2012.
- National OHS Construction Induction Training (White Card) – 2016.
- Lyssavirus Vaccinated December 2016.

Alex has worked as an ecologist for over 3 years. Alex has experience in managing and conducting ecological surveys and reporting associated with the preparation of Flora and Fauna Assessments and Biodiversity Development Assessment Reports under the Biodiversity Assessment Methodology (BAM). Alex is practiced in the application of the NSW *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and other relevant legislation for a range of stakeholders, including land holders, private groups and government. Alex has extensive experience in the preparation of a range of environmental report writing, including constraints advice, planning proposals, Federal referrals and preliminary documentation, Flora and Fauna Assessments, Management Plans, Review of Environmental Factors and Biodiversity Development Assessment Reports.

Prior to joining Eco Logical, Alex completed a Master of Sustainability at the University of Sydney. Alex's research project involved working with Taronga Zoo's sustainability department to improve environmental compliance and help deliver the integration of voluntary sustainability initiatives. Alex also has experience in GIS mapping of coastal environments and assessing both terrestrial and aquatic flora and fauna. Alex has also worked on delivering sustainable economic empowerment for subsistence farming communities in Tanzania.

RELEVANT PROJECT EXPERIENCE

BBAM and BAM Assessments

- Calderwood BDAR Assessment
- Mt Gilead BioBanking Assessment
- Mt Brown BioBanking Assessment
- Cawdor BioBanking Assessment
- Wambo Coalmine Peabody – Hunter Valley
- Rickards Road, Castlereagh – BioBanking Assessment

Planning Proposals and Rezoning

- South Campbelltown Planning Proposal (Mir Group of Companies)
- West Dapto Planning Proposal (Stocklands)
- Jacaranda Ponds Planning Proposal (Celestino)
- Sydney Science Park Planning Proposal (Celestino)

- Corrimal Cokeworks Planning Proposal (Legacy Property)
- Kiama Saddleback Mountain Rd Planning Proposal(Unicomb Development Services Pty Ltd)
- Elizabeth Street, Redfern Planning Proposal (Land and Housing Corporation NSW)

Federal Approvals

- Macarthur Gardens North Preliminary Documentation (Land and Housing Corporation NSW)
- Rickards Road, Castlereagh Post Approvals Management and Referral
- Jacaranda Ponds Preliminary Documentation (Celestino)
- El Caballo Blanco Gledswood Hills Post Approvals Management (Sekisui House)
- CSR Horsley Park Post Approvals Management (CSR & Calibre Consulting)

Impact Assessments

- Barkers Mill - Biodiversity and Riparian Assessment (Macarthur Developments)
- Canyonleigh – Flora and Fauna Assessment (Highlands Heavy Industries)
- Coalcliff - Flora and Fauna Assessment (Ingham Planning)
- Cromer – Flora and Fauna Assessment (Brewster Murray Architects)
- Elizabeth Macarthur Creek – Flora and Fauna Assessment (AECOM)
- Freemans Reach – Vegetation validation and targeted flora and fauna surveys (Celestino)
- Kingswood – Ecological Constraints Analysis
- Delhi Road Upgrade – Flora and Fauna Assessment
- Jacaranda Ponds – Rezoning Planning Proposal
- Oakdale – Constraints Analysis (Michael Brown Planning)
- Quakers Hill – Constraints Analysis (AECOM)
- Western Sydney Parklands Trust – Ecological Constraints Analysis
- Wollongong LGA– Review of Environmental Factors (Wollongong City Council)
- Calderwood Valley – Flora and Fauna Assessments and Ecological Constraints Analysis (Lendlease)
- Gregory Hills Sewer Pipeline - REF (Dart West Developments)
- Kogarah Sewer Pipeline - REF (Rose Atkins Rimmer Infrastructure)
- Camden Road Sewer Pipeline - REF (Rose Atkins Rimmer Infrastructure)
- Riverstone Sewer Pipeline – REF (Rose Atkins Rimmer Infrastructure)

Fauna Handling and Clearance Supervision

- Kellyville Residential subdivision – Dam Dewatering
- Mt Carmel – Hollow bearing tree clearance supervision (Western Earthmoving)
- Schofields – Hollow bearing tree clearance supervision (North Western Surveys)
- El Cabello Blanco Cumberland Plain Land Snail clearance survey (Cardno)
- Glenmore Park Cumberland Plain Land Snail clearance survey (CCL Developments)

Threatened Fauna Management Plans

- Horsley Nest Box Management Plan (Allan Price and Scarratts)
- Manooka Valley – Hollow Bearing Tree Assessment and Nest Box Installation Plan (Green Fields Development Company)
- Warrawong Green and Golden Bell Frog Management Plan (Kennards Self Storage)
- Riverstone Green and Golden Bell Frog Management Plan (Rose Atkins Rimmer Infrastructure)

Targeted Fauna Survey

- Mt Gilead – Targeted Microchiropteran bat surveys, frog surveys and squirrel glider surveys (Lend Lease)
- Glenarra - Targeted Squirrel Glider surveys
- Helensburgh – Targeted microbat surveys
- Jacaranda Ponds – Targeted Koala, microbat and forest owl survey
- Sydney Science Park – targeted migratory bird survey, Green and Golden Bell Frog, Microbat survey
- Calderwood Targeted Powerful owl Survey

Other relevant skills

- Participated in 4-day Advanced Plant Identification Skills for Research and Environmental Assessment Course run by Belinda Pellow and David Keith, 2016.

Appendix B : Planning proposal consultation

Gilead Balance Land Planning Summary. Prepared by GLN Planning Consulting Strategy, 11 July 2019.

Provided as a separate document.

Appendix C : Response to Submissions Report

Provided as a separate document.

Appendix D : Threatened species likelihood table and assessment of candidate species

The table below lists the threatened species known or considered likely to occur within the BCAA based on previous surveys, Atlas, EPBC Act Protected Matters Search, Biodiversity certification credit calculator tool and/or expert opinion. Those species categorised as 'species credit' species (all threatened flora species and approximately half of all threatened fauna species) that were filtered into the BCAA by the biocertification credit calculator version 1.9 and validated as species credit species against the threatened species profile ecological data from the BioNet Atlas of NSW Wildlife (Step 1 of section 4.3 of the BCAM) are indicated. At this stage of the candidate species assessment, additional species are added to the list if they have been recently listed in the TSC Act, there are records on the Atlas or have been recorded in past ecological surveys/reports (Step 2 of section 4.3 of the BCAM). A Wildlife Atlas search was undertaken by ELA in July 2019 to identify any additional species to be added to the table.

It should be noted that species which are predicted by habitat surrogates as part of the biocertification tool (Ecosystem credit species) are not included within this table. Additionally, species listed as 'Marine' and/or 'Migratory' have not been included in the table below.

The 'Likelihood' and 'Justification' columns justifies the culled list of candidate species for further assessment and the 'Additional survey required' indicates whether additional survey is required to complete a formal Biocertification assessment (Step 3 of section 4.3 of the BCAM).

Five categories for likelihood of occurrence of species are used in this report and are defined below. Assessment of likelihood was based on species' locality records, presence or absence of suitable habitat features within the BCAA, results of previous studies, on site field surveys and professional judgement.

- known/yes - the species is known to occur within suitable habitat within the BCAA.
- likely - a medium to high probability that a species occupies or uses habitat within the BCAA.
- potential - suitable habitat for a species occurs within the BCAA, but there is insufficient information to categorise the species as likely to occur, or unlikely to occur.
- unlikely - a very low to low probability that a species occupies or uses habitat within the BCAA.
- no - habitat within the BCAA and in the immediate vicinity is unsuitable for the species, or, in the case of plants, the species was not located during searches of the BCAA.

TSC/EPBC Act Status

- CE = Critically Endangered species, population or ecological community.
- E = Endangered species, population (E2) or ecological community (E3).
- V = Vulnerable species, population or ecological community.

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Acacia bynoeana	Bynoe's Wattle	E	V	BCAM, Atlas, PMST	*Acacia bynoeana* is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains, and has recently been found in the Colymea and Parma Creek areas west of Nowra. It is found in heath and dry sclerophyll forest, typically on a sand or sandy clay substrate, often with ironstone gravels (OEH 2015d).	No	Potential	Marginal habitat present.	Yes.
Acacia pubescens	Downy Wattle	V	V	BCAM, Atlas, PMST	*Acacia pubescens* occurs on the NSW Central Coast in Western Sydney, mainly in the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon. It is associated with Cumberland Plains Woodlands, Shale / Gravel Forest and Shale / Sandstone Transition Forest growing on clay soils, often with ironstone gravel (OEH 2015d).	No	Potential	Marginal habitat present.	Yes
Allocasuarina glareicola		-	E	PMST	*Allocasuarina glareicola* is primarily restricted to the Richmond district on the north-west Cumberland Plain, with an outlier population found at Voyager Point. It grows in Castlereagh woodland on lateritic soil (OEH 2015d).	No	Unlikely	No habitat present and outside known range.	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Asterolasia elegans		E	E	PMST	*Asterolasia elegans* is restricted to a few localities on the NSW Central Coast north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby LGAs. It is found in sheltered forests on mid- to lower slopes and valleys, in or adjacent to gullies (OEH 2015d).	No	Unlikely	Marginal habitat present and outside known range.	No
Astrotricha crassifolia	Thick-leaf Star-hair	V	V	PMST	*Astrotricha crassifolia* is known from two separate disjunct areas, a 'northern metapopulation' near Gosford and a 'southern metapopulation' near Sutherland including the Royal National Park and Woronora Plateau.	No	Unlikely	Marginal habitat present and outside known range.	No
Callistemon linearifolius	Netted Bottle Brush	V		Atlas	*Callistemon linearifolius* has been Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. Within its range it grows in dry sclerophyll forest on the coast and adjacent ranges.	No	Potential	Marginal habitat present	Yes
Caladenia tessellata	Thick Lip Spider Orchid	E	V	PMST	*Caladenia tessellata* occurs in grassy sclerophyll woodland, often growing in well-structured clay loams or sandy soils south from Swansea, usually in sheltered moist places and in areas of increased sunlight. It flowers from September to November (OEH 2015d).	No	Unlikely	Only marginal habitat present	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	PMST	*Cryptostylis hunteriana* is known from a range of vegetation communities including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); where it appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*). Coastal Plains Scribbly Gum Woodland and Coastal Plains Smoothed-barked Apple Woodland is potential habitat on the Central Coast. Flowers between November and February, although may not flower regularly (OEH 2015d).	No	Unlikely	No suitable habitat present.	No
Cynanchum elegans	White-flowered Wax Plant	E	E	BCAM, Atlas, PMST	*Cynanchum elegans* is a climber or twiner with a variable form, and flowers between August and May, peaking in November. It occurs in dry rainforest gullies, scrub and scree slopes, and prefers the ecotone between dry subtropical rainforest and sclerophyll woodland/forest. The species has also been found in littoral rainforest; *Leptospermum laevigatum – Banksia integrifolia* subsp. *integrifolia* coastal scrub; *Eucalyptus tereticornis* open forest/ woodland; *Corymbia maculata* open forest/woodland; and *Melaleuca armillaris* scrub to open scrub (OEH 2015d).	No	Potential	Marginal habitat present.	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Dillwynia tenuifolia		V		BCAM	The core distribution is the Cumberland Plain from Windsor and Penrith east to Dean Park near Colebee. Other populations in western Sydney are recorded from Voyager Point and Kemps Creek in the Liverpool LGA, Luddenham in the Penrith LGA and South Maroota in the Baulkham Hills Shire. In western Sydney, may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays (OEH 2015d).	No	Unlikely	Outside known range. Only Marginal habitat present.	No.
Epacris purpurascens var. *purpurascens*		V	-	BCAM, Atlas	Found in a range of habitat types, most of which have a strong shale soil influence (OEH 2015d).	No	Potential	Marginal habitat present.	Yes
Eucalyptus benthamii	Camden White Gum	V	V	BCAM, Atlas, PMST	*Eucalyptus benthamii* occurs in wet open forest on well drained sandy alluvial soils along stream channels, small terraces and alluvial flats on valley floors (OEH 2015d).	No	Potential	Habitat Present	Yes
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	Atlas	*Eucalyptus nicholii* is sparsely distributed but widespread on the New England Tablelands from Nundle to north of Tenterfield, being most common in central portions of its range (OEH 2015d). It is widely planted outside its natural range..	No	No	Outside of its known range.	No
Genoplesium baueri	Bauer's Midge Orchid	V	-	Atlas, PMST	Known from coastal areas from northern Sydney south to the Nowra district. Previous records from the Hunter Valley and Nelson Bay are now thought to be	No	Unlikely	No suitable habitat present.	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					erroneous. Grows in shrubby woodland in open forest on shallow sandy soils (OEH 2015d).				
Grevillea juniperina subsp. *juniperina*	Juniper-leaf Grevillea	V		BCAM	Endemic to Western Sydney. Grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium (often with shale influence), typically containing lateritic gravels. Recorded from Cumberland Plain Woodland, Castlereagh Ironbark Woodland, Castlereagh Scribbly Gum Woodland and Shale/Gravel Transition Forest (OEH 2015d).	No	Potential	Suitable habitat present.	Yes
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	V	V	BCAM, Atlas, PMST	*Grevillea parviflora* subsp. *parviflora* is sporadically distributed throughout the Sydney Basin mainly around Picton, Appin and Bargo. Separate populations are also known further north from Putty to Wyong and Lake Macquarie and Cessnock and Kurri Kurri. It grows in sandy or light clay soils over thin shales, often with lateritic ironstone gravels. It often occurs in open, slightly disturbed sites such as tracks (OEH 2015d).	No	Potential	Suitable habitat present.	Yes
Grevillea parviflora subsp. *supplicans*		E	-	BCAM	Has a very restricted known distribution (approximately 8 by 10 km) and is confined to the north-west of Sydney near Arcadia and the Maroota–Marramarra Creek area, in Hornsby and Baulkham Hills LGAs. Occurs in heathy woodland associations on skeletal sandy soils over massive sandstones (OEH 2015d).	No	No	Outside range and only marginal habitat present.	No.
Gyrostemon thesioides		E	-	BCAM, Atlas	Within NSW, has only ever been recorded at three sites, to the west of Sydney, near the Colo, Georges and Nepean Rivers. Grows on hillsides and riverbanks and may be restricted to fine sandy soils (OEH 2015d).	No	Potential	Within range and suitable	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
								habitat present.	
Haloragis exalata subsp. *exalata*	Wingless Raspwort	V	V	BCAM, PMST	Square Raspwort occurs in 4 widely scattered localities in eastern NSW. It is disjunctly distributed in the Central Coast, South Coast and North Western Slopes botanical subdivisions of NSW. It appears to require protected and shaded damp situations in riparian habitats (OEH 2015d).	No	Potential	Marginal habitat present.	Yes
Hibbertia puberula subsp. *glabrescens* (formerly *Hibbertia sp. Bankstown*)		CE	CE	BCAM	Currently known to occur in only one population at Bankstown Airport. Occurs on tertiary alluvial soil along Airport Creek within 'Cooks River/Castlereagh Ironbark Forest'.	No	Unlikely	Outside of range and no suitable habitat present.	No.
Hibbertia superans		E		BCAM	Occurs from Baulkham Hills to South Maroota in the northern outskirts of Sydney, where there are currently 16 known sites. The species occurs on sandstone ridgetops often near the shale/sandstone boundary (OEH 2015d).	No	Unlikely	Outside of range and marginal habitat present.	No.
Hypsela sessiliflora			Ex	BCAM	Currently known from only two adjacent sites on a single private property at Erskine Park in the Penrith LGA. Known to grow in damp places, on the Cumberland Plain, including freshwater wetland, grassland/alluvial woodland and an alluvial woodland/shale plains woodland ecotone (OEH 2015d).	No	Potential	Marginal habitat present.	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Leucopogon exolasius	Woronora Beard-heath	V	V	Atlas, PMST	*Leucopogon exolasius* is found along the upper Georges River area and in Heathcote National Park. It is associated with Sydney Sandstone Gully Forest on rocky hillsides and creek banks (OEH 2015d).	No	Unlikely	No suitable habitat present.	No
Leucopogon fletcheri subsp. *fletcheri*		E		BCAM	Restricted to north-western Sydney between St Albans in the north and Annangrove in the south, within the local government areas of Hawkesbury, Baulkham Hills and Blue Mountains. Occurs in dry eucalypt woodland or in shrubland on clayey lateritic soils, generally on flat to gently sloping terrain along ridges and spurs (OEH 2015d).	No	No	Outside range and marginal habitat present.	No
Marsdenia viridiflora R. Br. subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs		E	-	Atlas	*Marsdenia viridiflora* grows in vine thickets and open shale woodland. Recent records are from Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys. Previously known north from Razorback Range (OEH 2015d).	No	Potential	Suitable habitat present within BCAA. Recently recorded (2018) at St Helens Park, 5km to north-east	Yes
Melaleuca deanei	Deane's Paperbark	V	V	BCAM, Atlas, PMST	Found in heath on sandstone, and also associated with woodland on broad ridge tops and slopes on sandy loam and lateritic soils (OEH 2015d).	No	No	No suitable habitat present.	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Pelargonium sp. *striatellum*	Omeo's Stork's Bill	E	E	PMST	The species is known to occur in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes. During dry periods, the species is known to colonise exposed lake beds. It is not known if the species' rhizomes and/or soil seedbank persist through prolonged inundation or drought (OEH 2015d).	No	No	No suitable habitat present.	No
Persicaria elatior	Tall knotweed	V	V	BCAM	In south-eastern NSW has been recorded from Mt Dromedary (an old record), Moruya State Forest near Turlinjah, the Upper Avon River catchment north of Robertson, Bermagui, and Picton Lakes. Also occurs in in northern NSW and Queensland. Grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	No	Potential	Marginal habitat present.	Yes
Persoonia bargoensis	Bargo Geebung	E	V	BCAM, Atlas, PMST	Associated with woodland to dry sclerophyll forest, on sandstone and clayey laterite on heavier, well-drained, loamy, gravelly soils of the Hawkesbury Sandstone and Wianamatta Shale in the catchments of the Cataract, Cordeaux and Bargo Rivers (OEH 2015d).	No	Potential	Marginal habitat present.	Yes
Persoonia hirsuta	Hairy Geebung	E	E	BCAM, Atlas, PMST	*Persoonia hirsuta* occurs from Singleton in the north, south to Bargo and the Blue Mountains to the west. It grows in dry sclerophyll eucalypt woodland and forest on sandstone (OEH 2015d).	No	Unlikely	Only marginal habitat present.	No.

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Persoonia nutans	Nodding Geebung	E	E	BCAM, PMST	Associated with dry woodland, Castlereagh Scribbly Gum Woodland, Agnes Banks Woodland and sandy soils associated with tertiary alluvium, occasionally poorly drained. Endemic to the Western Sydney (OEH 2015d).	No	Unlikely	No suitable habitat present.	No
Pimelea curviflora var. *curviflora*		V	V	BCAM, PMST	*Pimelea curviflora* var. *curviflora* is confined to the coastal area of the Sydney and Illawarra Region. In Sydney it is known from between northern Sydney in the south and Maroota in the north-west. It grows on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands (OEH 2015d).	No	Unlikely	Outside known range. Only Marginal habitat present.	No.
Pimelea spicata	Spiked Rice-flower	E	E	BCAM, Atlas, PMST	In western Sydney, *Pimelea spicata* occurs on an undulating topography of well structured clay soils, derived from Wianamatta shale. It is associated with Cumberland Plains Woodland (CPW), in open woodland and grassland often in moist depressions or near creek lines. Has been located in disturbed areas that would have previously supported CPW (OEH 2015d).	No	Potential	Suitable habitat present.	Yes
Pomaderris brunnea	Rufous Pomaderris	V	V	BCAM, Atlas, PMST	*Pomaderris brunnea* occurs in a limited area around the Colo, Nepean and Hawkesbury Rivers, including the Bargo area and near Camden. It also occurs near Walcha on the New England tablelands and in far eastern Gippsland in Victoria It grows in moist woodland or forest on clay or alluvial soils of floodplains and creek lines (OEH 2015d).	Yes	Yes	Recorded within BCAA	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Pterostylis saxicola	Sydney Plains Greenhood	E	E	BCAM, Atlas, PMST	Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where *Pterostylis saxicola* occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils. Restricted to western Sydney between Freemans Reach in the north and Picton in the south. There are very few known populations and they are all very small and isolated (OEH 2015d).	No	Potential Recorded west of Nepean River, November 2018	Suitable habitat present.	Yes
Pultenaea aristata	Prickly Bush-pea	V	V	Atlas, PMST	*Pultenaea aristata* is restricted to the Woronora Plateau where it occurs in dry sclerophyll woodland and wet heath on sandstone.	No	Unlikely	Outside known range and only marginal habitat present.	No.
Pultenaea pedunculata	Matted Bush-pea	E	-	BCAM, Atlas	In NSW, *Pultenaea pedunculata* is known from three disjunct populations, in the Cumberland Plains in Sydney, the coast between Tathra and Bermagui and the Windellama area south of Goulburn. It grows in woodland vegetation but plants have also been found on road batters and coastal cliffs (OEH 2015d).	No	Potential	Suitable habitat present.	Yes
Syzygium paniculatum	Magenta Lilly Pilly	E	V	Atlas, PMST	*Syzygium paniculatum* naturally occurs within rainforest vegetation types, predominately littoral rainforest. It is a widely planted species outside of its natural habitat.	No	Unlikely	Only marginal habitat present.	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Tetratheca glandulosa		V		BCAM	Restricted to Baulkham Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah, and Wyong LGAs. Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone (OEH 2015d).	No	Unlikely	Outside known range and marginal habitat present.	No
Thelymitra sp. Kangaloon	Kangaloon Sun-orchid	CE	CE	PMST	*Thelymitra* sp. *Kangaloon* is only known to occur on the southern tablelands of NSW in the Robertson / Kangaloon / Fitzroy Falls area at 550-700 m above sea level. It is thought to be a short-lived perennial, flowering in late October and early November. It is found in swamps in sedgelands over grey silty grey loam soils. It is known to occur at three swamps that are above the Kangaloon Aquifer, and that are a part of the ecological community “Temperate Highland Peat Swamps on Sandstone” which is listed under the EPBC Act.	No	No	Outside known range. No suitable habitat present.	No
Thesium australe	Austral Toadflax	V	V	Atlas, PMST	Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast (OEH 2015d).	No	Potential	Within known range, potential habitat present.	Yes
FAUNA									
Invertebrates									

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Meridolum corneovirens	Cumberland Plain Land Snail	E	-	BCAM, Atlas	Associated with open eucalypt forests, particularly Cumberland Plain Woodland. Found under fallen logs, debris and in bark and leaf litter around the trunk of gum trees or burrowing in loose soil around clumps of grass. Urban waste may also form suitable habitat (OEH 2015d).	Yes	Likely	Recorded within BCAA records across Appin Road and in Noorumba Reserve, no leaf litter accumulation present	Yes
Petalura gigantea	Giant Dragonfly	E	-	Atlas,	Found along the east coast of NSW, this species is associated with permanent swamps and bogs with free water and open vegetation.	No	No	No suitable habitat present	No
Amphibians									
Heleioporus australiacus	Giant Burrowing Frog	V	V	BCAM, Atlas, PMST	Forages in woodlands, wet heath, dry and wet sclerophyll forest. Associated with semi-permanent to ephemeral sand or rock based streams, where the soil is soft and sandy so that burrows can be constructed (OEH 2015d).	No	Potential	Marginal habitat present	Yes
Litoria aurea	Green and Golden Bell Frog	E	V	BCAM, Atlas, PMST	This species has been observed utilising a variety of natural and man-made waterbodies such as coastal swamps, marshes, dune swales, lagoons, lakes, other	No	Potential	Suitable habitat present	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					estuary wetlands, riverine floodplain wetlands and billabongs, stormwater detention basins, farm dams, bunded areas, drains, ditches and any other structure capable of storing water. Preferable habitat for this species includes attributes such as shallow, still or slow flowing, permanent and/or widely fluctuating water bodies that are unpolluted and without heavy shading. Large permanent swamps and ponds exhibiting well-established fringing vegetation (especially bulrushes–Typha sp. and spikerushes–Eleocharis sp.) adjacent to open grassland areas for foraging are preferable. Ponds that are typically inhabited tend to be free from predatory fish such as Mosquito Fish (*Gambusia holbrooki*) (OEH 2015d).				
Litoria littlejohnii	Littlejohn's Tree Frog	V	V	Atlas, PMST	Littlejohn's Tree Frog occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops. It appears to be restricted to sandstone woodland and heath communities at mid to high altitude (OEH 2015d).	No	Unlikely	No suitable habitat present	No
Litoria raniformis	Southern Bell Frog	E	V	PMST	Relatively still or slow-flowing sites such as billabongs, ponds, lakes or farm dams, especially where Typha sp., Eleocharis sp. and Phragmites sp. (Bulrushes) are present. This species is common in lignum shrublands, black box and River Red Gum woodlands, irrigation channels and at the periphery of rivers in the southern parts of NSW. This species	No	No	Outside known range	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					occurs in vegetation types such as open grassland, open forest and ephemeral and permanent non-saline marshes and swamps. Open grassland and ephemeral permanent non-saline marshes and swamps have also been associated with this species (OEH 2015d).				
Pseudophryne australis	Red-crowned Toadlet	V		Atlas	Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings (OEH 2015d).	No	Potential	Marginal habitat present	Yes
Reptiles									
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Atlas, PMST	Typical sites consist of exposed sandstone outcrops and benching where the vegetation is predominantly woodland, open woodland and/or heath on Triassic sandstone of the Sydney Basin. They utilise rock crevices and exfoliating sheets of weathered sandstone during the cooler months and tree hollows during summer (OEH 2015d).	No	Unlikely	No suitable habitat present	No
Varanus rosenbergi	Rosenberg's Goanna	V	-	BCAM, Atlas	Associated with Sydney sandstone woodland and heath land. Rocks, hollow logs and burrows are utilised for shelter (OEH 2015d).	No	Potential	Potential habitat present	Yes
Birds									

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Anthochaera phrygia	Regent Honeyeater	E	E & M	BCAM, Atlas, PMST	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of River Oak (*Casuarina cunninghamiana*). Areas containing Swamp Mahogany (*Eucalyptus robusta*) in coastal areas have been observed to be utilised. The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes. As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar (OEH 2015d).	No	Potential	Potential habitat present	Yes
Botaurus poiciloptilus	Australasian Bittern	V	-	PMST	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats. Reedbeds, swamps, streams, estuaries (OEH 2015d).	No	Potential	Marginal habitat present	Yes
Dasyornis brachypterus	Eastern Bristlebird	E	E	Atlas, PMST	Habitat is characterised by dense, low vegetation and includes sedgeland, heathland, swampland, shrubland, sclerophyll forest and woodland, and rainforest, as well as open woodland with a heathy understorey. In northern NSW occurs in open forest with tussocky grass understorey. All of these vegetation types are fire prone, aside from the rainforest habitats utilised by the northern population as fire refuge. Age of habitat since fires (fire-age) is of paramount importance to this species; Illawarra and southern populations reach maximum densities in habitat that has not been burnt for at least 15 years;	No	Unlikely	No suitable habitat present	No

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					however, in the northern NSW population a lack of fire in grassy forest may be detrimental as grassy tussock nesting habitat becomes unsuitable after long periods without fire; northern NSW birds are usually found in habitats burnt five to 10 years previously (OEH 2015d).				
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Atlas	Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains. Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters, extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (OEH 2015d).	No	Unlikely	No suitable habitat present	No
Pezoporus wallicus	Eastern Ground Parrot	V	-	Atlas	Occurs in high rainfall coastal and near coastal low heathlands and sedgelands, generally below one metre in height and very dense (up to 90% projected foliage cover). These habitats provide a high abundance and diversity of food, adequate cover and suitable roosting and nesting opportunities for the Ground Parrot, which spends most of its time on or near the ground.	No	No	No suitable habitat present	No
Mammals									

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Cercartetus nanus	Eastern Pygmy-possum	V	-	Atlas	Found in wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath. Pygmy-Possums feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit. Small tree hollows are favoured as day nesting sites, but nests have also been found under bark, in old birds nests and in the branch forks of tea-trees (OEH 2015d).	No	Potential	Marginal habitat present	Yes
Isoodon obesulus	Southern Brown Bandicoot	E	E	Atlas, PMST	This species is associated with heath, coastal scrub, heathy forests, shrubland and woodland on well drained soils. This species is thought to display a preference for newly regenerating heathland and other areas prone to fire (OEH 2015d).	No	Unlikely	No suitable habitat present	No
Petaurus norfolcensis	Squirrel Glider	V	-	Atlas	Associated with dry hardwood forest and woodlands. Habitats typically include gum barked and high nectar producing species, including winter flower species. The presence of hollow bearing eucalypts is a critical habitat value (OEH 2015d).	Yes	Known	Recorded within BCAA	Yes
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	PMST	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (OEH 2015d).	No	Unlikely	No suitable habitat present	No
Phascolarctos cinereus	Koala	V	V	BCAM, Atlas, PMST	Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70%, with acceptable Eucalypt food trees. Some preferred Eucalyptus species are:	Yes	Known	Suitable habitat present	Yes

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
					Eucalyptus tereticornis, E. punctata, E. cypellocarpa, E. viminalis (OEH 2015d)				
Mammal-bats									
Chalinolobus dwyeri (Breeding Habitat)	Large-eared Pied Bat	V	V	BCAM, Atlas, PMST	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests. This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces. Found in well-timbered areas containing gullies (OEH 2015d).	Yes	known	Recorded foraging within BCAA	Yes for presence of breeding habitat (caves)
Miniopterus australis (Breeding habitat)	Little Bentwing Bat	V	-	BCAM, Atlas	East coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. Moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and banksia scrub (OEH 2015d).	Yes	Known	Recorded foraging within BCAA	Yes for presence of breeding habitat (caves)
Miniopterus schreibersii oceanensis (Breeding habitat)	Eastern Bent-wing Bat	V	-	BCAM, Atlas	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland. It forages above and below the tree canopy on small insects. Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (OEH 2015d).	Yes	Known	Recorded foraging within BCAA	Yes for presence of breeding habitat (caves)

Scientific name	Common name	TSC Act	EPBC Act	Data source	Habitat association	Recorded on site	Likelihood	Justification	Species requiring survey
Myotis macropus (Breeding habitat)	Southern Myotis	V	-	BCAM, Atlas	The Large-footed Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. Will occupy most habitat types such as mangroves, paperbark swamps, riverine monsoon forest, rainforest, wet and dry sclerophyll forest, open woodland and River Red Gum woodland, close to water. While roosting (in groups of 10-15) is most commonly associated with caves, this species has been observed to roost in tree hollows, amongst vegetation, in clumps of Pandanus, under bridges, in mines, tunnels and stormwater drains, however with specific roost requirements. Forages over streams and pools catching insects and small fish. In NSW females have one young each year usually in November or December (OEH 2015d)	Yes	Known	Recorded foraging within BCAA	Yes for presence of breeding habitat (HBT within 200m of water)
Pteropus poliocephalus (Breeding habitat)	Grey-headed Flying-Fox	V		BCAM, Atlas, PMST	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas. Camps are often located in gullies, typically close to water, in vegetation with a dense canopy (OEH 2015d).	Yes	Known	Recorded foraging within BCAA	Yes for breeding habitat

Appendix E : Floristic vegetation type analysis

Provided as a separate spreadsheet

Appendix F : Flora species recorded within the BCAA

A full list of all native species recorded within 66 plots is provided below.

A separate spreadsheet includes cover and abundance data by plot, vegetation zone and vegetation type.

Family	Species
Acanthaceae	*Brunoniella australis*
	Brunoniella spp.
	Pseuderanthemum variabile
Adiantaceae	*Adiantum aethiopicum*
	Adiantum formosum
	Adiantum hispidulum
	Cheilanthes distans
	Cheilanthes sieberi
	Pellaea falcata
Amaranthaceae	*Alternanthera denticulata*
	**Alternanthera pungens*
	Alternanthera spp.
	Amaranthus spp.
	**Gomphrena celosioides*
Anthericaceae	*Arthropodium milleflorum*
	Arthropodium spp.
	**Chlorophytum comosum*
	Laxmannia gracilis

Family	Species
	Tricoryne elatior
	Tricoryne spp.
Aphanopetalaceae	*Aphanopetalum resinosum*
Apiaceae	**Cyclospermum leptophyllum*
	**Foeniculum vulgare*
	Platysace lanceolata
Apocynaceae	**Araujia sericifera*
	**Gomphocarpus fruticosus*
	**Gomphocarpus physocarpus*
	**Gomphocarpus spp.*
	Parsonsia straminea
	Tylophora barbata
	**Vinca major*
Araceae	**Zantedeschia aethiopica*
Araliaceae	*Astrotricha latifolia*
Asparagaceae	**Asparagus asparagoides*
	**Asparagus officinalis*
	**Asparagus plumosus*
Asphodelaceae	**Aloe spp.*
Aspleniaceae	*Asplenium flabellifolium*
Asteraceae	**Ageratina adenophora*
	**Ageratina riparia*
	**Asteraceae indeterminate*
	**Bidens pilosa*

Family	Species
	**Bidens subalternans*
	Brachyscome spp.
	Calotis dentex
	**Carthamus lanatus*
	**Carthamus spp.*
	Cassinia laevis
	Cassinia spp.
	Cassinia trinerva
	**Cirsium vulgare*
	**Conyza spp.*
	**Conyza sumatrensis*
	Coronidium elatum
	Cotula australis
	**Delairea odorata*
	**Delairea spp.*
	Euchiton sphaericus
	Euchiton spp.
	**Gamochaeta americana*
	**Gamochaeta calviceps*
	**Gamochaeta spp.*
	**Hypochaeris radicata*
	Lagenophora stipitata
	Olearia viscidula
	Ozothamnus diosmifolius

Family	Species
	Senecio hispidulus
	Senecio linearifolius
	**Senecio madagascariensis*
	Senecio prenanthoides
	**Senecio spp.*
	Sigesbeckia orientalis subsp. orientalis
	**Sonchus oleraceus*
	**Tagetes minuta*
	**Taraxacum officinale*
	**Tragopogon porrifolius subsp. porrifolius*
	Vernonia cinerea
	Vittadinia spp.
	**Xanthium spinosum*
	Xerochrysum bracteatum
Basellaceae	**Anredera cordifolia*
Bignoniaceae	*Pandorea pandorana*
Blechnaceae	*Doodia aspera*
	Doodia caudata
Brassicaceae	**Brassica spp.*
	**Brassicaceae indeterminate*
	**Hirschfeldia incana*
	**Lepidium africanum*
	**Lepidium bonariense*
	Lepidium pseudohyssopifolium

Family	Species
	**Lepidium spp.*
	Rorippa laciniata
Cactaceae	**Opuntia spp.*
	**Opuntia stricta*
Campanulaceae	*Wahlenbergia communis*
	Wahlenbergia gracilis
	Wahlenbergia spp.
Caryophyllaceae	**Cerastium glomeratum*
	**Paronychia brasiliana*
	**Petrorhagia nanteuilii*
	**Polycarpon tetraphyllum*
	**Silene gallica*
	**Spergularia spp.*
	Stellaria flaccida
	**Stellaria spp.*
Casuarinaceae	*Allocasuarina littoralis*
	Allocasuarina torulosa
	Casuarina cunninghamiana subsp. cunninghamiana
Chenopodiaceae	*Atriplex semibaccata*
	**Chenopodium album*
	**Chenopodium ambrosioides*
	Chenopodium carinatum
	**Chenopodium murale*
	Einadia hastata

Family	Species
	Einadia nutans
	Einadia nutans subsp. linifolia
	Einadia nutans subsp. nutans
	Einadia polygonoides
	Einadia spp.
	Einadia trigonos
Clusiaceae	*Hypericum gramineum*
	**Hypericum spp.*
Commelinaceae	*Commelina cyanea*
	**Tradescantia fluminensis*
Convolvulaceae	*Convolvulus erubescens*
	Dichondra repens
Crassulaceae	**Crassula multicava*
	Crassula sieberiana
Cyperaceae	*Carex inversa*
	Carex spp.
	Cyathochaeta diandra
	**Cyperaceae indeterminate*
	**Cyperus eragrostis*
	Cyperus gracilis
	Cyperus spp.
	Fimbristylis dichotoma
	Gahnia aspera
	Gahnia spp.

Family	Species
	Isolepis habra
	Lepidosperma filiforme
	Lepidosperma laterale
	Lepidosperma spp.
	Schoenus melanostachys
Dennstaedtiaceae	*Pteridium esculentum*
Dilleniaceae	*Hibbertia aspera*
	Hibbertia diffusa
	Hibbertia empetrifolia subsp. empetrifolia
	Hibbertia spp.
Doryanthaceae	*Doryanthes excelsa*
Elaeocarpaceae	*Elaeocarpus reticulatus*
Ericaceae	*Astroloma humifusum*
	Astroloma spp.
	Leucopogon juniperinus
	Leucopogon virgatus
	Lissanthe strigosa
Euphorbiaceae	**Euphorbia peplus*
Fabaceae (Caesalpinioideae)	**Gleditsia triacanthos*
	**Senna pendula var. glabrata*
	**Senna septemtrionalis*
Fabaceae (Faboideae)	*Desmodium gunnii*
	Desmodium varians
	Glycine clandestina

Family	Species
	Glycine spp.
	Glycine tabacina
	Hardenbergia violacea
	Hovea linearis
	Indigofera australis
	Jacksonia scoparia
	Kennedia rubicunda
	**Medicago polymorpha*
	Podolobium ilicifolium
	**Trifolium campestre*
	**Trifolium repens*
	**Trifolium spp.*
Fabaceae (Mimosoideae)	*Acacia binervia*
	Acacia brownii
	Acacia decurrens
	Acacia implexa
	Acacia myrtifolia
	Acacia spp.
	Acacia terminalis
	Acacia ulicifolia
Gentianaceae	**Centaurium erythraea*
	**Centaurium tenuiflorum*
Goodeniaceae	*Goodenia hederacea*
Haloragaceae	*Gonocarpus tetragynus*

Family	Species
	Gonocarpus teucrioides
Juncaceae	**Juncus bufonius*
	Juncus spp.
	Juncus usitatus
Lamiaceae	*Clerodendrum tomentosum*
	Mentha satureioides
	Plectranthus parviflorus
	Scutellaria spp.
Lauraceae	*Cassytha glabella*
	Cassytha spp.
Linaceae	**Linum spp.*
	**Linum trigynum*
Lindsaeaceae	*Lindsaea linearis*
Lobeliaceae	*Pratia purpurascens*
Loganiaceae	*Logania albiflora*
Lomandraceae	*Lomandra confertifolia*
	Lomandra confertifolia subsp. rubiginosa
	Lomandra cylindrica
	Lomandra filiformis
	Lomandra filiformis subsp. coriacea
	Lomandra filiformis subsp. filiformis
	Lomandra gracilis
	Lomandra longifolia
	Lomandra multiflora subsp. multiflora

Family	Species
	Lomandra obliqua
Loranthaceae	*Amyema spp.*
Luzuriagaceae	*Eustrephus latifolius*
	Geitonoplesium cymosum
Malvaceae	**Malva parviflora*
	**Modiola caroliniana*
	Sida corrugata
	**Sida rhombifolia*
	**Sida spp.*
Meliaceae	*Melia azedarach*
Menispermaceae	*Stephania japonica*
Moraceae	*Ficus coronata*
	Ficus rubiginosa
	**Morus alba*
Myrsinaceae	**Anagallis arvensis*
	Myrsine howittiana
	Myrsine variabilis
Myrtaceae	*Angophora bakeri*
	Angophora floribunda
	Angophora spp.
	Backhousia myrtifolia
	Callistemon salignus
	Corymbia gummifera
	Corymbia maculata

Family	Species
	Eucalyptus amplifolia
	Eucalyptus botryoides <--> saligna
	Eucalyptus crebra
	Eucalyptus elata
	Eucalyptus eugenioides
	Eucalyptus fibrosa
	Eucalyptus microcorys
	Eucalyptus moluccana
	Eucalyptus pilularis
	Eucalyptus punctata
	Eucalyptus tereticornis
	Kunzea ambigua
	Leptospermum trinervium
	Melaleuca linariifolia
	Melaleuca styphelioides
	Melaleuca thymifolia
	Myrtaceae indeterminate
	Tristaniopsis laurina
Oleaceae	**Ligustrum lucidum*
	**Ligustrum sinense*
	Notelaea longifolia
	**Olea europaea*
	**Olea europaea subsp. cuspidata*
Orchidaceae	*Dendrobium linguiforme*

Family	Species
	Dendrobium speciosum
	Plectorrhiza tridentata
	Sarcochilus hillii
Oxalidaceae	*Oxalis perennans*
	Oxalis spp.
Passifloraceae	*Passiflora herbertiana subsp. herbertiana*
Phormiaceae	*Dianella caerulea*
	Dianella caerulea var. producta
	Dianella longifolia
	Dianella revoluta
	Stypandra glauca
Phyllanthaceae	*Breynia oblongifolia*
	Glochidion ferdinandi var. ferdinandi
	Phyllanthus hirtellus
	Phyllanthus spp.
	Poranthera microphylla
Phytolaccaceae	**Phytolacca octandra*
Pittosporaceae	*Billardiera scandens*
	Bursaria spinosa
	Pittosporum revolutum
	Pittosporum undulatum
Plantaginaceae	**Plantago lanceolata*
	Plantago spp.
	Veronica plebeia

Family	Species
Poaceae	*Anisopogon avenaceus*
	Aristida ramosa
	Aristida spp.
	Aristida vagans
	Austrostipa pubescens
	Austrostipa ramosissima
	Austrostipa spp.
	Austrostipa verticillata
	**Avena barbata*
	**Avena spp.*
	Bothriochloa macra
	Bothriochloa spp.
	**Briza minor*
	**Briza subaristata*
	**Bromus catharticus*
	**Bromus diandrus*
	**Bromus molliformis*
	**Bromus spp.*
	**Chloris gayana*
	Chloris truncata
	Chloris ventricosa
	Cleistochloa rigida
	Cymbopogon refractus
	Cynodon dactylon

Family	Species
	**Dactylis glomerata*
	Dichelachne micrantha
	Dichelachne spp.
	**Digitaria spp.*
	Echinopogon caespitosus
	Echinopogon ovatus
	**Ehrharta erecta*
	**Eleusine tristachya*
	Elymus multiflorus
	Elymus scaber var. scaber
	Elymus spp.
	Enteropogon acicularis
	Entolasia stricta
	Eragrostis brownii
	**Eragrostis curvula*
	Eragrostis leptostachya
	Eragrostis spp.
	Eriochloa pseudoacrotricha
	Eriochloa spp.
	Imperata cylindrica
	Lachnagrostis filiformis
	**Lolium perenne*
	**Lolium spp.*
	Microlaena stipoides

Family	Species
	**Nassella neesiana*
	**Nassella trichotoma*
	Notodanthonia longifolia
	Oplismenus aemulus
	Oplismenus imbecillis
	Panicum effusum
	Panicum simile
	Panicum spp.
	Paspalidium distans
	Paspalidium spp.
	**Paspalum dilatatum*
	**Paspalum spp.*
	**Pennisetum clandestinum*
	**Phalaris spp.*
	Poa labillardierei var. labillardierei
	Poa sieberiana
	**Poaceae indeterminate*
	Rytidosperma racemosum
	Rytidosperma spp.
	**Setaria parviflora*
	**Setaria spp.*
	**Sporobolus africanus*
	Sporobolus creber
	**Sporobolus fertilis*

Family	Species
	**Sporobolus spp.*
	Themeda australis
	**Vulpia spp.*
Polygonaceae	**Acetosa sagittata*
	**Persicaria spp.*
	**Polygonum aviculare*
	Rumex brownii
Polypodiaceae	*Pyrrosia rupestris*
Portulacaceae	*Calandrinia pickeringii*
	Portulaca oleracea
Proteaceae	*Grevillea mucronulata*
	Persoonia linearis
	Stenocarpus salignus
Ranunculaceae	*Clematis aristata*
	Clematis glycinoides
	Clematis spp.
Rhamnaceae	*+Pomaderris brunnea*
	Pomaderris ferruginea
	Pomaderris spp.
Rosaceae	**Rosa rubiginosa*
	**Rubus fruticosus sp. agg.*
Rubiaceae	*Asperula conferta*
	Galium binifolium
	Galium spp.

Family	Species
	Morinda jasminoides
	Opercularia diphylla
	Opercularia hispida
	Opercularia spp.
	Pomax umbellata
Rutaceae	*Boronia rubiginosa*
	Correa reflexa
	Zieria smithii
Sapindaceae	**Cardiospermum grandiflorum*
	**Cardiospermum spp.*
	Dodonaea triquetra
	Dodonaea viscosa
	Dodonaea viscosa subsp. spatulata
Smilacaceae	*Smilax australis*
Solanaceae	**Cestrum parqui*
	**Datura sp.*
	**Lycium ferocissimum*
	Solanum cinereum
	**Solanum mauritianum*
	**Solanum nigrum*
	Solanum prinophyllum
	**Solanum pseudocapsicum*
	Solanum pungetium
	**Solanum spp.*

Family	Species
Stackhousiaceae	*Stackhousia spp.*
Sterculiaceae	*Lasiopetalum ferrugineum*
Stylidiaceae	*Stylidium graminifolium*
Thymelaeaceae	*Pimelea linifolia*
Ulmaceae	*Trema tomentosa var. aspera*
Urticaceae	*Urtica incisa*
Verbenaceae	**Lantana camara*
	**Verbena bonariensis*
	**Verbena officinalis*
	**Verbena spp.*
Violaceae	*Hybanthus monopetalus*
	Melicytus dentatus
	Viola betonicifolia subsp. betonicifolia
	Viola hederacea
Vitaceae	*Cayratia clematidea*
	Cissus hypoglauca
Xanthorrhoeaceae	*Xanthorrhoea media*
	Xanthorrhoea spp.

Appendix G : Fauna species recorded within the BCAA

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Invertebrates				
Meridolum corneovirens	Cumberland Plain Land Snail	End		
Fish				
Anguilla reinhardtii	Longfin eel			
Anguilla sp.	Shortfin Eel			
Gambusia holbrooki	Mosquito Fish			X
Amphibians				
Litoria dentata	Bleating Tree Frog			
Litoria fallax	Eastern Dwarf Tree Frog			
Litoria latopalmata	Broad-palmed Frog			
Litoria lesueuri	Lesueur's Frog			
Litoria peronii	Peron's Tree Frog			
Litoria tyleri	Tyler's Tree Frog			
Litoria verreauxii	Verreaux's Frog			
Crinia signifera	Common Eastern Froglet			
Limnodynastes peronii	Striped Marsh Frog			
Limnodynastes tasmaniensis	Spotted Grass Frog			
Uperoleia laevigata	Smooth Toadlet			
Reptiles				
Amphibolurus muricatus	Jacky Lizard			
Physignathus lesueurii	Eastern Water Dragon			
Chelodina sp.	Long-Necked Turtle Species Unknown			
Cacophis squamulosus	Golden-crowned Snake			
Pseudechis porphyriacus	Red-bellied Black Snake			
Diplodactylus vittatus	Wood Gecko			
Phyllurus platurus	Broad-tailed Gecko			
Ctenotus taeniolatus	Copper-tailed Skink			
Eulamprus quoyii	Eastern Water-skink			
Eulamprus tenuis	Barred-sided Skink			
Lampropholis delicata	Dark-flecked Garden Sunskink			
Lampropholis guichenoti	Pale-flecked Garden Sunskink			
Varanus varius	Lace Monitor			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Bird species				
Acanthorhynchus tenuirostris	Eastern Spinebill			
Acridotheres tristis	Common Myna			X
Aegotheles cristatus	Australian Owlet-nightjar			
Alcedo azurea	Azure Kingfisher			
Alisterus scapularis	Australian King-Parrot			
Anas castanea	Chestnut Teal			
Anas superciliosa	Pacific Black Duck			
Anthochaera carunculata	Red Wattlebird			
Anthochaera chrysoptera	Little Wattlebird			
Aquila audax	Wedge-tailed Eagle			
Ardea pacifica	White-necked Heron			
Artamus cyanopterus	Dusky Woodswallow	Vulnerable		
Cacatua galerita	Sulphur-crested Cockatoo			
Calyptorhynchus lathami	Glossy Black Cockatoo	Vulnerable		
Chenonetta jubata	Australian Wood Duck			
Colluricincla harmonica	Grey Shrike-thrush			
Coracina novaehollandiae	Black-faced Cuckoo-shrike			
Corcorax melanorphamphos	White-winged Chough			
Corvus coronoides	Australian Raven			
Cracticus nigrogularis	Pied Butcherbird			
Cracticus torquatus	Grey Butcherbird			
Dacelo novaeguineae	Laughing Kookaburra			
Dacelo novaeguineae	Laughing Kookaburra			
Egretta novaehollandiae	White-faced Heron			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Eolophus roseicapillus	Galah			
Eurystomus orientalis	Dollarbird			
Falco cenchroides	Nankeen Kestrel			
Falco peregrinus	Peregrine Falcon			
Fulica atra	Eurasian Coot			
Gallinula tenebrosa	Dusky Moorhen			
Geopelia cuneata	Diamond Dove			
Geopelia placida	Peaceful Dove			
Gerygone olivacea	White-throated Gerygone			
Grallina cyanoleuca	Magpie-lark			
Gymnorhina tibicen	Australian Magpie			
Haliastur sphenurus	Whistling Kite			
Hirundo neoxena	Welcome Swallow			
Leacosarcia melanoleuca	Wonga Pigeon			
Lopholaimus antarcticus	Topknot Pigeon			
Malurus cyaneus	Superb Fairy-wren			
Manorina melanocephala	Noisy Miner			
Manorina melanophrys	Bell Miner			
Meliphaga lewinii	Lewin's Honeyeater			
Menura novaehollandiae	Superb Lyrebird			
Neochmia temporalis	Red-browed Finch			
Ninox boobook	Southern Boobook			
Ocyphaps lophotes	Crested Pigeon			
Origma solitaria	Rockwarbler			
Pachycephala rufiventris	Rufous Whistler			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Pardalotus punctatus	Spotted Pardalote			
Phalacrocorax melanoleucos	Little Pied Cormorant			
Phaps chalcoptera	Common Bronzewing			
Platycercus adscitus	Eastern Rosella			
Podargus strigoides	Tawny Frogmouth			
Psephotus haematonotus	Red- rump Parrot			
Psophodes olivaceus	Eastern Whipbird			
Ptilonorhynchus violaceus	Satin Bowerbird			
Rhipidura albiscapa	Grey Fantail			
Rhipidura leucophrys	Willie Wagtail			
Rhipidura rufifrons	Rufous Fantail		Migratory	
Scythrops novaehollandiae	Channel-billed Cuckoo			
Sericornis frontalis	White-browed Scrubwren			
Strepera graculina	Pied Currawong			
Sturnus vulgaris	Common Starling			X
Tachybaptus novaehollandiae	Australasian Grebe			
Threskiornis spinicollis	Straw-necked Ibis			
Trichoglossus haematodus	Rainbow Lorikeet			
Turdus merula	Eurasian Blackbird			X
Vanellus miles	Masked Lapwing			
Zoothera lunulata	Bassian Thrush			
Mammals (non-flying)				
Antechinus flavipes/stuartii	Yellow-footed/Brown Antechinus			
Bos taurus	European cattle			X
Equus caballus	Horse			X
Lepus capensis	Brown Hare			X

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Oryctolagus cuniculus	Rabbit			X
Macropus giganteus	Eastern Grey Kangaroo			
Macropus robustus	Common Wallaroo			
Wallabia bicolor	Swamp Wallaby			
Rattus fuscipes	Bush Rat			
Rattus rattus	Black Rat			X
Petaurus breviceps	Sugar Glider			
Petaurus norfolcensis	Squirrel Glider	Vulnerable		
Trichosurus vulpecula	Common Brushtail Possum			
Phascolarctos cinereus	Koala	Vulnerable	Vulnerable	
Pseudocheirus peregrinus	Common Ringtail Possum			
Vombatus ursinus	Common Wombat			
Vulpes vulpes	European Fox			X
Mammals (flying - megachiropertran and microchripteran				
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	Vulnerable		
Ozimops (*Mormopterus) ridei*	South-eastern Freetail Bat			
Micronomus (*Mormopterus*) *norfolkensis*	Eastern Coastal Freetailed-Bat	Vulnerable		
Austronomus australis	White-striped Freetail-bat			
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Vulnerable	
Rhinolophus megaphyllus	Eastern Horseshoe-bat			
Chalinolobus dwyeri	Large-eared Pied Bat	Vulnerable	Vulnerable	
Chalinolobus gouldii	Gould's Wattled Bat			
Chalinolobus morio	Chocolate Wattled Bat			
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Vulnerable		
Miniopterus australis	Little Bentwing-bat	Vulnerable		
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	Vulnerable		
Myotis macropus	Southern Myotis	Vulnerable		
Nyctophilus spp.	long-eared bat			
Scoteanax rueppellii	Greater Broad-nosed Bat	Vulnerable		
Scotorepens orion	Eastern Broad-nosed Bat			
Vespadelus pumilus	Eastern Forest Bat			
Vespadelus vulturnus	Little Forest Bat			

Appendix H Fauna species recorded by remote movement sensing cameras

Table 27: Results of remote movement sensing cameras that were set at Sites 1 to 8.

Site number		1	2	3	4	5	6	7	8
Camera Number		4743	4743	4632	4742	4749	8961	8579	4631
Species name	**Common name**								
Birds									
Corcorax melanorhamphos	White-winged Chough		X						
Cracticus tibicen	Australian Magpie		X					X	X
Grallina cyanoleuca	Magpie-lark or Peewee		X	X					
Leucosarcia picata	Wonga Pigeon					X			
Manorina melanocephala	Noisy Miner						X		
Menura novaehollandiae	Superb Lyrebird				X	X			
Phaps chalcoptera	Common Bronzewing		X						
Psophodes olivaceus	Eastern Whipbird					X			
Sturnus vulgaris	Common Starling				X				
Zoothera lunulata	Bassian Thrush					X			
Ocyphaps lophotes	Crested Pigeon						X		
Native mammals									
Antechinus stuartii	Brown Antechinus							X	
Macropus robustus	Common Wallaroo	X							X
Tachyglossus aculeatus	Echidna		X		X			X	
Vombatus ursinus	Common Wombat			X	X	X		X	X
Wallabia bicolor	Swamp Wallaby	X	X	X	X	X		X	X
Trichosurus vulpecula	Brush-tail Possum				X	X			
Introduced mammals									
Bos taurus	Cattle		X	X		X	X	X	
Equus caballus	Horse			X					
Oryctolagus cuniculus	Rabbit			X					
Rattus rattus	Black Rat	X							

Vulpes vulpes	European Red Fox	X	X	X	X	X	X		X
Rattus sp	Unknown Rat species		X						
Total number of species recorded		**4**	**9**	**7**	**7**	**10**	**4**	**6**	**5**

Table 28: Results of remote movement sensing cameras that were set at Sites 9 to 16.

Site number		**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Camera Number		**4651**	**4750**	**4745**	**4629**	**9003**	**4748**	**4652**	**4744**
Species name	**Common name**								
Birds									
Cracticus tibicen	Australian Magpie		X				X	X	
Ptilonorhynchus violaceus	Satin Bowerbird			X					
Chenonetta jubata	Wood Duck								X
Native mammals									
Antechinus stuartii	Brown Antechinus			X		X			
Macropus robustus	Common Wallaroo				X	X			
Phascolarctos cinereus[*1]	Koala				X				
Tachyglossus aculeatus	Echidna				X	X	X		
Vombatus ursinus	Common Wombat	X		X	X	X			
Wallabia bicolor	Swamp Wallaby	X	X		X	X			X
Trichosurus vulpecula	Brush-tail Possum			X		X			
Introduced mammals									
Bos taurus	Cattle		X				X	X	X
Equus caballus	Horse								X
Lepus europaeus	European Brown Hare								X
Vulpes vulpes	European Red Fox	X	X	X	X	X	X		X
Rattus sp	Unknown Rat species			X		X			
Total number of species recorded		3	4	6	6	8	4	2	6

* Threatened species listed under TSC Act / [1] Threatened species listed under the EPBC Act

Table 29: Results of remote movement sensing cameras that were set at Sites 17 to 21.

Site number		17	18	19	20	21
Camera Number		**8593**	**4630**	**4746**	**4740**	**9002**
Species name	**Common name**					
Birds						
Corcorax melanorhamphos	White-winged Chough					X
Native mammals						
Macropus robustus	Common Wallaroo				X	
Tachyglossus aculeatus	Echidna	X				
Vombatus ursinus	Common Wombat					
Wallabia bicolor	Swamp Wallaby				X	X
Trichosurus vulpecula	Brush-tail Possum					
*Petaurus norfolcensis**	Squirrel Glider			X		
Reptiles						
Varanus varius	Lace Monitor				X	
Introduced mammals						
Bos taurus	Cattle	X	X		X	X
Equus caballus	Horse	X	X			X
Rattus rattus	Black Rat				X	
Vulpes vulpes	European Red Fox		X		X	X
Total number of species recorded		**3**	**3**	**1**	**6**	**5**

* Threatened species listed under TSC Act

Appendix I : Hair Tube results

No.	Project	Line	Tube size	Hair tube	Species
1	Mt Gilead	1	Large	1	Horse(probable)
2	Mt Gilead	1	Large	3	Cow
3	Mt Gilead	1	Large	5	Fox(probable)
4	Mt Gilead	1	Large	7	No hair
5	Mt Gilead	1	Large	8	No hair
6	Mt Gilead	1	Large	9	No hair
7	Mt Gilead	1	Small	10	Horse(probable)
12	Mt Gilead	Illawarra	Cam	7	*Rattus rattus*
13	Mt Gilead	4	Small	4	No hair
14	Mt Gilead		Arboreal	4749	No hair
15	Mt Gilead	4	Small	2	No hair
16	Mt Gilead	4	Large	1	Fox
17	Mt Gilead	5	Large	9	*Rattus rattus*
18	Mt Gilead	5	Large	7	Cow (probable)
19	Mt Gilead		Cam	4744	Fox
20	Mt Gilead		Arboreal	4	No hair
21	Mt Gilead		Cam	4749	*Antechinus stuartii* (probable)
22	Mt Gilead	9	Large	3	No hair
23	Mt Gilead	8	Large	8 4653	Cow
24	Mt Gilead		Cam	4629	Cow
25	Mt Gilead		Cam	9003	Cow/horse
26	Mt Gilead	6	Small	6	Fox
27	Mt Gilead	2	Small	9	Fox
28	Mt Gilead	2	Small	8	No hair
29	Mt Gilead	7	Large	7	No hair
30	Mt Gilead	7	Large	1	Cow/horse

No.	Project	Line	Tube size	Hair tube	Species
31	Mt Gilead	1	Large	10	Cow/horse
32	Mt Gilead	7	Large	3	Cow(probable)
33	Mt Gilead	10	Large	3	Cow
34	Mt Gilead	6	Small	10	Cow
35	Mt Gilead	?	Large	15	Cow/horse
36	Mt Gilead	9	Large	7	Cow(probable)
37	Mt Gilead	10	Large	5	Cow(probable)
38	Mt Gilead	4	Small	10	Cow
39	Mt Gilead	6	Large	LS	Fox
40	Mt Gilead	6	Large	5	No hair
41	Mt Gilead	6	Large	3	Cow
42	Mt Gilead	2	Large	7	Fox
43	Mt Gilead	Bait station	Cam	4742	No hair
44	Mt Gilead	7	Small	8	Cow(probable)
45	Mt Gilead	11	Large	9	No hair
46	Mt Gilead	11	Large	5	Cow
47	Mt Gilead	11	Small	10	No hair

Appendix J : 2013 Anabat results

Anabat Results – Mt Gilead Stage 2 anabat assessment December 2016 to January 2017

Prepared by Dr Rodney Armistead

Methods

Seven anabat recorders were set at nineteen (19) different locations within the Mt Gilead Stage 2 biocertification study area between in December 2016 and March 2017 (see **Table 31**). The location of anabat survey site, site reference number, anabat number, date each Songmeter was set to record for, number of survey nights in which data was collected and a summary of the habitat at each site is provided in **Table 31**.

The survey effort included fifty (50) anabat survey nights. Surveys were conducted over a three-month period between December 2016 and March 2017. This is considered the optimal time to surveying for microbats in this region.

Data Analysis

Bat calls were analysed by Rodney Armistead in March 2017 using the program AnalookW (Version 3.8 25 October 2012, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW. Available: (http://www.forest.nsw.gov.au/research/bats/default.asp).

Bat calls were analysed using species-specific call profile parameters including call shape, characteristic frequency, initial slope and time between pulses (Reinhold et al 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et al 2006) were followed:

- Search phase calls were used in the analysis, rather than cruise phase calls or feeding buzzes (McKenzie et al 2002). Cruise phase or feeding calls cannot be used for identification purposes and were labelled as being unidentifiable.
- Recorded calls containing less than three pulses were not analysed and these sequences were labelled as unidentifiable as they are too short to confidently determine the identity of the species making the call (Law et al 1999).
- For those calls that were useful to identify the species making the call, two categories of confidence were used (Mills et al 1996):
    - Definitely present – the quality and structure of the call profile is such that the identity of the bat species making the calls is not in doubt
    - Potentially present – the quality and structure of the call profile is such that there is some / low probability of confusion with species that produce similar calls profiles
- Sequences produced by bats but of inferior quality were also labelled as unidentifiable.

- All calls labelled as unidentifiable were retained in the data as they can be used as an indicator of microbat activity at the site.
- *Nyctophilus* spp. (Long-eared bats) are difficult to identify or separate confidently to species level based upon their recorded calls. Therefore, we have made no attempt to identify any recorded *Nyctophilus* spp. calls to species level (Pennay et al 2004). There are two potential Nyctophilus species that could occur in the study area. Both species, *N. geoffroyi* (Lesser Long-eared Bat) and *N. gouldii* (Gould's Long-eared Bat) are relatively common and widely distributed across NSW.
- The Free-tailed Bats (previously referred to as the genus *Mormopterus*) have recently undergone taxonomic revision (Reardon et al 2014) and published reference calls for this group of species (Pennay et al 2004) are believed to contain errors (Greg Ford pers comm.). This report uses nomenclature for Free-tailed Bat species as referred to in Jackson and Groves (2015). The correlation between nomenclature used in this report and that used in NSW State legislation is presented in Table 30 below.
- Sequences not attributed to microbat echolocation calls (e.g. insect buzzes, wind, train and vehicle movement) were dismissed from the analysis.

Table 30: Correlations between current and previous nomenclature for the Free-tailed bats of NSW

Jackson and Groves 2015	Previously known as	Common Name	BC Act
Austronomus australis	*Tadarida australis*	White-striped Free-tailed Bat	
Micronomus norfolkensis	***Mormopterus norfolkensis***	**Eastern Coastal Free-tailed Bat**	**Vulnerable**
Ozimops petersi	*Mormopterus species 3 (small penis)*	Inland Free-tailed Bat	
Ozimops planiceps	*Mormopterus species 4 (long penis eastern form)*	Southern Free-tailed Bat	
Ozimops ridei	*Mormopterus species 2*	Ride's Free-tailed Bat	
Setirostris eleryi	***Mormopterus species 6***	**Bristle-faced Free-tailed Bat**	**Endangered**

Table 31. Site numbers, microbat recording device number, dates and actual survey nights for the anabat surveys at Mt Gilead

Site number	Unit number	Date set	Date collected	Actual survey nights	Location	Habitat description
1	SN81781	12 Jan 2017	13 Jan 2017	2	Illawarra Coal Site	This anabat recorder was set to record microbat activity among the HBTs present in the Illawarra coal site
2	SN81081	12 Jan 2017	13 Jan 2017	2	Illawarra Coal Site	This anabat recorder was set to record microbat activity at the edge of a weed infested woodland with numerous HBTs and pasture n the Illawarra coal site.
3	SN81997	10 Jan 2017	12 Jan 2017	2	Far north east	This anabat recorder was set on edge of a gully that is located among paddock / pasture habitat and a disturbed Large-leaved Privet and *Kunzea* spp. infested creek line. Several HBTs are located nearby.
4	SN81147	10 Jan 2017	12 Jan 2017	2	Far north east	This anabat recorder was set to record microbat activity at a farm dam. The dam has some riparian vegetation, emergent vegetation, dead trees in dams with no hollows and there are HBTs in surrounding area. The open nature of this very likely to support the foraging activities of the Large-footed Myotis.
4	SN82275 and SN82241	1 March 2017	9 March 2017	15 hours from two anabats over three nights	Far north east	This anabat recorder was set to record microbat activity at a farm dam. The dam has some riparian vegetation, emergent vegetation, dead trees in dams with no hollows and there are HBTs in surrounding area. The open nature of this very likely to support the foraging activities of the Large-footed Myotis. These additional survey hours were undertaken while conducting Green and Golden Bell Frog surveys at the dam.
5	SN81081	5 Jan 2017	10 Jan 2017	4	North - west corner of site	This anabat recorder was set to record microbat activity at the edge of paddock / pasture habitat and an area that contains several dead *Angophora floribunda* trees with hollows, dense

Site number	Unit number	Date set	Date collected	Actual survey nights	Location	Habitat description
						understorey vegetation and other living HBTs nearby. The anabat was set to record microbat activity in a fly way located between the dead *Angophora floribunda* trees.
6	SN81781	5 Jan 2017	10 Jan 2017	4	North - west corner of site	This anabat recorder was set to record microbat activity at the row a relatively thin (~50m wide) and 500 m long strip of Ironbark trees. Most of these trees are relatively young and therefore have not developed hollows. The anabat recorder was aimed towards the open paddock / pasture habitat to recording those species using the paddock as a fly way and / or to forage.
7	SN82275	5 Jan 2017	10 Jan 2017	4	North - west corner of site	This anabat recorder was set to record microbat activity at the edge of sandstone gorge. Several dead stags and the odd HBT is also present nearby.
8	SN81147	16 Jan 2017	20 Jan 2017	4	Eastern	This anabat recorder was set to record microbat activity in the eastern conservation zone that is located among heavily grazed area. The habitat is mostly pasture with large hollow bearing paddock trees. There is considerable space among and below the canopies of these trees for foraging bats.
9	SN82441	20 Jan 2017	24 Jan 2017	2	South-western	This anabat recorder was set to record microbat activity at a vegetated creek line. A metal culvert that forms a bridge with rocks and small amount of water is located nearby. The canopy is open above and just downstream of the bridge, but the canopy is closed and the vegetation becomes very dense further downstream. This anabat was set to determine if the metal culvert was being used as roosting habitat.

Site number	Unit number	Date set	Date collected	Actual survey nights	Location	Habitat description
10	SN81147	14 Jan 2017	16 Jan 2017	2	Central	This anabat recorder was set to record microbat activity beneath a sandstone overhang in sandstone lined gorge / gully / creek. At the time of the survey there was little to no flowing water in creek. Some small isolated pools were present. There are numerous caves, crevices, cracks and over-hanging rocks in this gully. This type of habitat continues for through these creek lines / gorges. This anabat was set to determine if Large-eared Pied Bats, Little Bent-wing Bats, Eastern Bent Wing Bats and Eastern Horseshoe Bats.
11	SN81781	16 Jan 2017	20 Jan 2017	4	Eastern	This anabat recorder was set to record microbat activity in a tilled paddock that has been grazed by cattle. There is a rock gully and woodland about 100 - 150m from the site where the anabat was set.
12	SN82241	5 Jan 2017	10 Jan 2017	4	Central west	This anabat recorder was set to record microbat activity at / near a farm dam near western drainage line and irrigation circle. This anabat was set to test for the presence of the foraging Large-footed Myotis at this open disturbed farm dam. There are numerous HBTs located in the western drainage line that could provide roosting habitat for Large-footed Myotis are present in the nearby drainage line.
13	SN81081	14 Dec 2016	16 Dec 2016	3	Central	This anabat recorder was set to record microbat activity near a farm dam that contains relatively clear water, despite the movement of cattle in and out of the dam. This anabat was set to test for the presence of the foraging Large-footed Myotis at this open disturbed farm dam.

Site number	Unit number	Date set	Date collected	Actual survey nights	Location	Habitat description
						This anabat recorder was set near some HBTs that could provide roosting habitat for Large-footed Myotis are present in the nearby drainage line.
14	SN81997	14 Dec 2016	16 Dec 2016	2	Central	This anabat recorder was set to record microbat activity within an open paddock habitat. There is a woodland nearby with mostly young trees that generally lack hollows. Because of the heavy rain that was falling, the anabat recorder was set in large metal pipes as heavy rain had been forecast during the survey period.
15	SN82241	14 Jan 2017	16 Jan 2017	2	Central	This anabat recorder was set to record microbat activity in a paddock / pasture with scattered hollow bearing paddock trees. A sandstone rocky gorge with undercut banks, crevices and small caves is located approximately 100m from this survey site. This rocky gorge is expected to provide habitat that could support the threatened Eastern Bentwing Bat, Little Bentwing Bat, Large-footed Myotis and Large-eared Pied Bat.
16	SN81081	20 Jan 2017	24 Jan 2017	2	South-western	This anabat recorder was set to record microbat activity at the edge of sandstone gorge / creekline that flows in an south to north direction. This rocky / woodland habitat is expected to that could support the threatened Eastern Bentwing Bat, Little Bentwing Bat, Large-footed Myotis and Large-eared Pied Bat.
17	SN81997	20 Jan 2017	24 Jan 2017	2	South-western	This anabat recorder was set to record microbat activity in bushland in the south / eastern corner of site. The anabat recorder was set to record near two large hollow bearing *E. punctata* trees with hollows. This survey site is located near sandstone gorge that could support the threatened Eastern

Site number	Unit number	Date set	Date collected	Actual survey nights	Location	Habitat description
						Bentwing Bat, Little Bentwing Bat, Large-footed Myotis and Large-eared Pied Bat..
18	SN82243	20 Jan 2017	24 Jan 2017	2	South-western	This anabat recorder was set to record microbat activity in Cumberland Plain Woodland, that has been severely under scrubbed and disturbed by grazing. A farm dam, thin strip of relatively young Kunzea spp. and Acacia spp. dominated vegetated strip and a water channel are located nearby
19	SN82275	20 Jan 2017	24 Jan 2017	1	South-western	In southern paddock, some *E. moluccana* HBTS present. Pasture that has been heavily grazed.

Results

There were 9,095 call sequences recorded during this survey. Of these, 5,567 (61.21%) were deemed useful because the call profile was of sufficient quality or length to enable positive identification of the bat species that made the call to genus or species. The remaining 3,529 call sequences were either short or of low quality, thus preventing positive identification of the bat that made these calls (Table 32 and Table 33).

There were at least 16 and up to 19 bat species recorded during this survey (Table 33 to Table 35). The species diversity across the 19 survey sites varied from at least six species at Site 18 through to at least 15 species at sites 2, 4 and 8 (Table 33 to Table 35).

The most widespread species included the common *Chalinolobus gouldi* (Gould's Wattled Bat) which was recorded at all 19 surveys. Whilst, *Austronomus australis* (Yellow-bellied Sheathtail Bat), *C. morio* (Chocolate Wattled Bat), *Mormopterus* (*Ozimops*) *ridei* (Eastern Freetail Bat), *Vespadelus pumilus* (Eastern Forest Bat) and *V. vulturnus* (Little Forest Bat) were recorded at most the survey sites. Thus, showing that these species are broadly distributed across the study area (Table 33 to Table 35). The two *Vespadelus* spp. have been grouped together as they have similar call profiles and it is difficult to separate the calls (see below for further information). However, these two species have broad distributions, occur in forested habitats such as those present within the study area and they are all know to occur in the region.

Eight species listed as threatened under the NSW *Threatened Species Conservation Act 1995* (TSC Act) were recorded during this survey (Error! Reference source not found. **-** Error! Reference source not found. Error! Reference source not found. and Figure 39 **-** Table 33 to Table 35). Of the eight threatened species that were recorded, definite calls were recorded for six species listed as vulnerable and one species listed as endangered, as shown below:

- *Chalinolobus dwyeri* (Large-eared Pied Bat) (vulnerable)
- *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) (vulnerable)
- *Miniopterus australis* (Little Bentwing Bat) (vulnerable)
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat) (vulnerable)
- *Mormopterus* (*Micronomus*) *norfolkensis* (Eastern Freetail Bat)
- *Myotis macropus* (Large-footed Myotis) (vulnerable).

Two other threatened species was recorded as being potentially present within the study area, including;

- *Scoteanax rueppellii* (Greater Broad-nosed Bat) (vulnerable)
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) (vulnerable).

Chalinolobus dwyeri (Large-eared Pied Bat) is listed under both TSC Act and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was recorded during this survey.

The following section outlines the threatened species recorded,

- Large-eared Pied Bat was found to be broadly distributed across the study area. The species was recorded at Sites 3, 4, 5, 7 8, 9, 12. 14 and 17. Generally the species was identified as single calls. However, 42 Large-eared Pied Bats calls was recorded at Site 12. Forty-two (42) calls were recorded from this species at Site 12. Site 12 is in a creek line with steep or vertical sandstone rock walls, sandstone break-aways, rocky crevices and dry rainforest vegetation. Potential roosting habitat for this species was identified across much of the creek line systems present within the study area.

- *Miniopterus australis* (Eastern Bentwing Bat) was found to be broadly distributed across the study area. Indeed, this species was recorded at 14 of the 19 survey sites. Whilst the Large-eared Pied Bat was recorded at nine of the 19 survey sites (Sites 3, 4, 5, 7, 8, 9, 12, 14 and 17) (**Table 32**). This species generally roosts in caves, stormwater drains, abandoned mines and tunnels (Churchill 2008).

- *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat) was recorded in low numbers and only at a few survey sites. This species was recorded at Sites 4, 7, 8, 14 and 19. The low number of records and limited distribution of this species at the study sites reflects its summer migratory patterns. From late Spring to mid-Autumn, this species resides in its maternal caves located in the Great Dividing Range. The individuals recorded during the present survey may not have migratory from the Sydney basis with

- Definite Large-footed Myotis calls were also recorded at nine of the survey sites (Sites 1, 3, 4, 6, 7, 10, 12, 14 and 16) (**Table 32**).

Survey Limitations

The species recorded in this survey with overlapping call profiles include Eastern Coastal Free-tailed Bat and Ride's Free-tailed Bat. The calls of these two species overlap in the range 30 kHz to 32 kHz. Eastern Coastal Free-tailed Bat calls were identified by alternation in call frequency between pulses, a flat shape (initial slope S1 of less than 100 octaves per second) and a characteristic frequency of between 31 – 36 kHz. Calls were identified as Ride's Free-tail Bat if the call shape was flat (initial slope S1 of less than 100 octaves per second) and the frequency was between 28 – 32 kHz.

Gould's Wattled Bat and Ride's Free-tailed Bat also have calls that overlap in the range 28.5 kHz and 32 kHz. Ride's Free-tailed Bat was identified by non-alternating flat pulses in the frequency range of 28 kHz to 31 kHz. Gould's Wattled Bat display curved pulses with up-sweeping tails, a frequency of 27.5 – 32.5 kHz and alternation in call frequency between pulses. Ride's Free-tailed Bat display non-alternating flat pulses usually with a slope below 200 OPS. Calls with intermediate characteristics were assigned mixed species labels.

The calls of Eastern False Pipistrelle, Greater Broad-nosed Bat and *Scotorepens orion* (Eastern Broad-nosed Bat) can be difficult to separate as their call frequencies and some other call characteristics overlap.

- Eastern False Pipistrelle bat calls have a characteristic frequency between 35 and 39 kHz, display curved, often steep pulses without up-sweeping tails and sometimes with down-sweeping tails. The pre-characteristic section is often long. This species can only be separated from Eastern Broad-nosed Bat, as stated above when the characteristic frequency is above 38 kHz.
- Greater Broad-nosed Bats can be distinguished by a frequency of 32 – 36 kHz, lack of a tail or short down-sweeping tail, frequency of the knee greater than 37 kHz, and drop of more than 3 kHz from the knee to the characteristic section.
- Eastern Broad-nosed Bat calls fall between 34 and 37 kHz but can only be separated from Eastern False Pipistrelle when calls are between 34 and 35 kHz, and the frequency of the knee is above 38 kHz.

When calls showed characteristics intermediate between these three species they were assigned mixed species labels.

Eastern Bentwing Bats have call profiles that overlap with other species in this region, including *Vespadelus darlingtoni* (Large Forest Bat) and *Vespadelus regulus* (Southern Forest Bat). Eastern Bentwing Bat calls can be identified by a characteristic frequency of 43.5 – 47.5 kHz, a down-sweeping tail, uneven time between call pulses, uneven pulse shape within a sequence and a drop of more than 2 kHz between the knee and characteristic section of the call. Large Forest Bat calls have a characteristic frequency of 40 - 44 kHz, have no tail or up-sweeping tails. Large Forest Bats often have a long characteristic section which can aid in separating this species from the Southern Forest Bat. Southern Forest Bat calls fall between 43.5 – 46 kHz, are curved and generally have up-sweeping tails but can have down-sweeping tails. Some of the calls recorded during this survey displayed a drop of more than 2 kHz, downward sweeping tails and variability between the pulses leading to an identification of Eastern Bentwing Bat.

The calls of Little Bentwing Bats are generally easily separated from those of Chocolate Wattled Bat by higher frequency falling between 54.5 and 64.5kHz, however both have down-sweeping tails. Chocolate Wattled Bats generally call between 49.5 and 52 kHz in this region but call at frequencies up to 54.5 kHz in other regions of NSW. Calls falling between 54 and 55.5 kHz can be difficult to separate. Little Bentwing Bat calls often display variable shape and time between pulses and rarely call below 58 kHz. When calls with down sweeping tails were recorded at 54 to 55.5 kHz they were assigned mixed species labels.

In this region, calls of Chocolate Wattled Bat, Little Bentwing Bat, *Vespadelus vulturnus* (Little Forest Bat) and *Vespadelus pumilus* (Eastern Forest Bat) can overlap. Both Little Forest Bat calling between 48.5 and 53 kHz and Eastern Forest Bat calling between 50.5 and 58 kHz have up-sweeping tails whilst Chocolate Wattled Bat and Little Bentwing Bat have down sweeping tails. Eastern Forest Bat can be separated from Little Forest Bat when the frequency falls above 53 kHz. When calls fall between 53 and 55 kHz and do not have tails it is very difficult to separate these four species. When distinguishing characteristics are absent, calls are assigned to multi-species groups or characterized as unidentifiable.

The calls of Southern Myotis and the *Nyctophilus* group of species are difficult to separate. Calls can sometimes be identified as *Nyctophilus spp*. when the time between calls (TBC) is higher than 95ms and the initial slope S1 is lower than 300 octaves per second (OPS). Calls can sometimes be identified as Southern Myotis when the time between calls (TBC) is lower than 75ms and the initial slope S1 is greater than 400 (OPS). Southern Myotis calls are often louder and more distinct, recorded in longer sequences and more variable in shape and TBC than *Nyctophilus* spp. calls. In addition, there is often two kinks in the slope of *Nyctophilus* spp. calls. Where the TBC is between 75 and 95ms and the OPS is between 300 and 400 calls are assigned a mixed species label of Southern Myotis / Long-eared Bats (Pennay, Law and Reinhold 2004).

Table 32: Microbat species diversity recorded at Illawarra Coal and Balance Lands between 16 December 2016 and 9 March 2017

Species Name	Common Name	Site 1 SN81871		Site 2 SN81081		Site 3 SN81997		Site 4 SN81147, SN82275 and SN82241		Site 5 SN81781	
		12 to 13 January 2017		12 to 13 January 2017		10 to 12 January 2017		10 to 12 January 2017, 1 to 9 March 2017		5 to 10 January 2017	
		Set to survey among a weed infested *Eucalyptus moluccana* Woodland		Set to survey at the boundary of weed infested *Eucalyptus moluccana* Woodland and pasture		Set to survey among paddock trees, pasture and Kunzea dominated creek line		Set to survey a farm dam that is partially surrounded by trees and pasture		Set to survey among pasture, dead hollow bearing stags, vegetated creek-line nearby	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-Striped Freetail Bat	X		X		X		X		X	
Chalinolobus dwyeri[1]	Large-eared Pied Bat					X		X		X	
Chalinolobus gouldii	Gould's Wattled Bat	X		X		X		X		X	
Chalinolobus morio	Chocolate Wattled Bat	X		X		X		X		X	
*Falsistrellus tasmaniensis**	Eastern False Pipistrelle		X	X			X		X		X
*Miniopterus australis**	Little Bentwing Bat	X		X		X		X		X	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat							X			
Mormopterus (*Micronomus*) *norfolkensis**	Eastcoast Freetail Bat			X		X		X		X	
Mormopterus (*Ozimops*) *ridei*	Eastern Freetail Bat	X		X				X		X	
*Myotis macropus**	Large-footed Myotis	X			X			X			X
Nyctophilus spp. In this region the non-threatened	In this region the non-threatened Lesser and Gould's Long-eared	X		X	X			X		X	

Species Name	Common Name	Site 1 SN81871		Site 2 SN81081		Site 3 SN81997		Site 4 SN81147, SN82275 and SN82241		Site 5 SN81781	
		12 to 13 January 2017		12 to 13 January 2017		10 to 12 January 2017		10 to 12 January 2017, 1 to 9 March 2017		5 to 10 January 2017	
		Set to survey among a weed infested *Eucalyptus moluccana* Woodland		Set to survey at the boundary of weed infested *Eucalyptus moluccana* Woodland and pasture		Set to survey among paddock trees, pasture and Kunzea dominated creek line		Set to survey a farm dam that is partially surrounded by trees and pasture		Set to survey among pasture, dead hollow bearing stags, vegetated creek-line nearby	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
N. geoffroyi and *N. gouldii* are likely to be present.	Bats are likely to be present.										
*Saccolaimus flaviventris**	Yellow-bellied Sheathtail Bat	X		X				X			
*Scoteanax rueppellii**	Greater Broad-nosed Bat		X		X		X				X
Scotorepens orion	Eastern broad-nosed Bat		X	X		X		X		X	
Vespadelus pumilus	Eastern Forest Bat		X		X		X	X		X	
Vespadelus vulturnus	Little Forest Bat		X		X		X		X		X
Species Diversity (Positive identification)		**8**		**10**		**7**		**13**		**10**	
Species Diversity (Possible identification)			**5**		**5**		**4**		**2**		**4**

* Threatened species listed under TSC Act

Table 33: Microbat species diversity recorded at Balance Lands between 16 December 2016 and 9 March 2017

Species Name	Common Name	Site 6 SN81781		Site 7 SN82275		Site 8 SN81147		Site 9 SN82441		Site 10 SN81147	
		5 to 10 January 2017		5 to 10 January 2017		16 to 20 January 2017		20 t0 24 January 2017		14 to 16 January 2017	
		Set to survey among a thin row of Ironbark young trees. Mostly pasture		Set survey at the edge of sandstone gorge with many hollow bearing trees located nearby		Set survey among paddock trees in eastern conservation zone		Set survey in creek line, small amount of \water, dense riparian vegetation and metal culvert		Set to survey a creek line with sandstone cracks, crevices and overhanging habitats in gorge/gully	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-striped Freetail Bat	X		X		X		X		X	
Chalinolobus dwyeri[1]	Large-eared Pied Bat				X	X		X			
Chalinolobus gouldii	Gould's Wattled Bat	X		X		X		X		X	
Chalinolobus morio	Chocolate Wattled Bat	X				X		X			
*Falsistrellus tasmaniensis**	Eastern False Pipistrelle		X		X	X					
*Miniopterus australis**	Little Bentwing Bat	X		X		X					
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat					X					
*Micronomus (Mormopterus) norfolkensis**	Eastern Coastal Freetail Bat	X		X		X		X			
Ozimops (*Mormopterus*) *ridei*	Eastern Freetail Bat	X		X				X			
*Myotis macropus**	Southern Myotis	X					X		X	X	
Nyctophilus spp. In this region the non-threatened *N. geoffroyi* and *N. gouldii* are likely to be present.	In this region the non-threatened Lesser and Gould's Long-eared Bats are likely to be present.	X					X	X		X	
*Saccolaimus flaviventris**	Yellow-bellied Sheathtail Bat	X		X		X					

Species Name	Common Name	Site 6 SN81781		Site 7 SN82275		Site 8 SN81147		Site 9 SN82441		Site 10 SN81147	
		5 to 10 January 2017		5 to 10 January 2017		16 to 20 January 2017		20 t0 24 January 2017		14 to 16 January 2017	
		Set to survey among a thin row of Ironbark young trees. Mostly pasture		Set survey at the edge of sandstone gorge with many hollow bearing trees located nearby		Set survey among paddock trees in eastern conservation zone		Set survey in creek line, small amount of \water, dense riparian vegetation and metal culvert		Set to survey a creek line with sandstone cracks, crevices and overhanging habitats in gorge/gully	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
*Scoteanax rueppellii**	Greater Broad-nosed Bat		X				X				
Scotorepens orion	Eastern Broad-nosed Bat		X		X	X				X	
Vespadelus pumilus	Eastern Forest Bat		X		X	X			X		X
Vespadelus vulturnus	Little Forest Bat		X		X		X		X		X
Species Diversity (Positive identification)		**9**		**6**		**11**		**7**		**5**	
Species Diversity (Possible identification)			**5**		**5**		**4**		**3**		**2**

* Threatened species listed under TSC Act

[1] Threatened species listed under the EPBC Act

Table 34: Microbat species diversity recorded at Balance Lands between 16 December 2016 and 9 March 2017

Species Name	Common Name	Site 11 SN81781		Site 12 SN82241		Site 13 SN81081		Site 14 SN81997		Site 15 SN82241	
		16 to 20 January 2017		5 to 10 January 2017		14 to 16 December 2016		14 to 16 December 2016		14 to 16 January 2017	
		Set to survey pasture that has been heavily grazed horses.		Set survey near dam among pasture with a few scattered paddock trees nearby		Set to survey near a farm dam that is surrounded by trees		Set survey among scattered paddock trees. The understorey vegetation has been severely underscrubbed.		Set survey among large paddock hollow bearing paddock trees. Pasture with sandstone creek nearby	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-striped Freetail Bat	X		X		X		X		X	
Chalinolobus dwyeri[*1]	Large-eared Pied Bat			X				X			
Chalinolobus gouldii	Gould's Wattled Bat	X		X		X		X		X	
Chalinolobus morio	Chocolate Wattled Bat	X		X		X		X		X	
*Falsistrellus tasmaniensis**	Eastern False Pipistrelle		X	X				X			
*Miniopterus australis**	Little Bentwing Bat			X						X	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat										
Mormopterus (*Micronomus*) *norfolkensis**	Eastcoast Freetail Bat	X		X				X			
Mormopterus (*Ozimops*) *ridei*	Eastern Freetail Bat	X				X		X			
*Myotis macropus**	Large-footed Myotis		X	X			X	X			X
Nyctophilus spp. In this region the non-threatened *N. geoffroyi* and *N. gouldii* are likely to be present.	In this region the non-threatened Lesser and Gould's Long-eared Bats are likely to be present.		X	X		X		X		X	
*Scoteanax rueppellii**	Greater Broad-nosed Bat		X		X				X		

Species Name	Common Name	Site 11 SN81781		Site 12 SN82241		Site 13 SN81081		Site 14 SN81997		Site 15 SN82241	
		16 to 20 January 2017		5 to 10 January 2017		14 to 16 December 2016		14 to 16 December 2016		14 to 16 January 2017	
		Set to survey pasture that has been heavily grazed horses.		Set survey near dam among pasture with a few scattered paddock trees nearby		Set to survey near a farm dam that is surrounded by trees		Set survey among scattered paddock trees. The understorey vegetation has been severely underscrubbed.		Set survey among large paddock hollow bearing paddock trees. Pasture with sandstone creek nearby	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Scotorepens orion	Eastern Broad-nosed Bat	X					X	X			
Vespadelus pumilus	Eastern Forest Bat		X		X		X		X		X
Vespadelus vulturnus	Little Forest Bat		X		X		X		X		X
Species Diversity (Positive identification)		**6**		**9**		**5**		**10**		**5**	
Species Diversity (Possible identification)			**6**		**3**		**4**		**2**		**3**

* Threatened species listed under TSC Act / [1] Threatened species listed under the EPBC Act

Table 35: Microbat species diversity recorded at Mt Gilead between December 2016 and March 2017

Species Name	Common Name	Site 16 SN81081		Site 17 SN81997		Site 18 SN82243		Site 19 SN82275	
		20 to 24 January 2017		20 to 24 January 2017		20 to 24 January 2017		20 to 24 January 2017	
		Set to survey over the canopy of a vegetated sandstone gorge		Set to survey a woodland with a small sandstone based creek is nearby. Numerous hollow bearing trees are present in this area		Set to survey in a patch of Cumberland Plain Woodland that is severely underscrubbed and disturbed by grazing. Farm dam and water channel are nearby		Set to survey among hollow bearing paddock trees in the far southern end of the study area.	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Austronomus australis	White-striped Freetail Bat	X		X				X	
Chalinolobus dwyeri[*1]	Large-eared Pied Bat				X				
Chalinolobus gouldii	Gould's Wattled Bat	X		X		X		X	
Chalinolobus morio	Chocolate Wattled Bat	X		X		X			
*Falsistrellus tasmaniensis**	Eastern False Pipistrelle		X		X		X		X
*Miniopterus australis**	Little Bentwing Bat	X		X				X	
*Miniopterus schreibersii oceanensis**	Eastern Bentwing Bat							X	
Mormopterus (*Ozimops*) *ridei*	South-eastern Freetail Bat						X	X	
*Myotis macropus**	Large-footed Myotis	X							X
Nyctophilus spp. In this region the non-threatened *N. geoffroyi* and *N. gouldii* are likely to be present.	In this region the non-threatened Lesser and Gould's Long-eared Bats are likely to be present.	X							X
*Saccolaimus flaviventris**	Yellow-bellied Sheathtail Bat				X				
*Scoteanax rueppellii**	Greater Broad-nosed Bat		X		X		X		X
Scotorepens orion	Eastern Broad-nosed Bat		X		X		X	X	
Vespadelus pumilus	Large Forest Bat	X			X				X

Species Name	Common Name	Site 16 SN81081		Site 17 SN81997		Site 18 SN82243		Site 19 SN82275	
		20 to 24 January 2017		20 to 24 January 2017		20 to 24 January 2017		20 to 24 January 2017	
		Set to survey over the canopy of a vegetated sandstone gorge		Set to survey a woodland with a small sandstone based creek is nearby. Numerous hollow bearing trees are present in this area		Set to survey in a patch of Cumberland Plain Woodland that is severely underscrubbed and disturbed by grazing. Farm dam and water channel are nearby		Set to survey among hollow bearing paddock trees in the far southern end of the study area.	
		Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present	Positively identified	Possibly present
Vespadelus vulturnus	Little Forest Bat		X		X				X
Species Diversity (Positive identification)		**7**		**4**		**2**		**6**	
Species Diversity (Possible identification)			**4**		**7**		**4**		**6**

* Threatened species listed under TSC Act / [1] Threatened species listed under the EPBC Act

Call profiles

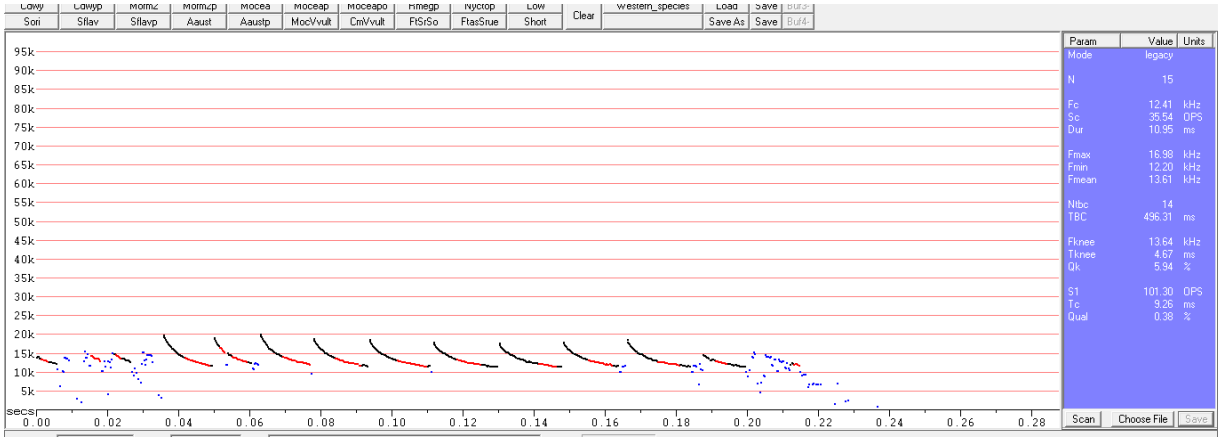

Figure 39: Call profile for *Austronomus australis* (White-striped Freetail Bat)

Recorded at Site 7 which is located on the edge of pasture and directed into vegetated creek (SN82275), at 0315 (03.15 am), 12 January 2017

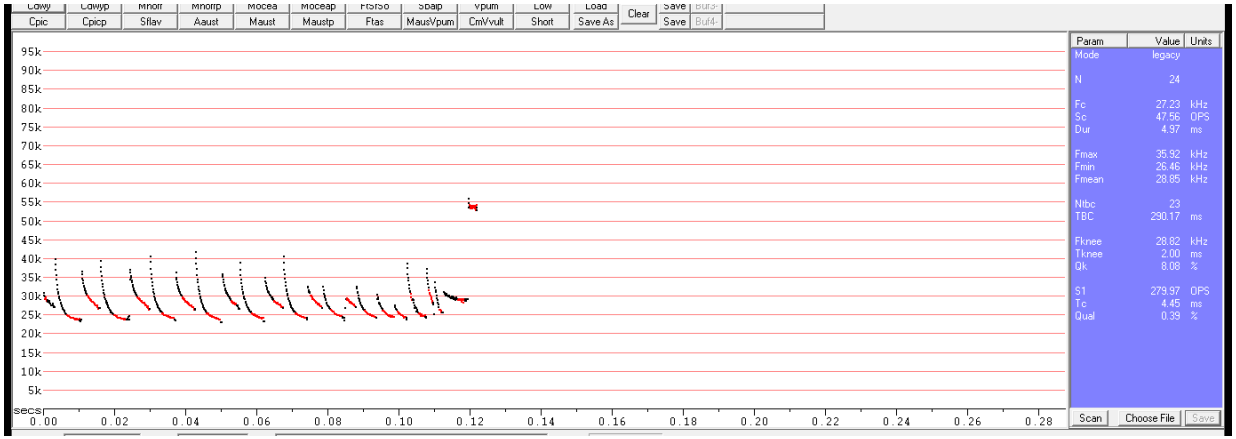

Figure 40: Call profile for *Chalinolobus dwyeri* (Large-eared Pied Bat)

Recorded at Site 6 which was set in a thin Ironbark woodland (SN81781) at 2011 (8.11 pm), 8 January 2017

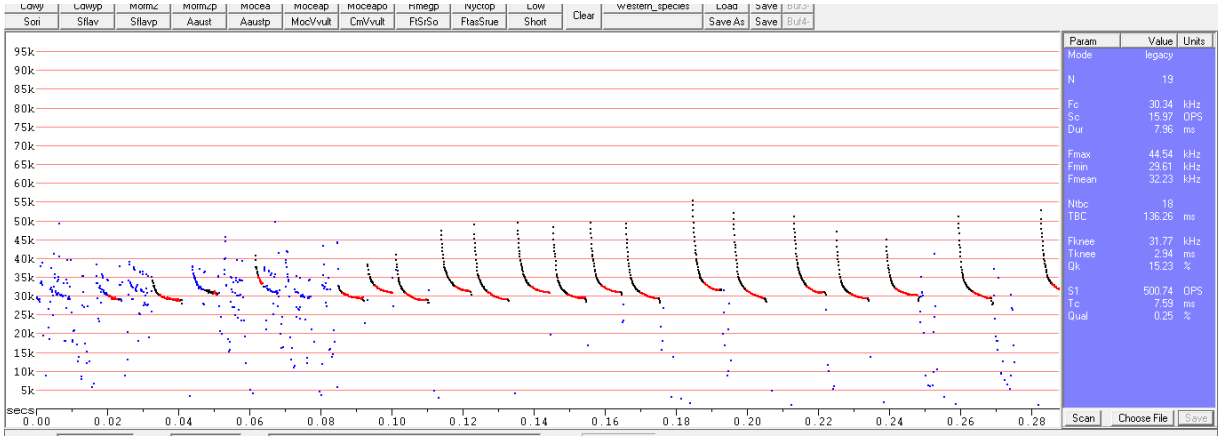

Figure 41: Call profile for *Chalinolobus gouldii* (Gould's Wattled Bat)

Recorded at Site 2 set in the Illawarra Coal land on the edge of paddock/forest edge) (SN81081), at 0231 (2.31 am), 13 January 2017

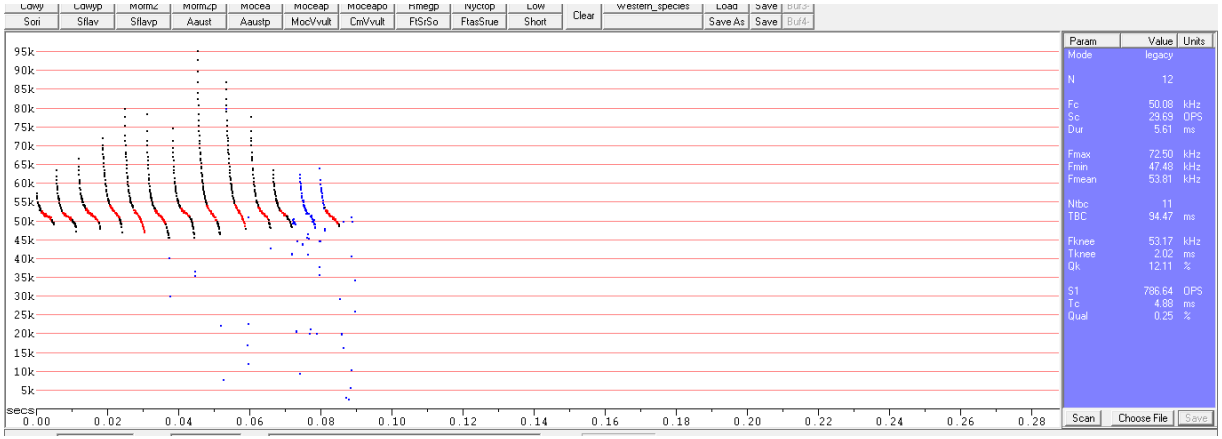

Figure 42: Call profile for *Chalinolobus morio* (Chocolate Wattled Bat)

Recorded at Site 3 which was set on edge of pasture habitat and creek (SN81997), at 0430 (4.30 am) 12 January 2017

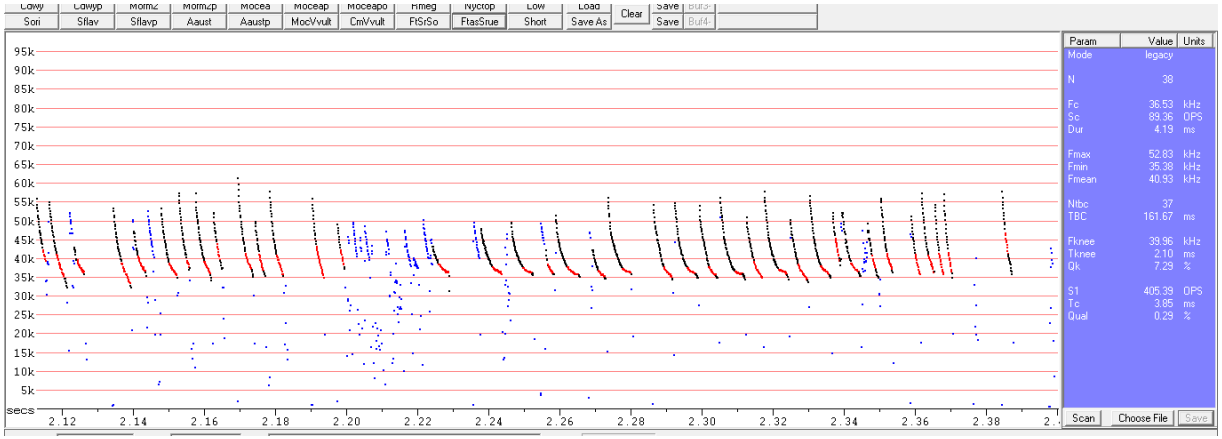

Figure 43: Call profile for *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)

Recorded at Site 7, which is located on the edge of pasture and directed into vegetated creek (SN82275), at 2033 (8.33 pm) 20 December 2016

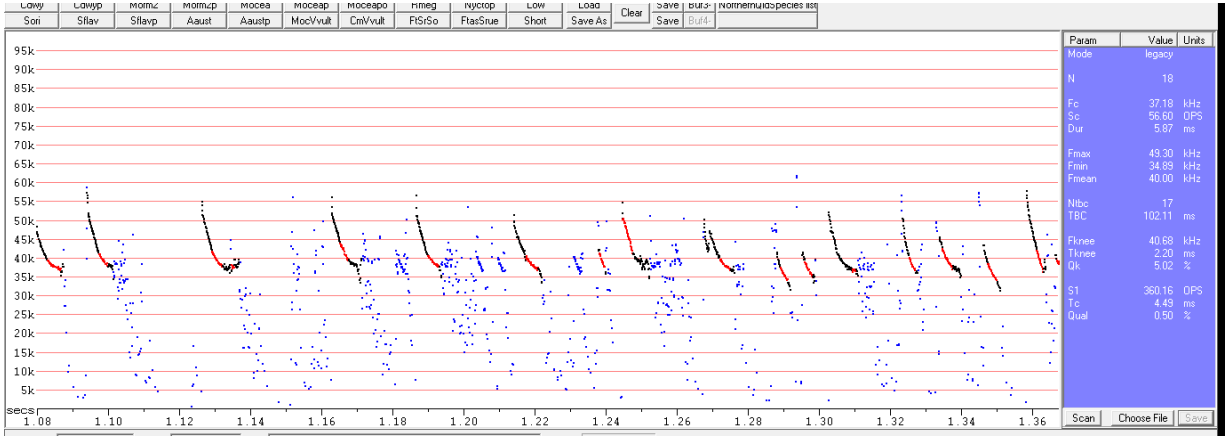

Figure 44: Possible call profile for *Falsistrellus tasmaniensis* (Eastern False Pipistrelle), *Scoteanax rueppellii* (Greater Broad-nosed Bat) and *Scotorepens orion* (Eastern Broad-nosed Bat)

Recorded at Site 1 set among weed infested Eucalyptus moluccana woodland (SN81081) at 2041 (8.41 pm), 12 January 2017

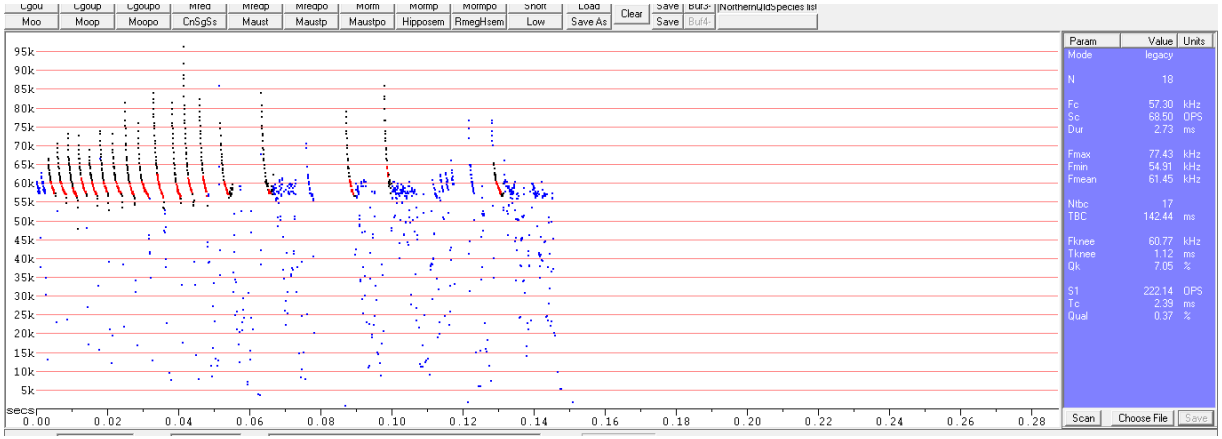

Figure 45: Call profile for *Miniopterus australis* (LIttle Bentwing Bat)

Recorded at Site 12 set near a farm dam a located in pasture and near some paddock trees (SN82241), at 2107 (9.07 pm) 6 February 2017

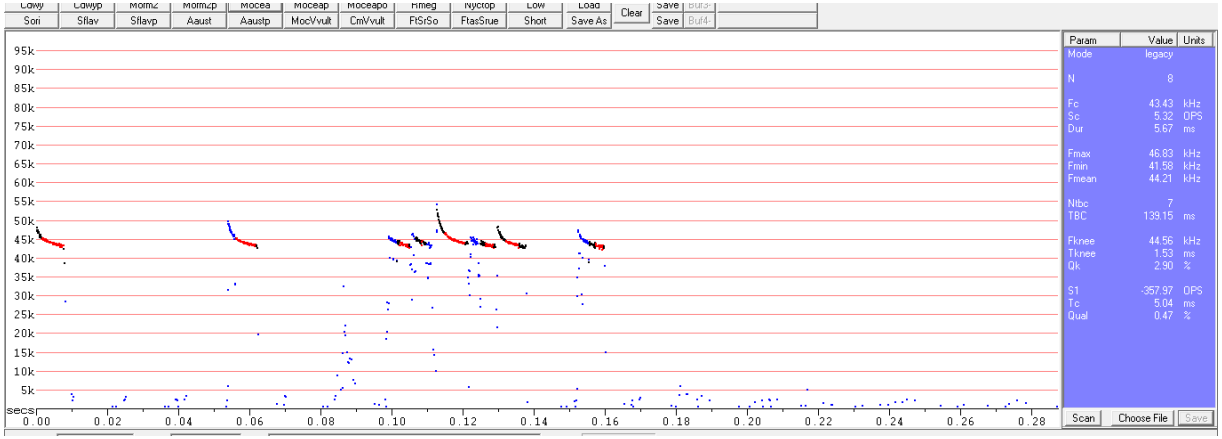

Figure 46: Call profile for *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat)

Recorded at Site 7, which is located on the edge of pasture and directed into vegetated creek (SN82275), at 2213 (10.13 pm) 20 December 2016

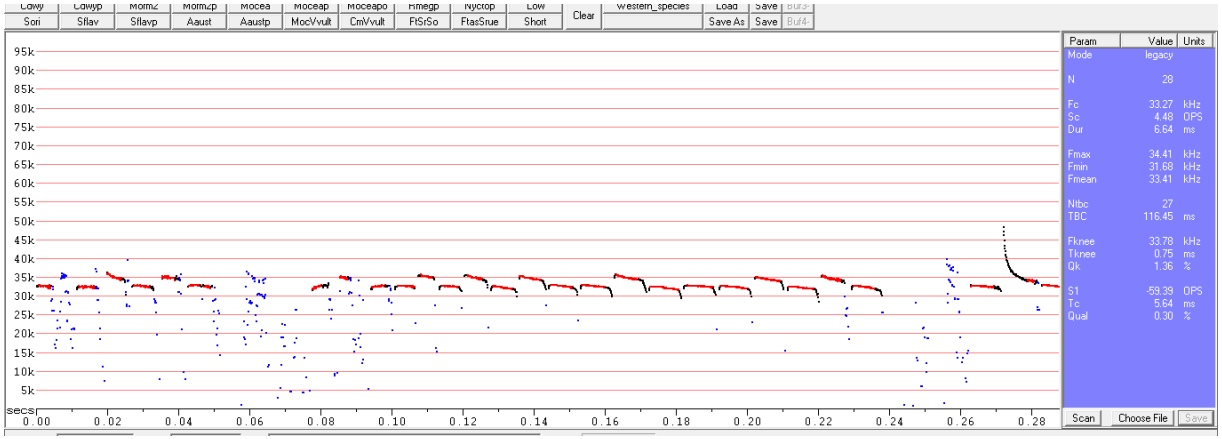

Figure 47: Call profile for *Mormopterus* (*Micronomus) norfolkensis* (Eastcoast Freetail Bat)

Recorded at Site 8 set open woodland among the conservation zone (SN81147) at 2011 (8.11 pm) 16 December 2016

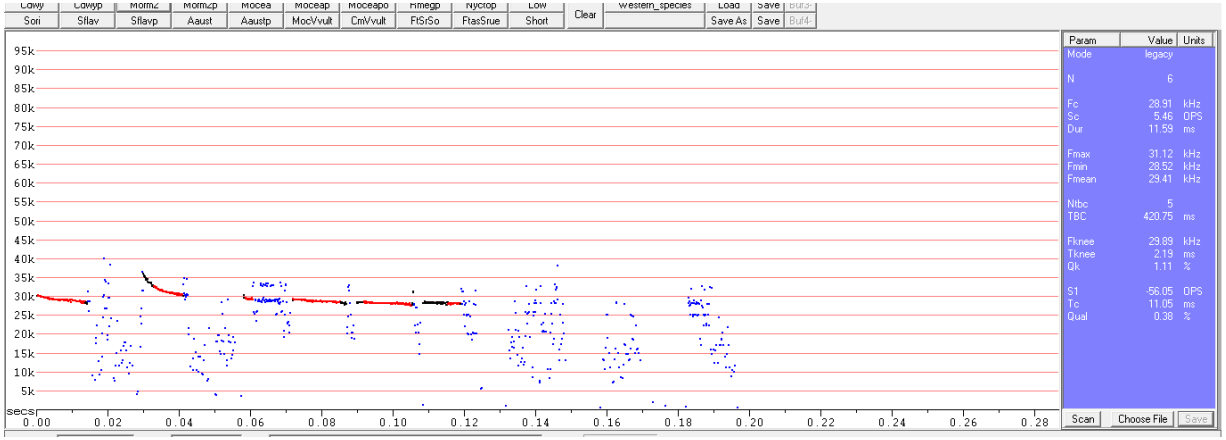

Figure 48: Call profile for *Mormopterus* (*Ozimops) ridei* (Eastern Freetail Bat)

Recorded Site 5 which is located on the north east corner among open vegetation and dead *Angophora floribunda* trees (SN81081), at 2345 (11.45 pm), 5 January 2017

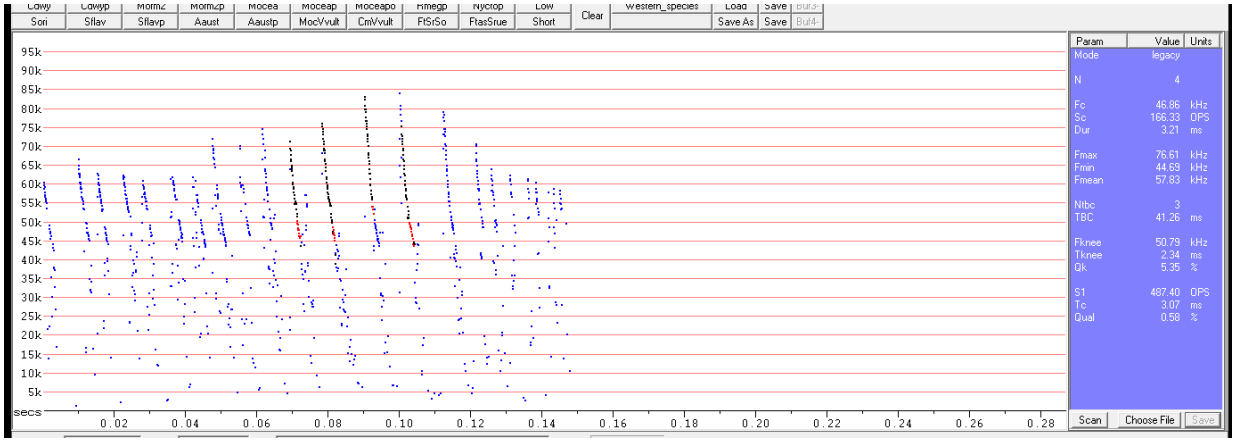

Figure 49: Call profile for *Myotis macropus* (Large-footed Myotis)

Recorded Site 5 which is located on the north-east corner among open vegetation and dead *Angophora floribunda* trees (SN81081), at 0130 (1.30 am), 9 January 2017

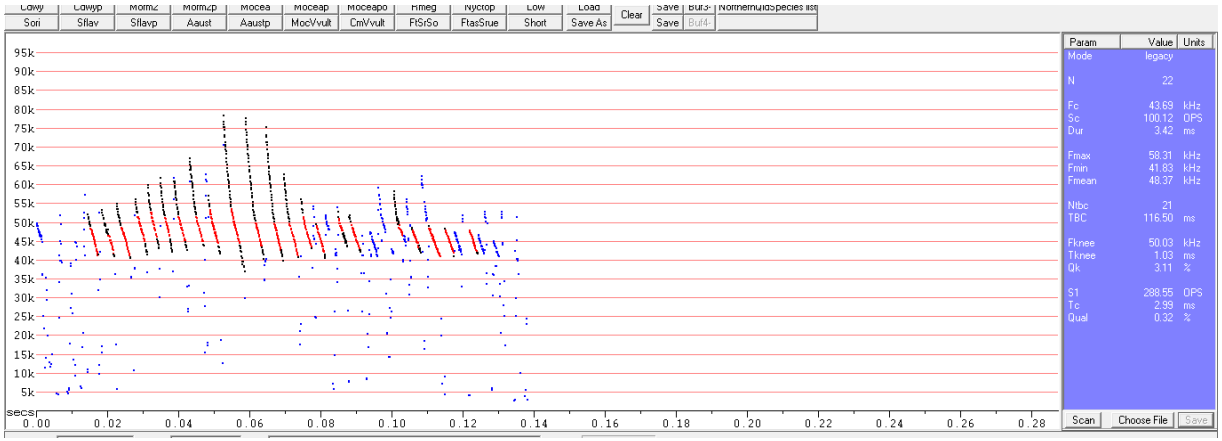

Figure 50: Call profile for *Nyctophilus spp.* (Long-eared Bat)

Recorded at Site 14 set among pasture surrounded by woodland (SN81997), at 2214 (8.14 pm), 14 December 2016

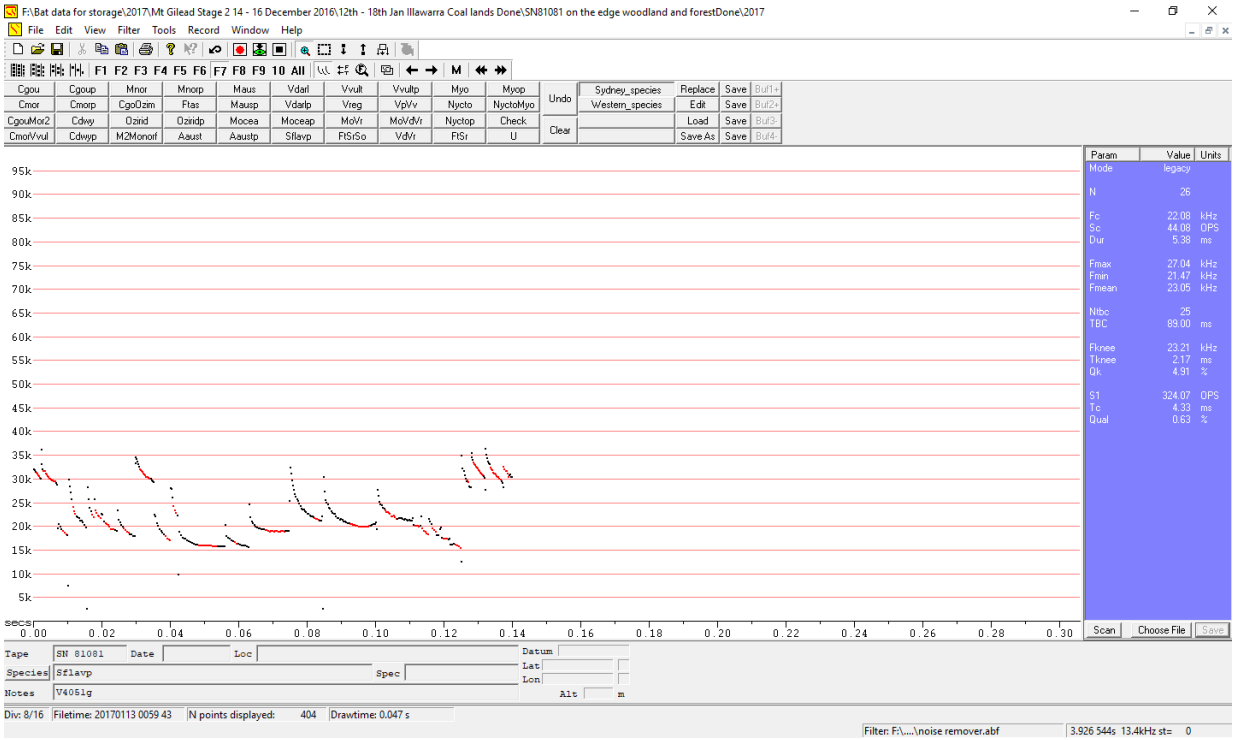

Figure 51: Potential call profile for *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) (lower frequency call) and *Chalinolobus gouldii* (Gould's Wattled Bat) / *Ozimops ridei* (Ride's Free-tailed Bat) call (higher frequency)

Recorded at Site 1 which was set in a Illawarra Coal site (near to a wooded area) (SN81081), at 0059 (12.59 am) 8 January 2017

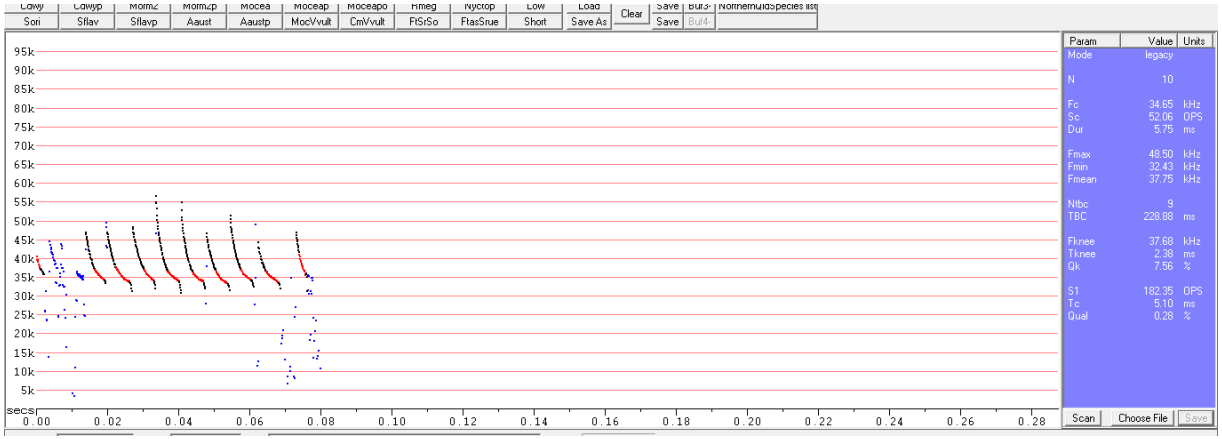

Figure 52: Call profile for *Scotorepens orion* (Eastern Broad-nosed Bat)

Recorded at Site 14 located in pasture that is surrounded by woodland (SN81997), at 2338 (11.38 pm) 14 January 2017

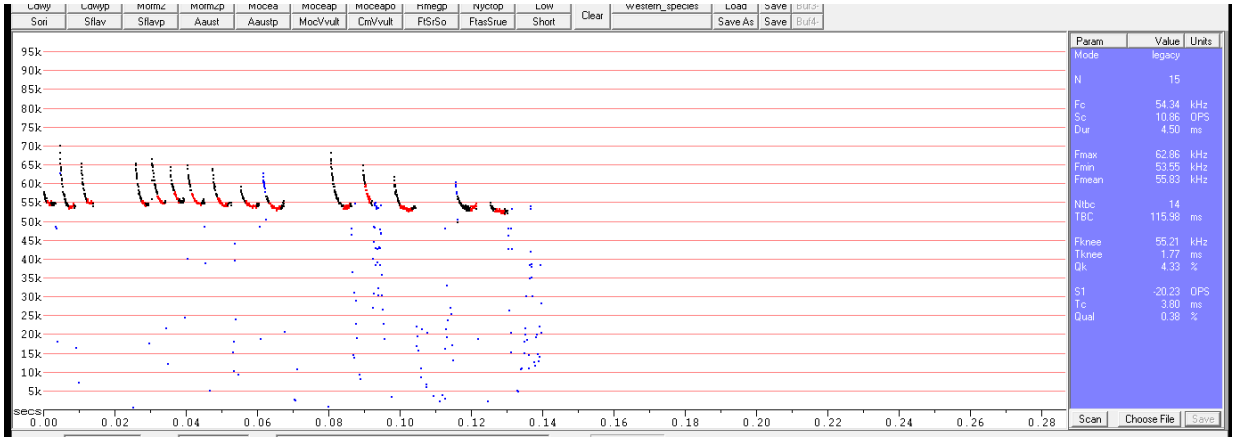

Figure 53: Call profile for *Vespadelus pumilus* (Eastern Forest Bat)

Recorded at Site 5 which is located on the north-east corner among open vegetation and dead Angophora floribunda trees (SN81081), at 2323 (11.23pm), 8 January 2017

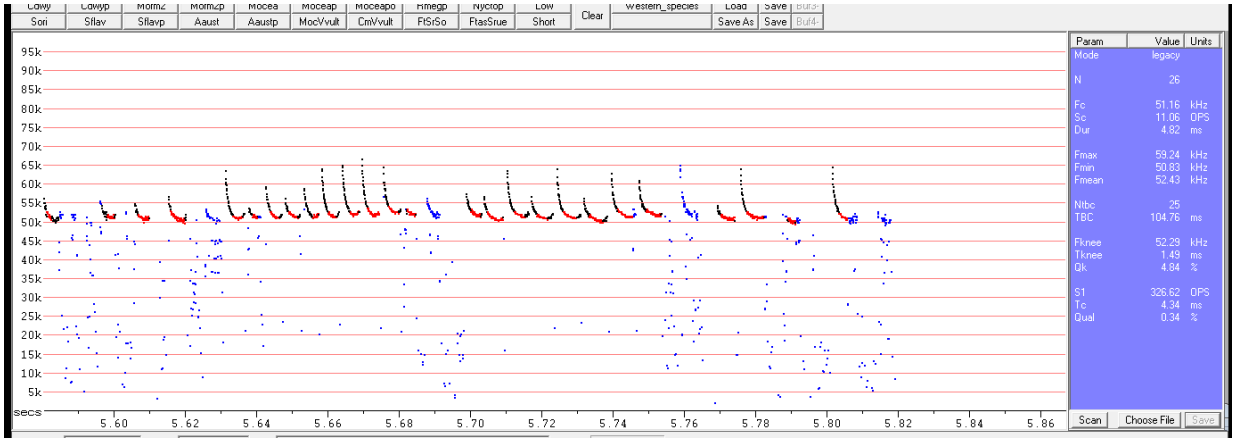

Figure 54: Possible call profile for *Vespadelus pumilus* (Eastern Forest Bat) and *Vespadelus vulturnus* (Little Forest Bat)

Recorded at Site 1 located in the Illawarra Land woodland habitat (SN81781), at 2042 (8.42 pm) 13 January 2017

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Appendix K : Transect/plot data

Zone 1: HN526 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Weedy)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG19	17	20.5	1	0	0	0	60	0	0	38	293086	6220188	56
MG20	8	14	3	0	0	12	102	0	0	78	293035	6219584	56
MG21	12	43	0	10	0	2	46	0	0	26	292857	6221254	56
MG22	7	10	0	2	0	0	73	0	0	17	293353	6222095	56

Zone 2: HN526 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Scattered Trees)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG39	15	4.5	8	4	0	0	50	0	0	19	292808	6221120	56

Zone 3: HN526 - Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion (Regen)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG37	16	38	8	2	0	0	6	0	0.5	14	292691	6221010	56

Zone 4: HN528 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Pasture improved)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB04	18	30.5	0	28	0	2	48	0	0.6	11	294025	6219552	56
BB09	12	27	0	0	0	30	70	1	0.6	52	295543	6221360	56
BB11	27	17.5	0	58	0	12	52	0	0.6	21	294287	6220184	56
MG06	8	27	0	2	0	2	24	0	0.6	11	293570	6220793	56

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG08	8	25	0	4	0	2	16	0	0.6	68	293446	6221325	56
MG14	15	8	0	12	0	26	12	0	0.6	0	293856	6219770	56
MG25	15	20.5	0	2	0	6	24.1	0	0.6	23	295258	6220445	56
MG30	27	16.5	0	38	8	6	34	2	0.6	19	296689	6222119	56
MG38	14	24	0	6	0	2	12	0	0.6	7	293855	6219554	56
MG44	30	39	4	40	4	10	36	0	0.6	3	296822	6222450	56
MG46	16	11.5	0	28	0	12	4	0	0.6	16	294386	6221949	56
MG47	23	43	0	15	0	4	10	0	0.6	0	295015	6222576	56
MG48	30	39	0	22	0	20	4	1	0.6	21	294489	6222093	56

Zone 5: HN528 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Scattered Trees)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB05	13	33	0	10	0	8	70	0	0.4	8	294155	6220149	56
BB10	3	24	0	0	0	0	74	1	0.4	35	295348	6221287	56
MG16	18	21	0	2	0	2	52	1	0.4	32	293978	6219350	56
MG36	8	27.5	0	0	0	6	28	1	0.4	27	295211	6220584	56

Zone 6: HN528 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (DNG)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB01	18	0	0	94	0	22	74	0	0	0	294399	6220961	56
MG45	11	0	0	44	0	0	38	0	0	0	295191	6222785	56

Zone 7: HN528 - Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion (Cleared)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MGCL02	2	0	0	0	0	2	96	0	0	0	295646	6221211	56
MGCL04	2	0	0	16	0	0	100	0	0	0	296918	6222297	56

Zone 8: HN529 - Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (Good)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG32	17	30.5	0	36	0	4	32	4	1	31	293982	6223220	56

Zone 9: HN529 - Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (Weedy)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG33	9	13	0	0	0	2	57	1	0	33.5	293828	6223241	56

Zone 10: HN529 - Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (DNG)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG34	9	0	0	62	0	0	46	0	1	0	293929	6223054	56
MG35	15	0	0	20	0	30	68	0	1	0	293654	6223301	56

Zone 11: HN529 - Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (Cleared)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MGCL01	5	0	0	0	0	2	94	0	0	0	294016	6223174	56

Zone 12: HN538 - Grey Myrtle dry rainforest of the Sydney Basin Bioregion and South East Corner Bioregion (Good)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB02	39	21	40	0	6	28	20	1	0.45	19	294912	6221241	56
MG01	33	76	0	0	0	20	10	1	0.45	37	294712	6221160	56
MG40	36	39	0	2	0	10	5	2	0.45	62	293724	6220247	56
MG41	35	58	6	0	0	2	46	1	0.45	20	293783	6221195	56
MG43	30	62	9	0	0	0	70.5	2	0.45	25	294228	6221150	56

Zone 13: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (Good)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB03	49	23	21	70	10	22	0	0	0.82	28	292932	6220710	56
BB12	37	27	5	30	0	36	0	0	0.82	52	296400	6220725	56
MG02	29	35	0	0	0	10	0	1	0.82	45	293246	6219566	56
MG04	33	11.1	49.5	2	0	2	0	2	0.82	29	294805	6221129	56
MG07	47	49	22	16	2	12	8	3	0.82	77	293191	6220161	56
MG09	31	35	19	24	2	8	0	1	0.82	85	292975	6221450	56
MG17	53	26.5	4.5	10	6	14	0	3	0.82	38	295408	6220523	56
MG18	43	52	9	14	0	2	2	1	0.82	41	295160	6220892	56
MG28	44	19.5	3	56	2	44	0	0	0.82	26	296425	6220974	56
MG29	43	57	9	44	4	30	0	0	0.82	92	296414	6219842	56
MG31	37	36	26.5	22	2	8	0	0	0.82	29	296398	6220176	56
MG42	44	17	24	14	0	0	0	1	0.82	46	293725	6221333	56

Zone 14: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (Thinned/Shrubby)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG11	42	27	42	42	0	6	12	0	0	20	293834	6221881	56
NW05	24	0	7	26	0	40	15.1	0	0	0	293040	6221520	56
NW06	43	0	31	46	2	36	12	0	0	4.5	293928	6221750	56

Zone 15: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (Pasture improved)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
BB06	43	5.5	0	50	0	40	12	0	0.43	28	294199	6219677	56
BB07	31	23.5	0	46	0	18	6	0	0.43	12	293817	6221003	56
BB13	19	16.6	0	36	0	42	22	0	0.43	24	295440	6221634	56
MG03	13	48	0	4	0	10	22	2	0.43	10	293629	6219598	56
MG12	9	7.5	0	4	0	0	26	0	0.43	14	293832	6220660	56
MG15	25	39	0	10	0	6	10	0	0.43	19	294669	6220866	56
MG23	10	40.5	0	12	0	2	38	0	0.43	40	295462	6220582	56
MG24	11	45.5	0	0	0	6	10	1	0.43	15	294540	6220377	56
MG27	14	12.2	0	34	0	6	26	1	0.43	16	294952	6220606	56

Zone 16: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (Scattered Trees)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
A2_2013	5	15.5	0	16	0	2	100	1	0.43	0	295765	6220555	56
BB08	17	15.5	0	66	0	10	80	0	0	0	294015	6220242	56
MG26	12	35	0	6	0	2	22	1	0	8	295054	6220920	56

Zone 17: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (DNS)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MG10	35	0	38	2	4	2	16	0	0.33	9	293247	6221973	56
MG13	43	11	75	28	0	4	1	0	0.33	3	293746	6221565	56

Zone 18: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (DNG)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MGCL05	12	0	0	90	0	0	28	0	0	2	296877	6222420	56

Zone 19: HN556 - Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion (Cleared)

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
MGCL03	7	0	0	0	0	22	94	0	0	17	295182	6221182	56
NW11	30	0	0	30	0	2	82	0	0	0	293842	6221669	56
NW12	22	0	0	26	0	4	66	0	0	3	294195	6221100	56
NS13	2	0	0	0	0	0	98	0	0	0	293163	6221660	56
H11	3	0	0	0	0	0	92	0	0	0	295331	6221021	56

Appendix L : Lendlease Response to Principles for Koala Protection in the Greater Macarthur and Wilton Growth Areas and surrounds

Provided as a separate pdf document

Appendix M : Department of Planning and Environment response to the OCSE

Principles and final Koala corridors in Gilead

NSW GOVERNMENT | Planning, Industry & Environment

IRF21/4944

Ms Ranisha Clarke
Head of NSW Communities
Tower Three, International Towers Sydney
300 Barangaroo Avenue, Barangaroo NSW 2000

Via email: rashina.clark@lendlease.com

Attn: Brendan O`Brien

Dear Ranisha,

Thank you for your letter dated 3 December 2021 relating to the recently published Greater Macarthur update and Koala corridors in Gilead.

The Greater Macarthur update provides a strategic indicative map of Koala corridors in the entire growth area. As you are aware, Lendlease has been working with the Department under the Technical Assurance Panel (assurance panel) pilot program to prepare a draft planning proposal for Gilead Stage 2. An important part of this work has been the investigation of the following Koala corridors in Gilead:

- Corridor A along Menangle Creek,
- Corridor B along Woodhouse Creek, and
- The Gilead component of the Nepean Corridor.

The map at Attachment 1 reflects the outcomes of those investigations and is the current indicative mapping for these corridors. These corridors apply the recommendations and subsequent advice of the Office of the NSW Chief Scientist & Engineer (OCSE) and will provide valuable inputs into the draft proposal to be reviewed by the assurance panel. Please note these corridors also include land within the Cumberland Plain Conservation Plan, however the attached map only shows the corridors in relation to land known as Mt Gilead Stage 1 (Figtree Hill), Stage 2 (subject of the assurance panel program) and the adjacent Noorumba and Beulah reserves. These corridors may be further refined or amended as a result of the assurance panel program or any subsequent statutory rezoning process, however, must continue to apply the recommendations and advice of the OCSE.

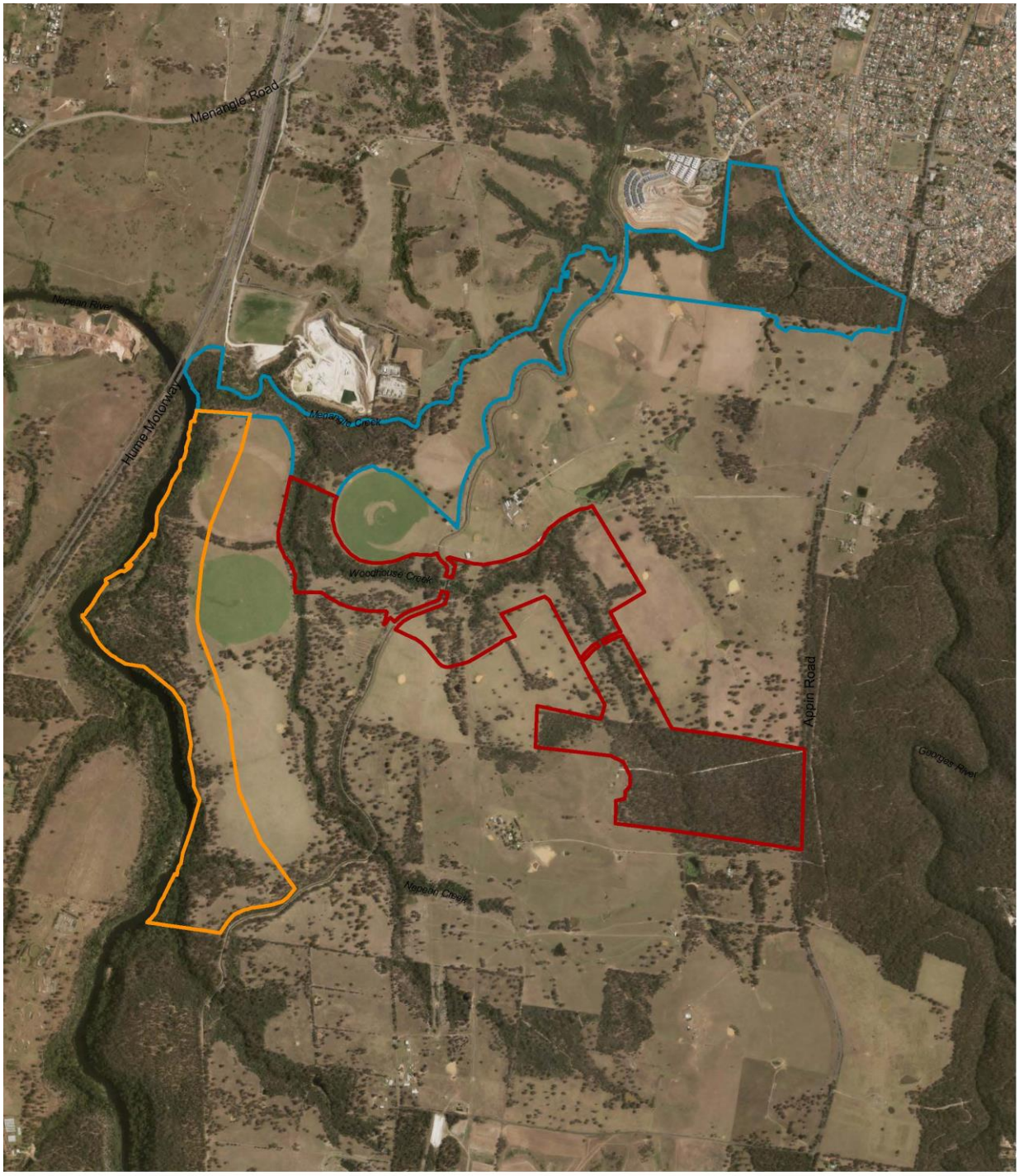
I look forward to working with Lendlease and the assurance panel to progress the preparation of a draft planning proposal in 2022. If you have any questions, please contact Naomi Moss, Manager Place and Infrastructure, at the Department of Planning, Industry and Environment on (02) 9228 6351 or via naomi.moss@planning.nsw.gov.au

Yours sincerely

6 December 2021

Adrian Hohenzollern
Director, Western District
Central River City & Western Parkland City
Department of Planning, Industry and Environment

4 Parramatta Square, 12 Darcy Street, Parramatta NSW 2150 | Locked Bag 5022 Parramatta NSW 2124 | planning.nsw.gov.au



Indicative Koala Corridors - Gilead

0 250 500 1,000 m

N

Nepean River Corridor (*Gilead Component)*

Woodhouse Creek Corridor (*Corridor B*)

Menangle Creek Corridor (*Corridor A*)

December 2021

Appendix N : Gilead Koala Management Plan

Provided as separate Pdf document

Appendix O : Construction Environment Management Plan

Provided as separate Pdf document

HEAD OFFICE
Suite 2, Level 3
668-672 Old Princes Highway
Sutherland NSW 2232
T 02 8536 8600
F 02 9542 5622

CANBERRA
Level 2
11 London Circuit
Canberra ACT 2601
T 02 6103 0145
F 02 9542 5622

COFFS HARBOUR
35 Orlando Street
Coffs Harbour Jetty NSW 2450
T 02 6651 5484
F 02 6651 6890

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Suite 1 & 2
49 Ord Street
West Perth WA 6005
T 08 9227 1070
F 02 9542 5622

DARWIN
16/56 Marina Boulevard
Cullen Bay NT 0820
T 08 8989 5601
F 08 8941 1220

SYDNEY
Suite 1, Level 1
101 Sussex Street
Sydney NSW 2000
T 02 8536 8650
F 02 9542 5622

NEWCASTLE
Suites 28 & 29, Level 7
19 Bolton Street
Newcastle NSW 2300
T 02 4910 0125
F 02 9542 5622

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92 Taylor Street
Armidale NSW 2350
T 02 8081 2685
F 02 9542 5622

WOLLONGONG
Suite 204, Level 2
62 Moore Street
Austinmer NSW 2515
T 02 4201 2200
F 02 9542 5622

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471 Adelaide Street
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T 07 3503 7192
F 07 3854 0310

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Unit 1, 51 Owen Street
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T 02 4201 2264
F 02 9542 5622

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5/20 Canty Street
Narooma NSW 2546
T 02 4302 1266
F 02 9542 5622

MUDGEE
Unit 1, Level 1
79 Market Street
Mudgee NSW 2850
T 02 4302 1234
F 02 6372 9230

GOSFORD
Suite 5, Baker One
1-5 Baker Street
Gosford NSW 2250
T 02 4302 1221
F 02 9542 5622

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2, 70 Pirie Street
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Appendix F

CS&E's Response to questions regarding the Campbelltown Koala population- February 2021

NSW GOVERNMENT | Chief Scientist & Engineer

Response to questions about advice provided in the Koala Independent Expert Panel Report 'Advice on the protection of the Campbelltown Koala population'

February 2021

Introduction

On 9 December 2019, the Minister for Energy and Environment and the Minister for Planning and Public Spaces requested that the Deputy Chief Scientist & Engineer chair an Independent Expert Panel (the Panel) to provide advice regarding the protection of the Campbelltown koala population.

This advice was to include:

- The adequacy of the proposed measures, by the property group Lendlease, for koala conservation on the land referred to as Mount Gilead Stage 2 (MGS2) and the consistency of these measures with the NSW Koala Strategy (the Strategy)
- What, if any, additional conservation measures are considered necessary? What, if any, site specific measures for koala species should be incorporated into the Cumberland Plain Conservation Plan (CPCP) for the Greater Macarthur Growth Area (GMGA) to support the long-term viability of the koala population.
- Whether east-west corridors linking the Nepean and Georges Rivers can contribute to the conservation of the Campbelltown Koala population; and if so, which east-west corridors and what measures should be taken to ensure their effectiveness

The Independent Expert Panel included Dr Chris Armstrong PSM (Deputy Chief Scientist & Engineer; chair), Professor Kathy Belov AO (The University of Sydney), Dr Carolyn Hogg (The University of Sydney) and Professor Jonathan Rhodes (The University of Queensland).

The Koala Independent Expert Panel report "*Advice on the protection of the Campbelltown Koala population*" (the 'Report) was provided to government on the 30 April 2020 and made four recommendations.

Subsequent to the release of the Report, Campbelltown City Council placed the Mt Gilead Stage 2 Biodiversity Certification Application on exhibition (until 17 February 2021) and the Department of Planning, Industry and Environment (DPIE) has commenced pre-lodgement discussions with Lendlease regarding future rezoning of the site as part of their Technical Assurance Panel (TAP) process.

DPIE has requested clarifications on questions regarding the corridors and buffer zones. This document provides the Panel's advice on those questions, with excerpts from the Report italicised within.

The advice considers the following documents that were provided by DPIE:

- Attachment A: Technical assurance panel plan (proposal cross section)
- Attachment B1: ecological corridor width (map)
- Attachment B2: Gilead Stage 2: A commentary on koala carrying capacity and corridor, review reports prepared by Eco Logical Australia on behalf of Lendlease Communities (Fig Tree Hill) Pt. Ltd. (Advice to Council)
- Email correspondence: Gilead – CS&E recommended questions (independent review)
    - Letter to DPIE requesting independent review
    - Attachment B2: BioLink revised advice (full report)
- Email correspondence to DPIE (dated 22 January 2021)

Overall comments on additional questions

The guiding principles for the Panel in providing its advice were to

> *"…maximise koala population persistence and abundance, koala habitat amount and connectivity, and minimise contact between koalas and the urban environment to reduce hazards and threats."*[1]

The Panel also notes that subsequent to the report being submitted, in June 2020, the Legislative council inquiry into koala populations and habitat in New South Wales found that *"given the scale of loss to koala populations across New South Wales as a result of the 2019-2020 bushfires and without urgent government intervention to protect habitat and address all other threats, the koala will become extinct in New South Wales before 2050".*[2]

Then in July 2020, the Minister for Energy and Environment announced the goal of doubling the number of koalas in NSW by 2050.[3] The Panel's advice was based on the goal of the NSW Koala Strategy released in 2018 to *"stabilise and then increase koala numbers over the longer-term, ensuring genetically diverse and viable populations across New South Wales"* and not on this new goal to double koala populations.

Other relevant points from the April 2020 Panel report include that[4]:

- *The habitat in this region contains high quality feed trees due to the sandstone shale transition forest. The Campbelltown koala population is expanding and therefore, it is essential that this habitat supports the movement of koalas such that dispersing koalas can move through the landscape, can breed to ensure genetic diversity, and can access refugia in times of stress, drought or other threats.*
- *Overall, the Panel finds that efforts to increase the availability of habitat while reducing the interface with threats, and maintain genetic and physical health status, are important pillars upon which to plan mitigation measures.*
- *The opportunity presents itself, through forward planning and commitments by parties to protect habitat, mitigate threats and reduce stressors. If this approach is successful, and if it can be monitored, managed and measured, it could show the way for future developments on the rural fringe to minimise the impacts that will arise.*
- *Key to the success of this will be ensuring that koalas are separated from the risks that threatened them, in particular road traffic, and predation by dogs. The proposed high densities for residential and urban development that are proposed makes it unlikely that koalas could persist in the long-term in the urban matrix. Exclusion fencing will be key to keeping them separated from this, as will ongoing observation of the koala population to monitor for disease, indirect stressors such as light and noise, and also to monitor genetic health, population size and distribution.*
- *Habitat and corridor protection in landscapes is not only beneficial to koalas but also other flora and fauna.*
- *Exclusion fencing to prevent koalas accessing Appin Road from the eastern or western side is critical, as is the use of exclusion fencing more broadly to keep koalas separated from dogs and road traffic in the developments. Efforts to sympathetically landscape buffer zones further*

[1] Report, pg. iv
[2] NSW Legislative Council, Portfolio Committee No. 7 – Planning and Environment (2020) Koala populations and habitat in New South Wales, Report 3 https://www.parliament.nsw.gov.au/lcdocs/inquiries/2536/Koala%20populations%20and%20habitat%20in%20New%20South%20Wales%20-%20Report%203.pdf
[3] Hannam, P (2020, July 26) Matt Kean aims to double koala population by 2050, *Sydney Morning Herald*
[4] Report, pg. v - viii

assists in separating koalas from urban impacts and related stressors, while the approach proposed by the proponents to landscape street scapes and backyards of dwellings so to exclude koala feed trees is welcome, as it removes an attractant for koalas into the urban matrix.

- *Wildlife corridors that end with no connection to other habitat can be a considerable risk, in particular where the habitat exposes wildlife to threats, and in doing so can create population sinks, where wildlife kills occur, causing vacancies in the location which subsequently attract more animals.*

In providing this advice, the Panel reinforces that the aim of the recommendations is not to set an upper bound on effort and outcomes to be achieved in protecting koalas and habitat: rather, they should be exceeded wherever possible to ensure the persistence of the koala population and to further protect the current koala habitat (for both koalas and for other flora and fauna).

The Panel also notes that it is important that the corridors provide functional connectivity, in that the corridors are actually utilised by koalas for east-west and north-south movement. Monitoring will need to be conducted post-installation of any management and/or corridor solution to understand if there are koala movements along corridors and whether koalas continue to persist in the landscape, and if no movement is shown for populations or there is a decline in movement, active management solutions are to be implemented.

This is grounded in the principles of adaptive management that the Panel endorsed within the Mt Gilead and CPCP region to assist in managing uncertainties associated with the timeframes and interdependencies within the koala population across this large area (described in the Report, pg. xii-xiii).

Adaptive management would also assist in proactive understanding of the implications of changes in land management, both in the proponent's and adjacent tenures. For example, the gazettal of Mount Gilead Homestead as Heritage Listed has positive outcomes for the Campbelltown koala population, via the removal of urban development threats in its footprint[5].

Adaptive and active management strategies would guide and inform risk management and mitigation actions and, in monitoring these actions, improve best practice over time via the response to emerging acute threats or realignment of management actions.

[5] NSW Heritage (14 October 2020) Mount Gilead Estate listing, https://apps.environment.nsw.gov.au/dpcheritageapp/ViewHeritageItemDetails.aspx?ID=5052615

Question 1: Corridor A viability for connectivity?

The Department is currently seeking to determine the viability of a culvert under Appin Road at Noorumba with TfNSW. If an appropriate Appin Road crossing can be achieved, what is the OCSE's view of the ability of the corridor west of Noorumba to allow for koala movement if it cannot be expanded and parts remain no greater than 100m with development on either side? Further, is there any evidence to suggest the likelihood of a Koala using an underpass, that goes under a 6 or 4 lane road?

For context, Campbelltown Council and the proponent both want Corridor A for connectivity for koalas (rather than habitat), and there are discussions about the future of Appin Road (currently anticipated to become 6 lanes).

Viability of a culvert

- There is good evidence that koalas use culvert structures (e.g. Woolgoolga to Ballina Pacific Highway upgrade), with a documented case of successful crossing of a 100 m long culvert[6], noting that important aspects for koala crossings are in their fit-out, including that they are dry and well ventilated structures.
- In the context of the culvert at Noorumba Reserve, the Panel noted in the Report that the proponent was considering a tree-top bridge across Appin Road.[7]
    - Initial advice from the Panel was that it held "…*reservations that the proponent's preferred approach for a koala crossing (a tree-top bridge structure) will be used by koalas*".[8]
    - An alternative posed by the Panel to the tree-top bridge structure was "…*the development of an underpass or culvert under Appin Road, or a gantry bridge above Appin Road (see Mona Vale example) should be explored*". [9]

Corridor and habitat

- The Panel is of the view that if an appropriate crossing can be achieved across Appin Road at the Noorumba Reserve, then Corridor A would be a viable koala corridor/habitat if the recommendations within the Report and this document are followed.
- The Panel questions the meaning of the phrase in the question text "…both want Corridor A for connectivity for koalas (rather than habitat) …". Habitat is essential in corridors, and the Panel notes in the Report that *"a wildlife corridor is a stretch of habitat that joins two or more areas of similar habitat."* Therefore, planning must include the protection and restoration of habitat in this corridor for it to function as a corridor.
- The Panel notes that there are recent sightings and evidence of koalas in the Noorumba Reserve and across Appin Road in the Bionet database (2019).
- *If the Noorumba site can be secured with an Appin Road crossing effective for koalas, then exclusion fencing between habitat and threats would still be required. Efforts to widen the corridors should also be made, while it is acknowledged that there are constraints with corridor widening west of Noorumba due to land use and tenure issues. Narrow corridors with open vegetation, without exclusion fencing place koalas at risk of exposure to threats such as roaming dogs and foxes, so fencing should be pursued. If fencing is not feasible, then buffer*

[6] Australian Museum Business Services (2012) Investigation of the Impact of Roads on Koalas, prepared by Australian Museum Business Services for the NSW Roads and Maritime Services
[7] Report, pg. 40
[8] Report, pg. viii
[9] Report, pg. 41

zones (~60 m wide) containing non-feed trees, and with monitoring to track predators, and population dynamics to understand these outcomes will be needed. Management decisions regarding the koala population in this area will be informed by those data, and responses could include further active management or even relocation to more suitable habitat. [10]

- Noting the connection between Noorumba Reserve and the rest of Corridor A to the west, there is an important strip of vegetation at Point 2 (Figure 1) that extends for approximately 400 m (east-west). If this cannot provide functional connectivity for koalas, Noorumba Reserve effectively becomes a 'dead end'; therefore, efforts should be made to ensure that this habitat functions as connectivity.
- The Upper Canal (between Point 2 and 3, Figure 1) could also prevent the east-west movement under the proposed development. The Panel did not see the topography at this point; therefore field inspections should be undertaken to understand the impact on the corridor and associated habitat, and the impact on koala movement.
- As per Recommendation 2(c), koala proof fencing along the strip of vegetation (Corridor A) from the Noorumba Reserve to Corridor B would allow the movement of koalas and other native species through the landscape, whilst mitigating direct threats such as predation.
- The Panel notes that tree species (for feed and shelter for koalas) and vegetation density are the key characteristics that would lead to functional connectivity, in conjunction with the removal and mitigation of threats (including indirect threats such as light and noise pollution). Buffer zones (of at least 30 m in fenced and 60 m in unfenced) and other mitigations here would aim to reduce these threats.
- The Panel recommends that all efforts should be made to expand and protect the current habitat, and that without appropriate fencing of Corridor A, the mitigation of threats will not be successful.
- The Panel notes that the Mount Gilead Homestead was gazetted as Heritage Listed by the NSW Government (14 October 2020). This will protect the 150 ha homestead from any further development that is not sympathetic to the heritage listing, which will also indirectly benefit adjacent koala habitat including Corridor A at Points 4 and 5 on Figure 1.
    - In noting this gazettal, the Panel recommends discussion with the Mount Gilead Homestead estate and the proponent as to how the protected farmland could provide additional protections for koalas. This includes the proposed increased habitat at Point 3 (Figure 1, Figure 2) and potential protections (such as fencing) at Point 4 and Point 5 (Figure 1). This can also be seen in Figure , which shows this as 'land to be conserved' (Points 3 and 5) and 'land to be conserved (homestead)' (Points 4 and 5) respectively. Discussions with the Homestead managers should include farm dog management.

[10] Report, pg. viii

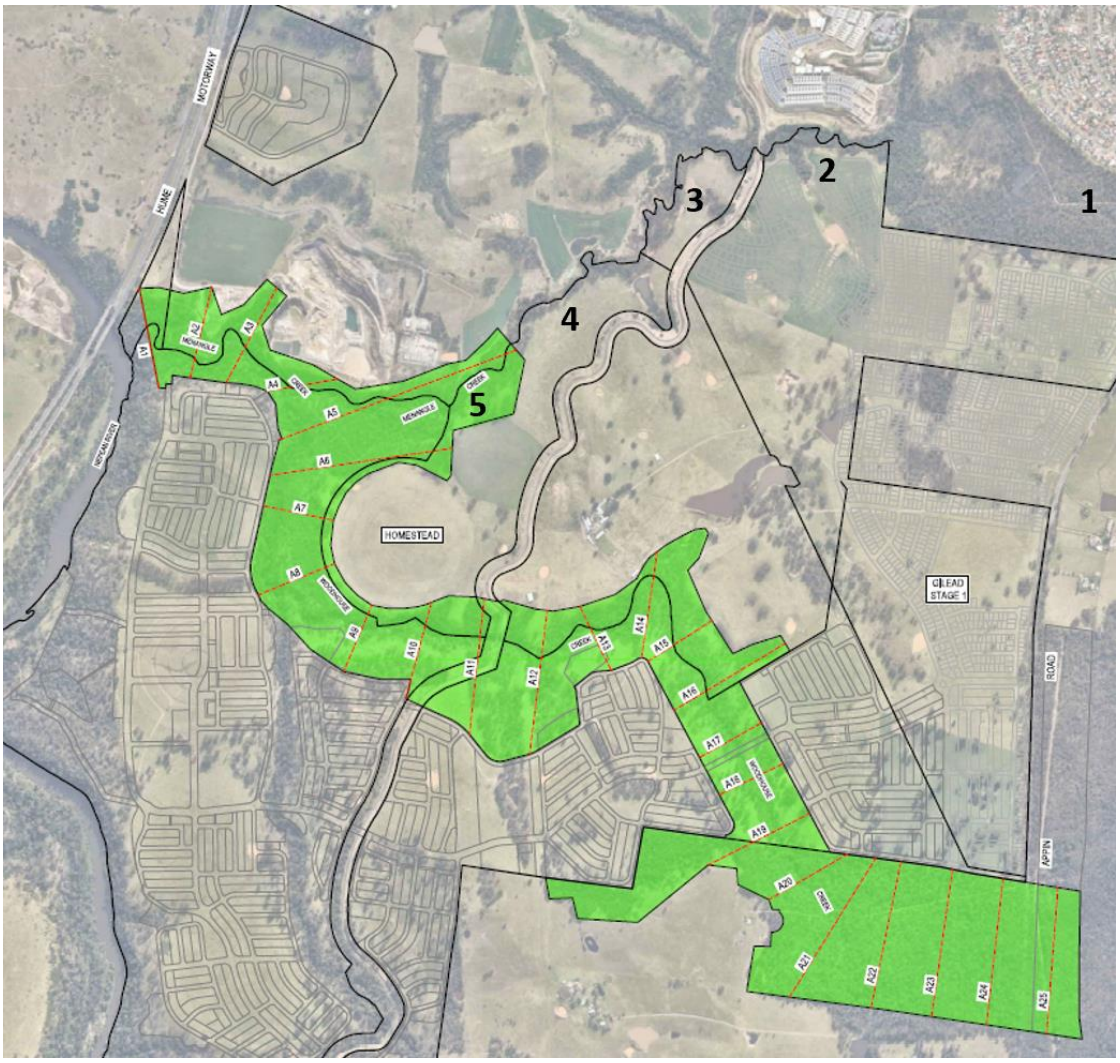


Figure 1: Mt Gilead Biobank Koala Corridor with points on Noorumba Reserve (Source: Lendlease)

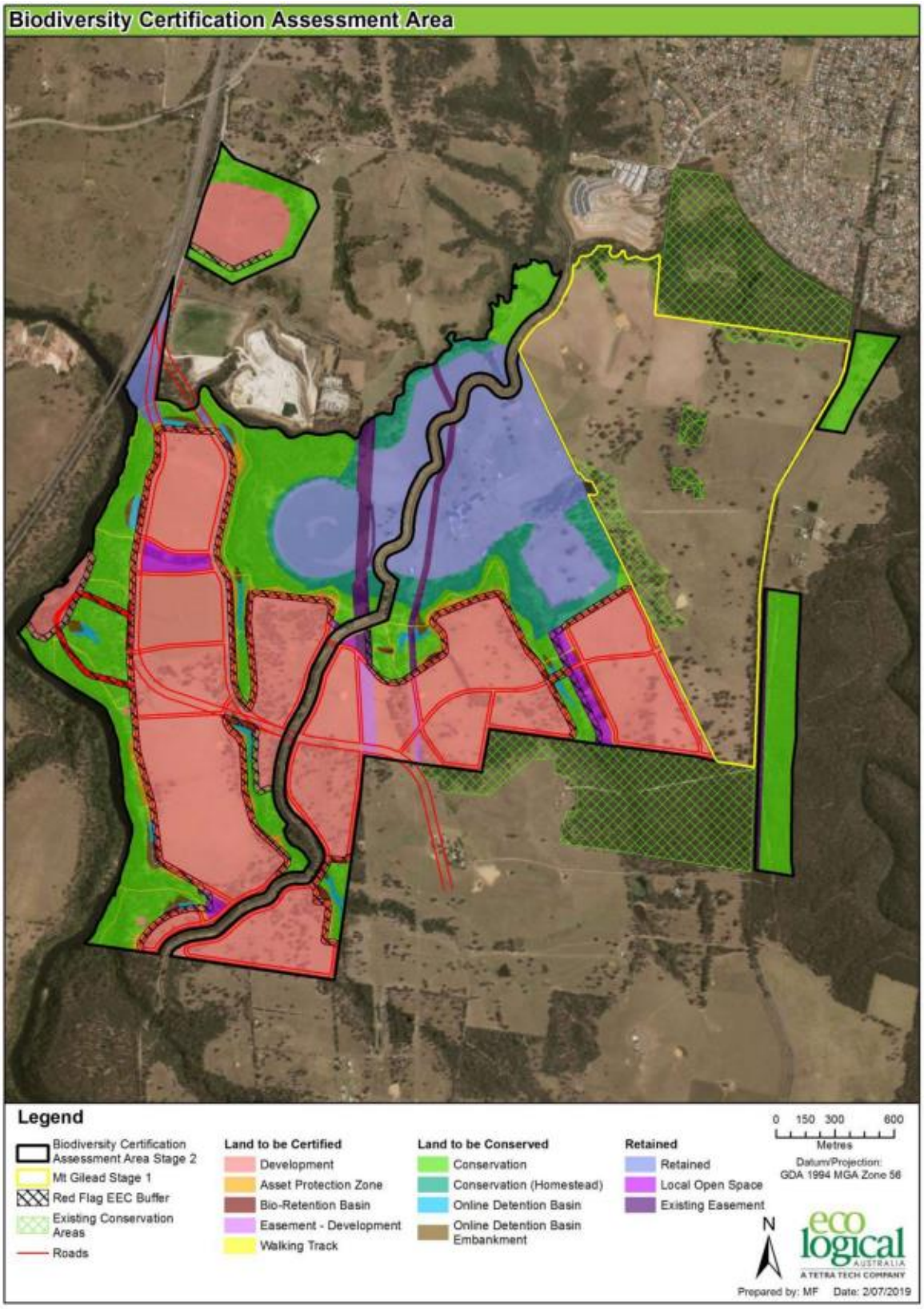


Figure 2: Mt Gilead Biobank Koala Corridor with points on Noorumba Reserve (Source: Lendlease)

Question 2: Can the calculation of average corridor width include adjacent landholdings?

For corridor B (Woodhouse Creek), the proponent is including adjacent landholdings north of Menangle Creek, the existing Beulah Biobank site to the south and land east of Appin Road, in the calculation of average corridor widths.

For context, refer to "Attachment Map" – Lendlease purports to have measured the width of Corridor B in accordance with the methodology outlined by Dr Steve Phillips in "Advice to Campbelltown City Council June 2020" (see "Attachment Advice to Council")

Can OSCE please provide advice on whether adjoining sites should be included for the purposes of calculating the average corridor width within the Mt Gilead Stage 2 lands? (i.e. should we consider "the corridor" only as it applies to proponent's landholdings?).

Adjacent landholdings

- In the report the Panel highlighted the importance of a holistic planning approach. Further that by "*…their very nature, the habitat corridors within the two study areas cross multiple tenures and landscapes, connect internally and with each other. Koalas, in using these corridors, do not recognise lines on maps.".*[11]
- The tenure of the land should not preclude it from being included in the corridor or buffer calculations. However, the features, management and future of the tenure need to be considered, including:
    - Within a corridor, barriers between the tenures such as fences or water bodies have the potential to stop koalas accessing the land. This limit its function as a corridor and should be considered – see further related discussion on Nepean River (Question 3).
    - Any habitat included in the corridor needs to be protected in perpetuity. There may be the need to investigate methods and/or levers to ensure the corridor and its fencing is protected on other tenures or in a change of tenure, including any future developments. For example, the proposed structure plan for the Greater Macarthur Growth Area has an indicative transport corridor that goes through Corridor B[12].
- In some cases, there will be different landholders that own adjacent tenure that is part of the corridor. For example, the proponent has included the existing Beulah Biobank within the corridor measures.
    - There is a need to protect the Biobank and other landholdings in the same manner as the rest of the corridor (including fencing, as per Report Recommendation 2). This will prevent the incursion of threats or the dispersion of koalas into the urban environment. This will require the proponent working with adjacent landholders.
    - Any structures (such as roads) that cross, or might have an impact on, the corridor have to be designed to be sympathetic to the protections of the corridor. For example, the proponent has proposed a road crossing Corridor B: in constructing this, consideration must be given to the aim of the corridor (i.e. allowing for koalas to move east-west whilst also persisting in the environment, via mitigating direct and indirect threats) and take appropriate mitigation actions to ensure that this structure does not negatively impact on this aim. Considerations would include how this would interact with the corridor fencing and what mitigation measures will be used to stop koalas getting into the development via the road.

[11] Report, pg. vi
[12] Report, pg. 20

- The management of a corridor on various tenures is a policy question and outside of the Panel's remit. The Panel did not consider whether there were legal or policy restrictions on the inclusion of other entities' offset land or private land, but viewed it from the perspective of koala habitat.
- *Beulah Biobank*
    - West of Appin Road can form part of Corridor B and can be included in the calculation. As per previous points, the Belulah Biobank should be fenced to form part of the corridor.
- *East of Appin Road*
    - East of Appin Road is part of the primary Georges River Corridor and should not be included in the calculation for Corridor B.
- *Land holdings north and east of Menangle Creek*
    - At Point 5 in Figure 1 is the confluence of Menangle and Woodhouse Creeks. The area north and east of this point (i.e. prior the confluence of the creeks) would be considered part of Corridor A – contributing to its length. Therefore, this should not be included in the calculation of Corridor B as a width component.
- *Mt Gilead Homestead*
    - The proponent notes that their corridor is "approximately 400 m wide (average) without Beulah Reserve. If we to include some of the rural land on the (heritage) Homestead Lot which is proposed to be zoned E3 (consistent with the draft Cumberland Plain Conservation Plan) the average width of the corridor would be approximately 600 m"[13]
    - The Panel notes that the gazettal of the Mount Gilead Homestead provides a protection of koala habitat from urban development and the associated direct/indirect impacts, effectively having the same desired attributes of a buffer zone for indirect threats (i.e. light and noise, although noting the comment in the response to Question 1 on farm dog management). Question 4 also provides further clarity around how the homestead and associated farmland should be treated.

Measurement of average corridor width

- The methodology from Dr Steve Phillips in his advice to council states that[14]:
    - *an optimum width of 409 m – 425 m be maintained as desirable*
    - *The means of which these measures are to be validated must also be transparent and statistically robust, to which end we propose a series of width measurements at 200 m intervals along the entire length of the SLA, each of which must evidence the minimum width requirement of 250 m*[15]
- Based on the Figure provided by Lendlease, the Panel does not understand how this methodology of Dr Phillips was applied by the proponent which is purported to be in accordance. For example, there is no consistency in the application of the 200 m intervals between the transects along the length. For example, the distance between A8 to A9 is much greater than the distance between A17 to A18.
- Further, there are irregularities in the orientation of the transects: for example, A4 is at an unusual angle to the other measures, and to the corridor (i.e. oblique, rather than perpendicular), and this is noted for a number of the other transects.
- Dr Phillips' calculation methodology requires a "…*series of width measurements…each of which must evidence the minimum width requirement of 250 m…"*. It appears to the Panel that

[13] Lendlease (17 December 2020), per comms
[14] Lendlease, Attachment Advice to Council, provided by DPIE to OCSE
[15] Strategic Linkage Area

rather than drawing 90 degree cross sections that demonstrate a minimum corridor width of 250 m, as is understood as the intent in Dr Phillips approach, instead lines appear to have been drawn at random angles to meet the minimum width requirement of 250 m (this may explain the orientation of the A4 transect). The Panel would expect the transects to measure corridor width to be perpendicular to the length of the corridor.

- The Panel views that the transects as drawn do not provide a realistic reflection of the actual corridor width, as there is no consistency in the distance between and angles of the transects, and the potential interaction between Corridors A and B (transects A5 and A6).
- Therefore, the Panel recommends that the Proponent should provide a clearly articulated, transparent and defendable method for calculating the corridor widths and the orientation of the transects.
- The Panel also notes the clarification sought in Question 4 regarding average corridor width and buffer to the corridor, this should be considered in the calculations.

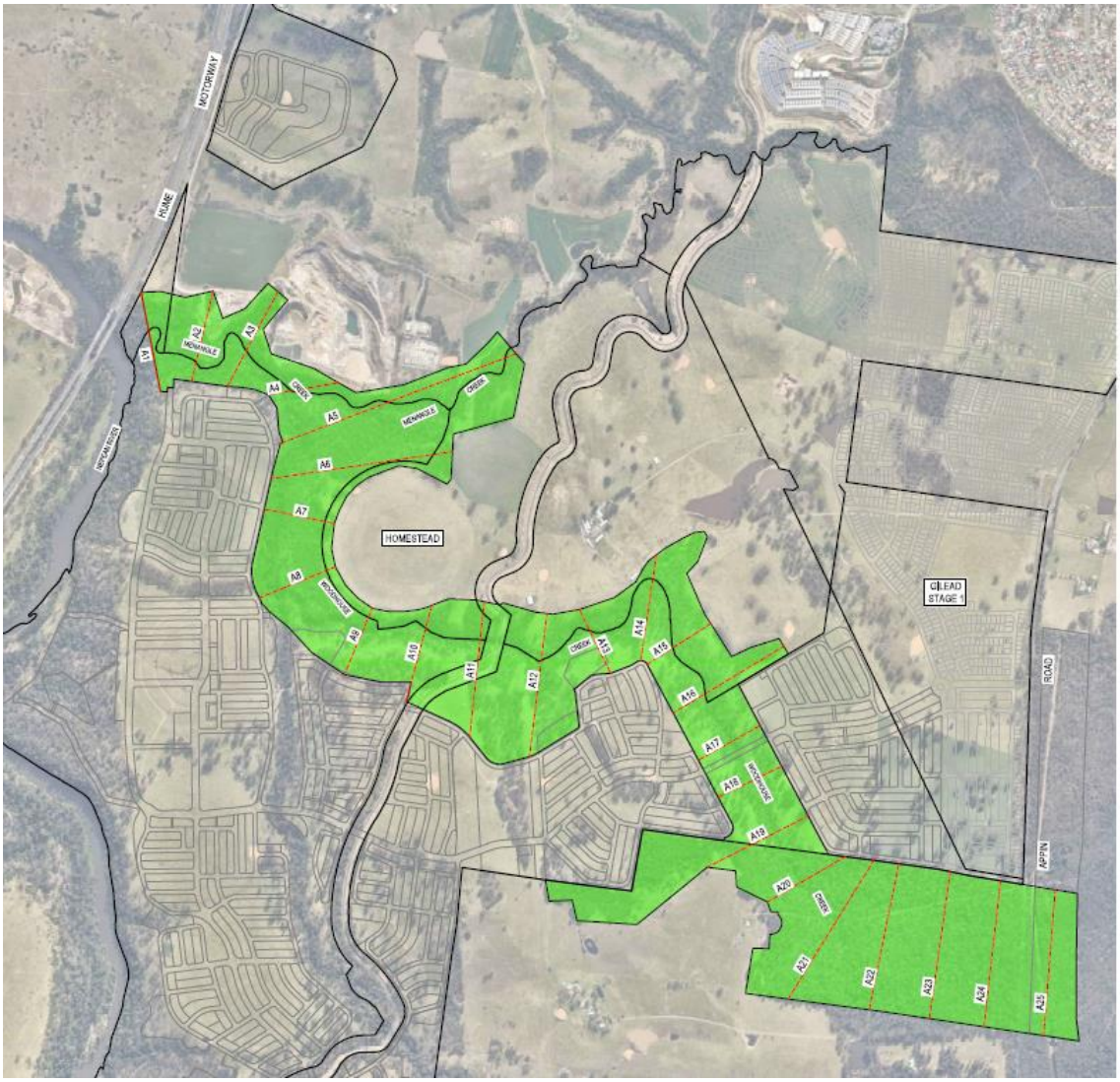


Figure 3: Mt Gilead Biobank Koala Corridor showing measurement lines (source Lendlease)

Question 3: Nepean River koala corridor

The OCSE advice focused on the east-west corridor. Can the OCSE please provide its view on the Nepean River Corridor? Should the vegetation on either side of the river be considered as two separate corridors or one corridor that spans the river and addresses the corridor requirements in Recommendation 2 c) of the OSCE report?

- The majority of the corridors examined were riverine, which provide important refugia and resilience to warming and drying climates[16]. This included the Nepean River and associated habitat, which was identified by the Department as a primary north-south corridor and as a strategic conservation area in the draft CPCP material, with possible protections including Biodiversity Stewardship Agreements (BSA).
- The Panel noted that a primary concern for the Nepean River habitat is to prevent a functional 'dead-end' at the northern point, which appears to be in the vicinity of MGS2. If functional connectivity is provided by Corridor A (Noorumba Reserve and Menangle Creek) and/or Corridor B (Woodhouse Creek), this would allow for east-west movement at the end of the Nepean River corridor.
- "*Close attention should be paid to test the feasibility of the design of the koala connectivity at the confluence of Menangle Creek and Nepean River, near the Hume Highway and possibly under three bridges*"[17].
- Although koalas have been known to swim, the Nepean River would effectively act as a barrier and therefore encourage koala movement separately along each side. Therefore, for the purposes of functional connectivity, koalas would move north-south along either side of the Nepean river, so in that sense habitat on each side of the river functions as separate corridors.
- Given that the two sides/corridors are parallel and adjacent to each other, some functions of one side will assist in the minimisation of stressors and/or threats to the adjacent bank. In particular, increasing separation from direct and indirect threats on the river side of the corridor (i.e. from the opposite side): for example, sound and noise attenuation from the adjacent side. Other functions, however, would not be provided by the adjacent corridor: for example the amount and quality (both food and shelter) of vegetation available to use and move through.
- Therefore, they should be treated as separate corridors that provide a symbiotic-like protection to the adjacent riverbank.
- The area highlighted in Figure 4 should be examined on the ground (field trip inspection) to ensure that the amount (width and density) and structure of the habitat and terrain will facilitate a functional corridor given distance to roads and suburban footprint that is evident on the map in Figure 4.
- The Panel also notes the potential for steep topography in the riparian zone and associated koala habitat (Figure). There is a need to understand this topography, and how the current koala population moves through the landscape, including if the koalas have a preference for moving long the steep river bank or whether they use the plateau (where the suburban footprint is planned), which will inform any additional protections. This is also important when considering the risk of fire. These issues should be addressed in the planning phase but prior to approval.
- Monitoring of the population and visual inspections of the site will assist in understanding these parameters once the developments are underway.

[16] Report, pg. vii
[17] Report, Recommendation 2(a)

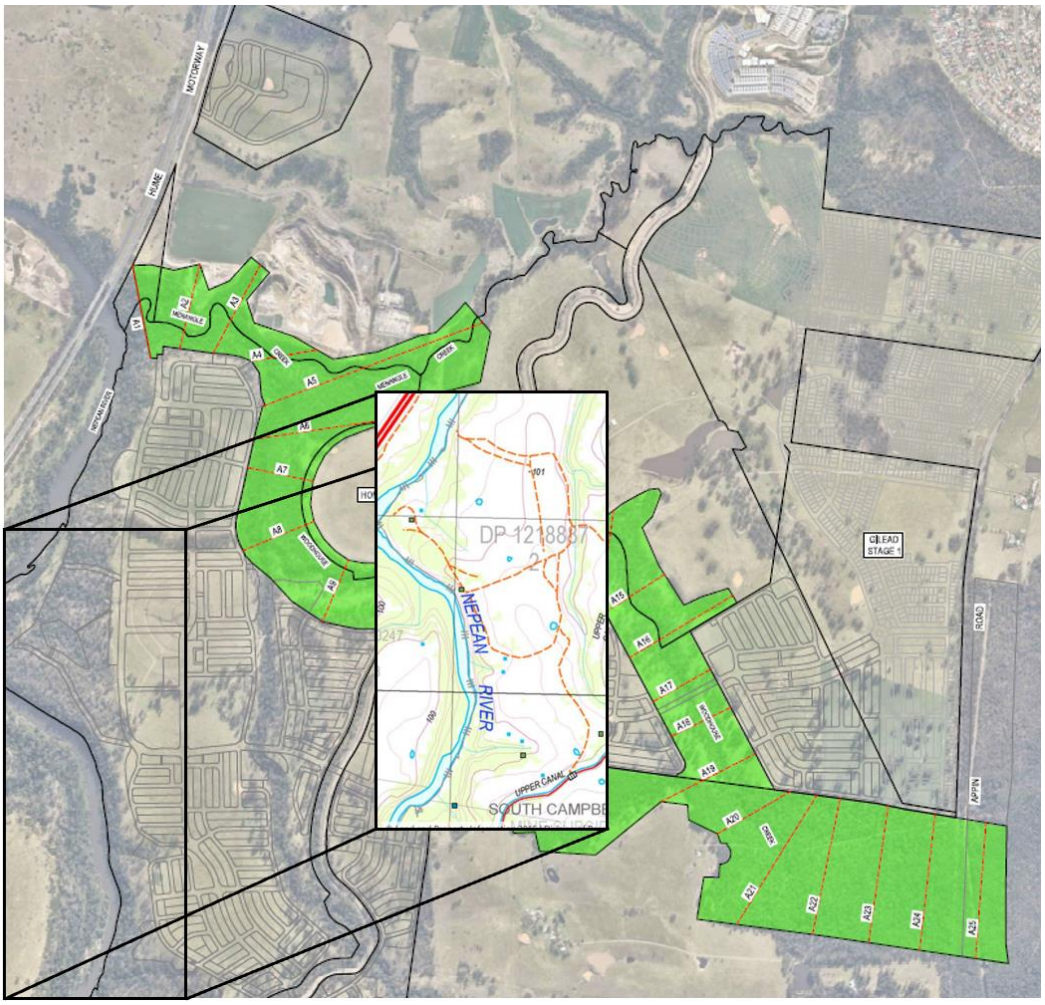


Figure 4: Steep topography associated with the Nepean River Corridor (Sources: Lendlease and overlay from SEED Portal[18])

[18] NSW SEED (Sharing and Enabling Environmental Data) Portal, https://www.seed.nsw.gov.au/

Question 4: Interpretation of Recommendation 2 (C) "Connectivity and Habitat"

EES has interpreted the OCSE requirement for corridors, buffers and exclusion fencing as detailed in the EES prepared diagrams below.

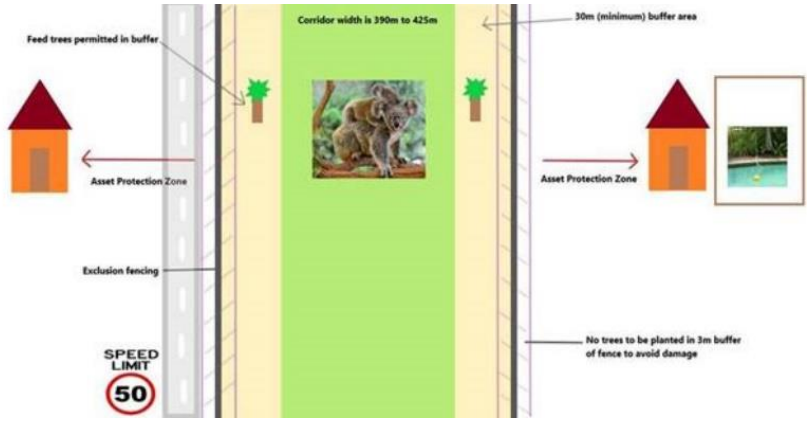


Figure 2: With exclusion fencing

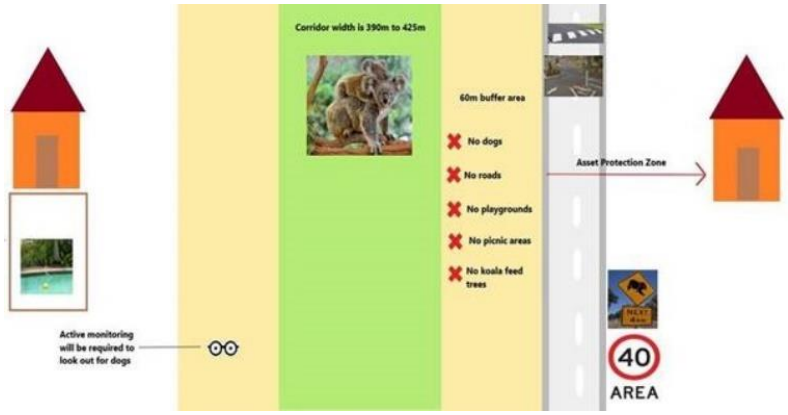


Figure 3: Without exclusion fencing

For context, the proponent has queried whether APZ (outer protection areas) should be permitted within the corridors and buffers to allow for areas of reduced fuel load/ flame intensity as refuse for fauna. (refer to "Attachment – proponent cross section")

Could we please confirm the OCSE's intention in regard to Recommendation 2 c) and whether EES's interpretation, as illustrated in the diagrams above, is accurate?

Why were buffer zones recommended?

- As discussed in the Report:
  - *Urban development in proximity to fauna has increased the potential 'edge effects' that species such as koalas experience*
  - *Edge effects can include both direct (i.e. vehicle strike and dog attacks) and indirect (i.e. light and noise pollution, urban storm runoff) impacts on fauna and flora, and can result in altered behaviour (for example, changes in home ranges or in how species disperse throughout a landscape) that can have longer term repercussions.*

- *There are a number of strategies and methods that can mitigate the impact on koalas, particularly at the interface of urban and native environments. This includes, but it is not limited to, vegetated buffer zones and managed habitat areas, koala exclusion fencing (includes fencing at the interface to roads, but also around pools and yards), predator and pest management (including weeding programs), vehicle-strike mitigation measures (under and overpasses, road grids, traffic calming devices and road design, signage, speed limits, etc.), and community awareness programs.*[19]

- The Mt Gilead Biocertification initially proposed a 30 m buffer (15 m inner buffer and 15 m outer buffer, and included the APZ), however the buffer was only on one side of the corridor, served a dual purpose and contained infrastructure and possible threats to koalas (including roads). See Figure 4 and Figure 5.

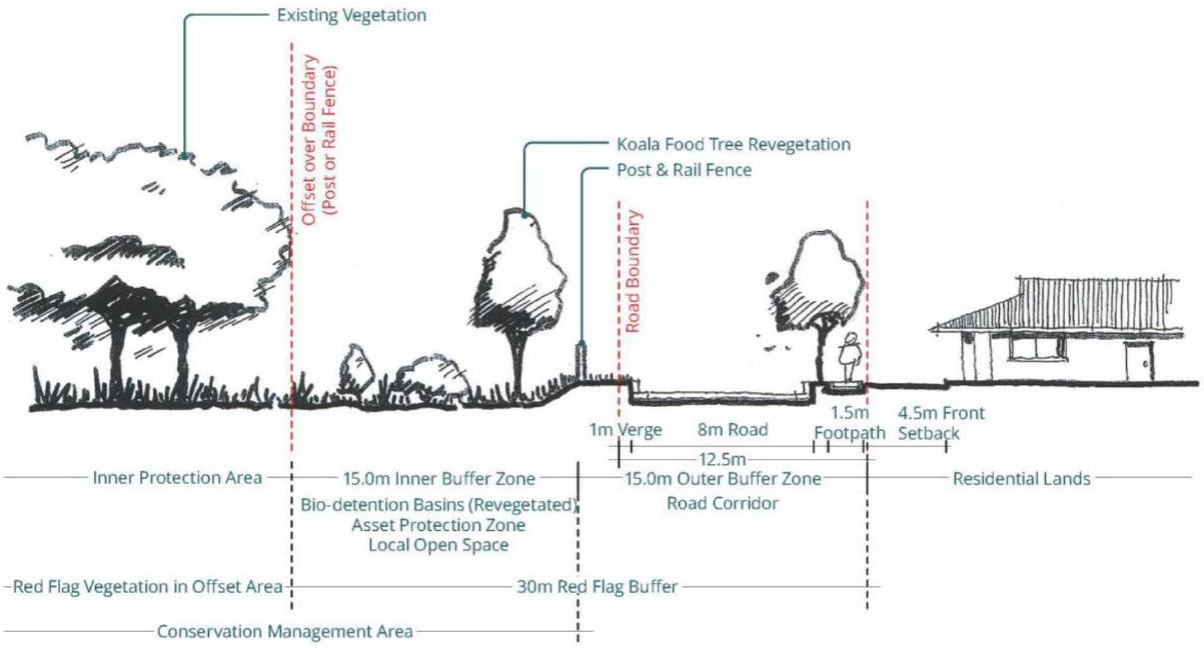


Figure 4: Example of buffer zone at proposed Mount Gilead Stage 2 development (Source: Eco Logical Australia, 2020)

[19] Report, pg. 49

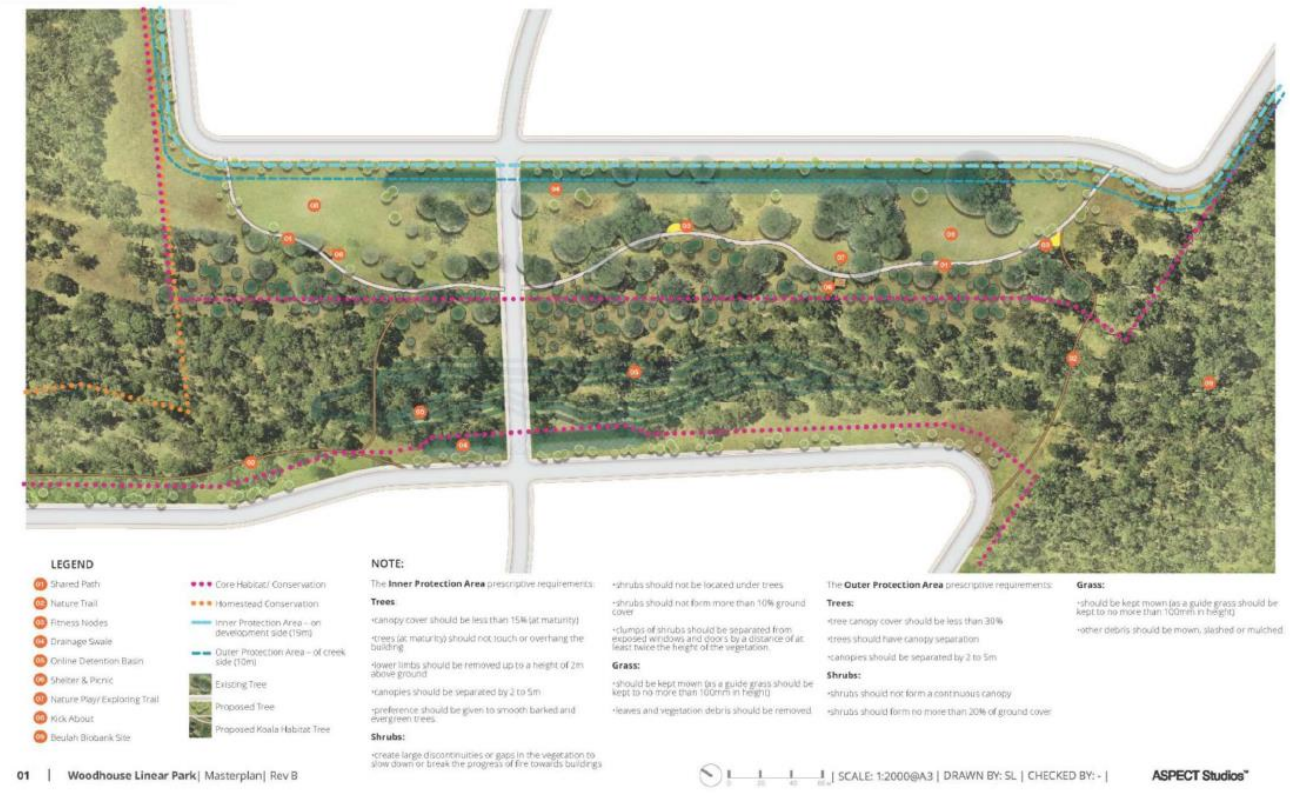


Figure 5: Mount Gilead Stage 2 Woodhouse Creek Koala corridor (Source: Eco Logical Australia, 2020)

- The Panel saw the design as ineffective as it permitted threatening activities in close proximity to koalas and koala habitat with no barrier to interaction between koalas and hazards.
- Further, the Panel's site visit allowed them to see the current habitat and assisted in their advice (Figure 6). In particular, this site visit showed the Panel the topography of the creek lines and the sparseness of the remaining vegetation (as you can see through the remaining habitat). As the habitat stands, it would not provide adequate protection to koalas and their habitat from the development, including in regard to light and sound penetration. Therefore, the recommendations that were made in the Panel's Report reflect the on-ground assessment and the need to improve and protect the koala corridor habitat.

Figure 6: Woodhouse creek – Panel site visit on 14 February 2020

- The recommendation of the Panel is to exclude the APZ from the buffer as the functional purpose of an APZ is different to a habitat buffer. The APZ is to protect the homes and infrastructure. A habitat buffer protects the habitat and the species within it.
    - "…*the functional roles of Asset Protection Zones (APZ) and of buffer zones to protect koalas are different, and as such need to be differentiated in the design of the interface. APZs serve a role of protecting people and property from bushfire hazard, while buffers associated with koala protection reduce the impact of threats, light and noise on koalas*…"[20]

[20] Report, pg. ix

- "…*The APZ should be in the development footprint, not the koala corridor/buffer, and the APZ should be on the development side of the exclusion fence. The APZ, unlike the buffer, could accommodate roadways and parks. People would be permitted into the koala buffer, but dogs would be prohibited from entering through the exclusion fence area*."[21]

- The NSW Rural Fire Service (RFS) defines an APZ as "… *a fuel reduced area surrounding a built asset or structure. This can include any residential building or major building such as farm and machinery sheds, or industrial, commercial or heritage buildings. An APZ provides:*
  - *a buffer zone between a bush fire hazard and an asset;*
  - *an area of reduced bush fire fuel that allows suppression of fire;*
  - *an area from which backburning may be conducted; and*
  - *an area which allows emergency services access and provides a relatively safe area for firefighters and home owners to defend their property.*

  Potential bush fire fuels should be minimised within an APZ. This is so that the vegetation within the planned zone does not provide a path for the transfer of fire to the asset either from the ground level or through the tree canopy".[22]

- The purpose of having a buffer separate to the APZ is to ensure that there is protection of the habitat and the species within that buffer and not subject them to the management activities required to maintain the APZ as well as the activities permitted within it.
- The Panel views the buffer as a vegetated protection for koalas and their habitat from direct and indirect threats (i.e. 'edge effects'), whilst the APZ is for the protection of the built urban environment: therefore, two distinct functions that necessitate their separation (Figure 7). However, this is not to say that there could not be some level of bushfire fuel reduction activities conducted within the buffer zone.
  - The buffer is designed to reduce the impact of direct and indirect impacts from humans, such as light and noise. Koalas could still persist in these areas and use them as part of the functional corridor but would also be able to retreat to existing habitat areas where the edge effects are less apparent.
  - In undertaking revegetation in the buffer, the layout and tree species chosen should achieve the function of protecting koalas from noise, light, etc. and provide possible refuge from fires (Figure 6 images provide an indication of the current habitat). These images illustrate that looking through and across the corridor, any koalas within the corridor would be relatively exposed, therefore designing vegetation in the buffers on either side of the corridor could be done in a way that reduces exposure and increases protection.
  - The Panel acknowledges that koalas will move along and utilise the buffer zone, so food and other habitat trees (shelter, etc.) could be incorporated into the design, whilst also recognising other metrics that would protect the current habitat (such as canopy height, canopy density, fuel load contribution, etc.)
  - Removing habitat from buffer areas should be avoided unless absolutely necessary.
  - The exclusion fencing also reduces the risk of predation or injury from domestic dogs, amongst other threats, and would also discourage koala movement into the urban environment (with associated threats such as vehicle strike).
  - In regards to refugia for koalas and other wildlife from bushfires, this risk could be potentially managed by sections of the koala proof fencing being able to be temporarily removed/lowered (allowing either koalas/other species to disperse and/or the ability for

[21] Report, pg. ix
[22] NSW RFS Standards for Asset Protection Zones, https://www.rfs.nsw.gov.au/__data/assets/pdf_file/0010/13321/Standards-for-Asset-Protection-Zones.pdf

fire fighters to gain access) and by appropriate revegetating and active management of fuel loads within the habitat buffer. In considering options for fencing, the proponents should (if not already) engage with RFS and the CPCP team within DPIE who are examining this issue within the broader region.

- Figure 9 provides a view of the Panel's thinking in response to Figure 6 – the Asset Protection Zone should be outside of the exclusion fencing, and the 'Inner Buffer Zone' should be doubled from 15m in Figure 6 to 30 m in Figure 9.

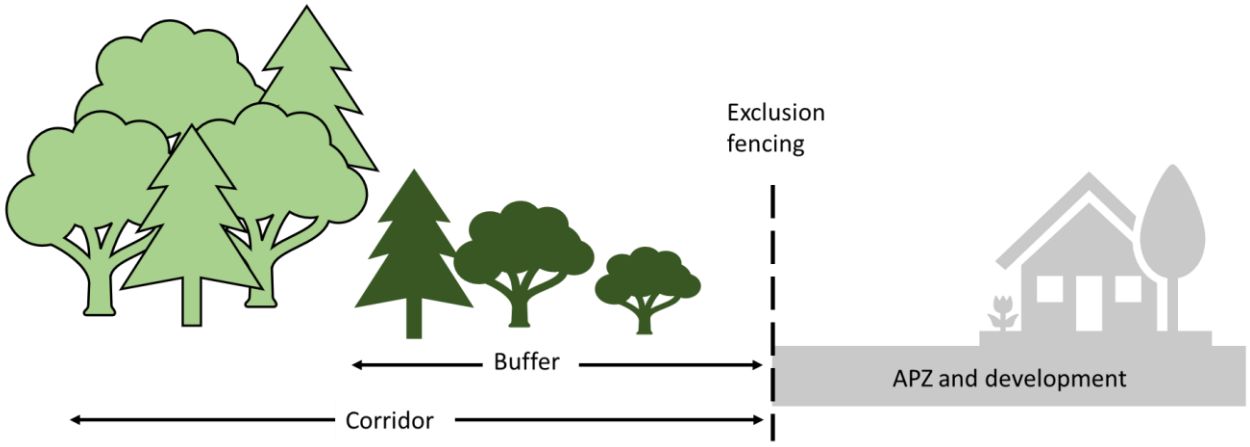


Figure 7: The separation of the vegetated buffer (which can include koala feed and shelter trees, with a bias towards the area adjacent to the corridor) and APZ

Requirements for corridors, buffers and fencing

- From the Report, Recommendation 2(c) states
  - "*Habitat within identified corridors should be:*
    - *protected (especially from development creep)*
    - *widened through revegetation (average size 390 to 425 m)*
    - *include a buffer on either side of the corridor habitat that is at least 30 m wide from the corridor to the exclusion fence with feed trees permitted in this buffer area*
    - *include, between the buffer area and the urban areas, koala proof fencing to prevent the movement of koalas out of the corridor into urban areas (with trees more than 3 m from the fencing to avoid damage) and the movement of domestic dogs (amongst other potential threats) into the corridor*
    - *for sites where exclusion fencing is infeasible due to steep terrain, then additional buffer width should be utilised (buffer ~60 m), with a traffic speed limit of 40 km/h and predator / dog monitoring*
    - *asset protection zone is outside the exclusion fencing, within the development footprint*

    Further, connectivity structures within corridors should also be assessed including local roads and other infrastructure (e.g. the Upper Canal)."[23]
- In arriving at this recommendation, the Panel noted that:
  - as a general rule for the overall review, and in the context of the planned urban growth in this area (~110,000 human inhabitants), "… *buffers should be at least 30 m wide from the edge of existing corridor habitat, occur on both sides of the corridor, and have exclusion fencing at their edge, with koala feed trees allowed to grow to the fence, with*

[23] Report, page xiv

a suitable distance between trees and fencing to prevent fallen boughs creating damage to the fence"[24].

- "*Every opportunity to maintain or increase the width of corridors should be taken and work to understand whether there is a minimum width to make a viable corridor, as well as how this minimum is affected by vegetation density of the corridor and urban density of the surrounding developments*"[25]
- "*east-west corridors within the Greater Macarthur Growth Area can provide connectivity and biodiversity values for flora and fauna species. Not all the identified corridors are suitable to provide connectivity for koalas, but the habitat should be protected for koala habitat, biodiversity values and amenity in the region*."[26]

- The Panel and the proponent have both identified "… *the Corridor B route to be important for koalas and other wildlife through the proposed development*" and, more broadly, the importance in the CPCP region.[27]
- The key tenet is that the primary aim should be to maximise koala habitat and to protect that habitat. Whilst average corridor widths (390 m to 425 m) have been used, this should be the minimum average to aim for, with *"…every opportunity to maintain or increase the width of corridors should be taken…"* .[28] We have reflected this concept in the figures below (Figure 8). This should not lead to perverse outcomes or be to the detriment of current habitat (i.e. habitat should not be removed from the corridor/buffer unless absolutely necessary), but with a revegetated corridor and buffer designed to protect and increase this habitat.
- As mentioned previously, the gazettal of the Mount Gilead Homestead also provides buffering between the koala habitat and urban development (Figure 8(B)). As in Figure 2, the Homestead includes both land to be conserved ('Conservation (Homestead)') and 'Retained' land. The 'Conservation (Homestead)' land, which the Panel understands is accessible koala habitat, could be counted in the corridor calculations if the habitat is protected in perpetuity. The Panel is not familiar with the allowed activities on the heritage listing and whether in the future the koala habitat ('Conservation (Homestead)') could be removed for activities 'sympathetic to the listing' e.g. farming. This matter should be clarified by the Department when reviewing material and making decisions.
- The Homestead's 'Retained' land, while acting as a buffer, should not be included in corridor calculations.
- Figure 8(A-C) provides a visual guide from the Panel in response to DPIE's interpretation (Figure 2 and Figure 3), with Table 1 providing a summary of activities allowed in the buffer zones.

[24] Report, pg. ix
[25] Report, pg. ix
[26] Report, pg. xiii
[27] Report, pg. viii
[28] Report, pg. ix

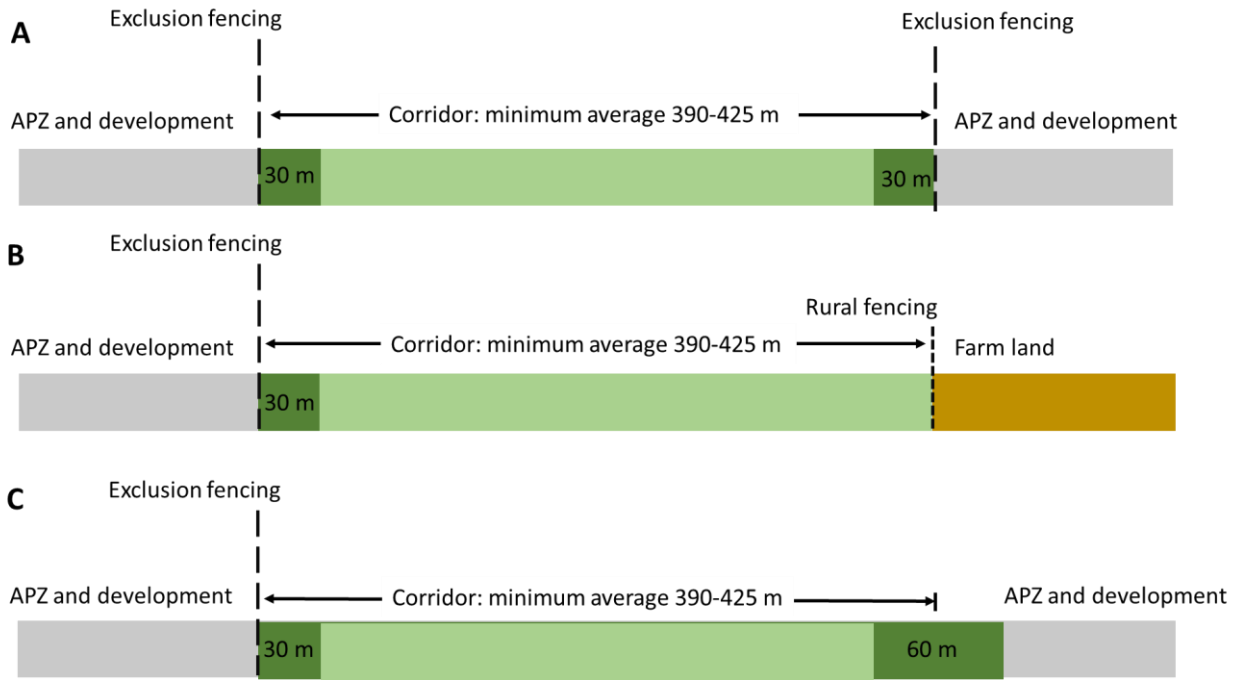


Figure 8: Recommendations for corridors. A) Development either side of the corridor, B) Development on one side and farmland on the other, C) Development on both sides, but with one side unable to be fenced.

Table 1: A non-exhaustive list of activities allowed within the various buffer zones

	Exclusion fencing (30 m buffer)	**No exclusion fencing (60 m buffer)**	**Rural fencing on homestead**
Members of the public	Acceptable; access via appropriate gates in koala exclusion fencing	Acceptable	N/A
Dogs	No dogs allowed within buffer	No dogs allowed within buffer	Proponent discuss with Homestead management about approach to managing farm dogs to prevent access to corridor.
Roads	No roads within buffer, unless required to cross corridor. Requires appropriate mitigation devices (raised, fenced, cattle grid etc)	No roads within buffer, unless required to cross corridor. Requires appropriate mitigation devices (raised, fenced, cattle grid etc) Reduced speed limits (40km/h) on adjacent roads to buffer with traffic calming devices	In discussion with the Homestead manager, roadways that cross corridors would require appropriate mitigation devices within the corridor (raised, fenced, cattle grid etc)
Playgrounds	No playgrounds within buffer	No playgrounds within buffer	N/A
Picnic Areas	No picnic areas within buffer	No picnic areas within buffer	N/A
Koala feed trees	Koala feed trees should form part of the buffer, ensuring that no large tree is within 3 m of the buffer	Koala feed trees could form part of the vegetation within the 30 m closest to the corridor; noting that there should be minimal koala feed/shelter trees in the outer 30 m (i.e. adjacent to the APZ and development) to discourage koala movement into these areas	N/A

Appendix G

CS&'s Advice regarding the protection of koala populations associated with the CPCP- 14 May 2021

NSW GOVERNMENT | Chief Scientist & Engineer

Advice regarding the protection of koala populations associated with the Cumberland Plain Conservation Plan

14 May 2021

Note: This version of the report has been edited to remove confidential information to allow public release. No changes have been made to the principles or recommendations made by the Expert Panel.

NSW GOVERNMENT | Chief Scientist & Engineer

The Hon Matt Kean MP
Minister for Energy and Environment

The Hon Rob Stokes MP
Minister for Planning and Public Spaces

Dear Ministers

Advice regarding the protection of koala populations associated with the Cumberland Plain Conservation Plan

In April 2021 you requested expert advice on the adequacy of the Cumberland Plain Conservation Plan's (CPCP's) koala specific measures in supporting a long-term strategic landscape-scale outcome for koalas across Wilton and Greater Macarthur Growth Areas. Further advice was sought on principles for koala protection measures for consent authorities to apply in considering site by site applications and their spatial application.

This builds on the findings and recommendations report '*Advice on the protection of the Campbelltown koala population'* submitted in April 2020 and additional advice provided to the Department of Planning, Industry and Environment (DPIE) in February 2021. It should be noted that the report only considered the Greater Macarthur Growth Area (GMGA) and not the Wilton Growth Area (WGA), which is an area of overlap for two different koala populations (Campbelltown and Southern Highlands) with different disease status.

An independent expert panel was established to provide advice chaired by myself and included Associate Professor Mathew Crowther (the University of Sydney), Dr Ben Moore (Western Sydney University) and Dr Martin Predavec (former Principal Scientist, DPIE).

This report is submitted to fulfil the Terms of Reference. The advice provides principles that should be applied across both the CPCP and surrounding regions for the protection of the South Western Sydney koala population. This includes an assessment of the CPCP proposed protection measures and how they relate to the principles.

In providing its advice the panel undertook briefings with DPIE and Transport for NSW and regional koala experts and a site visit was conducted. The advice only considers the protection of the koala population. It is noted that there are many other biodiversity (both flora and fauna) and cultural considerations that need to be made.

The CPCP aims to provide measures that enable koalas to persist in the region. This is including the strategic protection of habitat through a range of mechanisms, revegetation, installation of connectivity structures, threat management, monitoring and research.

The persistence of the South Western Sydney koalas requires ensuring resilience in the region. This includes the retention or provision of habitat of sufficient size and quality to compensate for the negative direct and indirect impacts of urbanisation and climate change (heatwaves, bushfire, declining habitat nutritional quality) as well as ensuring the persistence of multiple connected viable koala subpopulations, allowing proper metapopulation dynamics.

The Panel found that while overall the koala specific provisions of the CPCP are broadly adequate, it provides in this report comments and suggestions that could improve outcomes for koalas. There will be uncertainty about what hurdles will emerge in implementing the CPCP, and unforeseen events are also possible; these uncertainties will present challenges to decision makers and land

managers. The CPCP needs to include risk mitigation strategies including embedding adaptive management practices throughout the timeframes of the plan.

Sincerely

Dr Chris Armstrong, PSM
Chair, Independent Expert Koala Panel
Deputy Chief Scientist & Engineer

Principles for koala protection in the Greater Macarthur and Wilton growth areas and surrounds

Habitat and connectivity

1. **Strategic planning -** Habitat protection should be enabled through forward planning and commitments at a regional scale and over the lifetime of the development.
2. **Protected and connected -** Retain, increase, restore and protect koala habitat, reducing fragmentation and increasing connectivity. The habitat should support the movement of koalas such that dispersing koalas can move through the landscape, can breed to ensure genetic diversity, and can access and persist in refugia in times of stress, bushfire, drought, or other threats.
3. **Avoid dead-ends and population isolation -** Ensuring (as far as possible) that the habitat has *multiple* connections can help to prevent the formation of dead ends and population sinks and ensure that koalas (and other species) have routes to move through the landscape.
4. **Corridors provide habitat -** The term 'corridor' should not be misinterpreted to mean that its only function is a thoroughfare and the provision of connectivity. Not all identified corridors are suitable to provide connectivity for koalas, but the habitat should be protected for biodiversity values and amenity in the region, as well as protected koala habitat in some cases.
5. **Corridor widths -** Corridors should be widened where feasible through revegetation to an average minimum width of 390 - 425 m, include a buffer on either side (30 m wide where fenced and wider to ~ 60 m where fencing is infeasible), and trees should 3 m from the fence (to prevent tree branch damage to fence)
6. **Larger area, shorter edges -** Revegetation should be targeted to widen habitat units and corridors where feasible and aim to reduce the edge: area ratio of habitat (i.e. 'fingers' or areas between strips of habitat could by infilled with vegetation).
7. **Habitat buffers separate from APZ -** Buffer zones in corridors/habitat should be separate from Asset Protection Zones (APZs), with APZs on the urban side of the exclusion fence.
8. **Target shale soils -** Where possible, revegetation should target relatively higher quality soils (i.e. to produce higher quality habitat) – shale-based 'Blacktown soil landscape' is preferred to 'Hawkesbury sandstone landscape'.
9. **Earlier planting leads to more mature trees -** Early implementation of koala habitat planting, and restoration can lead to trees being at a more mature stage by the time they are needed, areas that will improve connectivity and nutrition (based on soil type) should be prioritised.
10. **Prevent degradation of habitat -** Early protection and active management will prevent the degradation and loss of existing habitat over the time during development – engage community and stakeholders to protect habitat.
11. **Plan for climate change -** Consider water sources, soil types, tree varieties, and well connected refugia.

Fauna crossings for linear infrastructure

12. **Safe movement -** Infrastructure that will cut across a designated corridor should include underpass or overpass structures to enable the movement of koalas along the corridor. Any infrastructure (such as roads) that cross, or might have an impact on, the corridor should be designed to be sympathetic to the protections of the corridor and to enable safe access across or under the linear infrastructure.
13. **Fencing underpasses -** Suitable fencing and connecting habitat put in place early enough through the process so that it is complete by the time the infrastructure is constructed.

14. **Underpass design -** Construction of connectivity structures for roads: overpasses, underpasses (including road bridges) or culverts, with associated exclusion fencing, cattle grids, gates to prevent koalas entering the roadway. Designing underpasses to maximise the likelihood of koala use – look to the latest evidence, include attributes such as clear line of site, avoidance of predator death traps, keep dry, include furniture such as logs for koalas, the bigger the better.

Threat mitigation

15. **Exclusion fencing -** Maintaining a separation between koalas and threats using exclusion fencing should be a priority, and where this is not feasible (e.g. steep terrain), fallback measures to reduce risk (e.g. vehicle speed limits) and monitoring should be undertaken. Fencing should be adaptively managed with design, location and maintenance evaluated.
16. **Spatial and temporal planning for threats -** Threat mitigation and reducing stressors should be enabled through forward planning and commitments at a regional scale and over the lifetime of the development.
17. **Reducing impacts from construction -** Ensure processes are in place to protect koalas during construction and operational phases of the development. e.g. an onsite ecologist present through the duration of pre-clearance surveys and clearing works, koala and wildlife relocation protocols, tree-felling protocols, and education programs for construction workers.
18. **Sensitive urban design -** Traffic calming measures, planning of greenspace, avoid koala feed trees in urban footprint, domestic dogs secured in neighbourhood backyards, fauna sensitive design
19. **Avoid stressors that repel koalas -** Some effects of increasing urbanisation can increase koala stress levels which in turn can lead to changed patterns of behaviour, avoidance of exposed habitat, increased propensity to disease. Utilise approaches to reduce these effects including buffers.

Disease management

20. **Avoid chlamydia incursion -** Much of the koala population within the CPCP appears currently to be free of *Chlamydia pecorum* infection. Planning and delivering protection measures should be progressed to maintain this disease-free status as much as possible, and to respond to it should it emerge.
21. **Identify koala routes and monitor for disease -** There is a need to have a monitoring stream that targets chlamydia entry into, and potentially within, the Campbelltown population. This should target specific locations where the Southern Highlands population may intersect.
22. **Vaccine trials -** The Campbelltown koala population may be a good place to conduct a vaccination trial, given its chlamydia-free status. Given the early stage development of the vaccination, a trial could be conducted on the interface between the two populations (the Campbelltown and the northern Southern Highlands population). Vaccines are still unproven so not yet a basis for management.
23. **Adaptive management for disease -** There should be the development of monitoring that matches triggers for actions: actions should be commensurate to the detection level.

Adaptive management

24. **Baseline data set -** Baseline data are required to better understand the status of the population(s), including numbers, distribution and how they functionally use the landscape.
25. **Surveys and monitoring -** Ongoing and regular survey and monitoring efforts, compared against the baseline, to detected population trends over time and inform adaptive management approaches (including the development and understanding of appropriate triggers and responses, including timeframes).

26. **New monitoring technologies -** New monitoring approaches enabled by smaller, cheaper, more sensitive devices, that are connected and remote will increase the extent and value of monitoring programs.
27. **Interface monitoring with NSW Koala Monitoring Framework -** Monitoring should inform the *NSW Koala Strategy*, as a designated monitoring site. Site specific monitoring will need to be conducted within the CPCP and that will evolve over time.
28. **Adaptive management informed by triggers -** Monitoring should include evaluation points tied to management 'trigger' actions and responses.
29. **Timely mitigation -** As per an adaptive management approach, a lack of information should not preclude mitigation activities occurring in a timely manner.
30. **Understand alternatives -** There is also a need to map alternative management approaches that could be employed if actions are not achieving the desired results.
31. **Risk-based emergency response protocols -** Interested stakeholders undertake a risk assessment (likelihood and consequence) and establish monitoring and response protocols – for threats with a fast or slow onset.

Contents

1 Introduction

On 9 December 2019, the Minister for Energy and Environment and the Minister for Planning and Public Spaces requested that the Deputy Chief Scientist & Engineer chair an Independent Expert Panel to provide advice regarding the protection of the Campbelltown koala population.

This advice was to include:

- The adequacy of the proposed measures, by the property group Lendlease, for koala conservation on the land referred to as Mount Gilead Stage 2 (MGS2) and the consistency of these measures with the 2018 NSW Koala Strategy
- What, if any, additional conservation measures are considered necessary? What, if any, site specific measures for koala species should be incorporated into the Cumberland Plain Conservation Plan (CPCP) for the Greater Macarthur Growth Area (GMGA) to support the long-term viability of the koala population.
- Whether east-west corridors linking the Nepean and Georges Rivers can contribute to the conservation of the Campbelltown Koala population; and if so, which east-west corridors and what measures should be taken to ensure their effectiveness

The Panel included Dr Chris Armstrong PSM (Deputy Chief Scientist & Engineer; chair), Professor Kathy Belov AO (The University of Sydney), Dr Carolyn Hogg (The University of Sydney) and Professor Jonathan Rhodes (The University of Queensland).

The report "*Advice on the protection of the Campbelltown Koala population*" Report (the 2020 Report) was submitted to government on the 30 April 2020.[1] The 2020 Report provided the Panel's findings and four recommendations. These findings and recommendations provided advice on the primary and secondary corridors in the GMGA and the need for adaptive and active management.

In February 2021, additional advice (the February 2021 Advice) was provided to the Department of Planning, Industry and Environment (DPIE) on specific questions related to corridors and buffer zones in the proposed MGS2 development.In April 2021, the Minister for Planning and Public Spaces and the Minister for Energy and Environment requested the Office of the Chief Scientist & Engineer (OCSE) provide advice on the adequacy of koala specific measures in the Wilton Growth Area (WGA) and GMGA in the CPCP.

This includes advice regarding the adequacy of the CPCP's koala specific measures in supporting a long-term strategic landscape-scale outcome for koalas across WGA and GMGA. The advice is to consider constraints such as existing development and current and future infrastructure (e.g. Upper Canal and transport routes) and risks that may lead to habitat losses in other regions (e.g. through changes in urban capable footprint).

Further advice was requested regarding:

1. Principles for consent authorities to apply in considering site by site applications in light of the CPCP advice, including how this applies to the Technical Assurance Panel (TAP) process for the Appin precincts in the GMGA.
2. Spatial application of the advice to the GMGA leading to amendment of the Greater Macarthur Plan.

The full terms of reference are at Appendix 1. This report is in fulfilment of the terms of reference.

An expert panel was established to provide this advice, chaired by the Deputy Chief Scientist & Engineer and included Associate Professor Mathew Crowther (School of Life and Environmental Sciences, the University of Sydney), Dr Ben Moore (Hawkesbury Institute for the Environment, Western Sydney University) and Dr Martin Predavec (Retired, former Principal Scientist, DPIE). OCSE provided secretariat support.

[1] OCSE (2020), Advice on the protection of the Campbelltown Koala population

In providing its advice the Panel has reviewed several reports and documents. The Panel met with representatives from DPIE including Planning, as well as Energy, Environment and Science (EES), Transport for NSW (TfNSW), Associate Professor Damien Higgins (Koala Health Hub, The University of Sydney) and was provided additional information from Dr Stephen Phillips, Biolink Ecological Consultants. On 30 April 2021 the Panel conducted a site visit to the GMGA region of the CPCP with representatives of the three agencies and of Walker Corporation, which is seeking to develop in both growth areas.

1.1 Western Parkland City including the Greater Macarthur and Wilton Growth Areas

The Western Parkland City builds on the regions surrounding Liverpool, Greater Penrith and Campbelltown-Macarthur.[2] Over the next ~40 years, it will be developed to accommodate an additional 760,000 people[3] including residential dwellings, industrial and corporate sites the Western Sydney Airport and Badgerys Creek Aerotropolis. Biodiversity certification for development across the Western Parkland City is being sought through the CPCP under the *Biodiversity Conservation Act 2016.*

The GMGA and WGA are regions slated for increased development over the next 30 years as part of the Western Parkland City (Figure 1). These two growth areas will include ~55,000 new homes and associated transport, industrial and community infrastructure.[4,5] Running through the Growth Areas is the Upper Canal, which supplies water to Sydney and is State-Heritage listed. Strategic biodiversity conservation through most of the Growth Areas is being conducted through the CPCP.

The GMGA extends from Glenfield to Appin and encompasses land in three Local Government Areas (LGAs): Campbelltown City Council, Camden Council and Wollondilly Shire Council. The GMGA, as set out in the *Greater Macarthur 2040* Plan, will include urban renewal precincts (Glenfield to Macarthur), land release precincts south of Campbelltown (including ~ 40,000 homes across Menangle Park, Gilead, North Appin and Appin), new transport routes, public and industrial infrastructure.[6] The WGA is wholly within the Wollondilly Shire Council LGA. The WGA, as set out in *Wilton 2040*, will include industrial, commercial, and residential infrastructure, as well as an additional 15,000 homes.[7]

1.2 The Cumberland Plain Conservation Plan

DPIE has undertaken strategic conservation planning to develop the CPCP. The CPCP covers the location and layout of urban development as well as biodiversity certification under the *Biodiversity Conservation Act 2016* (Figure 1), aiming to support biodiversity and urban growth by protecting important conservation values in a strategic manner. Under the draft CPCP, there is a conservation program that has been designed to *"improve ecological resilience and function, and to offset biodiversity impacts from new housing, employment areas and infrastructure."* The draft CPCP states that it will "*ensure that the condition of important koala habitat is improved, connectivity between koala sub-populations is maintained, threats to koalas are managed and the koala population in South Western Sydney persists*." Further information on the CPCP is in the 2020 Report.[8]

[2] https://www.greater.sydney/metropolis-of-three-cities/vision-of-metropolis-of-three-cities/western-parkland-city-vision
[3] The population of the Western Parkland City is projected to grow from 740,000 in 2016 to 1.1 million by 2036, and to well over 1.5 million by 2056. https://www.greater.sydney/metropolis-of-three-cities/vision-of-metropolis-of-three-cities/western-parkland-city-vision
[4] DPIE (2018) Greater Macarthur 2040. An interim plan for the Greater Macarthur Growth Area
[5] DPIE (2018) Wilton 2040. A plan for the Wilton Growth Area
[6] DPIE (2018) Greater Macarthur 2040. An interim plan for the Greater Macarthur Growth Area
[7] DPIE (2018) Wilton 2040. A plan for the Wilton Growth Area
[8] OCSE (2020), Advice on the protection of the Campbelltown Koala population

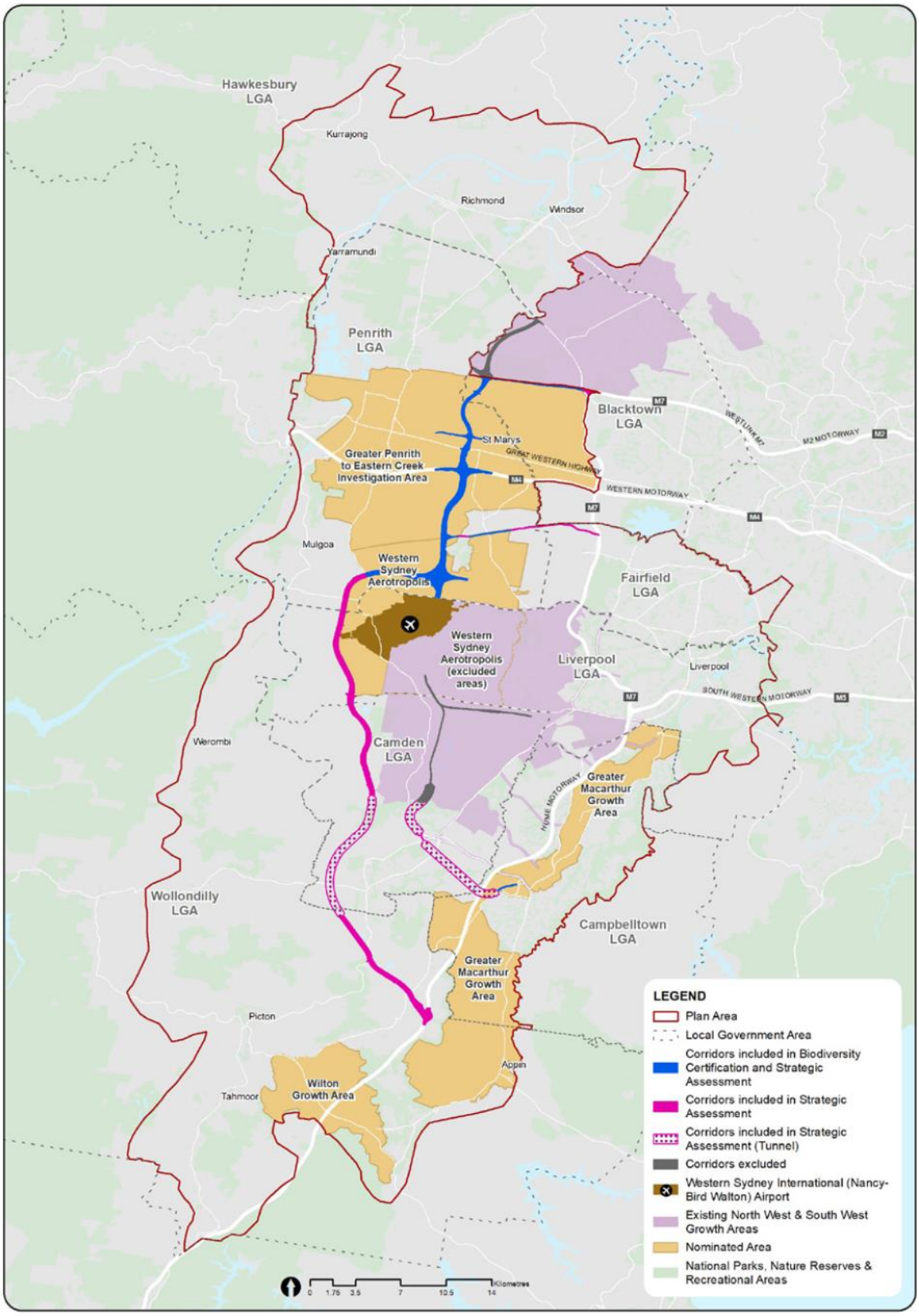


Figure 1: Draft CPCP area and scope
Source: DPIE (2020)[9]

[9] DPIE (2020) Highlights of the Draft Cumberland Plain Conservation Plan

2 Koala protection measures proposed in CPCP and related processes

2.1 The CPCP measures

The Sub-Plan B of the draft CPCP is a conservation program for koalas and has been developed to "*address impacts and potential risks to koalas in Western Sydney associated with existing and planned development in the Wilton and Greater Macarthur growth areas".* Sub-Plan B (and this current advice) is focussed on the WGA and GMGA since these two areas cover most koala records within the Cumberland Plain - two populations often referred to as the Campbelltown and Southern Highlands koala populations, but the level of distinction between them is unclear. There are five categories of commitments under the program: 1) Avoiding and minimising impacts, 2) Mitigating indirect and prescribed impacts, 3) Conserving koala habitat, 4) Managing landscape threats, and 5) Building knowledge and capacity.

Actions under the koala conservation program include, but are not limited to:

- Installation of exclusion fencing, along both sides of Appin Road and where feasible along koala corridors
- Establishment of the Georges River Koala Reserve
- Securing priority habitat and koala movement corridors
- Fauna crossings under Appin Road near Brian Road (near the Ousedale Corridor) and at the Kings Falls Bridge
- Habitat restoration and weed control
- A research program
- A health and welfare program

An updated list of commitments and actions, from the draft CPCP, provided to the Panel are at Table 1.

Sub-Plan B notes that there will be an evaluation program to track the progress and effectiveness of the conservation program over the life of the CPCP (35 years, until 2056).

The CPCP does not cover the whole Cumberland Plain region. There are areas that are subject to different biocertification processes (e.g. the proposed Lendlease MGS2 development in the GMGA) or are not part of the urban footprint (e.g. National Parks, WaterNSW Special Areas).

2.2 Other policies or processes

Koala habitat in the Wollondilly LGA is covered by *State Environmental Planning Policy (Koala Habitat Protection) 2021* (SEPP 2021).[10] Further it is noted that the Wollondilly Shire Council has closed its tender for the development of a Comprehensive Koala Plan of Management (CKPoM) (closed 24 March 2020).

The CKPoM[11] for Campbelltown City Council was approved in August 2020. This provides a strategic approach to the protection, management, and restoration of koala habitat for the entire Campbelltown LGA. Provisions in SEPP 2021 do not apply to Campbelltown LGA.

In the GMGA, DPIE have established a pilot TAP program to allow for state agencies, councils and landowners to work together to undertake strategic investigations for precincts.[12] The TAP, chaired

[10] https://www.planning.nsw.gov.au/Policy-and-Legislation/Environment-and-Heritage/Koala-Habitat-Protection-SEPP
[11] https://www.campbelltown.nsw.gov.au/LocalEnvironment/Koalatown/CouncilTakesActionOnKoalas
[12] https://www.planning.nsw.gov.au/Plans-for-your-area/Technical-Assurance-Panel

by DPIE, is made up of representatives from EES in DPIE, Government Architect NSW, Sydney Water, TfNSW, Wollondilly Shire and Campbelltown City Councils and other agencies such as Rural Fire Services (RFS) and Heritage NSW when required. The aim is to "*resolve complex planning issues and provide a recommended roadmap to resolve key issues upfront in a transparent way".*[13] This will include the implementation of any advice and recommendations from OCSE on koala protection measures.

[13] https://www.planning.nsw.gov.au/Plans-for-your-area/Technical-Assurance-Panel

Table 1: Draft CPCP commitments and actions for koala conservation

Commitments	Actions	Timing
Commitment 8 Mitigate indirect and prescribed impacts from urban, industrial, infrastructure and major infrastructure corridors development on the Southern Sydney koala population to best practice standards and in line with the Chief Scientist Koala Report (2020), and in accordance with Appendix E of the Plan.	1. Install koala exclusion fencing, including gates and grids, between the Plan's koala habitat that can safely support koalas and urban land within the Greater Macarthur Growth Area and Wilton Growth Area, except where exclusion fencing is not feasible or necessary due to slope, heritage or water courses. a. Ensure all koala-exclusion fencing is at least three metres from koala habitat trees. b. In nominated areas where exclusion fencing is not feasible, apply koala specific mitigation actions 60m from the koala habitat in accordance with Appendix E. c. Where fencing must cross existing or planned linear infrastructure such as gas and electricity transmission, consider appropriate access treatments such as gates to ensure the integrity of the koala-exclusion fencing. d. Fence off koala habitat corridors that are too narrow to safely support koalas and relocate koalas out of the unsafe corridors, noting the corridors will be protected and can be considered for future restoration to support koala movement. 2. Deliver a feasibility study into the koala exclusion fencing to help inform the design, locations and construction of the fencing. The feasibility study will ground-truth the fencing locations identified in the Plan and identify priorities for fencing in the first three years. 3. Install koala-exclusion fencing along the western alignment of the Georges River Koala Reserve where existing urban land is a threat to koalas. 4. Install koala-exclusion fencing at roadkill hotspots and at koala habitat, along both sides of Appin Road between Rosemeadow and Appin, to mitigate koala vehicle strikes. Fencing along Appin Rd will be in addition to planned fencing works to be delivered by Transport for NSW. 5. Undertake targeted stakeholder and community engagement to support the delivery of koala-exclusion fencing. 6. Establish a koala working group with representation from relevant government agencies to support implementation of the koala commitments and actions. The working group will provide advice to support implementation of the koala sub-plan, including advice to inform: • alignment, staging, and design of the koala exclusion fencing and fauna crossing, including advice about providing appropriate koala movement corridors • priority locations and approach for koala habitat restoration	Action 1: Life of Plan Action 2: Year 1 Action 3,4: Life of Plan Action 5: Years 1-3 Action 6: Before start of Plan Action 7: Life of Plan Action 8: Year 1-5

	• monitoring and evaluation of the koala commitments set out in Plan, including providing advice to support adaptive management based on monitoring and evaluation data • community and stakeholder engagement for the koala conservation commitments and actions • research and management actions relating to koalas. 7. Work with local councils, NPWS and OSL to ensure the threats posed by dogs on all public land identified as the Plan's koala habitat are managed. • For land that is not publicly accessible, either through the installation of signs and/or installation of fences • For land managed as a reserve or for recreation, incorporate requirements in a relevant Plan of Management 8. Provide safe fauna crossings, based on current best practice design, across Appin Road by: • installing a koala underpass culvert under Appin Road, near the intersection with Brian Road • augmenting the existing Kings Falls Bridge at the Georges River by constructing a bench adjacent to the bridge abutments, to allow dry passage for koala (and other fauna) under Appin Road, supporting north–south koala movement from the Georges River Koala Reserve to the southern koala habitat	
Commitment 9 Protect a minimum of 5,475 hectares of native vegetation[1] in the Cumberland subregion to conserve biodiversity values in perpetuity in accordance with the conservation lands selection steps which will require at least 11,000 hectares of conservation land.	1. Purchase land within the strategic conservation area to commence establishing reserves under the Plan with priority given to land listed for sale and land in the proposed Koala Reserve (Years 1-3).	Action 8: Life of Plan
Commitment 11 Establish a reserve to protect the north-south koala movement corridor along the Georges River between Appin and Kentlyn.	1. Protect up to 700 hectares of land between Appin and Kentlyn that is currently in ownership of NSW Government as the first stage in establishing the Georges River Koala Reserve. 2. Transfer the first stage of the Georges River Koala Reserve to National Parks and Wildlife Service (by December 2021) 3. Gazette the first stage of the Georges River Koala Reserve as a conservation reserve under the management of National Parks and Wildlife Service (by the end of 2023)	Action 1: Year 1 Action 2: Year 3-10 Action 3: Year 3-10 Action 4: Year 10-20

[1] While there is overlap between the TEC targets listed in commitments 8.1 and 8.2, there are differences in the listings between EPBC Act-listed and BC Act-listed TECs, such as differences in approach and criteria. Therefore, the BC Act-listed TECs in commitment 7.2 incorporate targets for EPBC Act-listed TECs.

	4. Protect an additional 430 hectares of land between Appin and Kentlyn through the purchase of land for the Georges River Koala Reserve. 5. Protect up to 755 hectares of land between Kentlyn and Long Point as future additions to the Georges River koala reserve. 6. Restore up to 80 hectares of cleared land for koala habitat within the Georges River Koala Reserve to strengthen the north-south koala movement corridor.	Action 5: Year 1-20
Commitment 13 Secure key koala habitat corridors in the Cumberland subregion in perpetuity	1. Secure priority habitat and koala movement corridors in accordance with the Conservation Lands Implementation Strategy (Commitment 8 Action 1) to protect habitat corridors in the Cumberland subregion. 2. Protect koala habitat as avoided land and through the application of new development controls in potential east–west koala movement corridors between the Georges River and the Nepean River. 3. Through restoration, ensure at least one north–south corridor (the Georges River Koala Reserve is at least an average of 390-425m wide and is contiguous (gaps between trees less than 100m). 4. Facilitate koala movement for at least one east–west corridor (Ousedale Creek) by a. constructing a koala underpass at Ousedale Creek corridor under Appin Road b. through restoration and koala exclusion fencing to ensure the corridor is contiguous (gaps between trees less than 100m) and a minimum average of 390-425m. 5. Fence off east–west koala habitat corridors that are too narrow to safely support koalas and relocate koalas out of the unsafe corridors, noting the corridors will be protected and can be considered for future restoration to support koala movement.	Action 1,2: Before start of Plan Action 3: Years 1-5 Action 4, 5: Years 1-3
Commitment 14 Undertake ecological reconstruction of up to a maximum of 25% of the Plan's offset target for native vegetation (Commitment 8) in conservation land established under the Plan.	1. Establish a Weed and Restoration control working group to guide the implementation of weed control activities under the Plan including the preparation of a Weed Control Implementation Strategy. 2. Develop a Restoration Implementation Strategy in consultation with key stakeholders and delivery partners, to: • provide a clear purpose for undertaking restoration, including when the Plan will require ecological reconstruction to meet its offset targets for impacted native vegetation communities • ensure the long-term sustainability of restoration considers genetic diversity in what is planted • identify restoration potential of land within priority sites • provide guidance on restoration expectations at priority sites • identify opportunities for landholders to undertake active restoration as part of a biodiversity stewardship agreement	Action 1: Year 1 Action 2: Year 1 Action 3: Life of Plan Action 4: Year 1-5 Action 5: Year 1-5

	• identify and potentially fund restoration on land adjacent to conservation land established under the Plan • develop a seed-procurement approach • determine any research needs. 3. Enter into written agreements with delivery partners and engage specialist providers where necessary to implement the restoration plan. 4. Undertake up to a maximum of 1,365 hectares of ecological reconstruction on conservation land targeting the following threatened ecological communities: • Cooks River Castlereagh Ironbark Forest • Cumberland Plain Woodland • River-flat Eucalypt Forest • Shale Gravel Transition Forest • Swamp Oak Forest. 5. Ecological restoration including planting trees to restore koala habitat in Georges River Koala Reserve and other priority locations in the strategic conservation area including: • along Ousedale Creek • around Appin The restoration of the Plan's koala habitat will primarily include the restoration of Cumberland Plain Woodland and Shale/Sandstone Transition Forest. 6. Establish pilot sites for ecological restoration of threatened ecological communities within the Plan Area.	Action 6: Year 2 onwards
Commitment 21 Provide opportunities for the residents of Western Sydney to learn about and actively participate in biodiversity conservation including koala conservation.	1. Invest in the *NSW Koala Strategy* to raise awareness of the Southern Sydney koala population and encourage community participation in koala conservation in Western Sydney.	Action 1: Year 4 Actions 2,3,4,: Year 5 Actions 5: Year 1 onwards
Commitment 23 Invest in research priorities that will support the implementation of the	1. Implement the research program with key outcomes including: • research that increases knowledge of population demographics, life-history and ecology of the Southern Sydney koala population, as part of the NSW Koala Strategy Research Plan	Action 1: Year 1 Actions 2,3: Year 2 onwards

Plan and help to deliver the Plan's outcomes.		
Commitment 24 Support rehabilitation measures to help maintain koala health and welfare.	1. Invest in the *NSW Koala Strategy* and other potential partners to implement the koala health and welfare program in South Western Sydney with key deliverables including: • monitoring of koalas including key threats and effectiveness of mitigation measures as part of the NSW Koala Strategy Monitoring Framework • designating the koalas in South Western Sydney as one of the dedicated monitoring sites for the NSW Koala Strategy • providing enhanced training in wildlife treatment for veterinarians • providing grants for community wildlife organisations for resources and carer recruitment and training • establishing health and welfare programs to support koalas from threats including vehicle strike, fire, disease and climate change. 2. Koalas that are captured and/or handled as part of a monitoring program will be vaccinated against chlamydia and have a tissue sample taken for genetic analysis, with the tissue samples lodged with the NSW Koala Biobank	Action 1: Year 1 onwards

3 Adequacy of Koala protection measures in South Western Sydney

This chapter provides a commentary from the Panel (Table 2) on the adequacy of the measures proposed for koala protection in the draft CPCP (Table 1).

3.1 Definition of adequacy and assessment

The Panel has been requested to provide advice regarding the 'adequacy' of the CPCP's koala specific measures in supporting a long-term strategic landscape-scale outcome for koalas across the WGA and GMGA. However, there is no clear definition of adequacy.

The CPCP has the aim of ensuring that the *"condition of important koala habitat is improved, connectivity between koala sub-populations is maintained, threats to koalas are managed and the koala population in South Western Sydney persists."*[14]

The 2020 Report assessed the adequacy of protection measures proposed in relation the 2018 NSW Koala Strategy which has the objective of stabilising and increasing koala numbers over the longer-term to ensure genetically diverse and viable populations across NSW.[15] The guiding principles were to *"maximise koala population persistence and abundance, koala habitat amount and connectivity, and minimise contact between koalas and the urban environment to reduce hazards and threats"*.[16]

In June 2020, after the 2020 Report was completed, the Legislative Council inquiry into koala populations and habitat in New South Wales found that *"given the scale of loss to koala populations across New South Wales as a result of the 2019-2020 bushfires and without urgent government intervention to protect habitat and address all other threats, the koala will become extinct in New South Wales before 2050"*.[17]

In July 2020, the Minister for Energy and Environment announced the goal of doubling the number of koalas in NSW by 2050 and the development of a 30-year plan to achieve that goal. A panel chaired by OCSE is working on that plan separately.

The Panel for the CPCP advice in this report, assessing the adequacy of actions in the CPCP, has based its analysis against the stated CPCP aims, abbreviated to: 1) improve habitat, 2) maintain connectivity, 3) manage threats, which together should 4) enable the population to persist. The Panel notes the difficulty in the term 'persist' but notes that it must aim towards a thriving and resilient koala population rather than simply a population 'hanging-on'.

The Panel's assessment of adequacy of mitigations and commitments in enabling persistence has considered:

a) what we know about the current status of the habitat and koala populations
b) plans around urban development and transport corridors for the GMGA and WGA that have been shared with the Panel
c) other trends that will affect the habitat and population over the 36-year timeframe, in particular the impacts of climate change, and the foreseeable movement of chlamydia disease into and within the area. These trends are described in more detail in Section 3.2.

[14] DPIE (2020) Sub-Plan B: Koalas. Draft Cumberland Plain Conservation Plan
[15] https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/programs-legislation-and-framework/nsw-koala-strategy
[16] OCSE (2020), Advice on the protection of the Campbelltown Koala population
[17] NSW Government (2020) Legislative Council. Portfolio Committee No. 7 – Planning and Environment. Koala populations and habitat in New South Wales

This assessment does carry with it considerable uncertainty due, in part, to information on current status of habitat and koalas being imperfect with gaps in our knowledge; plans and decisions about transport and layout and sequencing still being determined; fundamental epistemic uncertainty in our ability to know the climate change pathway that we are on, and as a result the local implications of that at a point of time in the future.

However, efforts are being made to improve our understanding of the current habitat and koala conditions (including proposed studies by EES on chlamydia, and a koala genetic baseline project as part of the NSW Koala Strategy) and deploying adaptive management approaches can enable some decisions to be made into the future that are informed by measurements and observations at the time.

Table 2 sets out the Panel's comments on the actions and commitments of the CPCP (detailed in Table 1). These comments reflect Panel observations including whether there is misalignment with previous advice from OCSE (2020 Report and/or February 2021 Advice), whether the action appears adequate based on the information available, whether there are additional issues that the Panel has deemed relevant in operationalising the actions.

A number of these elements are elaborated on further in Section 3.3 where more detailed discussion is provided. Section 3.3 also sets out overarching principles that can be used by proponents in moving forward in the CPCP, to maximise as much as possible the outcomes for koalas. These principles are applicable to identified locations within the CPCP (GMGA and WGA), locations in South Western Sydney within the CPCP but outside of the growth areas such as the area between the WGA and GMGA, or areas that may be in the near vicinity but outside the CPCP such as near Appin. These Principles for application outside the CPCP envelope are in response to the Panel's Term of Reference 2.

Table 2: Draft CPCP commitments and actions and associated Panel comments.
This Table should be read in conjunction with Table 1 that presents a fuller description of commitments and actions as provided by CPCP team in DPIE.

Commitment	Actions	Panel comments
8. Mitigate impacts	1. Install koala exclusion fencing	• Arrangements for the ongoing care and maintenance of mitigation structures, such as fencing, will need to be established in perpetuity. • Fencing is due to be delivered over the life of the CPCP, with the first stage to be completed by 2023. Installation of fencing, especially in road hotspots and around connectivity structures, should occur as a matter of priority. • Fencing should not have trees (including koala feed trees, shelter trees, and other tree species) within 3 m, to avoid falling branches compromising the structural integrity of the fences. The 3 m distance should be measured from the canopy of the tree (not the trunk) and the fence should be constructed on urban capable lands. • Where fencing is not feasible due to steep terrain the actions suggest specific development controls 60 m from the koala habitat will be used. The 2020 Report and February 2021 Advice provides guidance on habitat buffer zones for the corridors (summary at Appendix 2). This includes a 30 m buffer in areas with exclusion fencing and 60 m buffer in areas where exclusion fencing is not possible. The advice also provides guidance on Asset Protection Zones (APZs) which should be considered as separate to the habitat buffer as they serve different purposes. • Other corridors, that will be fenced-off, will provide insurance habitat if the main east-west corridors are unable to provide connectivity or are affected by events such as bushfires, etc. • There is a need to ensure that there is consistency of fencing across other tenures within and not within the CPCP. For example, it is not clear what fencing measures are occurring on the south side of Woodhouse Creek/Beulah Biobank Corridor, noting that the north side is subject to a biodiversity certification process separate but adjacent to the CPCP. Similarly, fencing proposed for the south-east WGA is subject to the Walker Corporation draft Koala Plan of Management (KPoM). • In the east of the WGA, there is a road that bisects koala habitat and results in it requiring connectivity (Figure 2, red circle). The islanded component would not be of a sufficient size to encourage one, let alone multiple, individual koalas to persist within the landscape, and the habitat serves no connectivity function. As it stands, the panel believes a better approach would be to not consider this as koala habitat (See Section 3.3.1.4).
	2. Feasibility for fencing and locations	
	3. Fencing along western alignment of Georges River koala reserve	• Fencing along other corridors and habitat units (in addition to the Georges River Koala Reserve), in both GMGA and WGA areas, will also be needed to separate koalas from threats.

Commitment	Actions	Panel comments
	4. Fencing at roadkill hotspots and both sides of Appin Rd	• These areas should be prioritised to reduce the impact of current levels of vehicle strike and should be developed in conjunction with connectivity structures (See Commitment 13 comments). • As roads and transport infrastructure are implemented out across and adjacent to habitat, attention will be required to the creation of further roadkill sites, fencing and underpasses and adaptive responses will be required.
	5. Stakeholder engagement on fencing	• Community will be key to identifying and reporting the integrity of mitigations day-to-day that may not be picked up by a monitoring network or inspections – such as damaged fencing, incursion of dogs, etc. Stakeholder engagement will be essential to ensure support for the fence – if people understand its purpose, they may support it, otherwise there is a risk it will be resented or vandalised. The Panel supports the community engagement process that is currently being procured.
	6. Working group for implementation	• There is need to include independent koala experts in the working group
	7. Dogs on public land managed	• The 2020 Report noted that there is the potential for areas of vegetation to be utilised for public amenity (via double-gating or similar protection), but this should be with the absence of dogs (i.e. dogs should not be in any of the corridors). Appropriate signage, community awareness programs, etc. should be used to convey this. • Community will be key to identifying and reporting the integrity of mitigations day-to-day that may not be picked up by a monitoring network or inspections – such as damaged fencing, incursion of dogs into habitat. • In Port Macquarie there are dog training courses that help dogs avoid koalas. This could be investigated and included as part of a community awareness program.[18]

[18] https://www.abc.net.au/news/2017-11-13/how-to-train-your-dogs-to-protect-native-wildlife/9144748

Commitment	Actions	Panel comments
	8. Safe fauna crossings	• Design, layout, and maintenance of these crossings will influence their use by koalas (Section 3.3.2). Irrespective of the type of structure employed, all crossings should be dry (and could include wildlife furniture such as logs) and should have line-of-sight to the other side (i.e. no bends but should be a straight structure) to encourage usage. Further they should be constructed alongside fencing, effectively providing fauna no other crossing options or the ability to move onto roads. • If a culvert option is preferred, there is benefit in exploring the feasibility of multiple culverts as a proactive measure to maximise connectivity (e.g. at the Ousedale corridor crossing Appin Rd). • The set of options for the crossings at Ousedale that the Panel was shown with minimal or no habitat evident. This issue is a priority and needs to be addressed as it is difficult to see how the connectivity would function. The Ousedale connectivity structures should connect directly to habitat on both the eastern and western side of Appin Road. • The Panel notes that the Walker Corporation has explored the option of an overpass at the Ousedale corridor. This option should be investigated as a priority as the east-west connection between the Georges River and Nepean River corridors is a primary element of the effectiveness and adequacy of the CPCP. • The Panel supports the Kings Falls Bridge connectivity structure as per the 2020 Report. It is understood that early planning has identified construction of 500m of fencing to the east of Kings Falls Bridge.. This area should be monitored and further fencing and/or other mitigations may be required. • The Plan proposes no additional koala crossings for WGA. However, the Walker Corporation KPoM[19] proposes koala crossings along Picton Road (Figure 2, blue and yellow circles) for south-east Wilton. This needs clarification, the Panel understands that there is currently an underpass in place but is uncertain of its condition and details of its design, and evidence of koala use, so can't advise on adequacy or refurbishment.

[19] EEM (2020) Wilton Koala Plan of Management. Prepared for Walker Corporation

Commitment	Actions	Panel comments
9. Protect native vegetation	1. Purchase land, with priority of land for sale and in koala Reserve	• The purchase, protection (via Biodiversity Stewardship Agreements (BSAs)) and/or maintenance of lands should be a priority action and conducted in a timely manner, as delays could cause degradation to the environment. The Panel recommends that this protection proceeds independent of the progression of development parcels. The Panel believes this is a key risk in the implementation of the CPCP – to achieve the aim of the CPCP, protections based on tenure must be put in place as soon as possible and must not be allocated over the life of the plan. • Land purchases and/or protection in the Ousedale corridor should also be prioritised, as it is proposed to be the key east-west corridor in the CPCP for connectivity between the Nepean and Georges Rivers. The Panel notes, prioritisation should not be the only criteria.

Commitment	Actions	Panel comments
11. Establish a reserve to protect koala movement Georges River	1. First stage government land 700 ha for Georges River Koala Reserve 2. Transfer to National Parks 3. Gazette as a conservation reserve 4. Protect additional 430 ha through purchases for Georges River Koala Reserve 5. Protect 755 ha for Georges River Koala Reserve 6. Restore 80 ha to koala habitat within Georges River Koala Reserve	• The establishment of and the current and proposed efforts to protect and improve the habitat in the Georges River Koala Reserve appear adequate and will help protect the habitat and provide a linkage across the landscape. • Like Commitment 9 comments, there is an extended period of time associated with this action, which could lead to the degradation of the habitat and other perverse consequences unless measures are taken to maintain quality, these could be through community programs or more formalised arrangements. • Further, revegetation and restoration efforts here (and elsewhere throughout the CPCP) should also occur as soon as possible, to ensure that vegetation has maximum time to establish and grow for koala and other fauna use. An additional benefit is carbon capture.
13. Secure habitat corridors in perpetuity	1. Secure habitat and corridors in accordance with CLIS	• Like Commitment 9 and 11, there is a need to ensure that this is conducted as soon as practical, as this will ensure the best outcomes for the habitat (i.e. reduction in threat ingress or degradation of the environment).

Commitment	Actions	Panel comments
	2. Protect habitat as avoided land in east-west corridors	• As per Commitment 9 and 11 comments, there is a difference between development controls and maintaining the environment. There is a risk, if not managed, this could lead to degradation of koala habitat (e.g. weed invasion, death of trees due to age or dieback, dumping, firewood removal, vandalism, etc.) • The Panel is not sure if the Nepean Creek to Beulah Corridor (Corridor C) and Mallaty Creek (Corridor D) are included (counted) as koala habitat, as koalas will not be able to access these lands. Regardless, the lands should be protected for their other biodiversity values and potential alternative connectivity routes.

Commitment	Actions	Panel comments
	3. Ensure at least 1 north-south corridor (Georges River) is average minimum with of 390-425 m	• Based on the Panel's review of draft CPCP maps the Georges River Corridor appears to meet the minimum average width (Appendix 2: Figure A3). • This habitat is also connected to large areas of habitat to the east, although it is understood that this easterly region is predominantly sandstone landscape and therefore poorer quality for koalas compared with the shale transition landscape in higher parts of the GMGA • The Georges River and Nepean River Corridors, Ousedale Creek habitat and the Elladale Creek habitat in the GMGA are all important for koala habitat with multiple subpopulation units building resilience into the population. The separation between habitat near the Georges River and to the west toward the Nepean River means that in the case of fire on one side or the other, there will be refugia to increase resilience and help ensure regional persistence of koalas in the face of an acute threat. • The Nepean corridor in the draft CPCP does not appear to the Panel to meet the average minimum width (Appendix 2: Figure A3). One of the drivers for this is a narrow section of habitat that the Panel identified early in the process, then followed up with a site inspection. The visit also revealed the steep topography in this area. A corridor in the north-west WGA also does not appear to the Panel to meet the minimum average width (Appendix 2: Figure A4). • The Panel has questions about the Primary Corridor along the Nepean River (Appendix 2: Figure A3), in relation to the methodology used to estimate width in respect of the functionality of the corridors – see below further discussion in Section 3.3.1.4. • The material supplied to the Panel currently focuses on Georges River Koala Reserve (acknowledged as important) but is almost silent on the Nepean River Primary Corridor in both the GMGA and WGA. The CPCP should acknowledge (and address) this importance. Also, of note is that the GMGA and WGA borders are not directly connected, yet the Nepean Corridor connects both these Growth Areas. The CPCP document is not clear on the intentions or protections for this habitat. The Panel notes that this report will provide principles and advice that can be used in locations outside of the two growth areas under TOR 2; see Section 3.3. • As set out in documents provided to the Panel, the plan west of Appin Road seems to prioritise secondary above primary corridors. Primary corridors may be more important than secondary corridors in terms of the extent of primary koala habitat, although the koala presence mapping is inconclusive in terms of whether more koalas use habitat that has been designated as Primary versus Secondary. The Nepean River Primary Corridor should be protected as Primary Corridor. • All areas to the west of Appin Road are important in part because they provide population resilience (e.g. refugia habitat against future fires that may occur in the Georges River Koala Reserve)

Commitment	Actions	Panel comments
	4. At least one east-west corridor (Ousedale Creek) a. underpass at Appin b. average 390-425 m and fenced	• The east-west connectivity function of Ousedale Creek Corridor is important. • The habitat in the north-south arm of Ousedale Creek (parallel to Appin Road), as well as the east-west oriented section are also important for the habitat they provide to koalas. • The habitat in Elladale Creek also provides considerable hectares of habitat that is important to conserve, and to maintain linkages to (for koalas) in the case that transport corridors dissect the unit. • The Ousedale Corridor is reliant on land purchases and restoration. Sub-Plan B notes that that securing and enhancing the corridor is due to start, but not finish, within the first five years of the plan's implementation. This should occur as soon as possible, to maximise the growth of revegetation and minimise the possible degradation of the environment. • The Upper Canal could be an impediment to koalas moving through the Ousedale Corridor. How koalas will be able to cross the Upper Canal needs to be considered as if koalas cannot easily cross the Upper Canal, the Ousedale corridor may not adequately provide east-west connectivity. • See comments on Commitment 8.8 • The overall east-west connectivity should not rely on one corridor. Multiple corridors must be protected. • The Panel notes that additional corridors with underpasses at Appin Road have been proposed at the Beulah Biobank and Noorumba Reserve in the proposed Lendlease MGS2 development. These will provide one or two additional routes between Georges River and Nepean River in the GMGA area and will prevent a dead end at the North end of the Nepean Corridor which was a highlighted concern in the 2020 Report.
	5. Fence off east west corridors too narrow, relocate koalas, habitat will be protected.	• Fencing corridors that are too narrow for koalas (e.g. Corridor C and D) at east-west ends facilitates use by residents, while bushland would be preserved. The Panel agrees with this approach for these Corridors. • These east-west corridors, whilst not currently slated for use for koalas, will provide vital insurance habitat if other options do not have the desired outcome for koala persistence • See Section 3.3.1.1 for the Panel's comments on a similar issue in the WGA.
14. Ecological reconstruction up to max 25% of offset target	1. Weed and restoration control working group and Weed Control Implementation Strategy	• This action is particularly important for land that will be either in private hands or will be subject to a BSA or land purchases. Efforts to avoid land degradation will require planning and collaboration with landholders across tenures. These efforts will also need clear monitoring.

Commitment	Actions	Panel comments
in conservation land	2. Restoration Implementation Strategy	• This action is particularly important for land that will be either in private hands or will be subject to a BSA or land purchases. Efforts to avoid land degradation will require planning and collaboration with landholders across tenures. • Consideration should be given to factors such as soil types for restoration of habitat, to target and/or maximise the highest quality habitat • Much extant koala habitat is on steeper land on Hawkesbury (sandstone) soil landscapes and shale-sandstone transitions, whereas shale-based soil landscapes were mostly historically cleared but offer significant potential for augmenting the nutritional quality of existing adjacent habitat. • Some mapping seen by the Panel pointed to revegetation and restoration efforts occurring on the south side of the WGA area within or adjacent to the Water NSW area (Special Area of the Sydney Drinking Water Catchment), which has been identified as a Primary Corridor (Figure 2, purple circles). The Panel has not seen detail on the planning or confirmation that this revegetation will go ahead, and some mapping doesn't show revegetation of this area. There is considerable land in this zone on some shale Blacktown soil landscape and with good quality revegetation potential.
	3. Written agreements to implement restoration plan	• Agreements for restoration should be enforceable so that the best possible chances to deliver quality habitat are in place.
	4. Maximum of 1,365 ha of ecological reconstruction on conservation land targeting 5 TECs	• See Principles on Habitat and Connectivity

Commitment	Actions	Panel comments
	5. Ecological restoration including in Georges River Koala Reserve, Appin, Ousedale Creek (primarily Cumberland Plain Woodland and Shale/ Sandstone transition forest)	• Absent in this Commitment 14 is any reference to the north-south Primary Corridor along the Nepean River (east side or west side of the river), and any discussion of securing habitat associated with the WGA, including the status of land at the eastern edge south of Picton Road (Figure 2, yellow circle), and habitat along corridors east/west of the Nepean River (Appendix 2: Figure A4). • Habitat south of the WGA within the Water NSW tenure had also been identified as suitable for revegetation but that is not mentioned (Figure 2, purple circles) • Soil type and quality, which includes water-holding capacity, is an important contributor to koala feed tree health and nutrition content (i.e. the quality of the habitat). This should be considered, with priority for higher quality habitat (especially in the context of a changing environment), although noting that this may not always be possible. Targeting revegetation on shale soil in preference to sandstone is recommended, due to the greater nutritional and water carrying properties of shale soils (Section 3.3.1.3). • The earlier the restoration efforts can be started, the more mature the habitat will be by the time development rolls out across the two growth areas.
	6. Pilot sites for restoration of TECs	• The Panel is unaware of what actions might arise or be reliant on this pilot. Nevertheless, this pilot should not preclude management and revegetation actions occurring in the meantime
21. Residents participation in biodiversity conservation	1. Invest in NSW Koala Strategy to raise awareness and encourage participation in koala conservation	• Citizen science will play an important part in understanding and protecting the koala population in the region. The Panel notes that there are existing and active community groups in this region. • Awareness around potential threats, particularly dogs, will be a vital component of community awareness
23. Invest in research priorities that support Plan's implementation	1. Research programs with outcomes of population demographics, life-history, and ecology as part of NSW Koala Strategy	• Whilst it is important that the CPCP monitoring can feed into and support the NSW Koala Strategy, there will be site specific monitoring that will need to be conducted to ensure the persistence of koalas in the region. Further, all monitoring should address clear goals. This is further outlined in Section 3.3.5.1 • Monitoring protocols should be established, and baseline monitoring should be conducted as soon as possible, as it can be used to set targets against which success can be measured. This will ensure consistency of methodology for valid comparisons and identification of trends. • Monitoring how koalas are using the landscape will also inform mitigation actions.

Commitment	Actions	Panel comments

24. Rehabilitation measures to maintain koala health and welfare	1. Implement Koala health and welfare program in South Western Sydney – monitoring threats and mitigation effectiveness; designated monitoring site; veterinarian training; grants for community wildlife orgs and carers; establish health and welfare programs for koalas from threats	• As Commitment 23 (Action 1), there will be region-specific monitoring that will need to be conducted.
		• A good example is monitoring related to chlamydia. This would include monitoring of the possible ingress of chlamydia into the area, and work should be undertaken that is informed by the chlamydia mapping work that will be undertaken by DPIE-EES in June 2021. This could provide early identification of:
		  ○ presence and absence of disease; and,
		  ○ routes of ingress of chlamydia through the landscape. Considerable movement barriers through the landscape (roads, rivers, reservoirs) provide opportunities to identify certain choke points where monitoring can occur to detect the presence of chlamydia and intervene in the spread of the disease.
		• In understanding where chlamydia is occurring or entering, this could inform approaches to koala health management to treat chlamydia if it eventuates in the area.
		• The NSW Government-supported genetics work on NSW koalas will also provide data that could inform ongoing management actions.

	2. Koalas handled to be vaccinated against chlamydia and tissue sample taken for genetic analysis and sent to Biobank	• Chlamydia vaccine development is still in the trial phase with efforts underway to explore effectiveness against disease variants and impacts for koalas in NSW. Given trial stage of vaccines, they should be deployed under a research protocol so that outcomes can be interpreted and contribute to development effort, until an agreed vaccine is established and approved (see Section 3.3.4.1). The Panel notes that trials are currently underway, and this can be rolled out quickly in the region. • Vaccines are yet an unproven technology and may not ever achieve their potential. While it is appropriate for the CPCP to recognise their potential and to incorporate them as part of the plan as a trial or research direction, at this stage they cannot be a substitute for other actions.

3.2 Major trends in South Western Sydney

There are several major trends that will impact koala populations in the South Western Sydney region over the coming decades. These will influence the viability and persistence of the koala populations over the next 30 - 40 years and are crucial factors to consider in making judgements on the adequacy of measures to enable koala persistence. Section 3.2 briefly describes these trends, while the discussion in Section 3.3 provides Panel commentary on the CPCP approach to mitigation and management actions considering these trends and the proposed planning developments.

3.2.1 Urbanisation

As discussed in Section 1.1 the GMGA and WGA are slated for development. These areas will include ~55,000 new homes, associated retail and community facilities, roads, and major infrastructure (including the Outer Sydney Orbital). This will change this region from semi-rural/peri-urban to urban/suburban. Conversion from rural-type landscapes toward urban has led to declines in koala numbers in other parts of NSW and in the southeast corner of Queensland.

Such declines in koala numbers are associated with "*habitat loss and fragmentation, reduced connectivity or isolation of populations reducing genetic diversity, increasing susceptibility to disease and increasing threats from vehicle strikes and dog attacks.*"[20]

The landscape wide approach to planning for the CPCP has been undertaken with a view to incorporating measures that will maintain habitat (including for koalas), reduce interactions with threats as the numbers of vehicles and domestic dogs increase, and maintain connectivity of habitat through the landscape. Development and construction in the area will occur over the next 36 years, with residents, industry and human activity then continuing indefinitely, so change will happen relatively quickly.

3.2.2 Koala populations and disease

There are two koala populations associated with the region of the GMGA and the WGA. These populations are known as the Campbelltown and Southern Highlands populations. Campbelltown koalas have a low population density (compared with other populations in NSW), but are understood to be growing in number, one of the few growing populations in NSW at the present time. More detailed information on the Campbelltown population is available in the 2020 Report (Section 1.3.1) [21]

Koalas in the vicinity of Campbelltown, based on current knowledge, have not shown evidence of chlamydia infection. Further south toward Wilton, into the north Southern Highlands and then further south the prevalence of chlamydia infection in koalas gradually increases. Evidence from other sites in NSW where Panel members have worked has demonstrated that when chlamydia infection enters a koala population, this can lead to a considerable decline in koala health, numbers and resilience as it reduces reproductive potential and the ability for population replacement and expansion. It is understood that based on current connectivity and observations, chlamydia could enter the Campbelltown region in the near term. A study to be conducted by EES in mid-2021 will look over the Campbelltown and Wilton regions, map koala presence using drone technology and sample for chlamydia.

A combination of mitigations, management and monitoring actions for chlamydia infection is described in Section 3.3.4 to reduce the impact of this into the future, as chlamydia could be an important threatening agent for these populations. Processes such as disease incursion can occur in a matter of months to years; this timing influences the options for management which is discussed more in Section 3.3.3.

[20] OCSE (2020), Advice on the protection of the Campbelltown Koala population
[21] OCSE (2020), Advice on the protection of the Campbelltown Koala population

The NSW Koala Strategy, which is in preparation, will have a goal to double the koala population in NSW by 2050. Whilst this population in Campbelltown only plays one part of the greater state-wide goal, the population is one of the few that is currently understood to be expanding and appears to be disease free, and as such a reduction in koala numbers would impact the ability to achieve the goal of doubling koala numbers across the state.

3.2.3 Future climate

Current predictions are that average global temperature increases of between 1.5ºC and 3ºC compared to pre-industrial levels may occur over the coming decades. Whether the change is closer to 1.5ºC or 3ºC will depend in part on the extent and success of international mitigation efforts to reduce emissions and minimise global temperature rise.

These global changes are expected to result in change at the local scale. The risks to habitat and landscapes from warming climate depend on factors such as the rate, duration, and magnitude of warming and geographical location. In NSW changes in temperature, evaporation, rainfall, and other climate variables are modelled using the NSW and ACT Regional Climate Model (NARCliM).[22]

Change could include increased intensity, duration or frequency of droughts, bushfires, and heatwaves, and changed rainfall patterns. Increased atmospheric CO_2 concentrations and temperatures and changes in rainfall will impact vegetation and in so doing alter the profile and nutritional status of koala foliage. The aggregated effect of these changes will be an overall reduction in the likelihood of koala persistence given the *status quo*. Mitigation measures such as improved availability and access to refugial habitat can compensate for these changes to some extent.

A key risk for koalas and demonstrated in 2019/20 is the threat of bushfires to wildlife and habitat. Maintaining a connected population from the Georges River Koala Reserve, west to the Nepean River Primary Corridor and associated GMGA habitat provides some resilience for the population which is described in more detail in Section 3.3.1.

As was evident in 2019/20 bushfires can have major impact on koala populations in a very short time frame - hours to days - which limits the possible mitigation efforts that can be put in place. This is described further in Section 3.3.1.2.

3.3 Principles for koala protection

As stated in the 2020 Report "*efforts to increase the availability of habitat while reducing the interface with threats, and maintain genetic and physical health status, are important pillars upon which to plan measures"*.[23]

This section of the report provides Panel feedback on some proposed mitigations in the CPCP including overarching principles that can inform the approach to koala protection measures across the GMGA, WGA and surrounding areas. This section builds on information in Table 2 and 3 and is informed by guidance in the *Conserving Koalas in the Wollondilly and Campbelltown Local Government Areas* report[24], the 2020 Report and February 2021 Advice. The section also provides an assessment, as far as it can, of the adequacy of the current draft CPCP proposed for koalas and provides recommendations on areas that will assist in ensuring the persistence of the koala populations.

A concern for the Panel is, if changes are recommended by it to the CPCP, whether these can be accommodated directly or whether they will require trade-offs in a planning sense, and if trade-offs are required, can these be done in a way that does not lead to perverse outcomes where the result is less satisfactory that the original situation. The Panel will not be involved with such negotiations

[22] https://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/About-NARCliM
[23] OCSE (2020), Advice on the protection of the Campbelltown Koala population
[24] DPIE (2019) Conserving Koalas in the Wollondilly and Campbelltown Local Government Areas

but has tried to provide principles below that can be used by the CPCP proponents to get to positions where the outcomes for koalas are improved. The Panel requests those involved with these discussions to consider the implications for koalas actively, considering the habitat and other species that may use the habitat, including in applying the principles. Every location and situation will be different and nuanced, and considering the situation on the ground will help avoid negative outcomes.

3.3.1 Habitat and connectivity

"Access to increased (or retained) koala habitat has prima facie benefits for koalas".[25] Koala habitat across the region needs to be retained, protected, managed (to prevent degradation) and increased (e.g. through revegetation) to support koala movement and persistence so that dispersing koalas can move through the landscape, can breed to ensure genetic diversity, and can access refugia in times of stress, bushfire, drought, or other threats.

Regional planning upfront and on the broad scale is beneficial in that it allows restrictions and requirements to be established now in planning policies and approval conditions that can help improve outcomes for natural assets and environmental values across a wide area of land. [26]

However, the *long term and ongoing program of urban development, out to 2056, will result in future unknown events and risks, and possibly opportunities, so scenario planning and mitigation options should be a core component of adaptative planning for preparedness and resilience*.[27]

[25] OCSE (2020), Advice on the protection of the Campbelltown Koala population
[26] OCSE (2020), Advice on the protection of the Campbelltown Koala population
[27] OCSE (2020), Advice on the protection of the Campbelltown Koala population

Principles for habitat and connectivity

1. **Strategic planning -** Habitat protection should be enabled through forward planning and commitments at a regional scale and over the lifetime of the development.
2. **Protected and connected -** Retain, increase, restore and protect koala habitat, reducing fragmentation and increasing connectivity. The habitat should support the movement of koalas such that dispersing koalas can move through the landscape, can breed to ensure genetic diversity, and can access and persist in refugia in times of stress, bushfire, drought, or other threats.
3. **Avoid dead-ends and population isolation -** Ensuring (as far as possible) that the habitat has *multiple* connections can help to prevent the formation of dead ends and population sinks and ensure that koalas (and other species) have routes to move through the landscape.
4. **Corridors provide habitat -** The term 'corridor' should not be misinterpreted to mean that its only function is a thoroughfare and the provision of connectivity. Not all identified corridors are suitable to provide connectivity for koalas, but the habitat should be protected for biodiversity values and amenity in the region, as well as protected koala habitat in some cases.
5. **Corridor widths -** Corridors should be widened where feasible through revegetation to an average minimum width of 390 - 425 m, include a buffer on either side (30 m wide where fenced and wider to ~ 60 m where fencing is infeasible), and trees should 3 m from the fence (to prevent tree branch damage to fence)
6. **Larger area, shorter edges -** Revegetation should be targeted to widen habitat units and corridors where feasible and aim to reduce the edge: area ratio of habitat (i.e. 'fingers' or areas between strips of habitat could by infilled with vegetation).
7. **Habitat buffers separate from APZ -** Buffer zones in corridors/habitat should be separate from Asset Protection Zones (APZs), with APZs on the urban side of the exclusion fence.
8. **Target shale soils -** Where possible, revegetation should target relatively higher quality soils (i.e. to produce higher quality habitat) – shale-based 'Blacktown soil landscape' is preferred to 'Hawkesbury sandstone landscape'.
9. **Earlier planting leads to more mature trees -** Early implementation of koala habitat planting, and restoration can lead to trees being at a more mature stage by the time they are needed, areas that will improve connectivity and nutrition (based on soil type) should be prioritised.
10. **Prevent degradation of habitat -** Early protection and active management will prevent the degradation and loss of existing habitat over the time during development – engage community and stakeholders to protect habitat.
11. **Plan for climate change -** Consider water sources, soil types, tree varieties, and well connected refugia.

3.3.1.1 Tenure and protection

A range of landholder tenures are associated with the CPCP and neighbouring land and are managed under differing legislative and policy instruments, which needs to be considered when making decisions. The habitat corridors across the Greater Macarthur and Wilton region cross multiple tenures and landscapes, connect internally and with each other. The koalas, in using these corridors, do not recognise lines on maps.[28]

[28] OCSE (2020), Advice on the protection of the Campbelltown Koala population

There is a need to understand the potential risks associated with different tenure, and the ability to holistically protect koalas and their habitat. If there is not a consistent approach across different tenures this may result in adverse impacts on koala populations. Shared and coordinated efforts across tenures within and outside the CPCP can help to ensure habitat and threat protection and improvement measures are aligned or consistent across the region (such as make sure both sides of a corridor are managed e.g. fencing etc.). Issues of habitat and potential threats beyond the CPCP nominated regions need to be considered as they will impact the outcomes for koalas.

Within the CPCP, due to the range of tenures and ownership, the protection and restoration of habitat requires many BSAs as well as by land purchases. These agreements and purchases will occur over the lifetime of the CPCP.

Any habitat included in the corridor needs to be protected in perpetuity. There may be the need to investigate methods and/or levers to ensure the corridor and its fencing is protected on other tenures or in a change of tenure, including any future developments.

The upfront protection of the habitat early in the process will aid in ensuring that habitat is not lost through degradation over time. Further areas that are to be acquired for habitat restoration will benefit through beginning early in the Plan, as koala feed trees can take up to 10-15 years to grow to a size and quality that is preferred by koalas. The Panel notes that wet weather conditions are ideal for tree planting and survival.

3.3.1.2 Climate change

The CPCP identifies climate change as a threat to native species and natural ecosystems. The CPCP states that it will *"support existing and new conservation programs"* for climate change adaptation, this includes research, priority strategic conservation areas and providing advice and support to councils to integrate research results, including the identification of climate refugia, in reserve management programs.[29]

Leaf Quality

Planning for future koala needs in a changing climate would assist to mitigate for the likely declining nutritional quality of foliage as a consequence of increasing atmospheric CO_2 concentrations and heat and drought stress, and given the fact that koalas nutritional needs are likely to change with increasing exposure to heatwaves. Increased atmospheric CO_2 is likely at the very least to cause the nutritional quality of foliage at some times of the year to decline[30] and more severe and frequent droughts and heatwaves can be expected to reduce leaf water content at times when it becomes most important to koalas. During heatwaves, we can expect koalas to become less tolerant of plant toxins, and this may change their tree choice.

Planning for the future nutritional adequacy of koala habitat (including the availability of free-standing water and water in foliage) should not be based upon an assumption of unchanged leaf quality in future but should assume an overall decline in the ability of habitats to support koalas in the future, and consequently, a greater reliance of today's high-quality habitat than we see at present. These risks could be mitigated by the introduction of artificial water stations like the Tree Troffs (formerly known as Blinky Drinkers) which could help sustain populations during drought conditions, and the expansion of habitat on higher-quality soil landscapes.

Bushfires

Bushfires also present a real threat to koalas in the region. As mentioned in the 2020 Report, "…*a recent report by Lane, Wallis, and Phillips (2020), that analysed koala records and the extent of the bushfire, found that over the preceding three koala generations the NSW koala population has declined by at least 28.52% and may be a large as 65.95%. The report also notes that the ongoing*

[29] DPIE (2020) Highlights. Draft Cumberland Plain Conservation Plan.
[30] Research in this area is ongoing at EucFACE at Western Sydney University. https://www.westernsydney.edu.au/hie/EucFACE

threat of climate change and its associated impacts (e.g. more frequent and intense bushfires) will severely affect koala populations and increase the risk of localised extinction events".

The *NSW Wildlife and Conservation Bushfire Recovery: Medium-term response plan*[31] includes actions that address koala recovery following the 2019–20 fires. The plan includes *'Appendix A – NSW Koala Strategy: Bushfire Recovery Actions'*. The actions include the identification of habitat refuges for koalas, conservation of koala habitat on private land, raising awareness about roaming domestic dog attacks, providing expert wildlife care, and training, measuring long-term trends in koala population and translocating koala to support population recovery.

There is need to understand how koalas are using the current landscape in regard to refugia, and this also highlights the need to ensure that there are multiple locations where koalas could persist within the CPCP. For example, the Nepean, Elladale and Ousedale Corridors could act as refugia for koalas from a bushfire event in the Georges River (and vice versa) and which individuals could expand from there to repopulate post-bushfire.

Changes in the climate also reflect the need for management and mitigation actions to be developed and employed sooner rather than later. There is a risk if these actions to protect koalas and their habitat are not coordinated in a consistent manner across both tenure and time. This includes the potential degradation of the environment or the lack of protections from threats.

3.3.1.3 Revegetation

To contextualise revegetation in the CPCP, the Panel noted that previous high-quality habitat often coincides with soil types that are now cleared farmland. The vegetation that remained, whilst not suitable for farming due to topography, also occurred in sandstone-dominated riverine incisions, which are lower quality for koalas in terms soil quality.

Therefore, revegetation should be strategic and targeted at achieving the best outcome for koala populations. This relates to aspects of the size and shape of habitat (increasing the area, reducing the jaggedness of edges, reducing linear habitat by infilling between these features, etc.). Where revegetation should look towards soil as an indicator of quality (i.e. relatively higher-quality typically occurs on shale-based soil types, such as Blacktown soil landscapes in this region). Revegetation should also look to maximise corridor widths (see Section 3.3.1.4).

However, revegetation should not result in perverse outcomes, such as increasing the habitat at one key location at the expense of reducing to below adequate at another location, when there are trade-offs are made.

Revegetation should also occur as a matter of priority. This will prevent the degradation of the environment (via either neglect or other forces, such as erosion), and will also allow the trees to mature by the time that those areas are subject to surrounding development.

3.3.1.4 Habitat and connectivity corridors

Corridors function to provide habitat and safe passage across the landscape to ensure connectivity for koalas. Relevant draft CPCP Commitments and Actions (Tables 1 & 2) include securing the habitat corridors in perpetuity (Commitment 13). As noted in the 2020 Report a *"wildlife corridor is a stretch of habitat that joins two or more areas of similar habitat. They can be in the form of a sequence of stepping-stones across the landscape or as a continual linear strip of vegetation/habitat".* Currently, koalas in the landscape can make use of both sparse paddock trees and trees in greater densities in the river incisions. The urbanisation of the region will remove the sparse paddock trees and combined with koala protective measures (i.e. fencing), elevates the importance of the corridors.

Corridors without a destination/linked population are meaningless. Corridors should facilitate the proper functioning of metapopulations, which require multiple interacting subpopulations.

[31] DPIE (2021) NSW Wildlife Conservation Bushfire Recovery. Medium-term response plan

It is important to ensure the preservation of multiple linked pieces of habitat. This builds resilience, and thereby persistence in the population by providing access to refugia and alternative habitat if an event (for example, bushfire) was to occur in another habitat.

An aim protecting corridors should be to reduce 'dead-ends' in the environment (as discussed in 2020 Report). An example of this is in the east of the WGA, where a planned collector road bisects koala habitat and results in it requiring connectivity (**Error! Reference source not found.**, red circle) (See Commitment 8, Action 2). The islanded component would not be of a sufficient size to encourage one, let alone multiple, individual koalas to persist within the landscape, and the habitat serves no connectivity function to the land. As it stands, the Panel believes a better approach would be to not consider this as koala habitat, but rather maintain the habitat for other benefits (public amenity, other species, etc.). This could be done without exclusion fencing, depending on the other species in place, whilst preventing koalas from entering (via the installation of koala proof fencing on the northern corridor and no connectivity structure also depending on the other fauna species).

The Panel acknowledges that there are a range of constraints but notes that all efforts should be made to widen corridors where feasible. The corridors are important for connectivity, but they must also ensure the ability for koalas to persist within (i.e. they should also be considered habitat). In some cases, corridors that provide connectivity between habitat units may be comprised of non-habitat trees, although for the purposes of this advice, it is assumed that the trees that comprise corridors contain koala food or habitat trees. All the corridors that are to be protected should not be treated as set-and-forget, as this could lead to degradation.

In Commitment 13 (Actions 3 and 4) there is a focus on the Georges River for north-south connectivity and Ousedale Creek for east-west connectivity. The Nepean River is considered a primary corridor and habitat, in a similar manner to the Georges River.[32] It is of the opinion of the Panel that the treatment of the Georges River Corridor (e.g. including increasing the width through restoration) is not mirrored to the same extent at the Nepean River corridor. The Nepean Corridor will provide access to refugia/alternative habitat if an event (for example, bushfire) was to occur in the Georges River. There are opportunities to improve the amount and quality of habitat in this corridor that could be explored to improve persistence.

Not all the identified corridors are suitable to provide connectivity for koalas (e.g. the Mallaty Creek corridor (Corridor D) does not cross Appin Road and is narrow), but the habitat should be protected for biodiversity values and amenity in the region. The habitat in Elladale Creek (Corridor F) also provides considerable hectares of habitat that is important to conserve, and to maintain linkages to or koalas in the case that transport corridors dissect the unit.

In the context of reducing threats, it would be viable to reduce the occurrence of fingers of habitat that have a large edge: area ratio by retaining the habitat strips and revegetating the gaps in between. Koala habitat in river and creek valleys provides important refugia and resilience to warming and drying climates, a characteristic that is likely to become increasingly important with climate change.

The connectivity whilst ensuring genetic diversity can also increase the likelihood that disease will spread. This is of particular importance in the intersection between the Campbelltown and Southern Highlands populations. This is expanded on in Section 3.3.4.

[32] DPIE (2019) Conserving Koalas in the Wollondilly and Campbelltown Local Government Areas

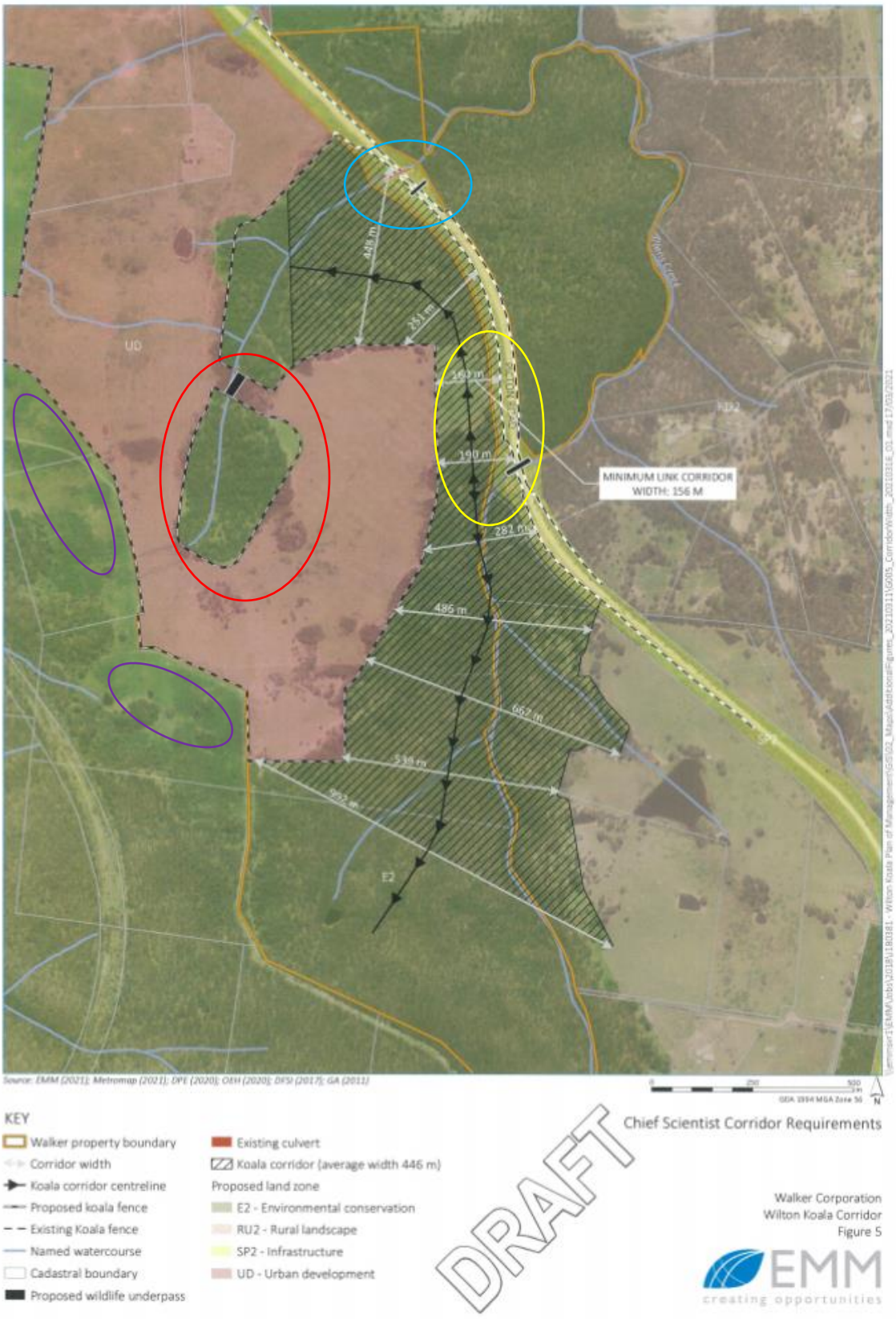


Figure 2: Dead-end and fenced proposed koala habitat including possible underpass in WGA
Circles: Red – Possible dead end/islanded habitat, Blue and Yellow – location of possible underpasses or existing underpasses for augmentation, Purple – Areas for possible revegetation
Source: Walker Corporation (2021) Pers comm.

Corridor widths and buffers

Recommendation 2 from the 2020 Report provides guidance on features of corridors in the GMGA. This includes habitat protection, widening (average minimum width 390 – 425 m or greater), inclusion of a buffer and exclusion fencing. Comments on corridors and buffers from the 2020 Advice and the February 2021 Advice are in Appendix 2. The February 2021 Advice in response to a question about the categorisation of habitat on opposite sides of a river is also relevant here, as well as the advice that on-the-ground inspection should be undertaken as to whether koalas are using the steep riverbank slope or instead the plateau.

Sub-Plan B notes habitat corridors that meet, or with restoration can meet, the requirements of the 2020 Report. 'Safe habitat' was considered to include *"corridors with an average minimum width of 390m - 425m that are fenced to protect koalas from urban threats such as vehicle strike and include safe crossings for koalas at Appin Road".* This includes the north to south corridors along the Nepean and Georges Rivers, and the east to west Ousedale creek corridor, and Elladale Creek habitat.

The maps provided to the Panel by DPIE indicate that the Georges River and the Ousedale Corridors in the GMGA meet the average minimum width recommended in the 2020 Report (390 - 425 m). However, the Nepean River Corridor does not appear to meet the minimum average width (Appendix 2: Figure A3). A noticeable driver of this is the very thin section that the Panel visited on their site inspection, where the topography is also noticeable steep. Further, most of the corridors in the WGA meet the average minimum width, but the northern bank of the north-west corridor does not appear to (Appendix 2: Figure A4).

Site inspections, if they haven't already occurred, should confirm the habitat and terrain characteristics and koala use if possible. A similar matter was raised in the February 2021 Advice for a different site. This includes an understanding of the local topography and how the current koala population moves through the landscape, including if the koalas have a preference for moving long the steep riverbank or whether they use the plateau (where the suburban footprint is planned), which will inform any additional protections. This is also important when considering the risk of fire. These issues should be addressed in the planning phase but prior to approval.

Noting the topography around the waterways, koalas could move through and persist in all but the steepest terrain. In saying that, as these barriers increase in their difficulty to navigate, this could lead to individuals spending more time in these landscapes. Koalas can swim and climb but to what extent and are there limits to the width of swimmable rivers and steep cliffs. Therefore, corridor measurements should reflect their functionality for koalas. Figure 3 is a cartoon aiming to demonstrate the potential for this issue of different topographies in the riparian zone and their differing functionalities (noting that the purple trees represent habitat that is less accessible/useable by koalas). It is not clear to the Panel whether and how much the mapped corridor widths along rivers in the CPCP truly represent the functional corridor as related to koalas. Efforts to check on the ground whether and where koalas do and don't use the rivers edges will inform the functionally useful corridor dimensions. Whether this work could be done by boat or drone survey or by foot is a matter for consideration.

The Panel also notes previous advice regarding riverbanks, in that "… *given that the two sides/corridors are parallel and adjacent to each other, some functions of one side will assist in the minimisation of stressors and/or threats to the adjacent bank. In particular, increasing separation from direct and indirect threats on the river side of the corridor (i.e. from the opposite side): for example, sound and noise attenuation from the adjacent side. Other functions, however, would not be provided by the adjacent corridor: for example, the amount and quality (both food and shelter) of vegetation available to use and move through*".

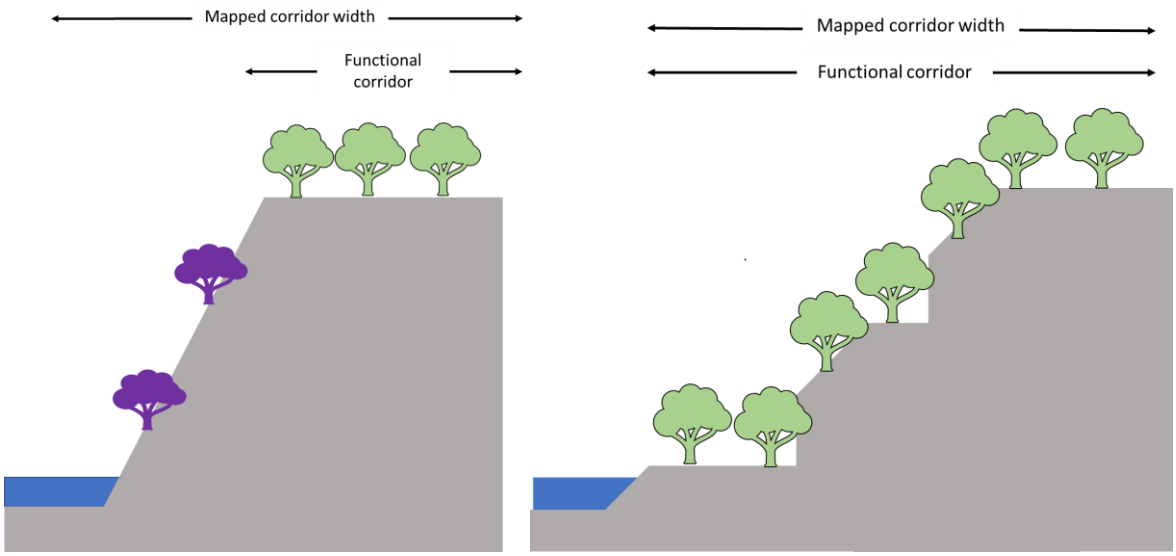


Figure 3: Corridors in riverine areas

The 'green' trees are those in the functional area of the corridor, the 'purple' trees are less likely to be easily accessible.

3.3.2 Connectivity and fauna crossings for linear infrastructure

Linear infrastructure including roads, gas pipelines, electricity infrastructure and the Upper Canal all present potential barriers to koala movement across the landscape. Panel comments on actions to improve connectivity and vehicle strike mitigation are at Table 2.

Principles for fauna crossings for linear infrastructure

12. **Safe movement -** Infrastructure that will cut across a designated corridor should include underpass or overpass structures to enable the movement of koalas along the corridor. Any infrastructure (such as roads) that cross, or might have an impact on, the corridor should be designed to be sympathetic to the protections of the corridor and to enable safe access across or under the linear infrastructure.
13. **Fencing underpasses -** Suitable fencing and connecting habitat put in place early enough through the process so that it is complete by the time the infrastructure is constructed.
14. **Underpass design -** Construction of connectivity structures for roads: overpasses, underpasses (including road bridges) or culverts, with associated exclusion fencing, cattle grids, gates to prevent koalas entering the roadway. Designing underpasses to maximise the likelihood of koala use – look to the latest evidence, include attributes such as clear line of site, avoidance of predator death traps, keep dry, include furniture such as logs for koalas, the bigger the better.

Crossing structures should be incorporated into planning and design of proposed infrastructure from the earliest stage.

The Actions commit to a connectivity structure at Kings Falls Bridge (as per 2020 Report Recommendation 1) and an underpass culvert under Appin Road (near the intersection with Brian Road). However, there is no mention of any structures in the WGA. The corridors in the WGA are all considered as Primary Corridors and connectivity structures will be required to prevent vehicle strike hotspots. The Walker Corporation KPoM shows proposed culverts in the WGA to improve connectivity (See Figure 2), these are mostly existing drainage culverts that could be augmented to improve usability for koalas. This is particularly important for the function of the area as the area will change significantly with development, koalas can use all the landscape at the moment and this will change with development with corridor widths in some places being only ~160 m width.

The GMGA and WGA will include several new transport routes and additional local roads as part of development. This includes the Link Road Corridor through or north of Mount Gilead and the Outer Sydney Orbital Connection through West Appin. The Panel was shown a set of options for these and notes that the routes with less impact on koala habitat appeared to the panel to be slightly favourable for koalas compared with options with more impact.

From the perspective of koala protection there is a need for these routes for transport and the infrastructure design for them to be compatible with and sympathetic to the aims of the CPCP in protecting koalas and their habitat. This includes preventing or minimising the dissection of habitat/corridors (the number of times transport routes that bisect koala habitat) i.e. reducing the amount of separations between habitats, thereby reducing habitat patchiness.

Other factors will need to be considered as they could have an impact. For example, the physical footprint (both during construction and post-construction), speed limits, noise breaks, lighting, etc.

The Upper Canal could be an impediment to koalas moving through the Ousedale Corridor. The Upper Canal infrastructure includes the canal, pipes over Ousedale Creek, a road and fencing. The area is Heritage Listed and considered a Controlled Area under the *Water NSW Act 2014*. The CPCP needs to consider how koalas will be able to cross the Upper Canal. If they cannot easily cross the Upper Canal the Ousedale corridor will not provide east-west connectivity. This needs to be assessed and should include site inspections.

3.3.3 Threat mitigation

There are several strategies and methods that can mitigate the impact of disturbances on koalas and their habitat, particularly at the interface of urban and native environments. This includes, but it is not limited to, vegetated buffer zones and managed habitat areas, koala exclusion fencing (includes fencing at the interface to roads, but also around residential pools and yards), predator and pest management (including weeding programs), disease monitoring and management (Section 3.3.4), vehicle-strike mitigation measures (under and overpasses, road grids, traffic calming devices and road design, signage, speed limits, etc.), and community awareness programs. Specific Panel comments on the threat mitigation are in Table 2.

Principles for threat mitigation

15. **Exclusion fencing -** Maintaining a separation between koalas and threats using exclusion fencing should be a priority, and where this is not feasible (e.g. steep terrain), fallback measures to reduce risk (e.g. vehicle speed limits) and monitoring should be undertaken. Fencing should be adaptively managed with design, location and maintenance evaluated.
16. **Spatial and temporal planning for threats -** Threat mitigation and reducing stressors should be enabled through forward planning and commitments at a regional scale and over the lifetime of the development.
17. **Reducing impacts from construction -** Ensure processes are in place to protect koalas during construction and operational phases of the development. e.g. an onsite ecologist present through the duration of pre-clearance surveys and clearing works, koala and wildlife relocation protocols, tree-felling protocols, and education programs for construction workers.
18. **Sensitive urban design -** Traffic calming measures, planning of greenspace, avoid koala feed trees in urban footprint, domestic dogs secured in neighbourhood backyards, fauna sensitive design
19. **Avoid stressors that repel koalas -** Some effects of increasing urbanisation can increase koala stress levels which in turn can lead to changed patterns of behaviour, avoidance of exposed habitat, increased propensity to disease. Utilise approaches to reduce these effects including buffers.

3.3.4 Disease

The Plan targets chlamydia as a key threat, with koalas in Campbelltown uninfected - although the 'Southern Highlands' population is considered to have chlamydia. Table 2 provides specific comments on actions related to chlamydia monitoring and management.

Monitoring that targets chlamydia is also a priority focus for the persistence of koalas within the CPCP region, as current sampled individuals have not shown a positive result for chlamydia. There should be clear triggers that lead to management actions to reduce the risks posed by chlamydia infection.

Principles for disease management

20. **Avoid chlamydia incursion -** Much of the koala population within the CPCP appears currently to be free of *Chlamydia pecorum* infection. Planning and delivering protection measures should be progressed to maintain this disease-free status as much as possible, and to respond to it should it emerge.
21. **Identify koala routes and monitor for disease -** There is a need to have a monitoring stream that targets chlamydia entry into, and potentially within, the Campbelltown population. This should target specific locations where the Southern Highlands population may intersect.
22. **Vaccine trials -** The Campbelltown koala population may be a good place to conduct a vaccination trial, given its chlamydia-free status. Given the early stage development of the vaccination, a trial could be conducted on the interface between the two populations (the Campbelltown and the northern Southern Highlands population). Vaccines are still unproven so not yet a basis for management.
23. **Adaptive management for disease -** There should be the development of monitoring that matches triggers for actions: actions should be commensurate to the detection level.

3.3.4.1 Comments on the Chlamydia vaccines

The Panel understands that the chlamydia vaccines are still in the development and trial phase. However, given the different chlamydia infection status across South Western Sydney (i.e. not found in Campbelltown and prevalent in the Southern Highlands), this could make the CPCP a perfect location for a vaccination trial. This trial could also be incorporated into a broader monitoring and management program.

The Panel notes that a trial could commence soon. There are currently trials underway, funded through the Research Plan of the NSW Koala Strategy, in the Liverpool Plains by Professor Mark Krockenberger and A/Prof Mathew Crowther (The University of Sydney) and Professor Peter Timms (University of the Sunshine Coast). [33]

3.3.5 Monitoring and adaptive management

As stated in the 2020 Report:

- *Adaptive management relies on the ongoing collection of information and data that informs future decisions about management, responding to threats as they emerge for acute issues, or changing the direction of management approaches to address longer term threats. This relies on appropriately targeted monitoring activities and the development of thresholds and targets and triggers to guide decisions.*

[33] https://www.environment.nsw.gov.au/topics/animals-and-plants/threatened-species/programs-legislation-and-framework/nsw-koala-strategy/nsw-koala-research-plan

- *Management decisions can include vaccination; fence repair; predator capture; relocation, translocation for breeding and gene dispersal; and education and social engagement programs.*
- *Nothing is guaranteed, and both chronic and acute threats can emerge in a landscape to deteriorate the situation for koalas. There will be uncertainty about what hurdles will emerge in implementing a proposed pathway forward, and unforeseen events are also possible; these uncertainties will present challenges to decision makers and land managers.*

Such hurdles could include outbreaks of insects such as psyllid and moth caterpillars that impact habitat quality. There have been numerous examples over the past decade affecting the Cumberland Plain. The most famous was the outbreak of *Cardiaspina* psyllids, around 2013, which caused widespread defoliation and dieback of *Eucalyptus moluccana* (commonly known as Grey Box, a dominant tree species of the endangered Cumberland Plain Woodland Community) from Blacktown to the foot of the Blue Mountains.[34] More recent outbreaks of caterpillars hit *Eucalyptus tereticornis* (commonly known as forest red gum, blue gum or red iron gum) and ironbark's near Pitt Town. These outbreaks are unpredictable, varying in extent, and often involve pest species that have not previously been known to impact these eucalyptus species. Such outbreaks in corridors could severely impact habitat quality, at least for periods of time

Principles for adaptive management

24. **Baseline data set -** Baseline data are required to better understand the status of the population(s), including numbers, distribution and how they functionally use the landscape.
25. **Surveys and monitoring -** Ongoing and regular survey and monitoring efforts, compared against the baseline, to detected population trends over time and inform adaptive management approaches (including the development and understanding of appropriate triggers and responses, including timeframes).
26. **New monitoring technologies -** New monitoring approaches enabled by smaller, cheaper, more sensitive devices, that are connected and remote will increase the extent and value of monitoring programs.
27. **Interface monitoring with NSW Koala Monitoring Framework -** Monitoring should inform the *NSW Koala Strategy*, as a designated monitoring site. Site specific monitoring will need to be conducted within the CPCP and that will evolve over time.
28. **Adaptive management informed by triggers -** Monitoring should include evaluation points tied to management 'trigger' actions and responses.
29. **Timely mitigation -** As per an adaptive management approach, a lack of information should not preclude mitigation activities occurring in a timely manner.
30. **Understand alternatives -** There is also a need to map alternative management approaches that could be employed if actions are not achieving the desired results.
31. **Risk-based emergency response protocols -** Interested stakeholders undertake a risk assessment (likelihood and consequence) and establish monitoring and response protocols – for threats with a fast or slow onset.

3.3.5.1 Comments on monitoring and adaptive management

The CPCP has committed to '*invest in research that will help to secure threatened species and increase understanding of threats and land management issues*' (Commitment 24) and has designated the koala as one of the dedicated species to be monitored. This will include investing in the NSW Koala Strategy to deliver research, monitoring and actions from the first year of the plan

[34] https://www.westernsydney.edu.au/newscentre/news_centre/story_archive/2013/climate_changing_for_bug_battle_in_western_sydney

via the NSW Koala Strategy Monitoring Framework. The 2020 Report provided recommendations for monitoring and adaptive management (Recommendation 3).

Sub-Plan B discusses the development of a monitoring plan and program. It is noted that monitoring efforts will include *"population monitoring (dynamics); genetics sampling; disease monitoring; tests for chlamydia; and monitoring of the effectiveness of mitigation actions, including for example, predator threat monitoring (including at the entrances of bridges and underpasses); infrastructure integrity (holes in fences); movement trackers (predators); location sensors – movement of koalas through landscape; and the effectiveness of underpasses for koala safety. All data collected from monitoring the Southern Sydney koala population will be used in the Plan's evaluation program to ensure the outcome for koalas is met."*[35]

It is difficult for the Panel to assess the proposed monitoring without reviewing a draft monitoring plan.

In the development of the monitoring plan it is important that the monitoring has clear goals, and that triggers are developed that will lead to management actions if they are exceeded. As a first step the baseline needs to be determined. The divergence of the metrics from the baseline data can then be used to gauge the success (or otherwise) of management actions, and population changes, and can indicate when new management actions are needed using an adaptive management approach.

The goals for monitoring could include but are not limited to:

- Threat management
- Understanding koala movements
- Population health (including chlamydia)
- Supporting and understanding broader climate change impacts

Monitoring should include, but is not limited to:

- Number of koalas
- Spatial distribution (this could be through drone surveys, trackers/location sensors or both)
- Sex ratios (is it only males that are moving through corridors or are there breeding females)
- Number of young (is the population breeding)
- Mortality (cause)
- Genetics (this will be enabled through the NSW Koala Strategy and the action to whole genome sequence koalas across NSW to develop management actions)[36]
- Disease status (to detect incursion of disease)
- Use of connectivity structures (predator threat monitoring)

Monitoring could also investigate the change in water availability, changes in vegetation (species dominance, nutritional leaf profiles, etc.). This will help improve management and understanding of climate change impacts.

Whilst this monitoring effort may feed into and support the monitoring of the NSW Koala Strategy, there will be site-specific monitoring for the CPCP that will evolve over time. As noted in the previous report, there could be a developer-fund that helps to support CPCP specific actions.

At the centre of any monitoring should be an adaptive management approach, which is informed by current monitoring and data, and can trigger management actions where required or trigger new monitoring priorities. Noting that Sub-Plan A of the CPCP sets out the adaptive management

[35] DPIE (2020) Sub-Plan B: Koalas. Draft Cumberland Plain Conservation Plan
[36] https://www.chiefscientist.nsw.gov.au/news/world-first-genomic-program-to-help-koalas

approach, and not the evaluation program, there is a need to include both into a clear framework that is updated over time and informed by new data and in consultation with experts. Further to this, there is a need for the Evaluation Committee and the Koala Working Group (Commitment 8.6) to include expertise on koalas and landscape ecology.

Appendices

Appendix 1 – Draft Terms of Reference

Advice regarding the protection of koala populations associated with the Cumberland Plain Conservation Plan

Following the report 'Advice on the protection of the Campbelltown koala population' released by the Deputy Chief Scientist & Engineer in August 2020, advice is sought on how to consider that report's recommendations in relation to the Cumberland Plain Conservation Plan (the CPCP).

The CPCP operates over a greater geographic area and within a different context to the original report.

The CPCP is seeking to avoid and minimise impacts to biodiversity and offset residual impacts on biodiversity from development in the Wilton and Greater Macarthur Growth Areas, the Western Sydney Aerotropolis and the Greater Penrith to Eastern Creek Urban Investigation Area, as well as parts of several major Western Sydney Transport Corridors. Koala habitat has been mapped in Wilton and Greater Macarthur Growth Areas and as such provides the scope for this Terms of Reference.

The CPCP is based on taking a landscape approach to offsetting these impacts, and includes a range of koala specific measures such as establishing the Georges River Koala Reserve, providing connectivity by protecting and restoring vegetation on public and private lands, reducing hazards from cars and predators by installing koala-exclusion fencing and by working with the community to promote actions that improve koala health and welfare.

There is further advice about the CPCP and its koala specific measures as an attachment to this Terms of Reference and a briefing will be provided for you by the Department of Planning, Industry and Environment and Transport for NSW.

Development and infrastructure impacts will occur on koalas in Greater Macarthur and Wilton Growth Areas through the CPCP, noting strong upfront avoidance of biodiversity values has occurred. The CPCP aims to improve condition of koala habitat, maintain connectivity between koala sub-populations, manage threats and ensure the koala population in South Western Sydney persists by avoiding, minimising, and offsetting these impacts through a strategic landscape-scale conservation program.

Advice is sought regarding the adequacy of the CPCP's koala specific measures in supporting a long-term strategic landscape-scale outcome for koalas across Wilton and the Greater Macarthur Growth Areas.

The advice should take into account constraints and risks including:

a. existing development and infrastructure
b. physical constraints such as the Sydney Water Canal and necessary major infrastructure such as the OSO2 Transport Corridor
c. increased corridor width into cleared land currently proposed for development which may result in trade-offs that lead to vegetation degradation or loss in other areas
d. loss of upfront conservation land through the negotiations underway with Walker Corporation for a Voluntary Planning Agreement if changes required to urban capable footprint.

The advice is requested by 30 April 2021 to be provided jointly to the Minister for Planning and Public Spaces and the Minister for Energy and Environment.

Following the CPCP advice, further advice is subsequently requested by 14 May 2021 to be provided jointly to the Minister for Planning and Public Spaces and the Minister for Energy and Environment, regarding:

1. Principles for consent authorities to apply in considering site by site applications in light of the CPCP advice, including how this applies to the Technical Assurance Panel process for the Appin precincts in the Greater Macarthur Growth Area.
2. Spatial application of the advice to the Greater Macarthur Growth Area leading to amendment of the Greater Macarthur Plan.

Appendix 2 – Corridors and Buffers

- Habitat within identified corridors should be:
    - protected (especially from development creep)
    - widened through revegetation (average size 390 to 425 m)
    - include a buffer on either side of the corridor habitat that is at least 30 m wide from the corridor to the exclusion fence with feed trees permitted in this buffer area
    - include, between the buffer area and the urban areas, koala proof fencing to prevent the movement of koalas out of the corridor into urban areas (with trees more than 3 m from the fencing to avoid damage) and the movement of domestic dogs (amongst other potential threats) into the corridor
    - for sites where exclusion fencing is infeasible due to steep terrain, then additional buffer width should be utilised (buffer ~60 m), with a traffic speed limit of 40 km/h and predator / dog monitoring asset protection zone is outside the exclusion fencing, within the development footprint
- Connectivity structures within corridors should also be assessed including local roads and other infrastructure (e.g. the Upper Canal).
- The buffer is designed to reduce the impact of direct and indirect impacts from humans, such as light and noise. Koalas could still persist in these areas and use them as part of the functional corridor but would also be able to retreat to existing habitat areas where the edge effects are less apparent.
- Buffer zones provide a mechanism to minimise edge effects – they reduce interactions between koalas and the urban environment. The buffer zones should:
    - provide separation between the built environment and other associated infrastructure (including roads) be wider when it is not feasible to have an exclusion fence at the edge of the buffer
    - not include APZs, particularly when subject to revegetation
    - not include roads, playgrounds, and picnic areas
    - facilitate the complete avoidance of direct impacts (i.e. road strike)
    - mitigate the impact of indirect impacts, such as attenuating noise and light pollution from the urban development, for native species within the environment
    - prevent koalas moving into urban areas and prevent threat such as dog attacks
    - give consideration to the long-term maintenance of the koala habitat and any proposed mitigation strategies (such as fence maintenance in perpetuity)
- Buffers should be at least 30 m wide from the edge of existing corridor habitat, occur on both sides of the corridor, and have exclusion fencing at their edge, with koala feed trees allowed to grow to the fence, with a suitable distance between trees and fencing to prevent fallen boughs creating damage to the fence.
- If there are not adequate measures to prevent koalas entering the urban environment, revegetation should discourage koalas utilising these buffer zones, this could be achieved by revegetating the buffer with native vegetation that include no koala preferential feed trees. In some locations such as steep terrain, exclusion fencing may not be feasible, and in these cases wider buffers would be required (~60 m), that don't include koala feed trees, and monitor for predators.
- If the preferred method of koala exclusion fencing is used, the buffer zone should be revegetated with preferred koala feed and shelter tree species, with thought given to how far back from the fence line revegetation occurs to ensure that the fence is still effective and that treefall does not pose a risk to its integrity.

- The purpose of having a buffer separate to the APZ is to ensure that there is protection of the habitat and the species within that buffer and not subject them to the management activities required to maintain the APZ as well as the activities permitted within it.
- In undertaking revegetation in the buffer, the layout and tree species chosen should achieve the function of protecting koalas from noise, light, etc. and provide possible refuge from fires. These images illustrate that looking through and across the corridor, any koalas within the corridor would be relatively exposed, therefore designing vegetation in the buffers on either side of the corridor could be done in a way that reduces exposure and increases protection.
- The Panel acknowledges that koalas will move along and utilise the buffer zone, so food and other habitat trees (shelter, etc.) could be incorporated into the design, whilst also recognising other metrics that would protect the current habitat (such as canopy height, canopy density, fuel load contribution, etc.)
- The Panel notes that tree species (for feed and shelter for koalas) and vegetation density are the key characteristics that would lead to functional connectivity, in conjunction with the removal and mitigation of threats (including indirect threats such as light and noise pollution). Buffer zones (of at least 30 m in fenced and 60 m in unfenced) and other mitigations here would aim to reduce these threats.
- the functional roles of Asset Protection Zones (APZ) and of buffer zones to protect koalas are different, and as such need to be differentiated in the design of the interface. APZs serve a role of protecting people and property from bushfire hazard, while buffers associated with koala protection reduce the impact of threats, light, and noise on koalas.

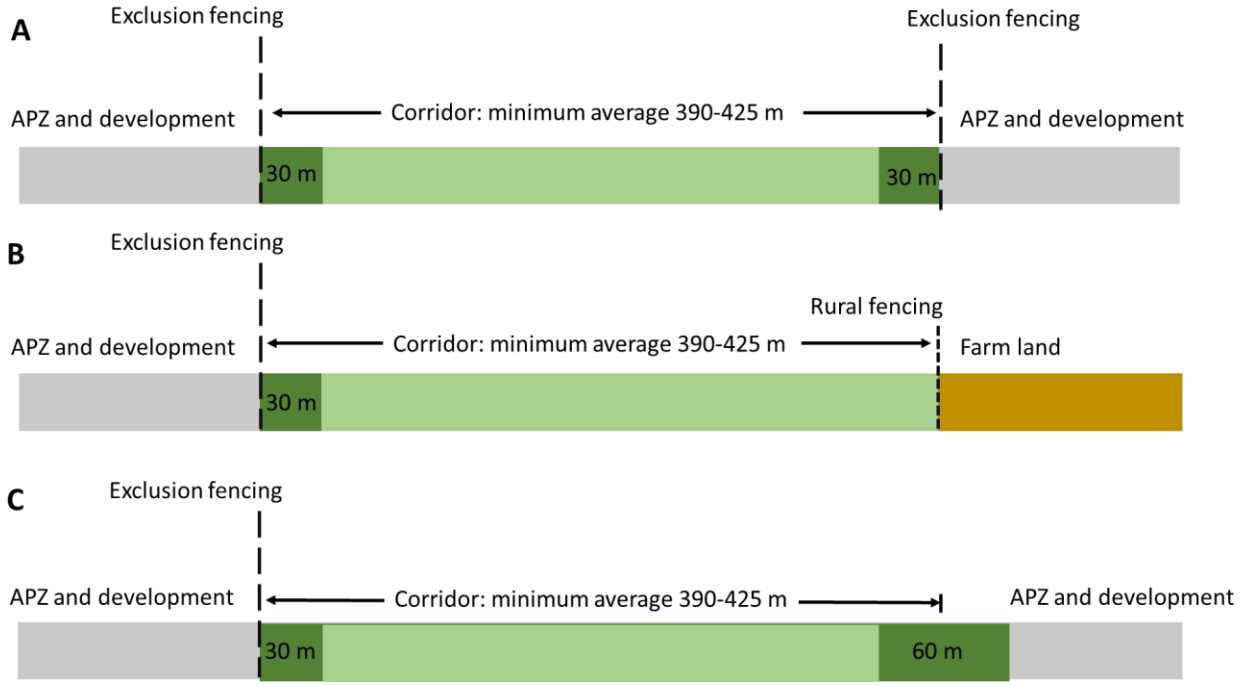


Figure A1: Recommendations for corridors. A) Development either side of the corridor, B) Development on one side and farmland on the other, C) Development on both sides, but with one side unable to be fenced.
Source: February 2021 Advice

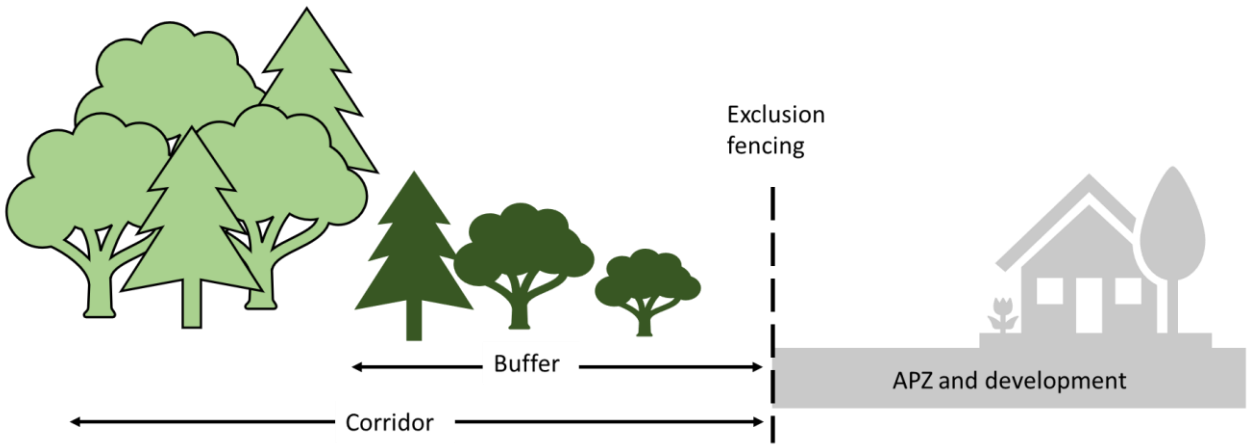


Figure A2: The separation of the vegetated buffer (which can include koala feed and shelter trees, with a bias towards the area adjacent to the corridor) and APZ
Source: February 2021 Advice

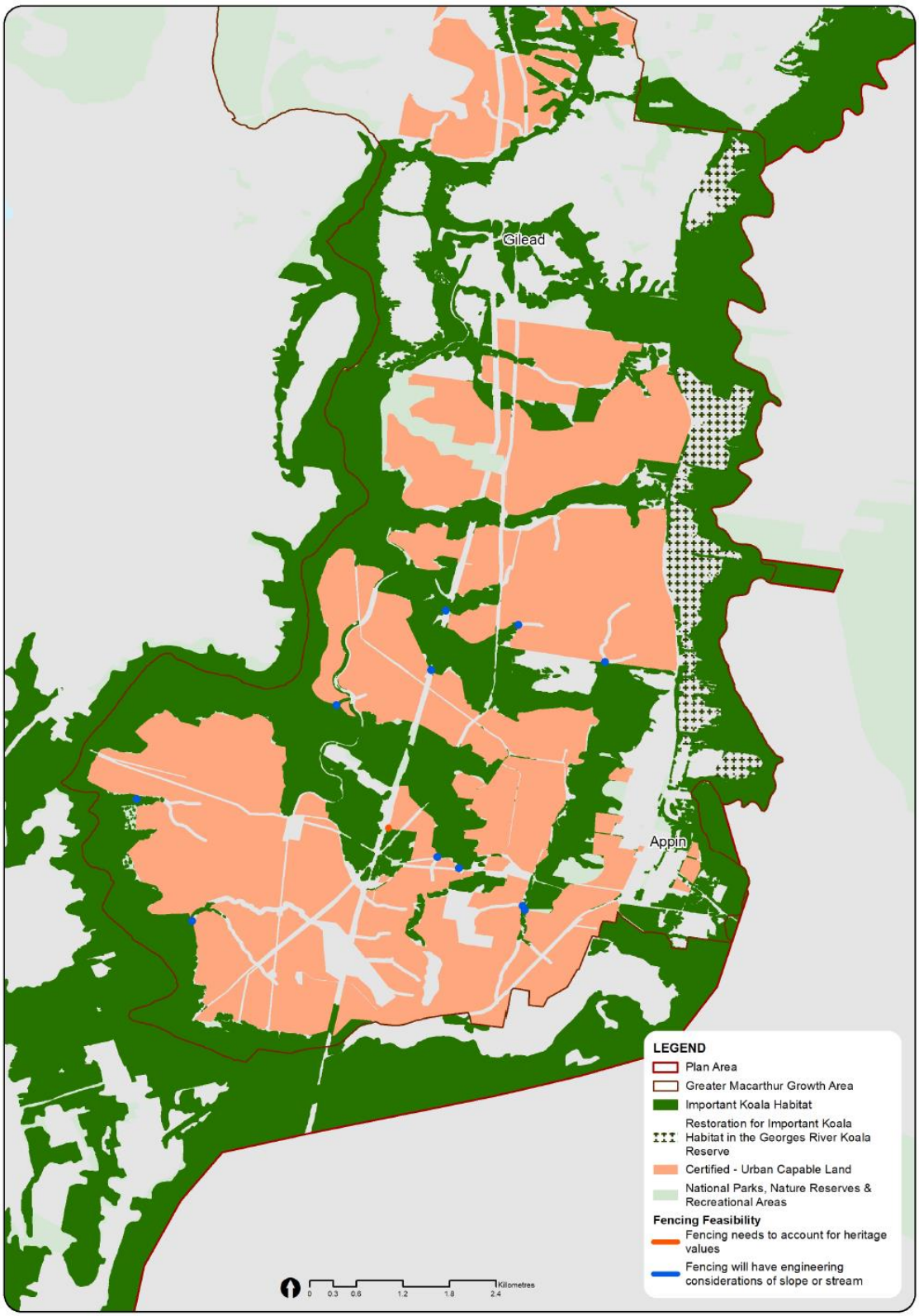


Figure A3: Koala important habitat, corridors and land categories in the GMGA
Source: DPIE (2020) Sub-Plan B: Koalas. Draft Cumberland Plain Conservation Plan

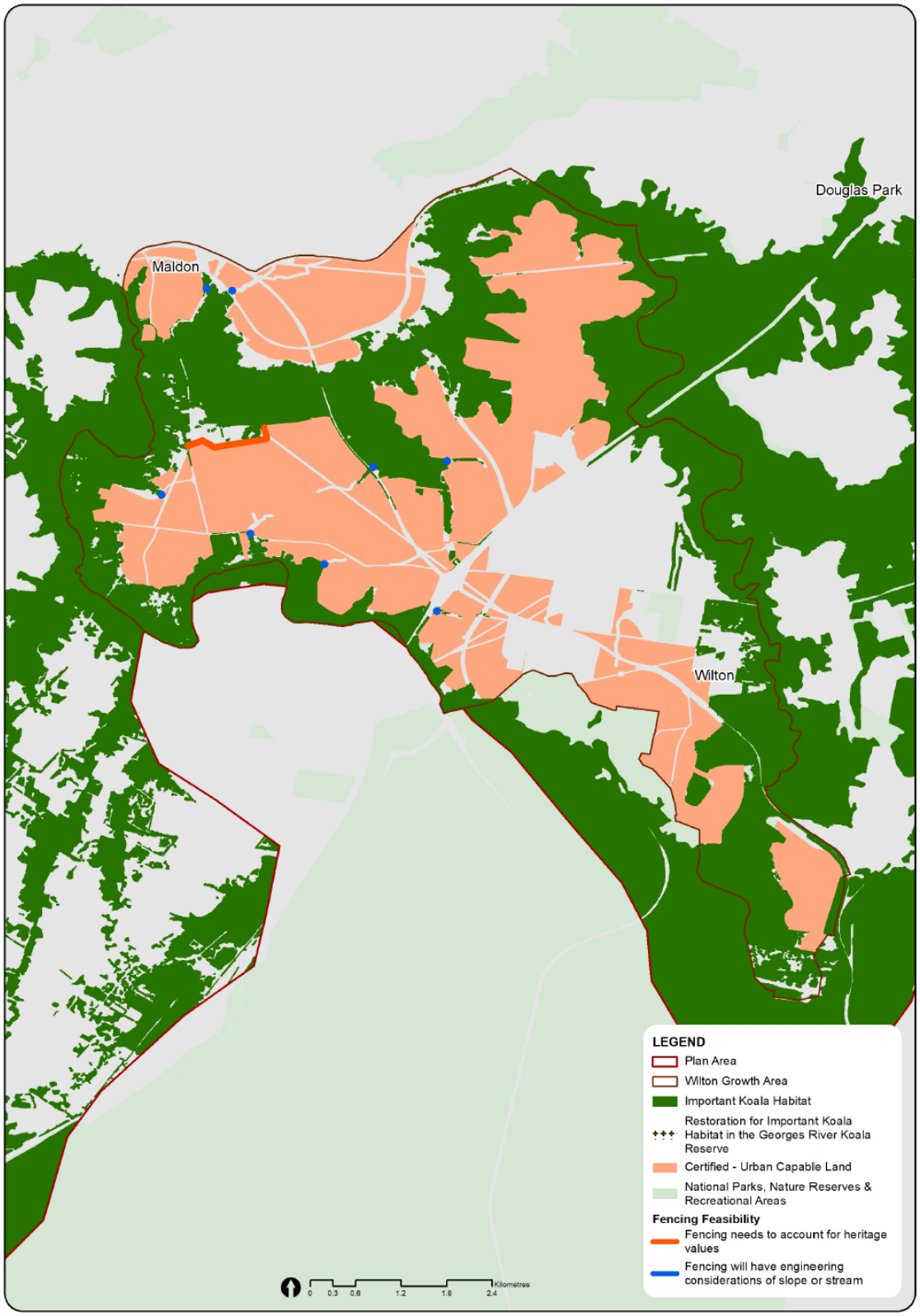


Figure A4: Koala important habitat, corridor and land categories in the WGA
Source: DPIE (2020) Sub-Plan B: Koalas. Draft Cumberland Plain Conservation Plan

Appendix H : Relevant Maps and Figures

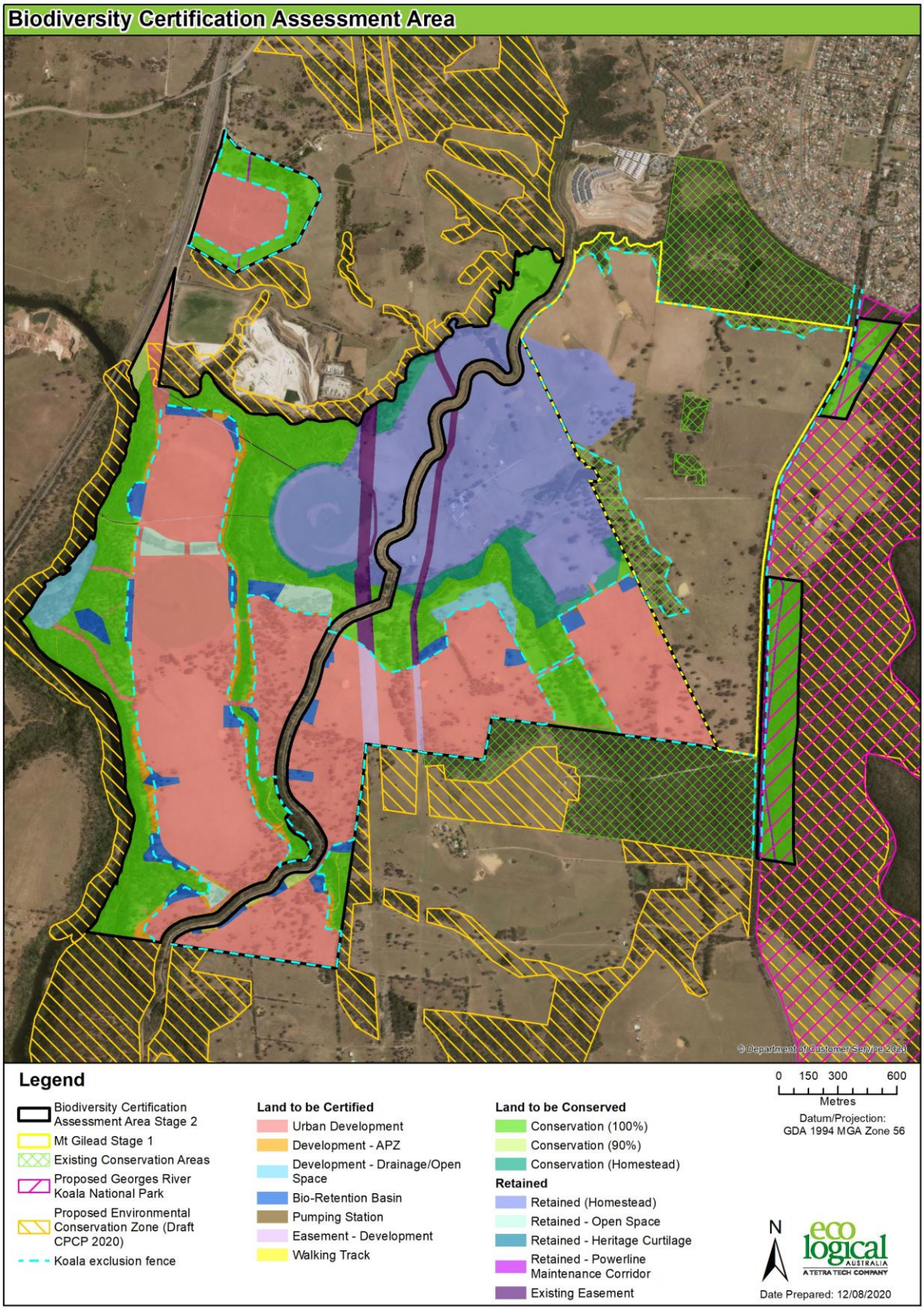


Figure 1: Land proposed for Biocertification and fenced koala Conservation area after ELA (2020)

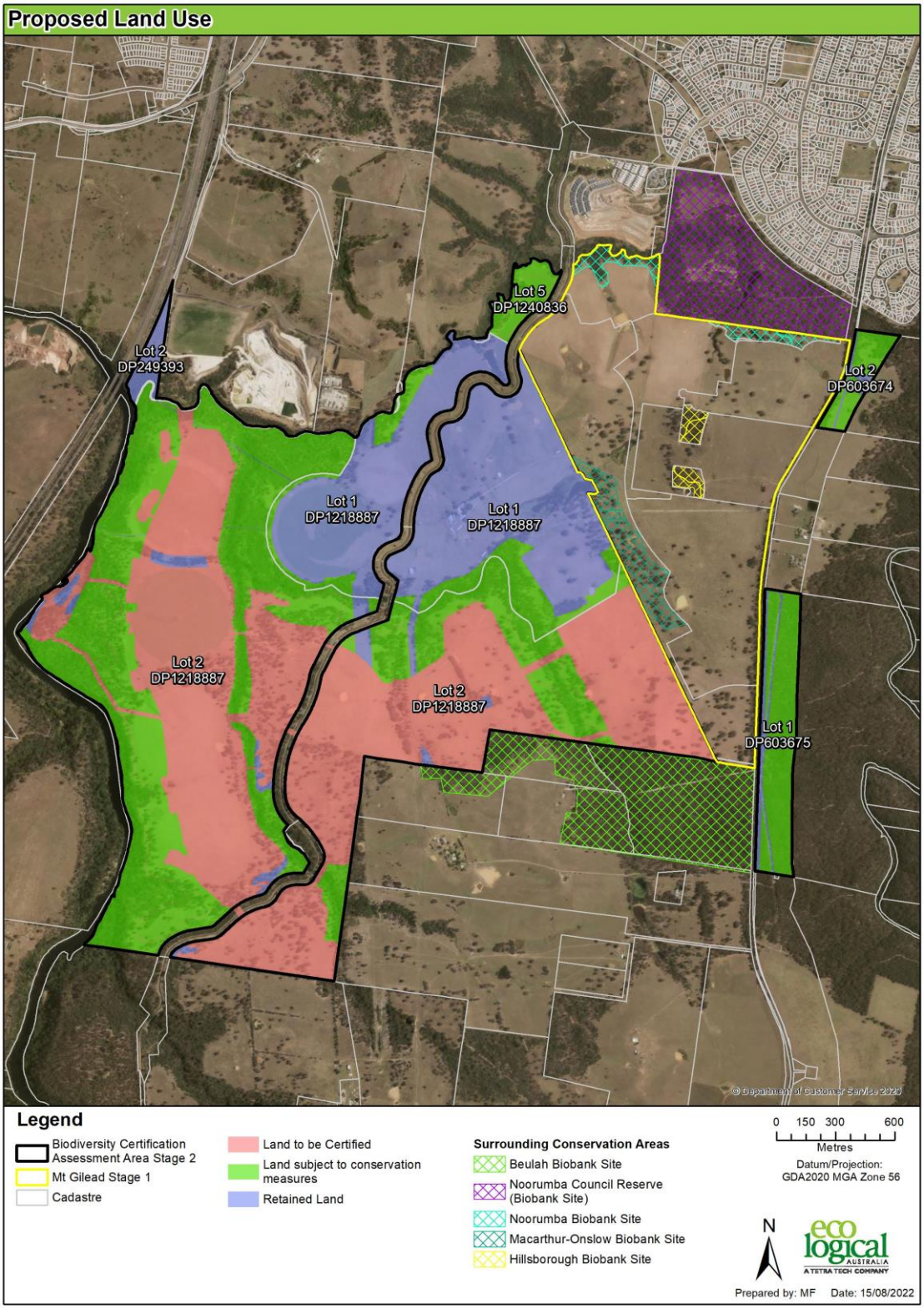


Figure 2: Land proposed for Biocertification and fenced koala Conservation area after ELA (2022 Revised BCAR)

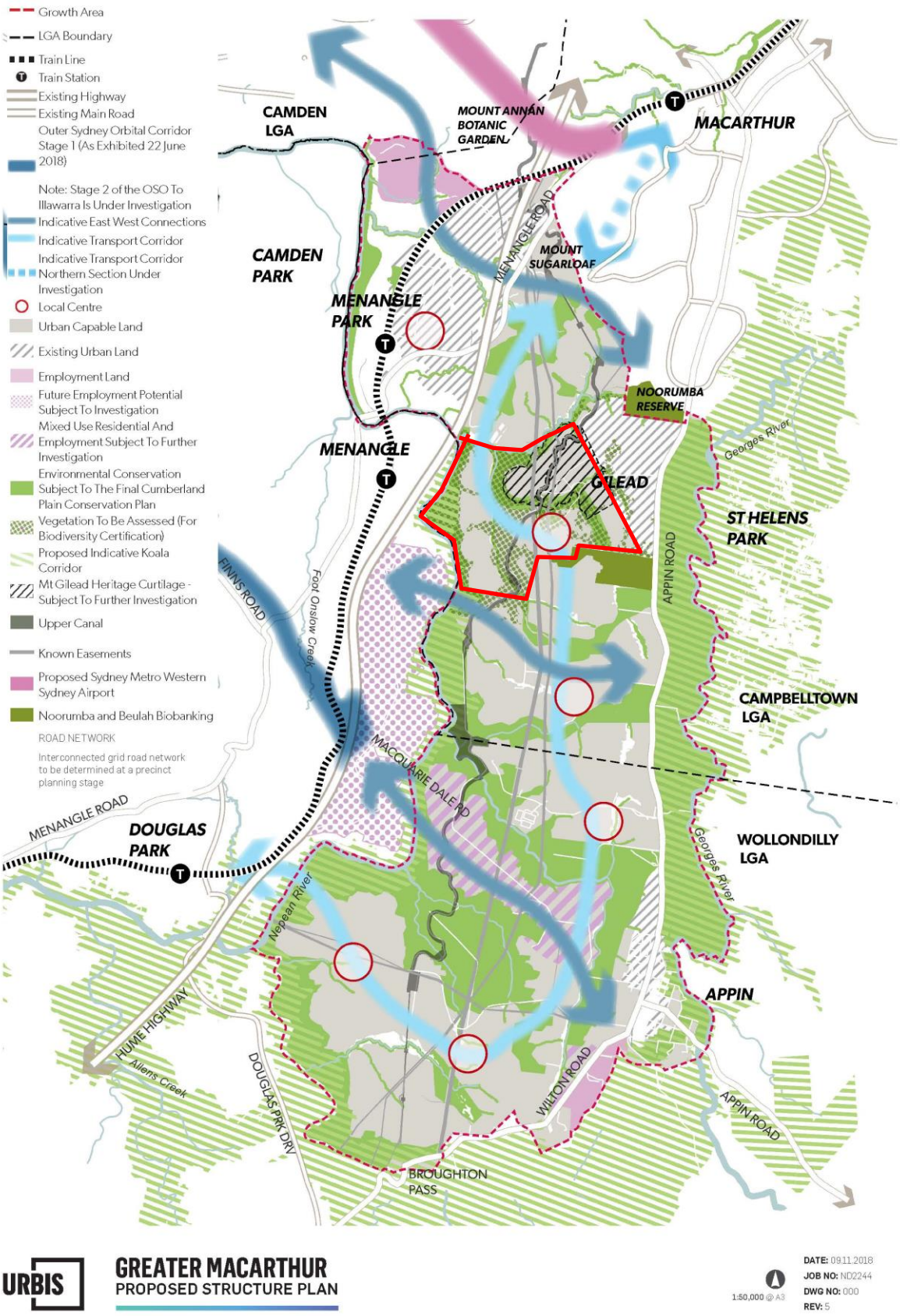


Figure 3: DPIE GMGA Structure Plan (Source DPIE 2018)

Note red outline shows approximate location of MGS2 application boundary

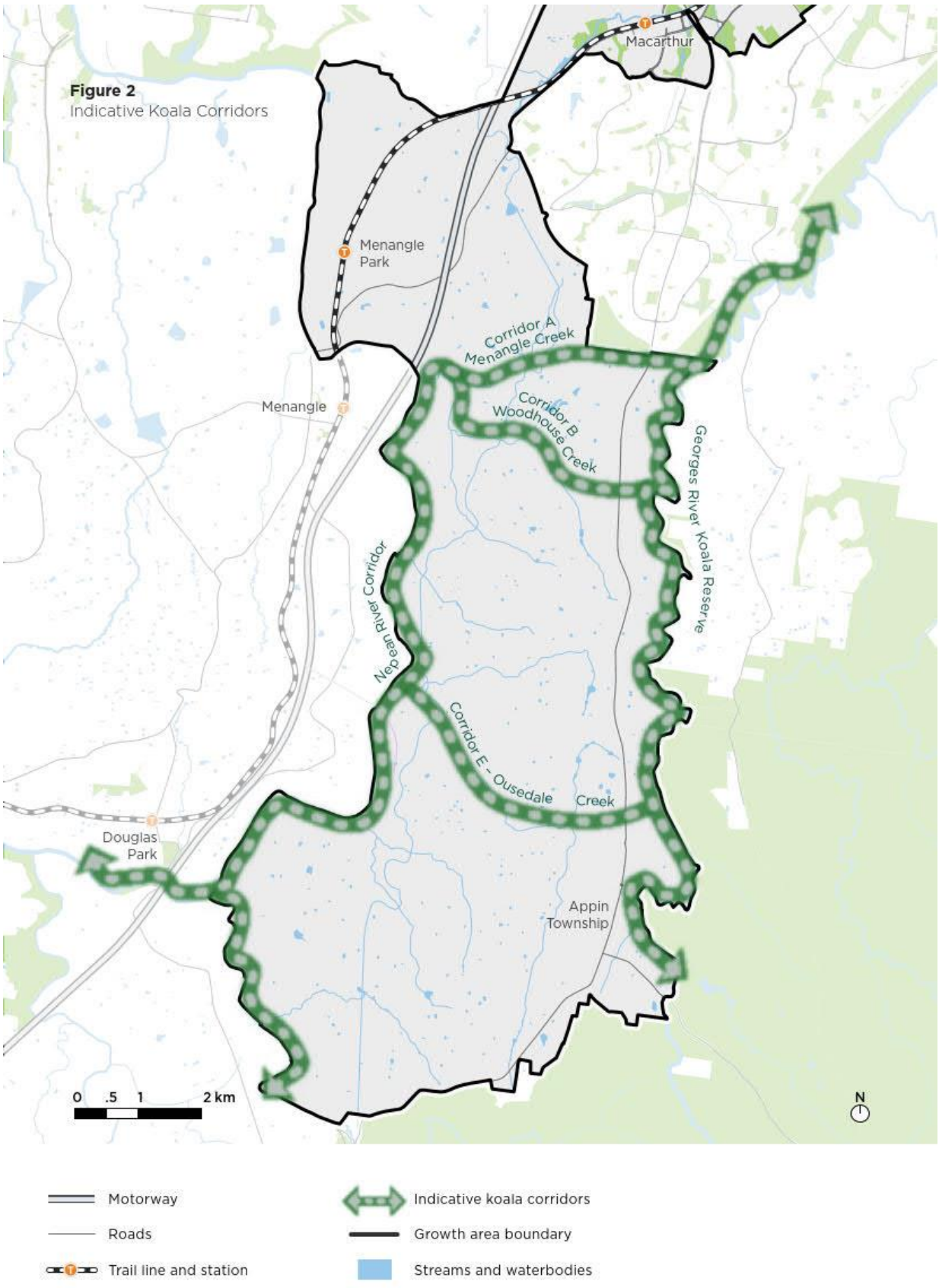


Figure 4: Indicative Koala corridors in Greater Macarthur 2040 Update (Dec 2021)

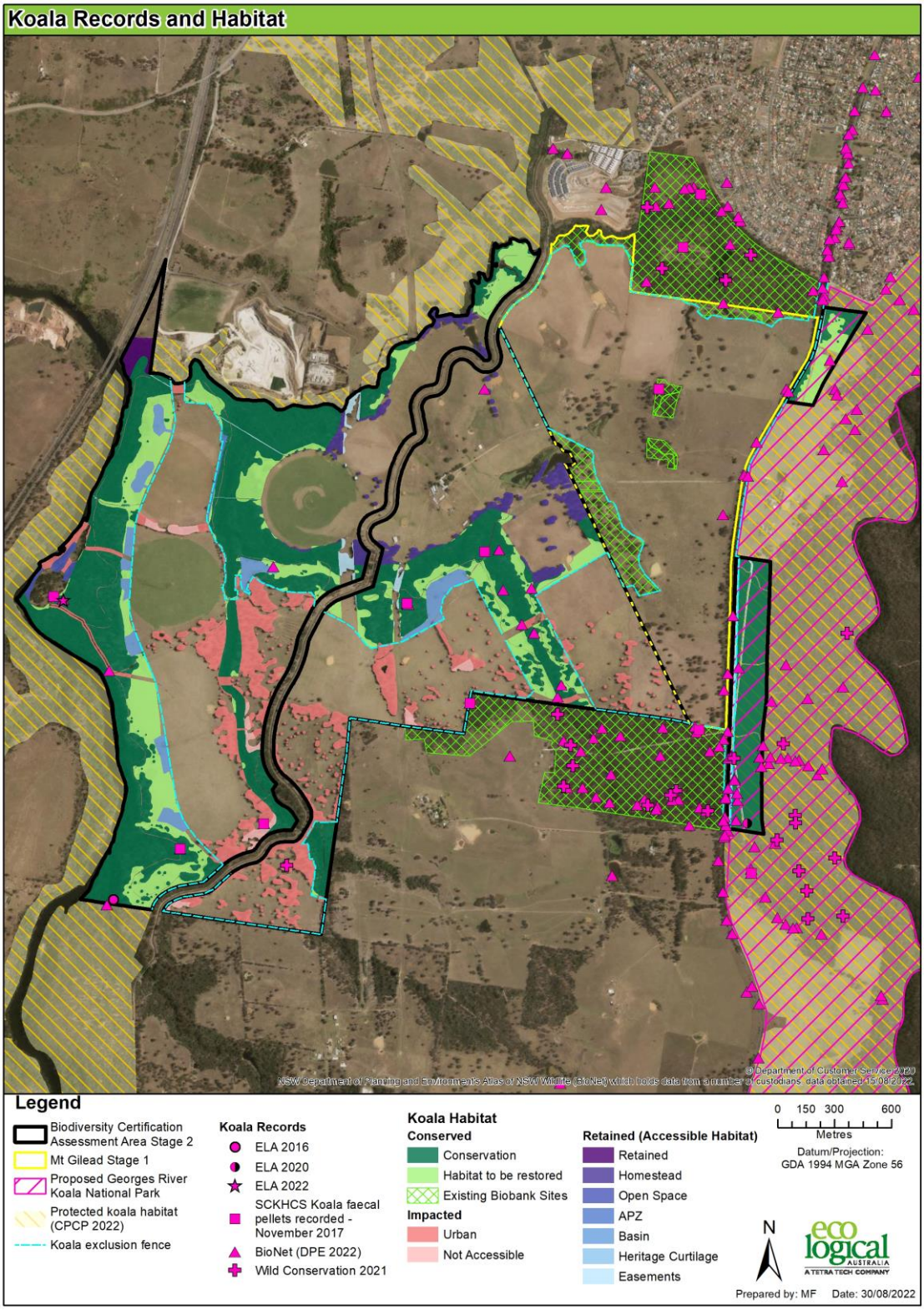


Figure 5: Proposed retained and protected Koala habitat in and adjacent to Mt Gilead Stage 2 including the 250 ha Mt Gilead Koala Conservation Area within MGS2

A bioretention basin showing the transition from open space to vegetated basin, with footpath on farside and fenced off conservation area in the background.

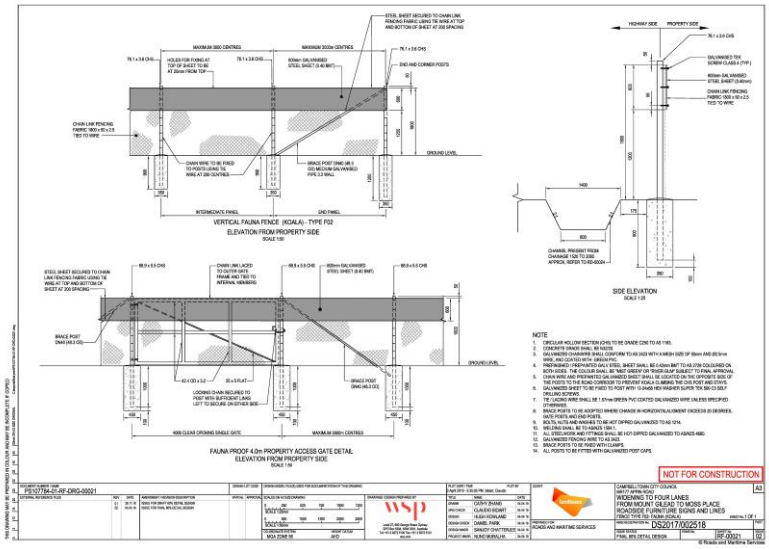
Established native vegetation within a bioretention basin acting as a buffer to the conservation area in the background.

An aerial view of a bioretention basin functioning alongside residential development and conservation areas

Figure 6: Typical examples of vegetated bio-retention basins showing the extent of vegetation

Traditional floppy-top Koala Exclusion Fence – RMS Picton Road

New Design Koala Exclusion Fence – RMS Picton Road



Gilead fence 1500mm high with 600mm panel

Figure 7: Gilead Koala exclusion Fence Design

Indicative Underpass at Beulah

Indicative underpass at Noorumba

Figure 8**: Indicative Appin Road Koala Underpass (Subject to Stage Government approval)**