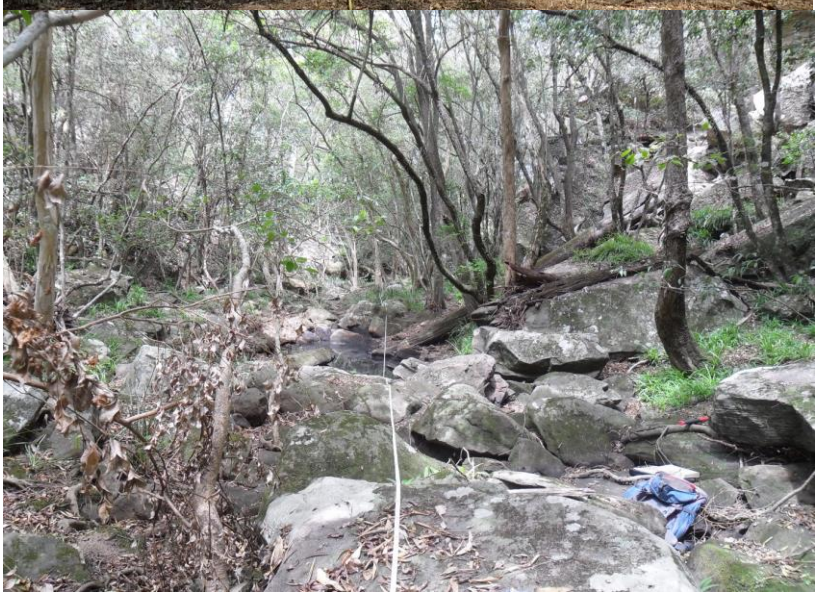
Mt Gilead – Stage 2

Biodiversity Certification Assessment Report & Biocertification Strategy

Prepared for
Lendlease Communities (Figtree Hill) Pty Limited

5 September 2022



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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
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*

Abbreviation	Description
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.

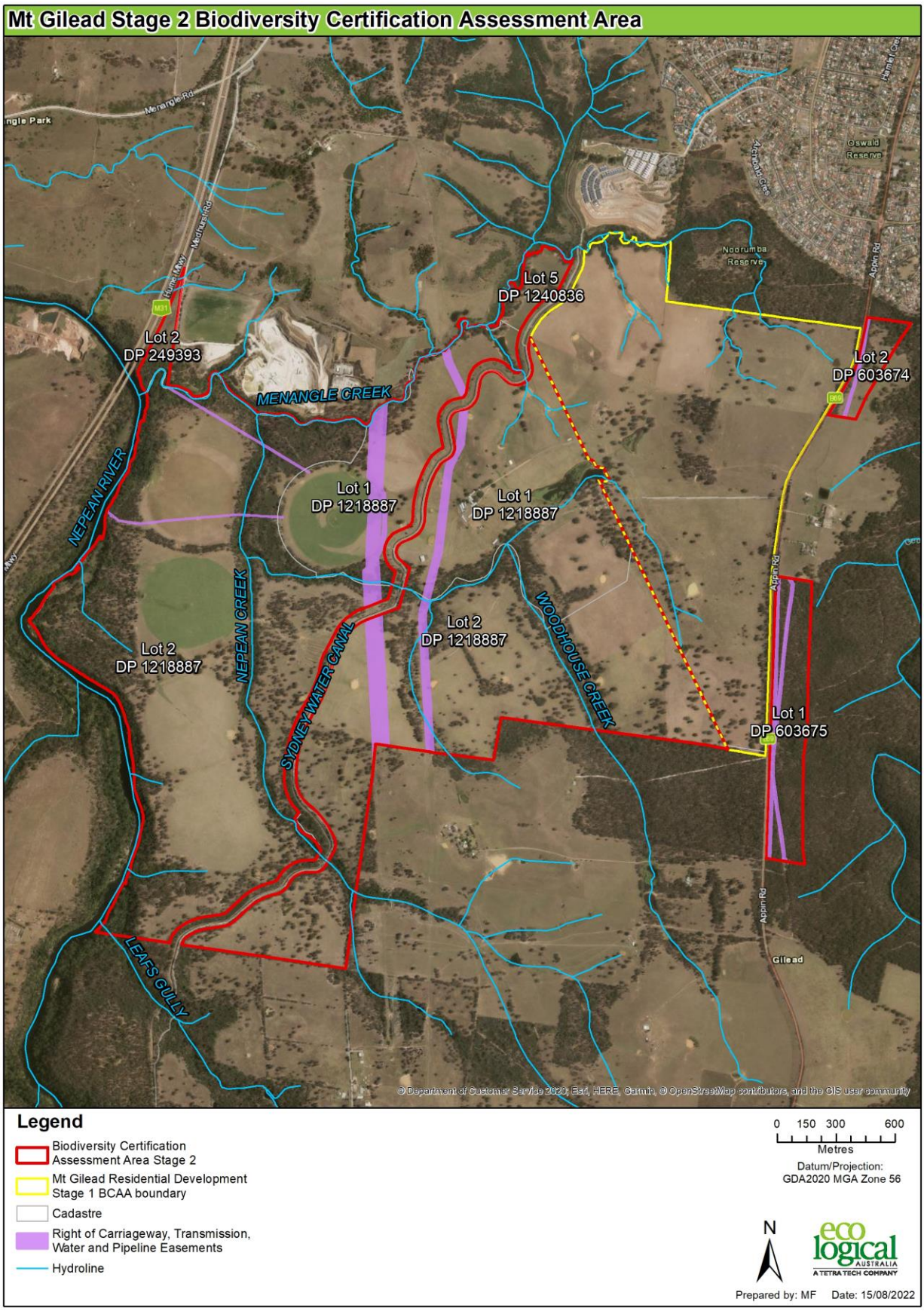


Figure 1: Mt Gilead Stage 2 Biodiversity Certification Assessment Area boundary

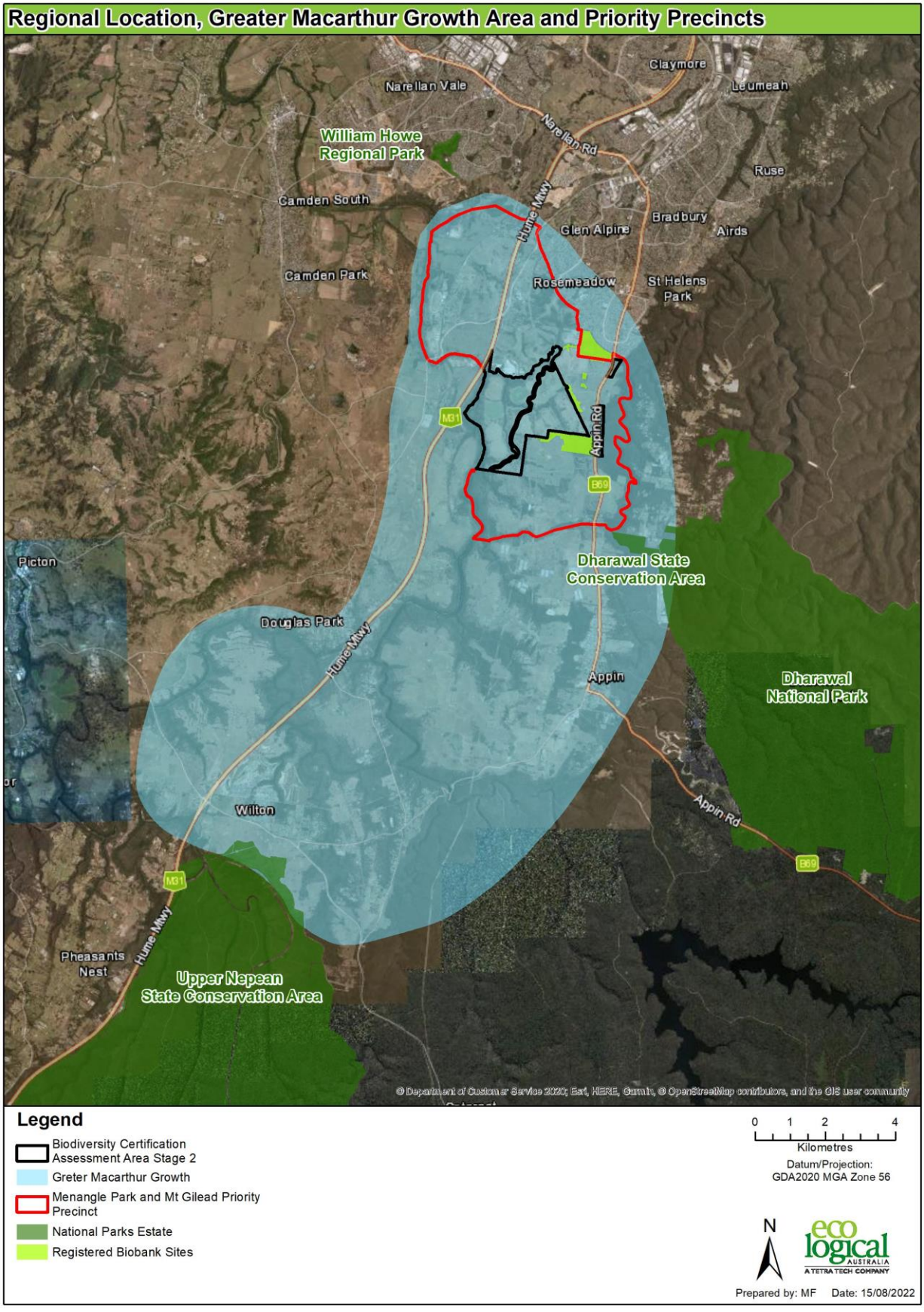


Figure 2: Regional location of the Mt Gilead Stage 2 Biodiversity Certification Assessment Area, Greater Macarthur Growth Area and Priority Precincts

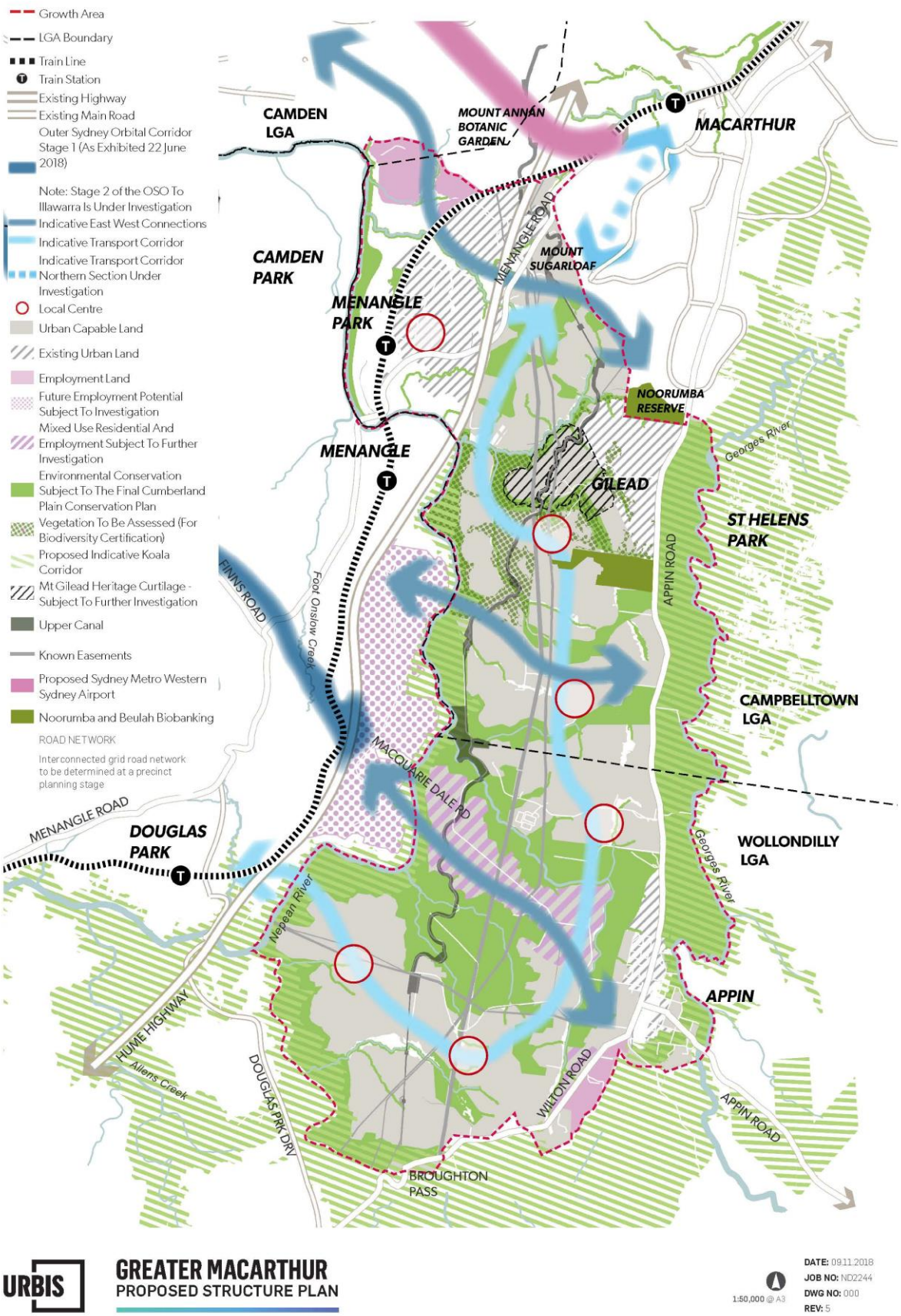


Figure 3: Department of Planning Macarthur Structure Plan (Source DPE 2018)

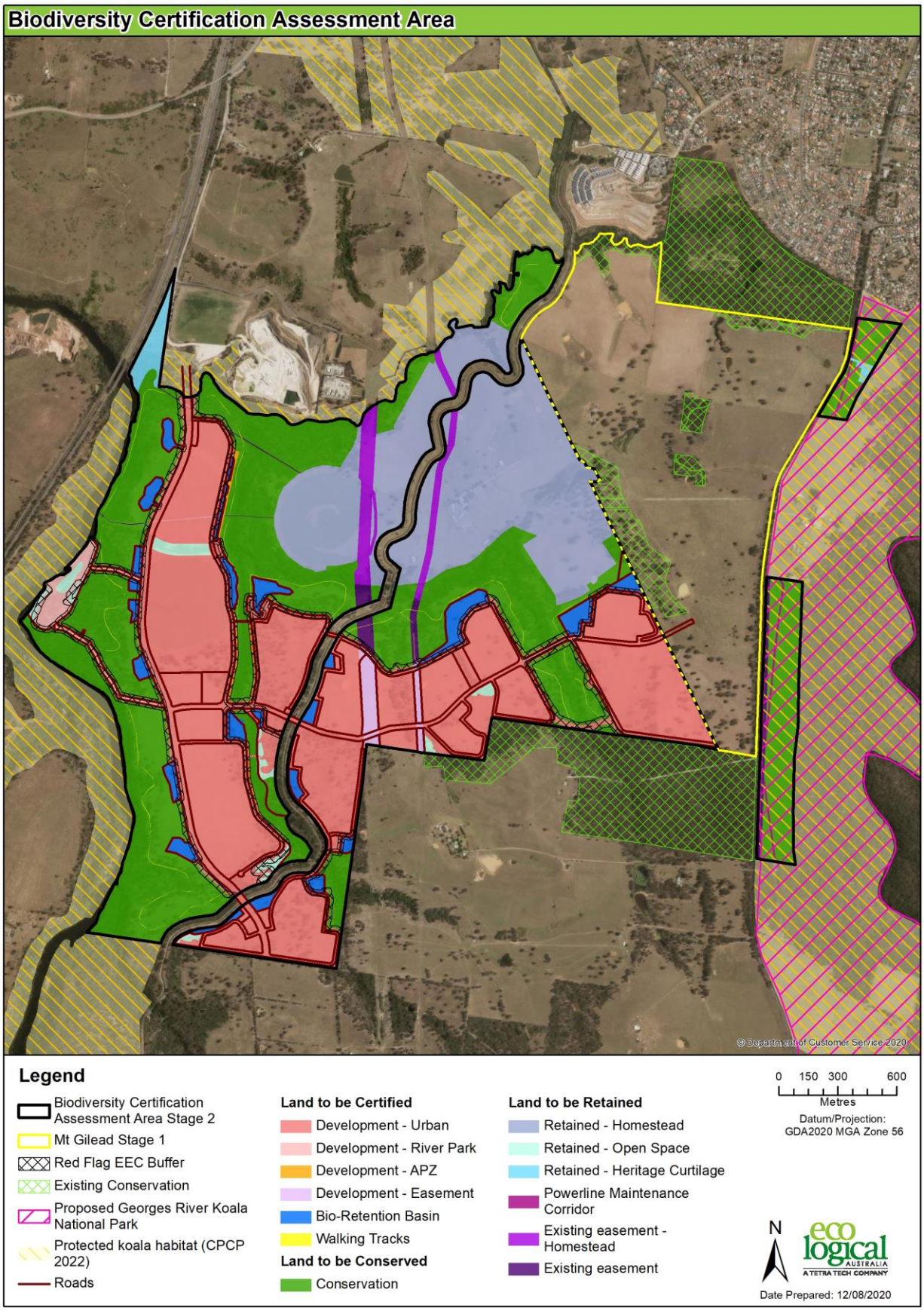


Figure 4: Concept Master Plan

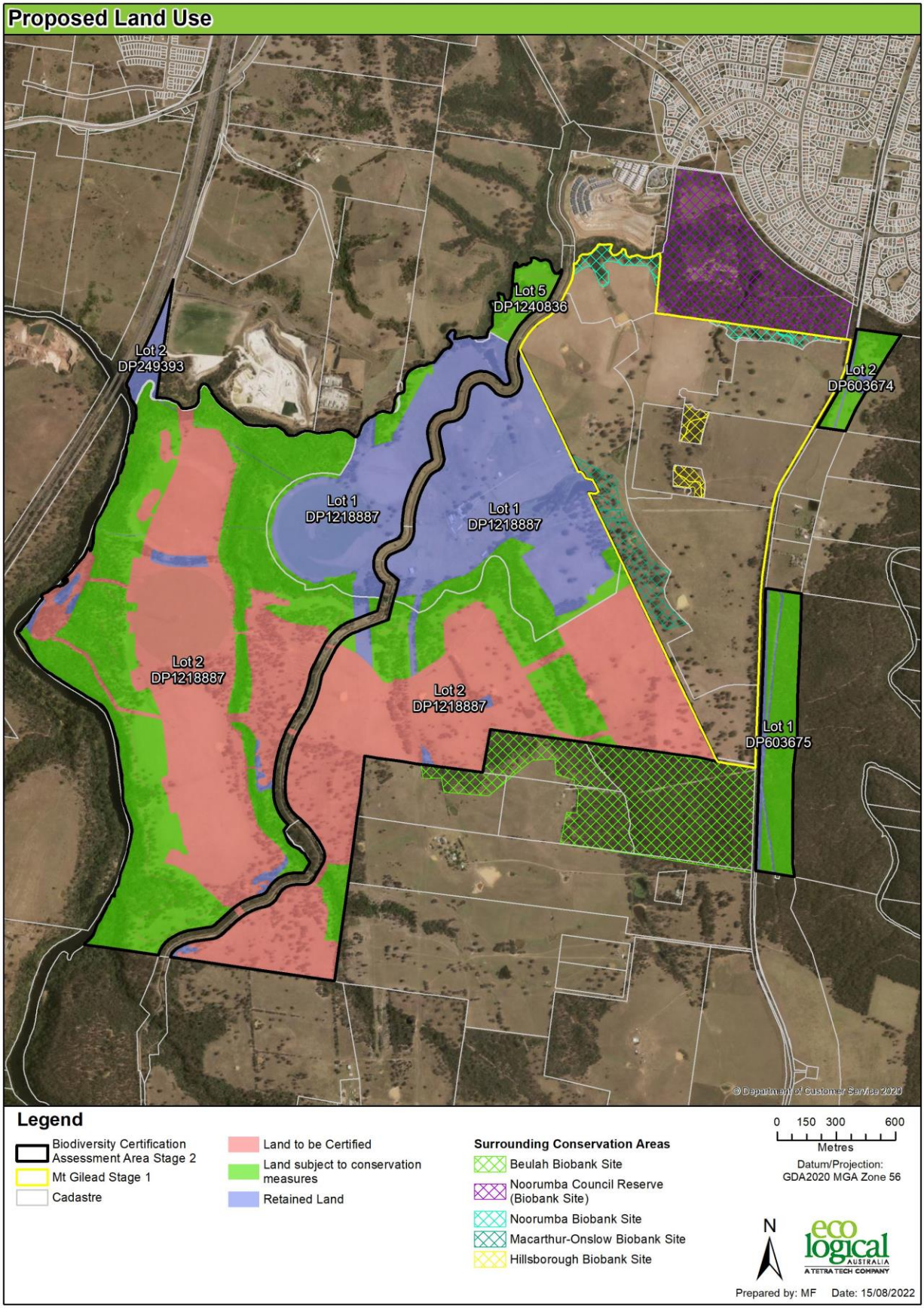


Figure 5: Mt Gilead Biodiversity Certification Assessment proposed land use

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.

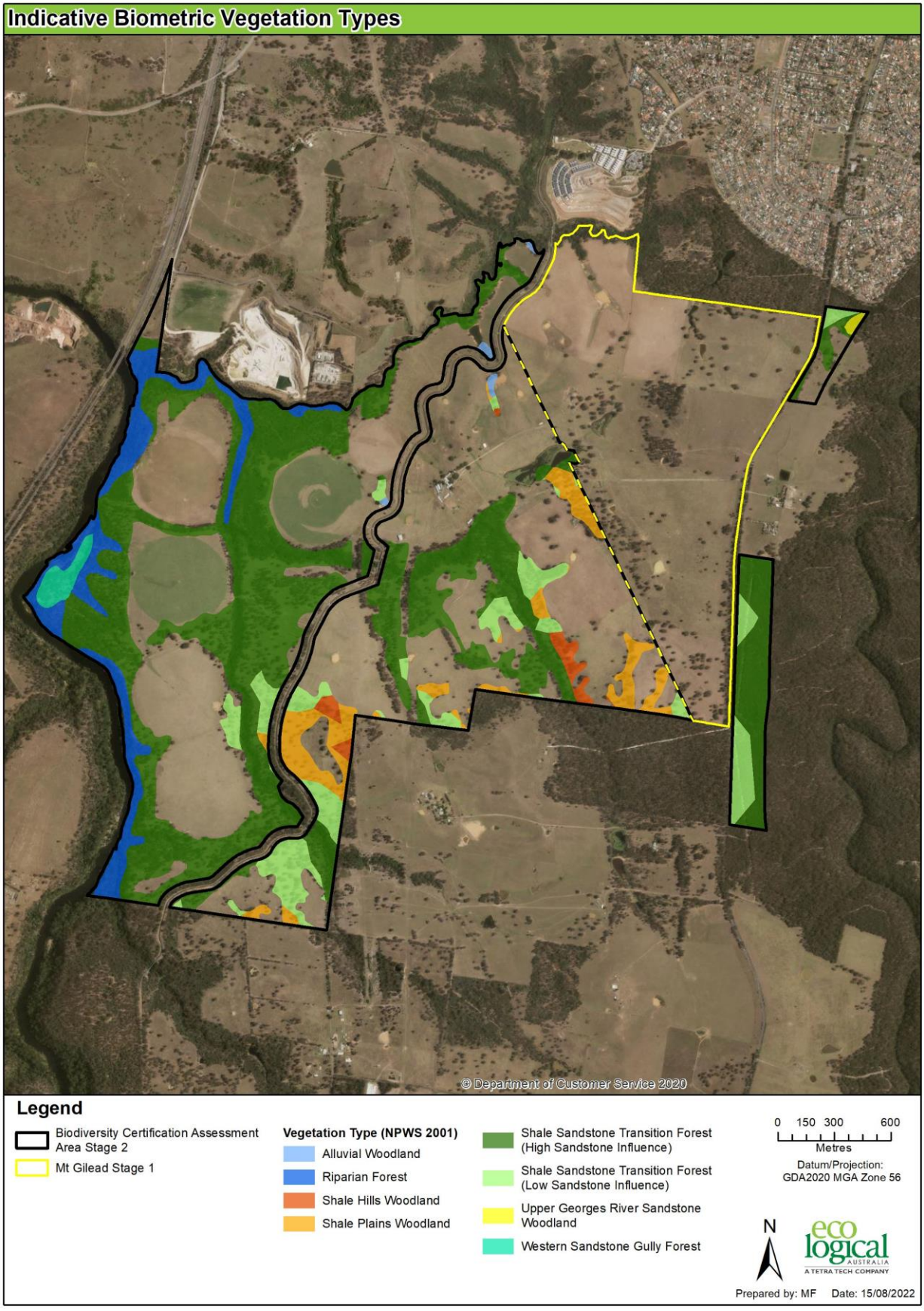


Figure 6: Vegetation units within the BCAA as mapped by NPWS (2001)

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 aurea* (Green and Golden Bell Frog)), targeted survey for these were not undertaken.	- 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
		- 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**. 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	- Koala, Squirrel Glider and Cumberland Plain Land Snail recorded

Previous studies	Survey area	Effort	Results
		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 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	The following threatened species were recorded in the study area:- • Koala • Cumberland Plain Land Snail • Little Lorikeet

Previous studies	Survey area	Effort	Results
		opportunistic sightings	• 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 (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.

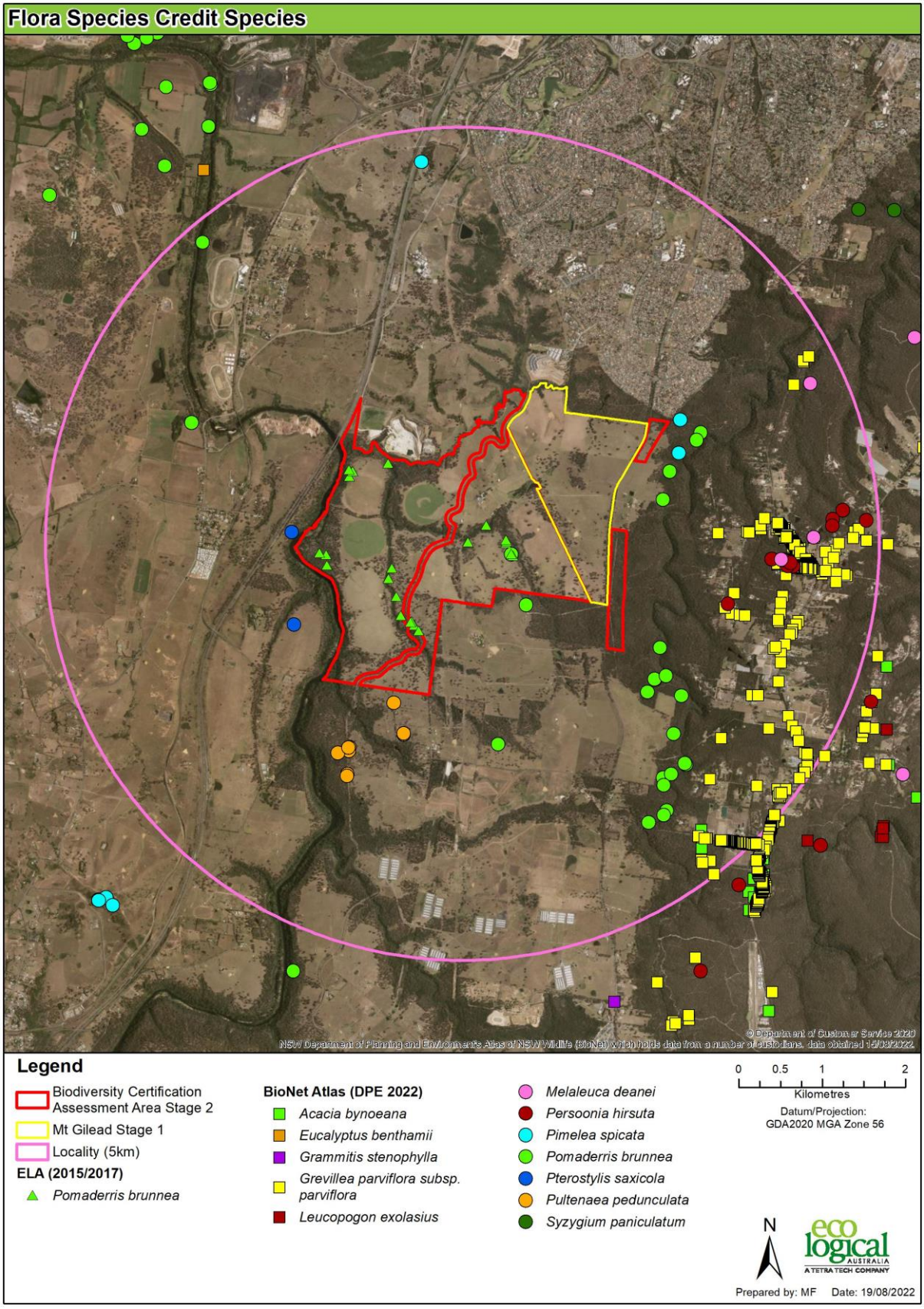


Figure 7: Threatened flora records within 5km of the BCAA (Source Atlas of NSW Wildlife and ELA, unpublished)

Note the precise locations of sensitive species are denatured and locations are not accurate

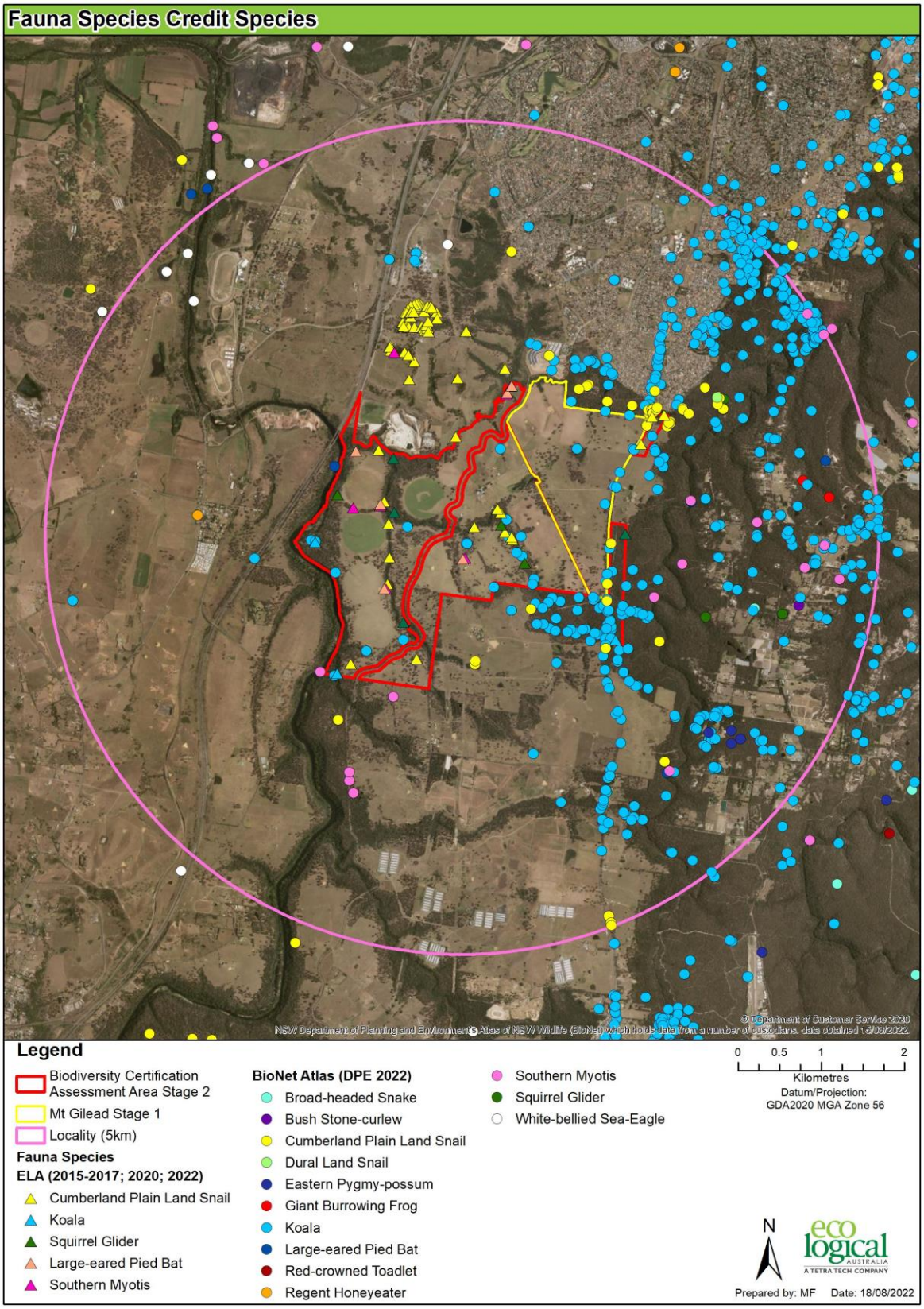


Figure 8: Threatened species credit fauna records within 5km of the BCAA (Source Atlas of NSW Wildlife and ELA, unpublished)

Note the precise locations of sensitive species are denatured and locations are not accurate

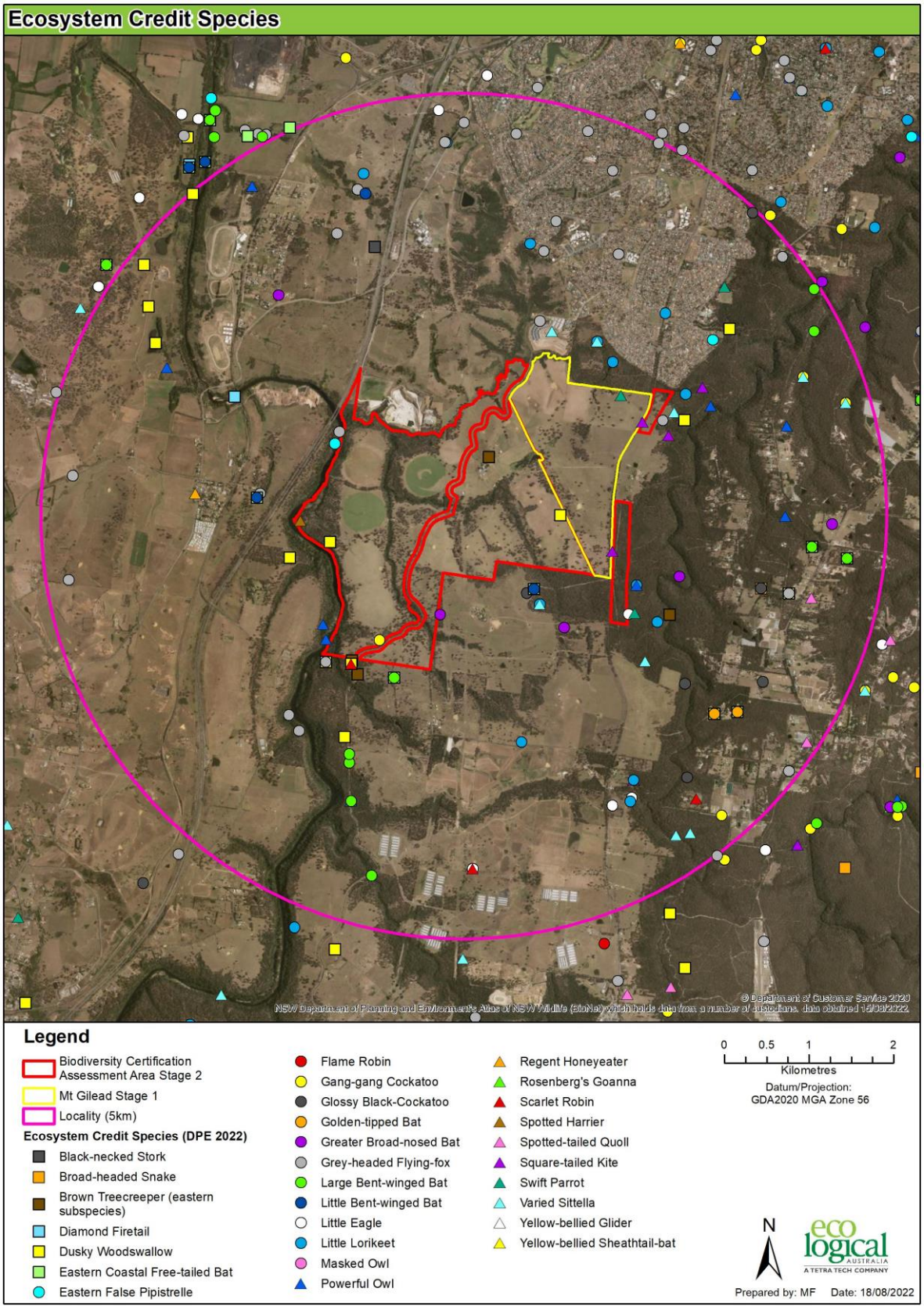


Figure 9: Threatened ecosystem credit fauna records within 5km of the BCAA (Source Atlas of NSW Wildlife and ELA, unpublished)

Note the precise locations of sensitive species are denatured and locations are not accurate

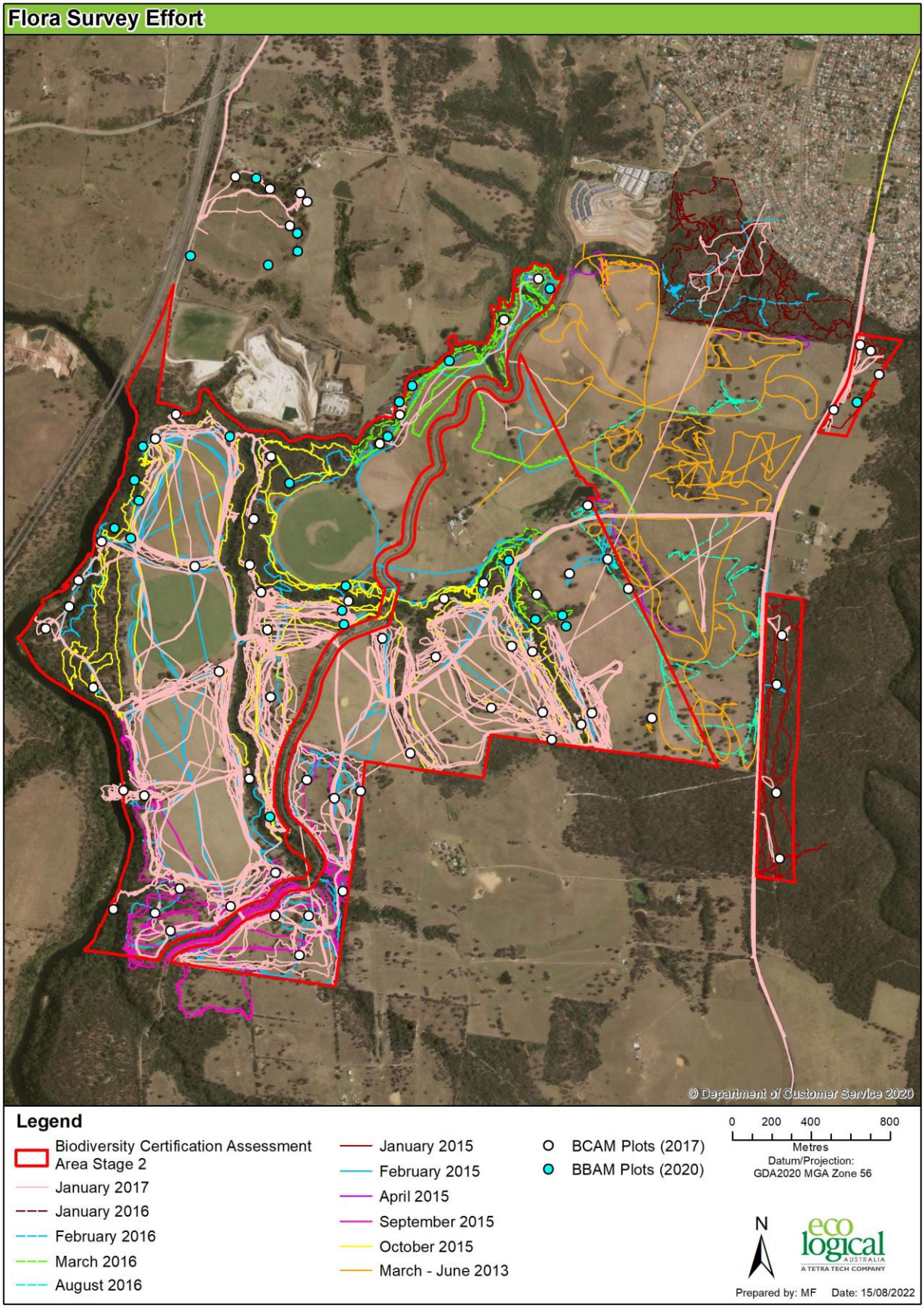


Figure 10: Combined flora survey effort across the BCAA and adjacent properties

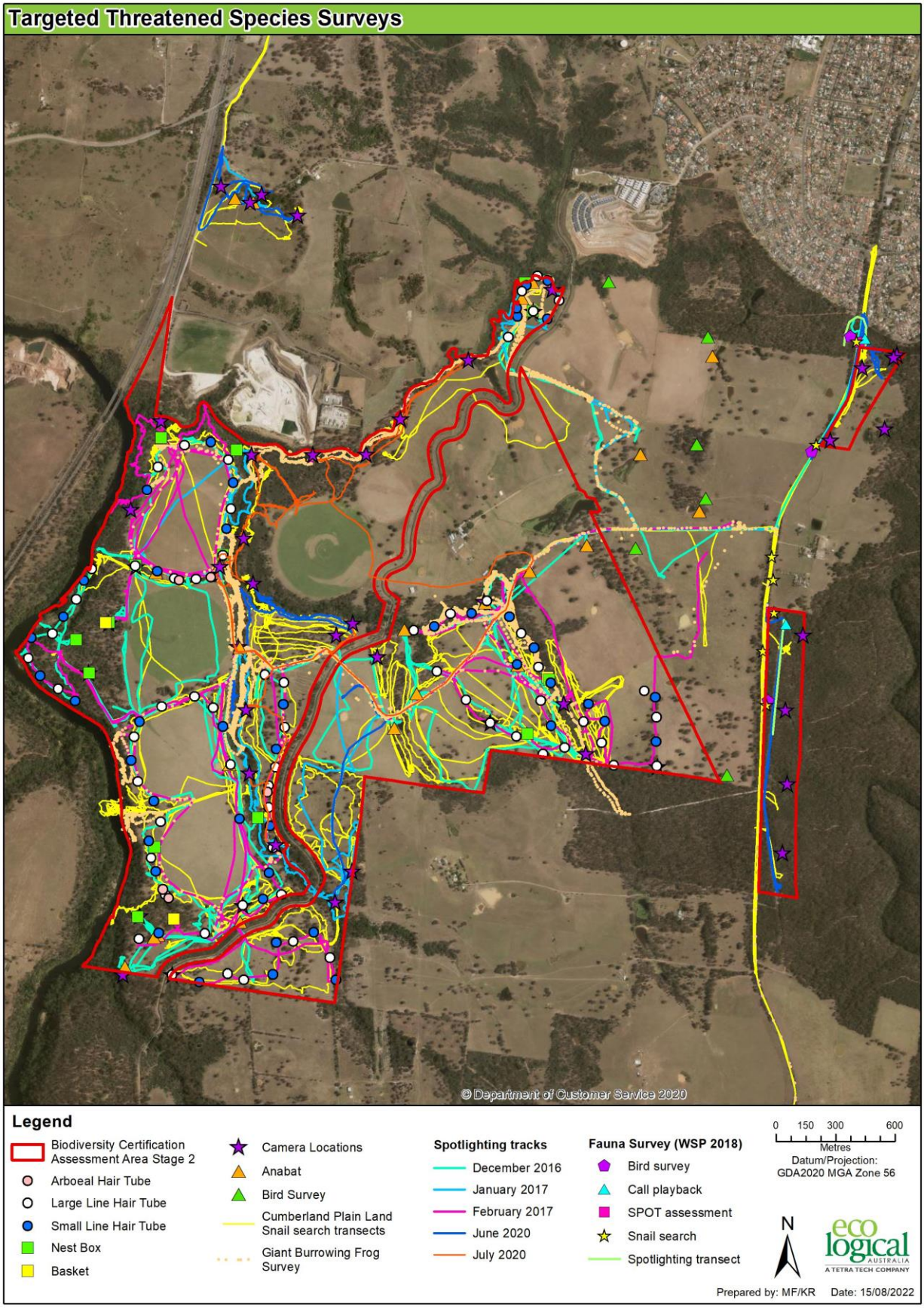


Figure 11: Fauna survey locations within and adjacent to the BCAA

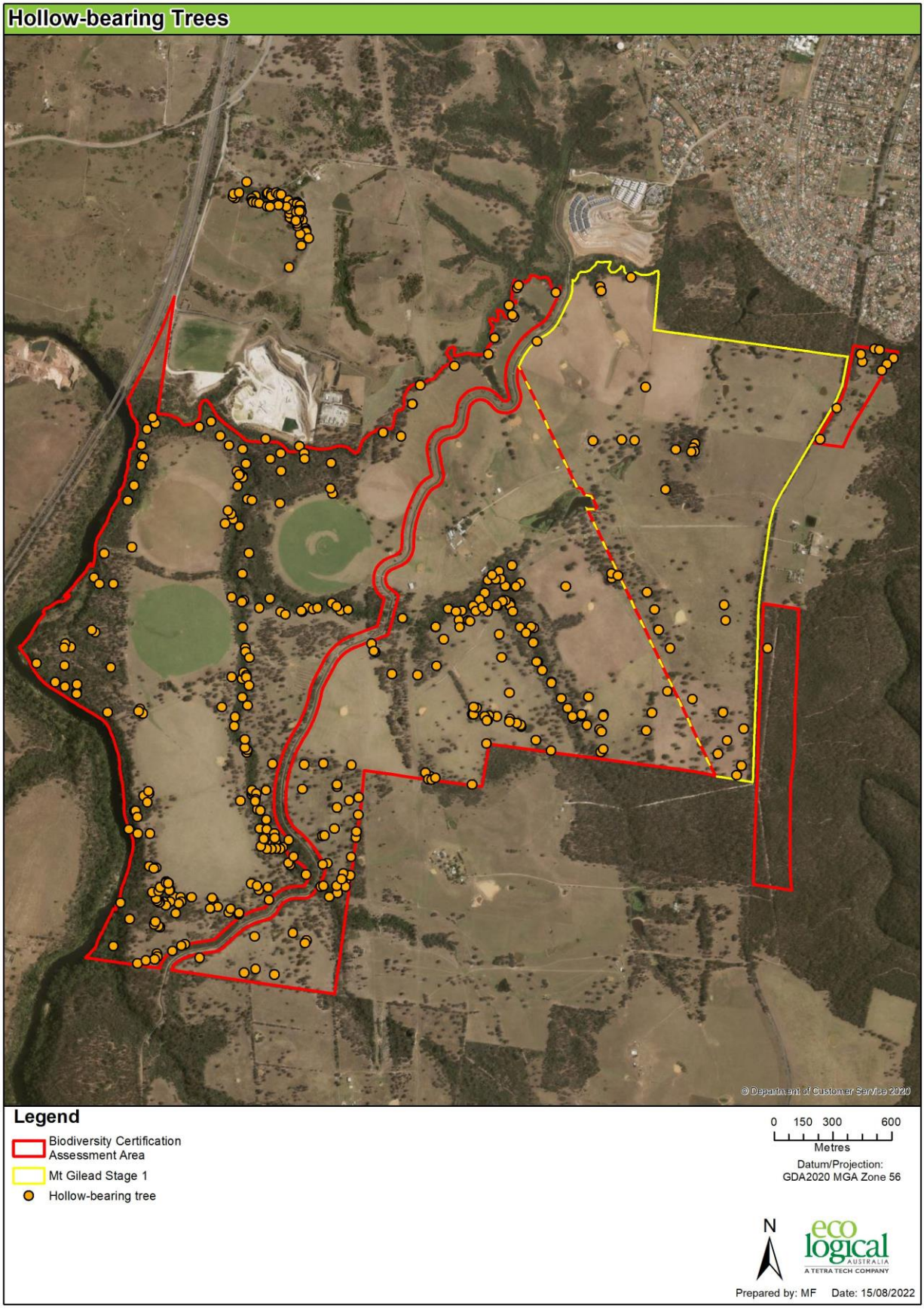


Figure 12: Location of Hollow Bearing Trees across the BCAA

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

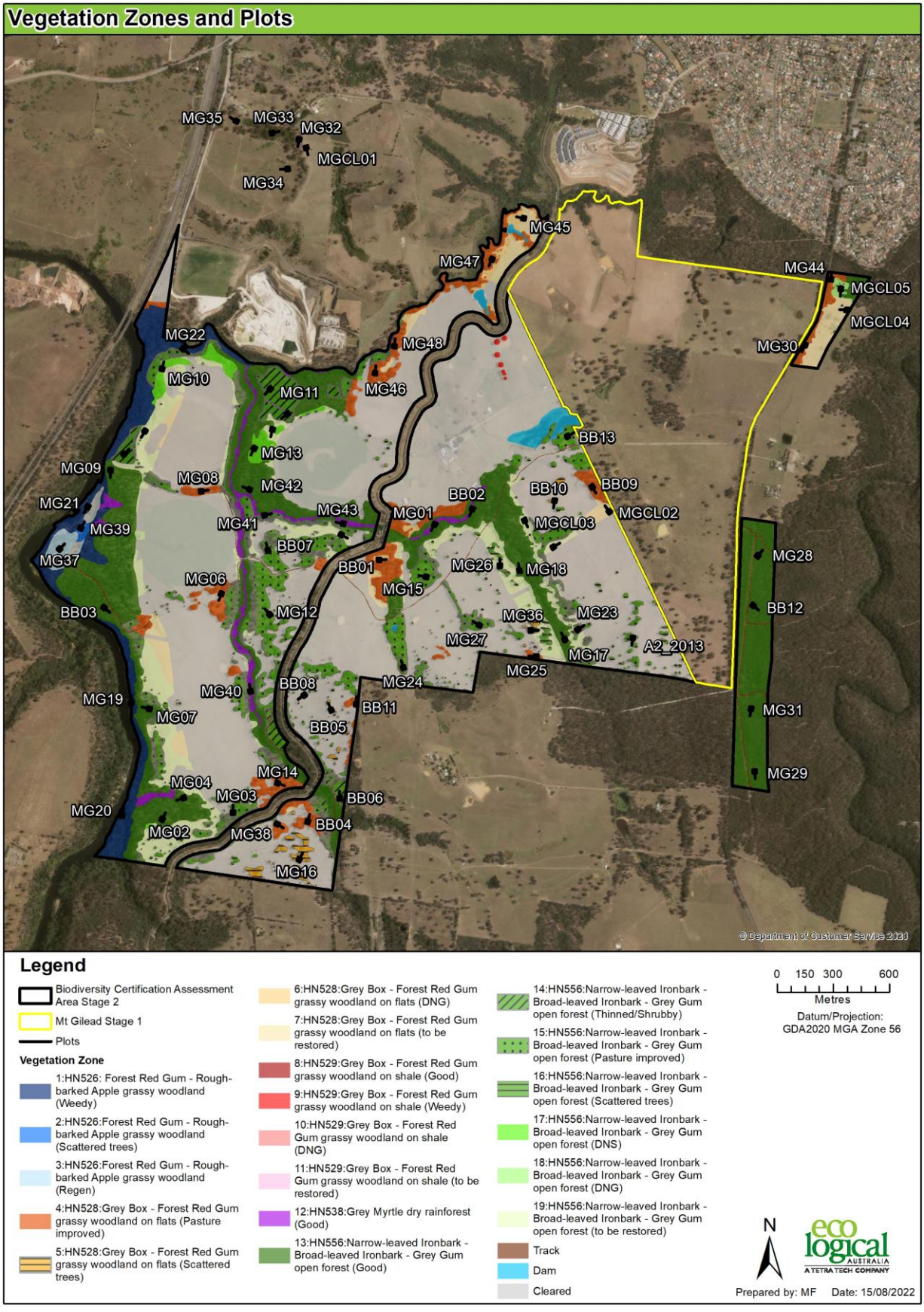


Figure 14 Vegetation Zones and plots as mapped by ELA 2015-2017 and refined 2020

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**.**

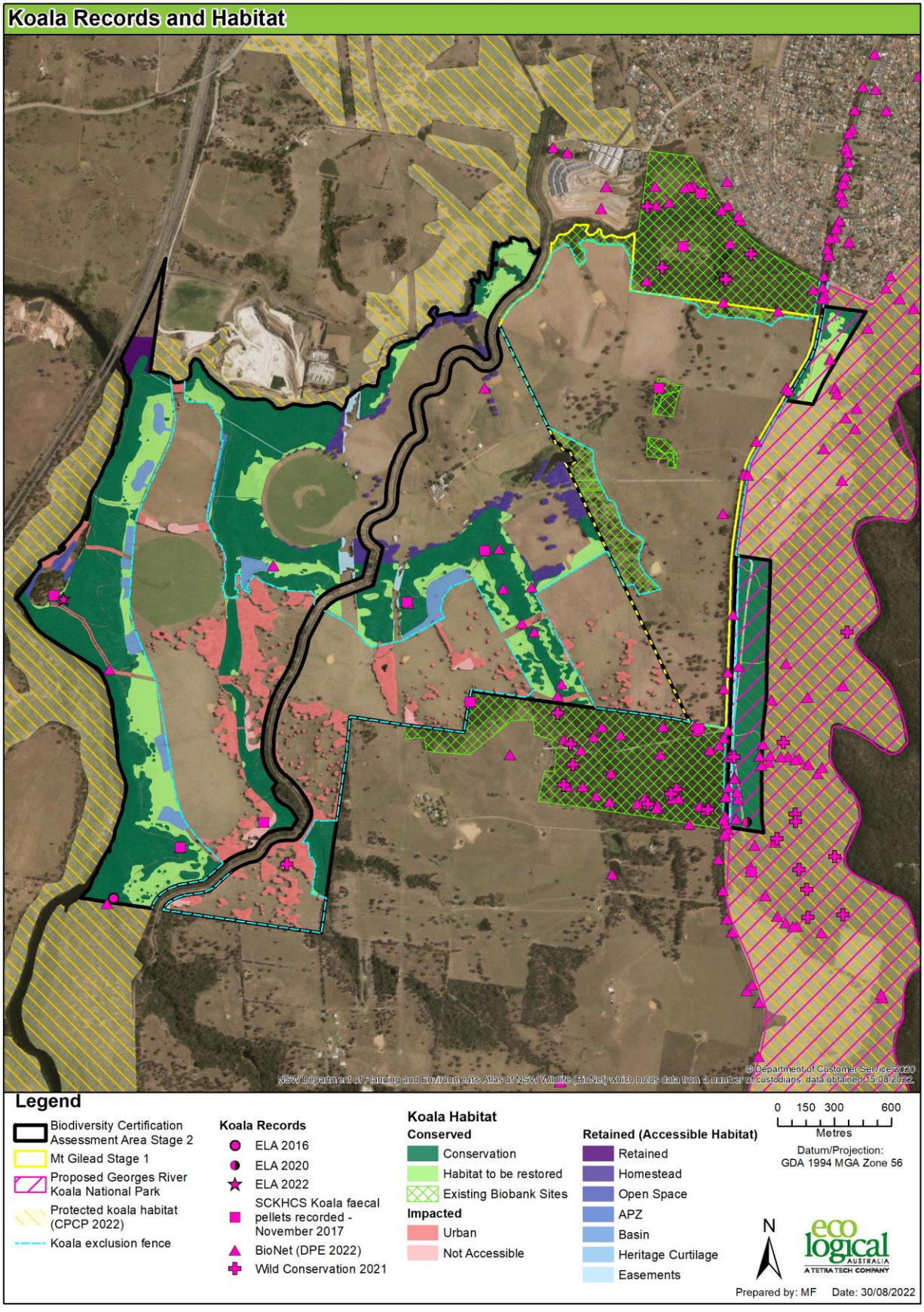


Figure 16 Records and habitat polygon for Koala within the BCAA

Figure 17: Records and habitat polygon for Squirrel Glider

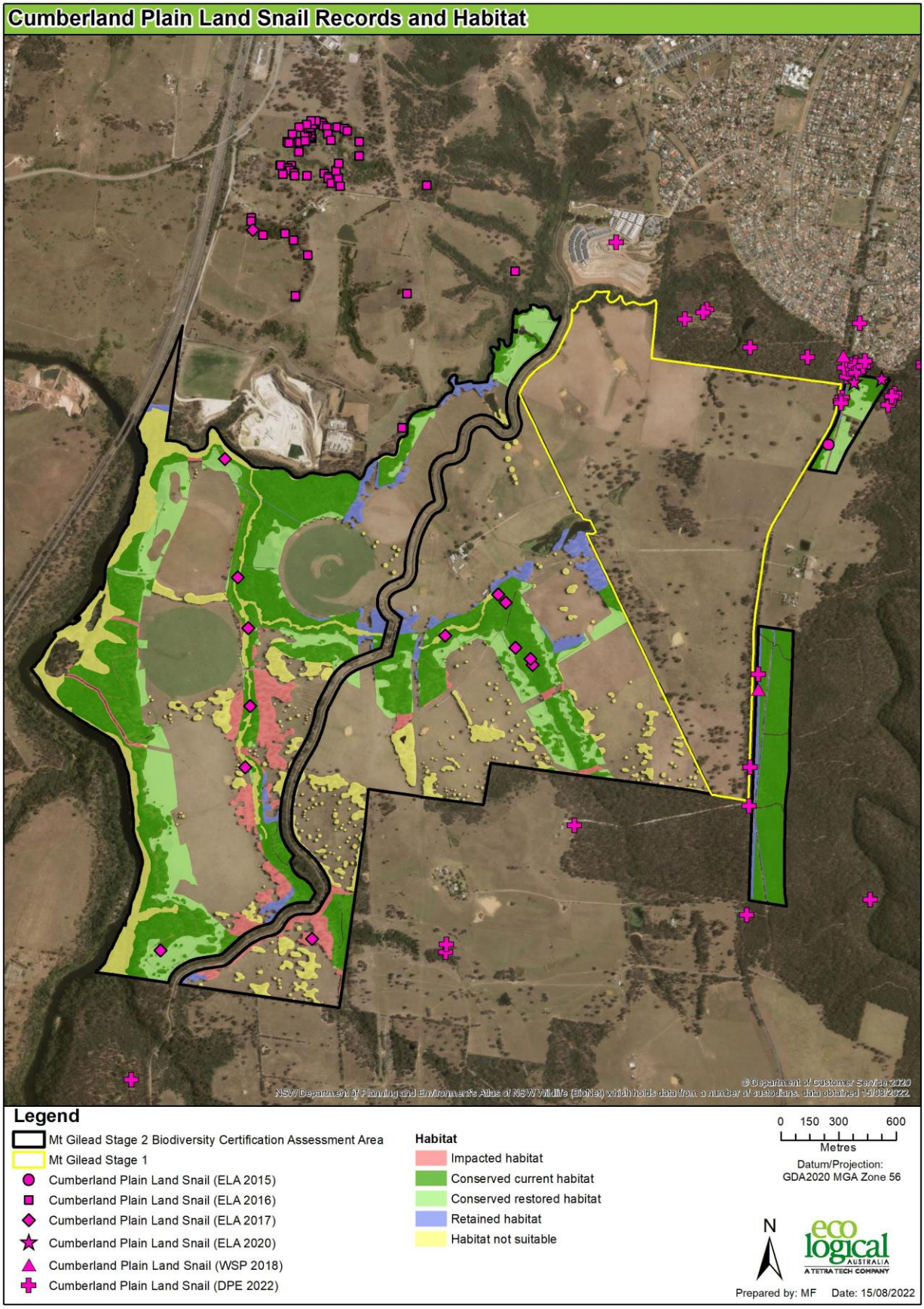


Figure 18: Records and habitat polygon for Cumberland Plain Land Snail

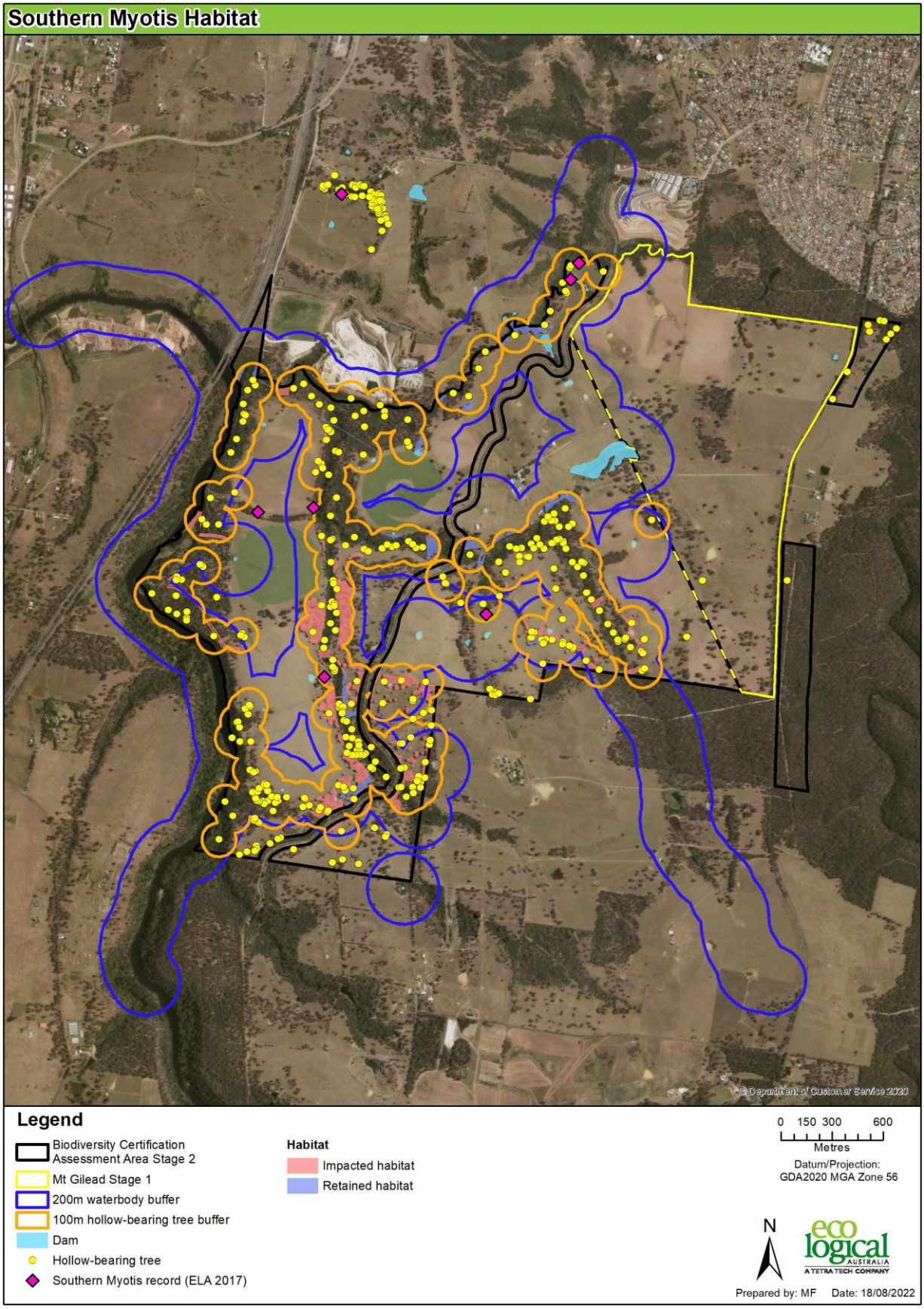


Figure 19: Records and habitat polygon for Southern Myotis prior to impacts and dam-dewatering

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

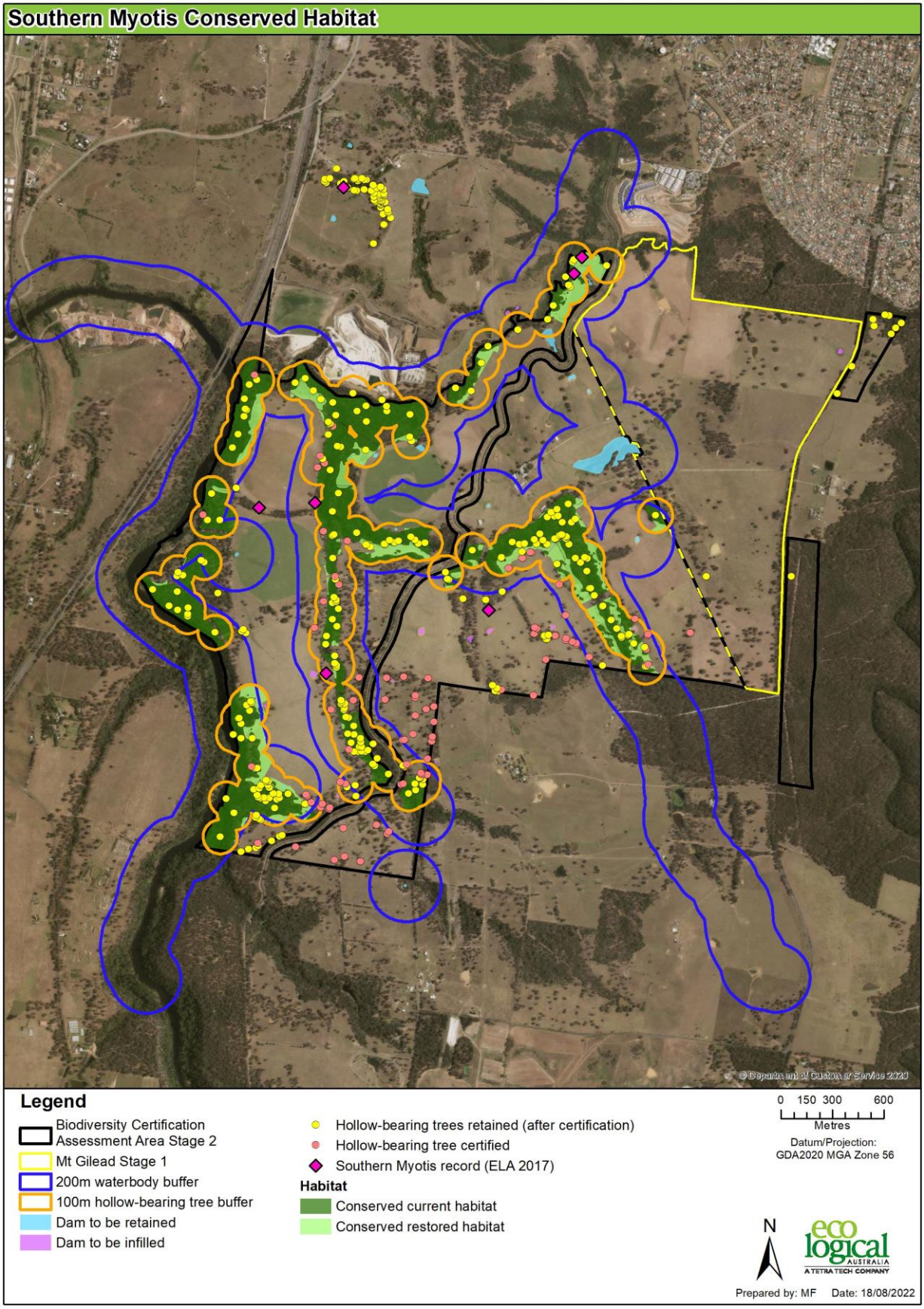


Figure 20: Records and habitat polygon for Southern Myotis post impacts, loss of hollow bearing trees and dam-dewatering

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**

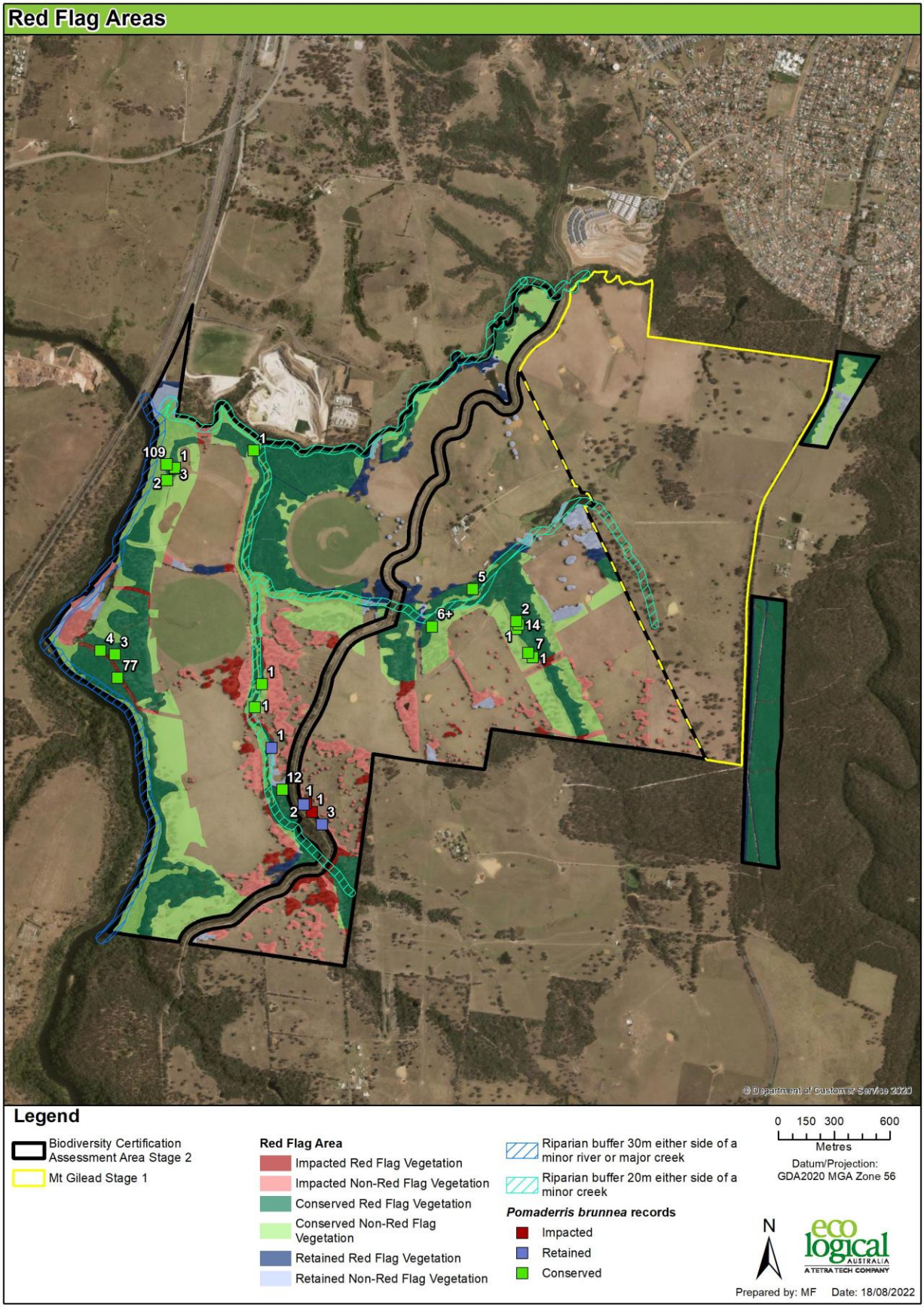


Figure 21: Red flag Vegetation, species and areas within the BCAA

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**.

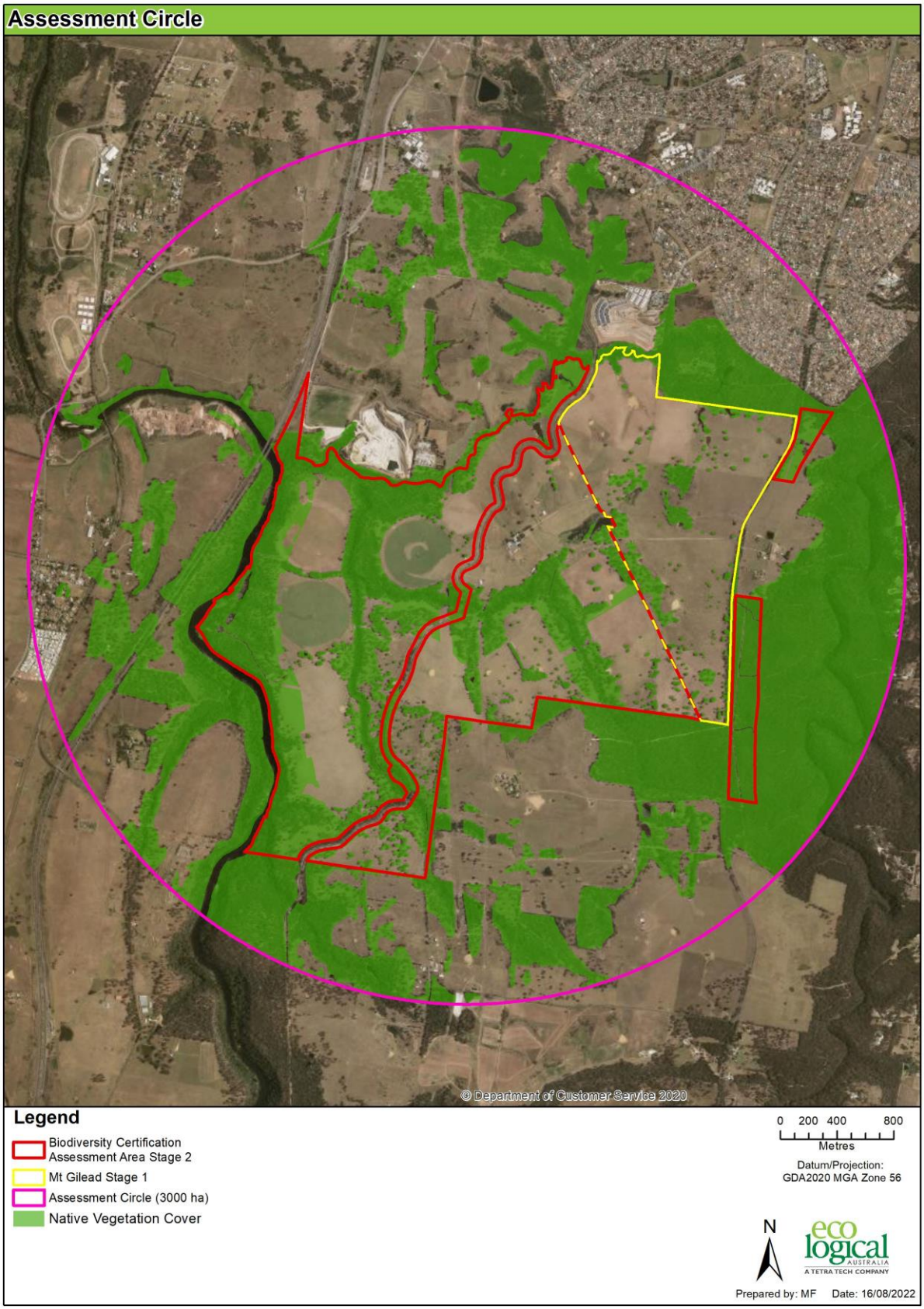


Figure 22: Assessment circle

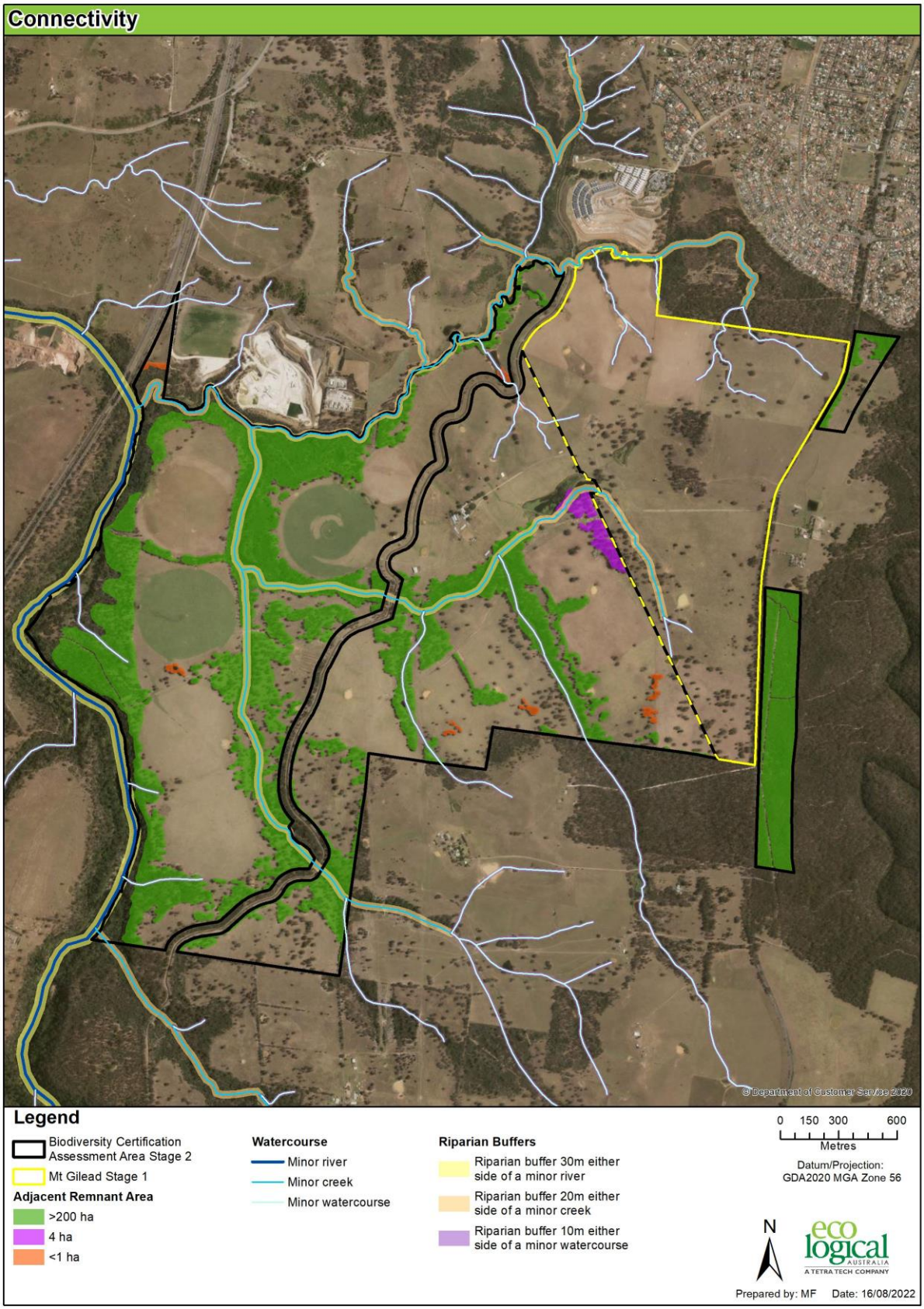


Figure 23: Connectivity

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

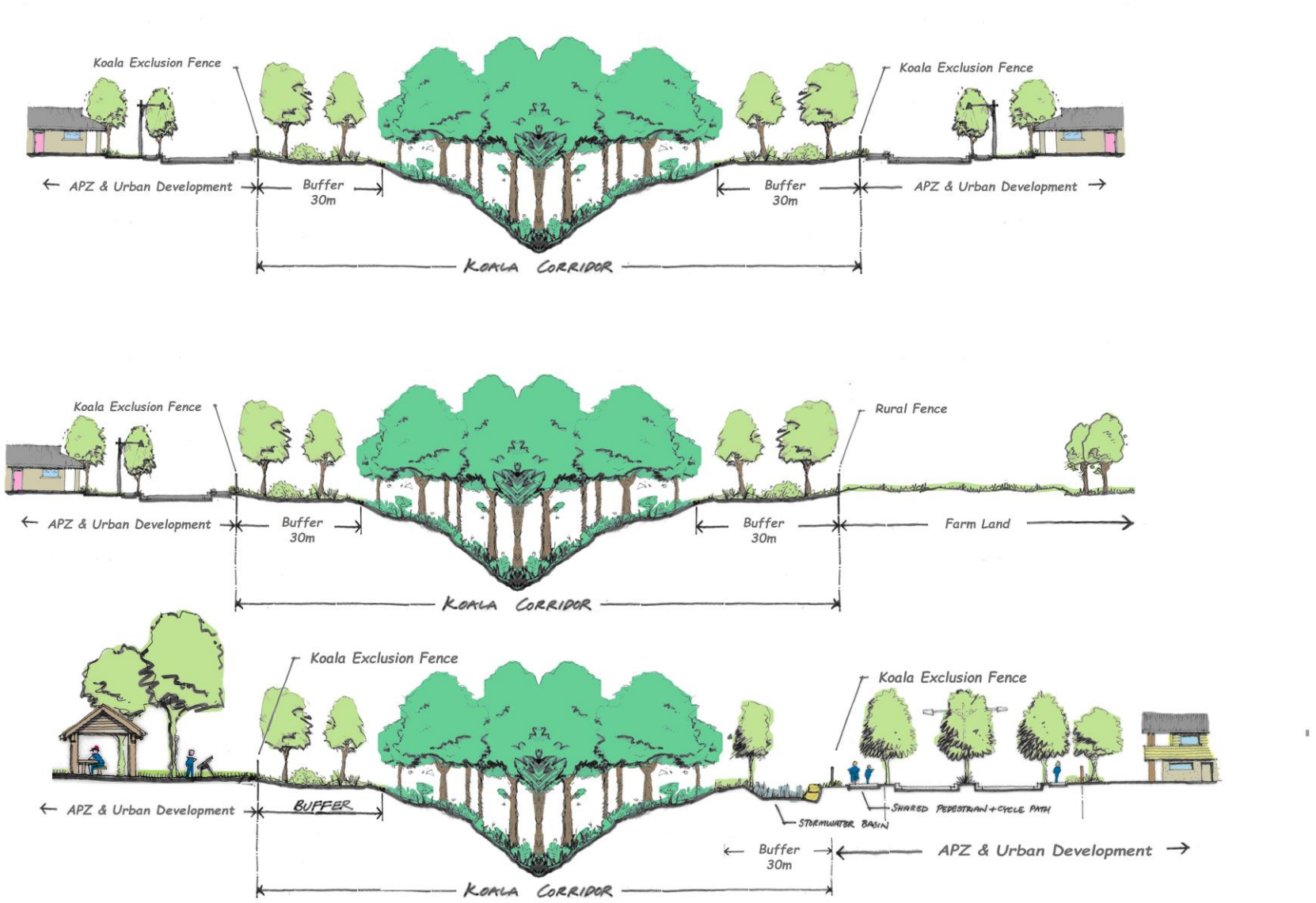
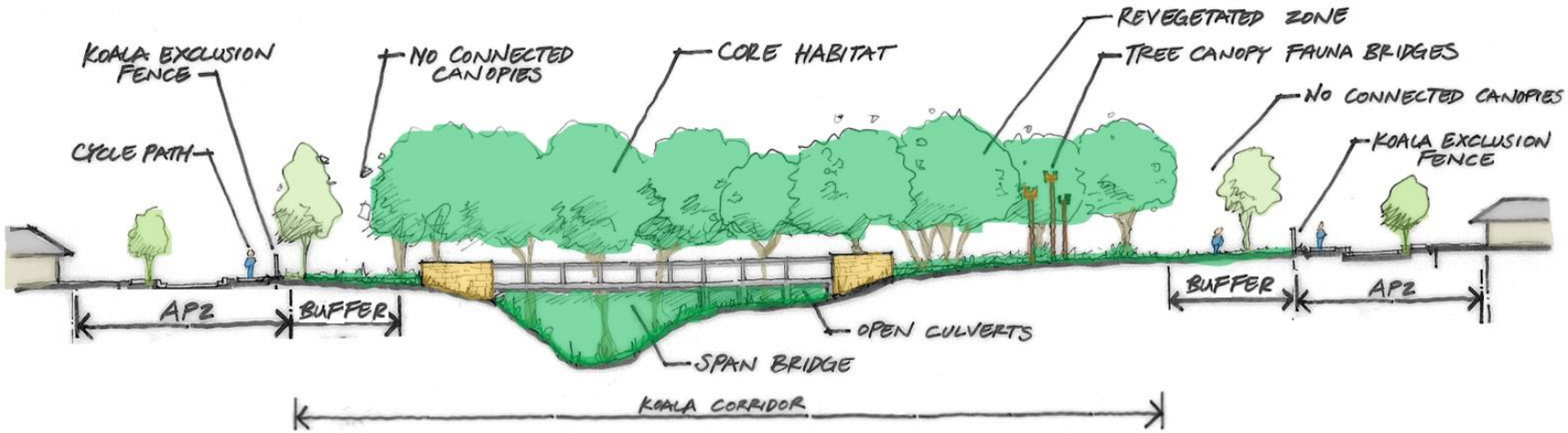


Figure 25: Typical interface of urban development, local open space and offset areas



WOODHOUSE CREEK BRIDGE

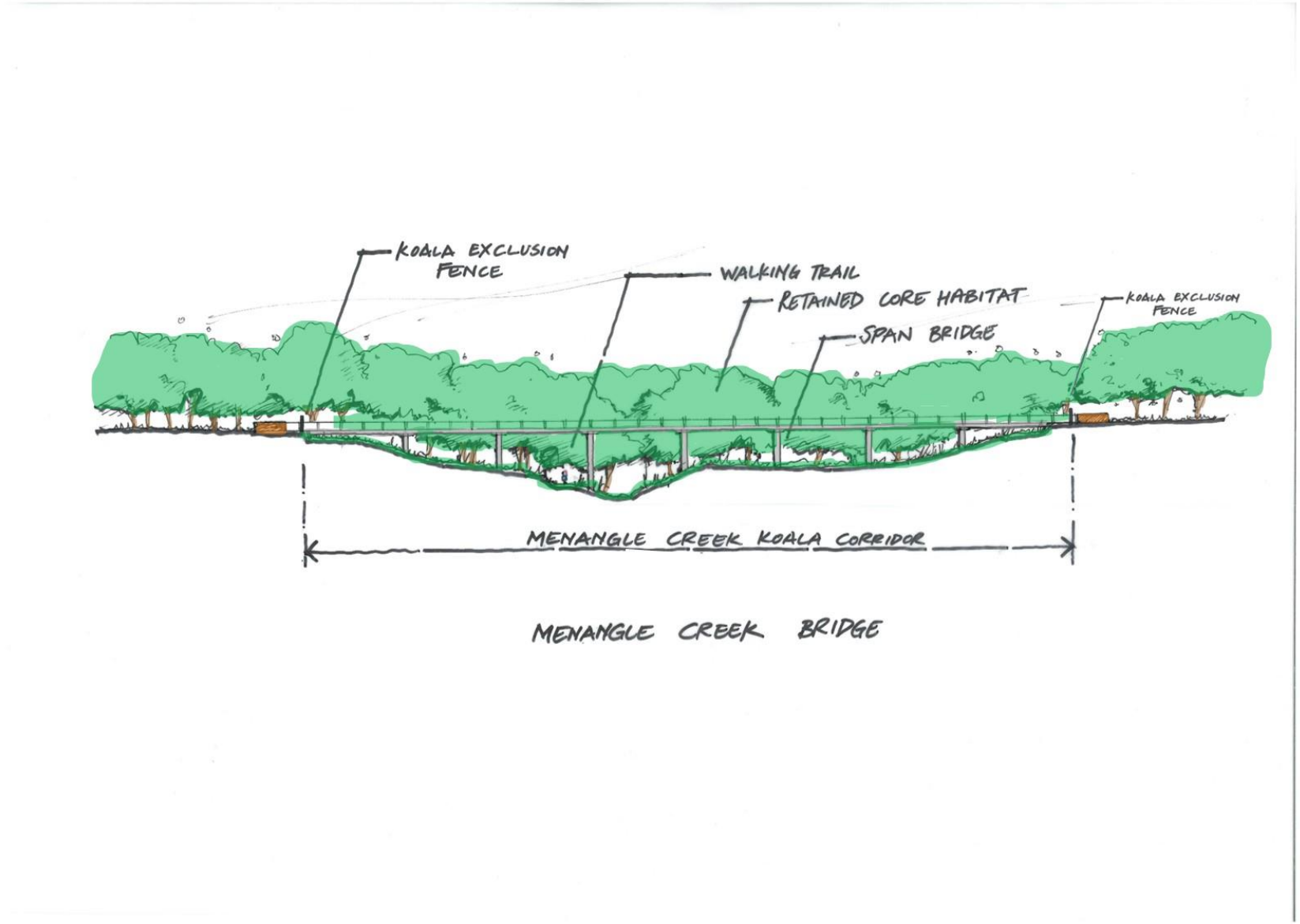


Figure 26: Typical cross section of creek crossing for Koala movement (Woodhouse and Menangle Creeks)

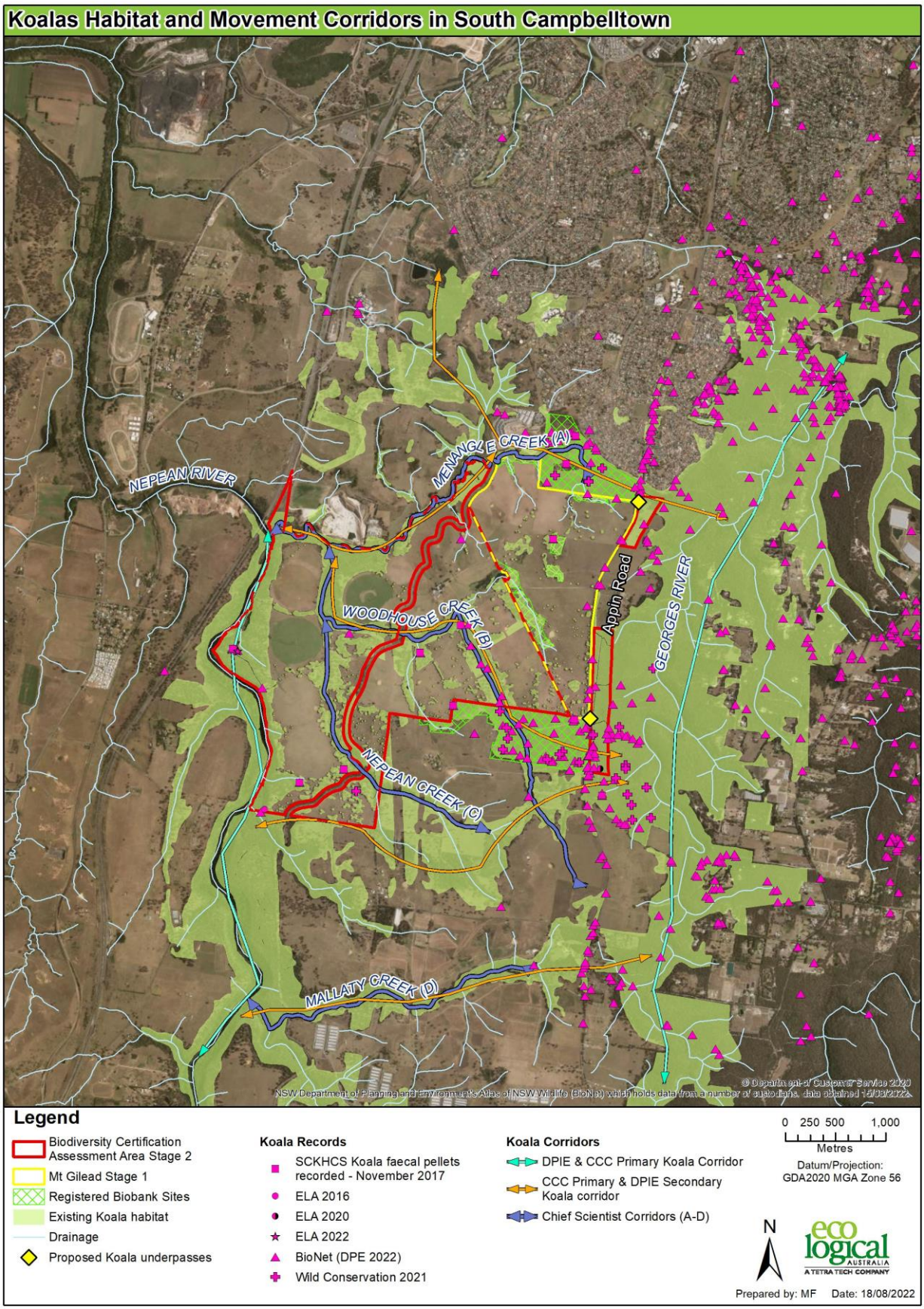


Figure 27 Koala records, habitat and movement corridors in the South Campbelltown Area as identified by CCC, DPIE & Chief Scientist

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	129
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	
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	101
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	
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	0
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	
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	997
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	
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**

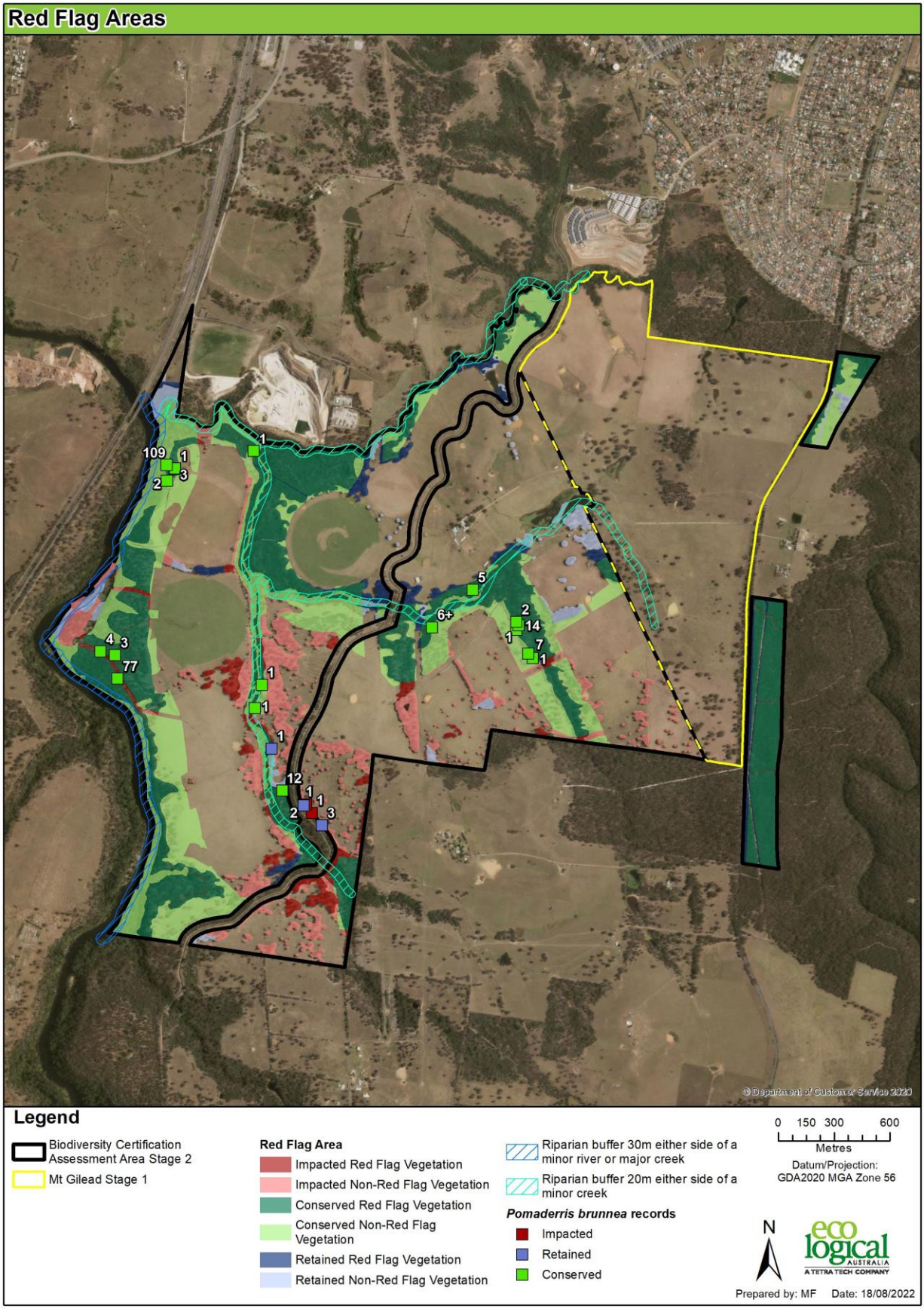


Figure 28: Impacted, conserved and retained red flag vegetation, species and areas of regional or state biodiversity conservation significance

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.

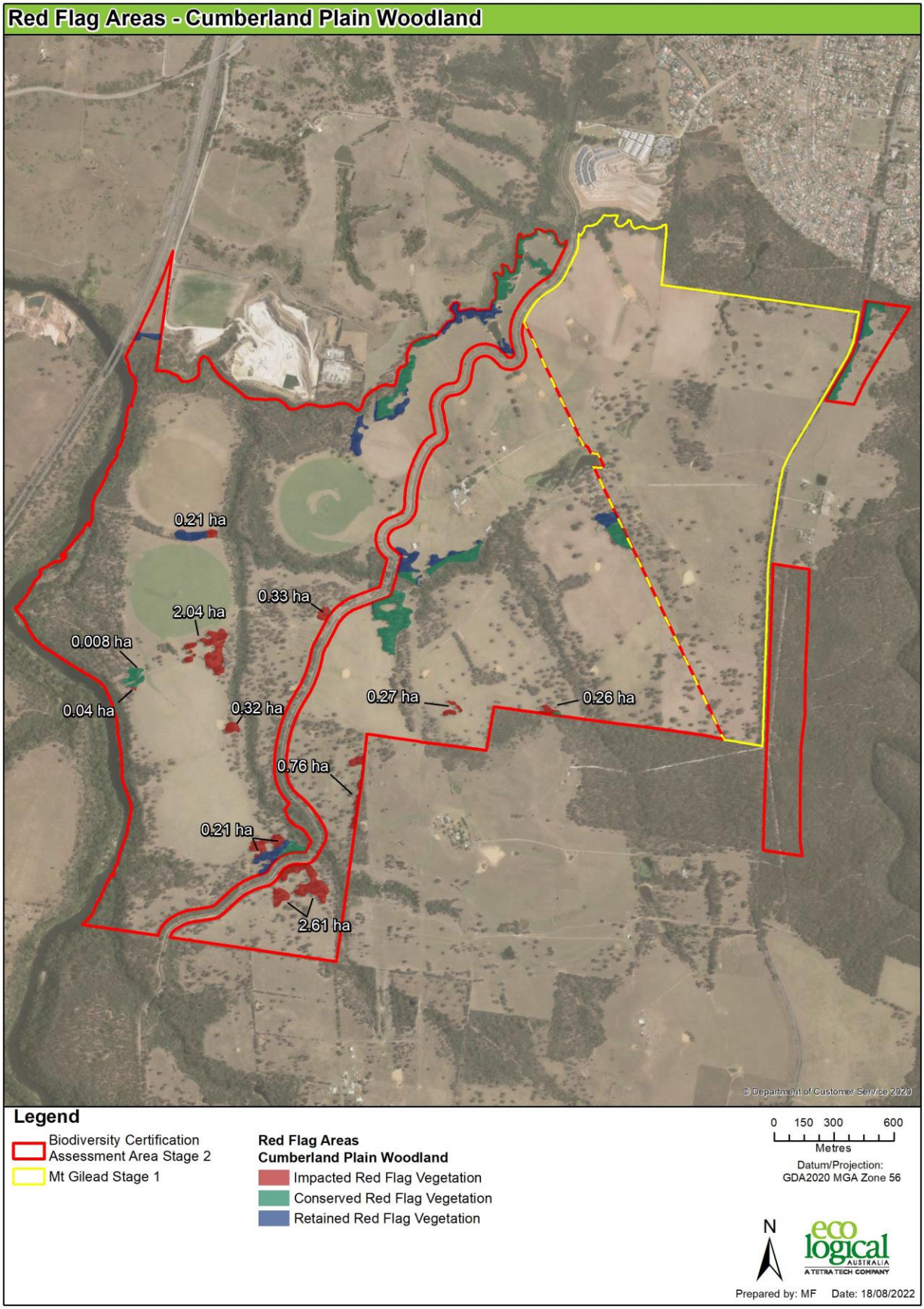


Figure 29: Distribution of impacted and protected Red Flag vegetation Patches 1 (CPW) within the BCAA

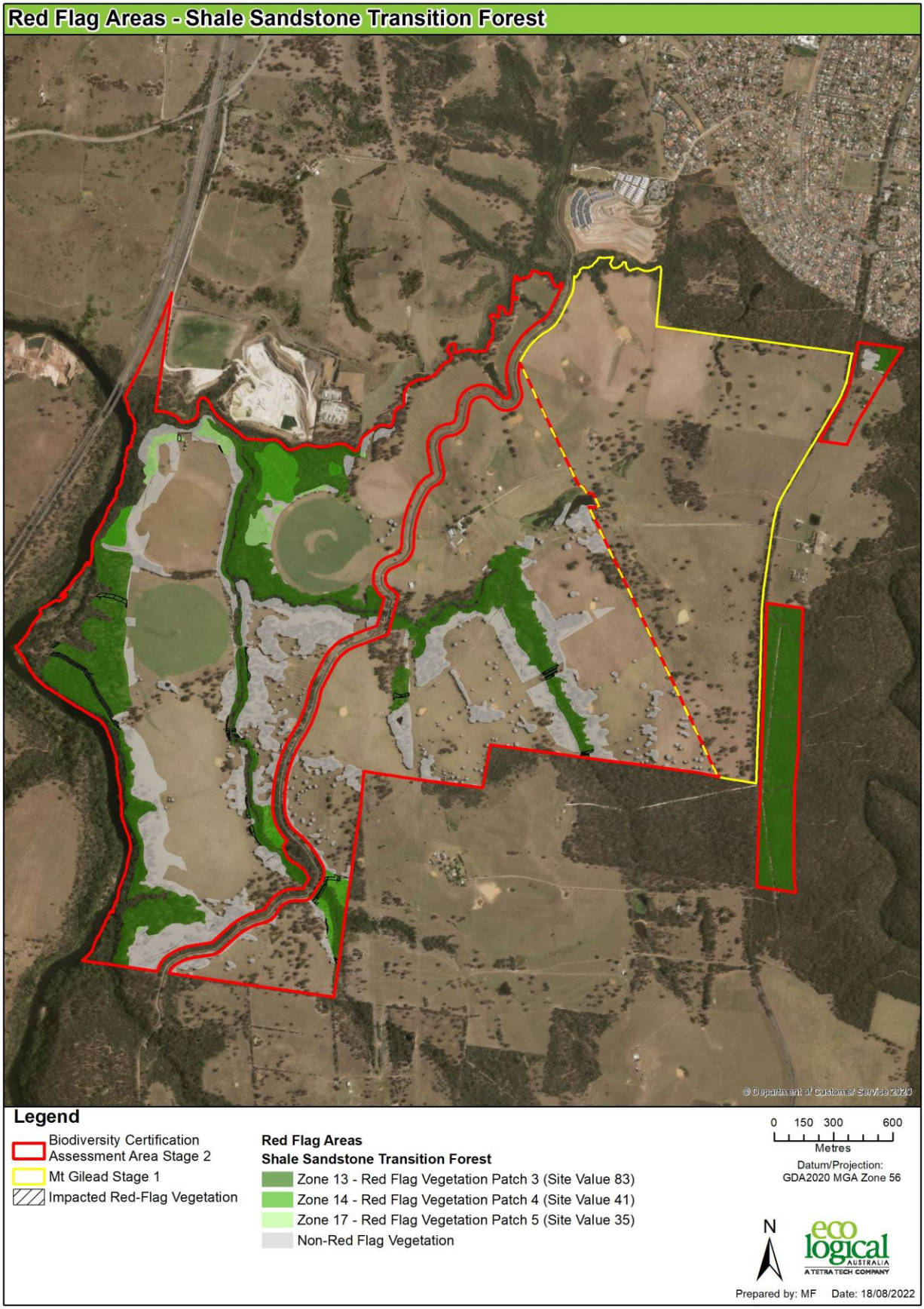


Figure 30: Distribution of impacted and protected Red Flag vegetation Patches 3, 4 and 5 (SSTF) within the BCAA

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

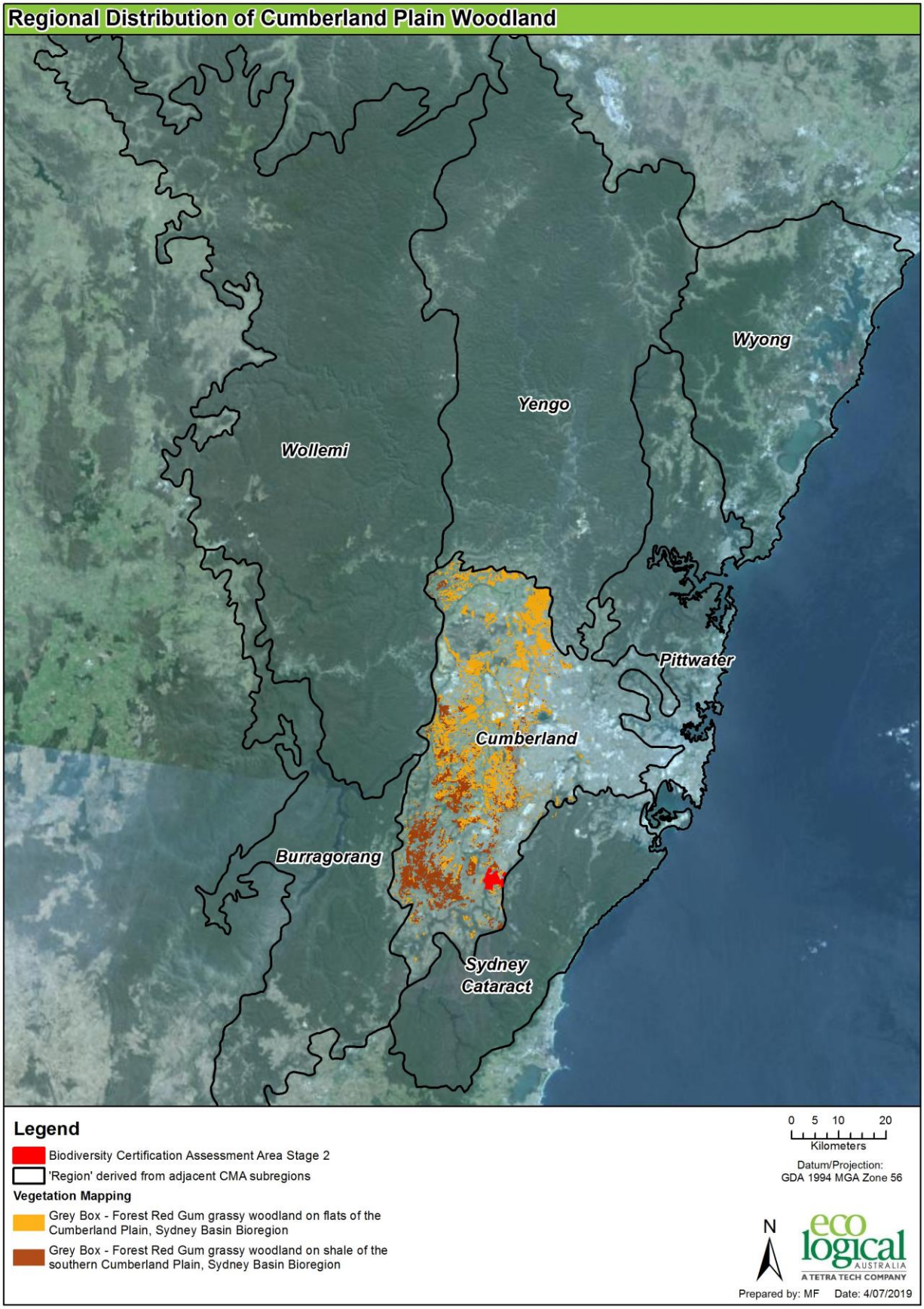


Figure 32: Regional distribution of red flag CPW vegetation

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.

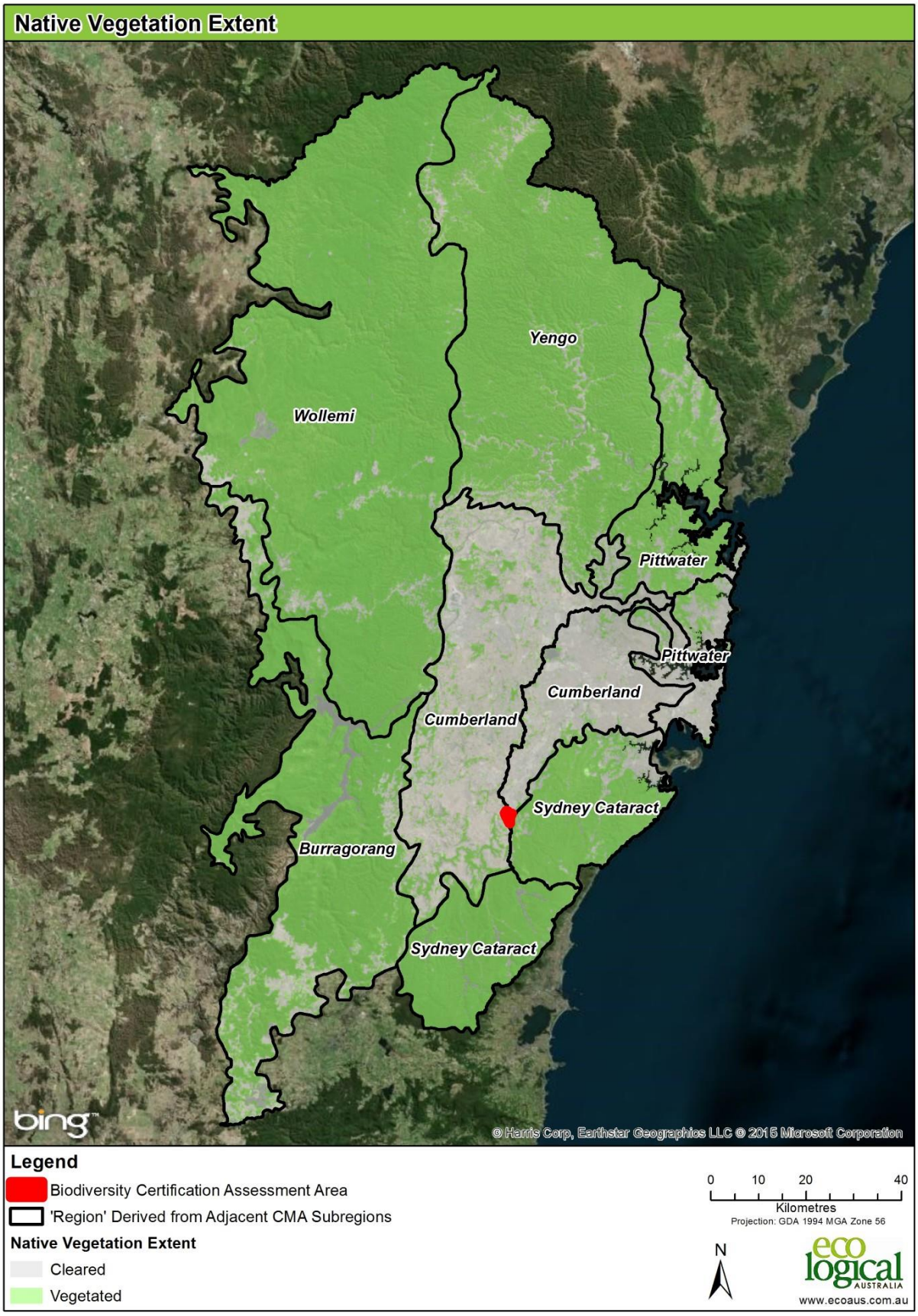


Figure 34: Native vegetation extent

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.

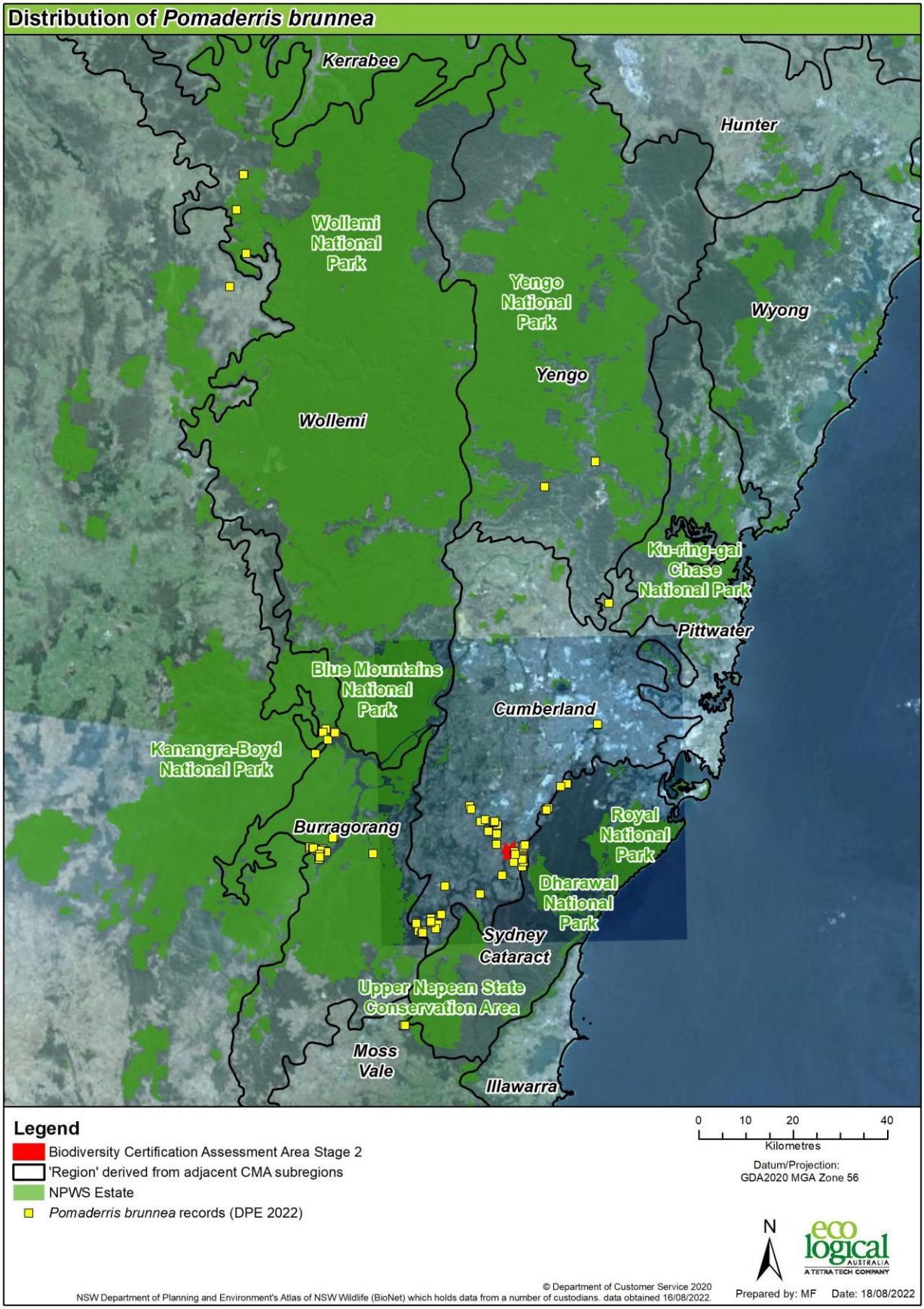


Figure 35: Regional distribution of *Pomaderris brunnea*

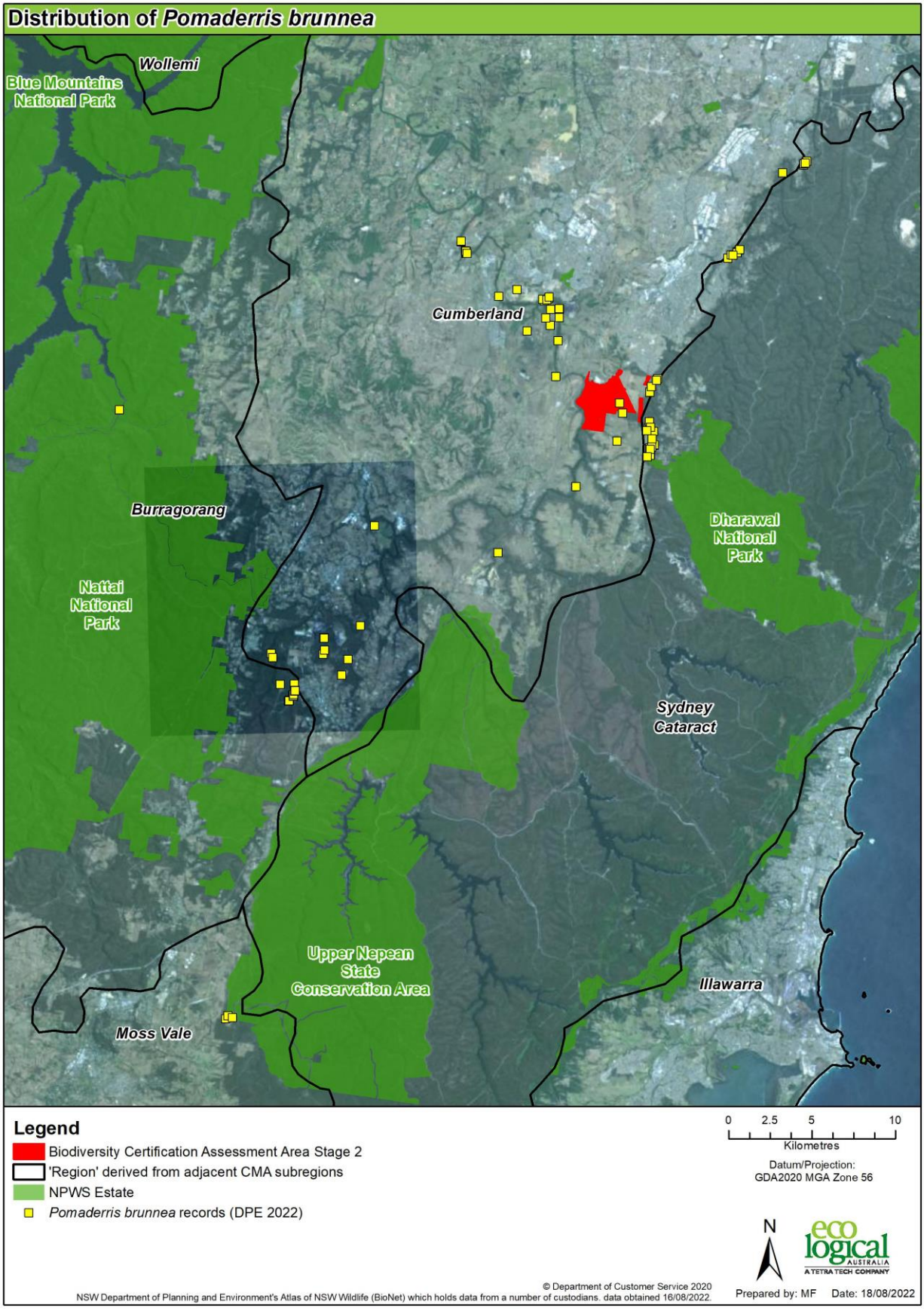


Figure 36: Regional (Camden to Bargo) distribution of *Pomaderris brunnea*

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.

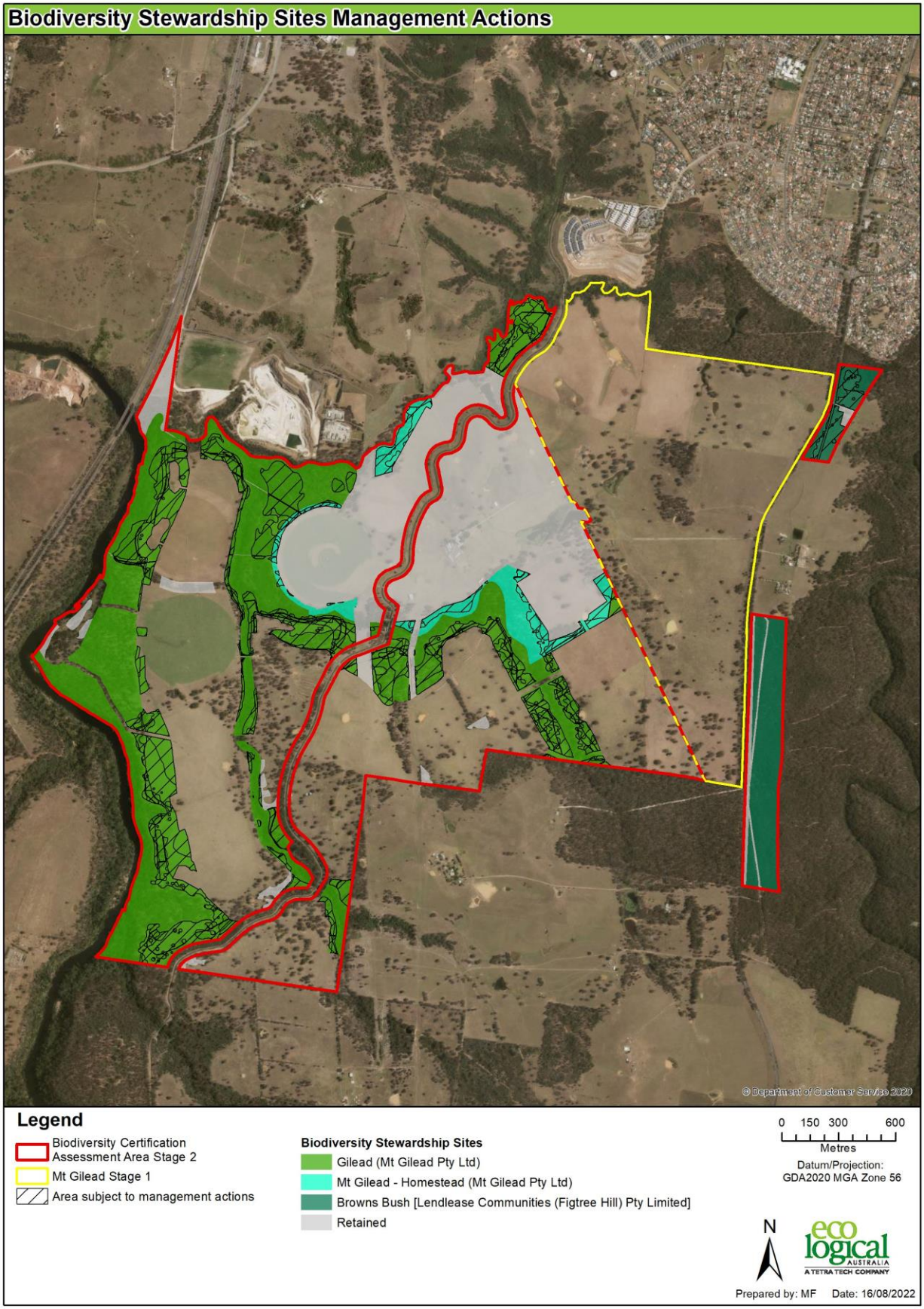


Figure 37: 'Additional' Management Actions (supplementary planting and habitat augmentation) within land proposed for conservation measures

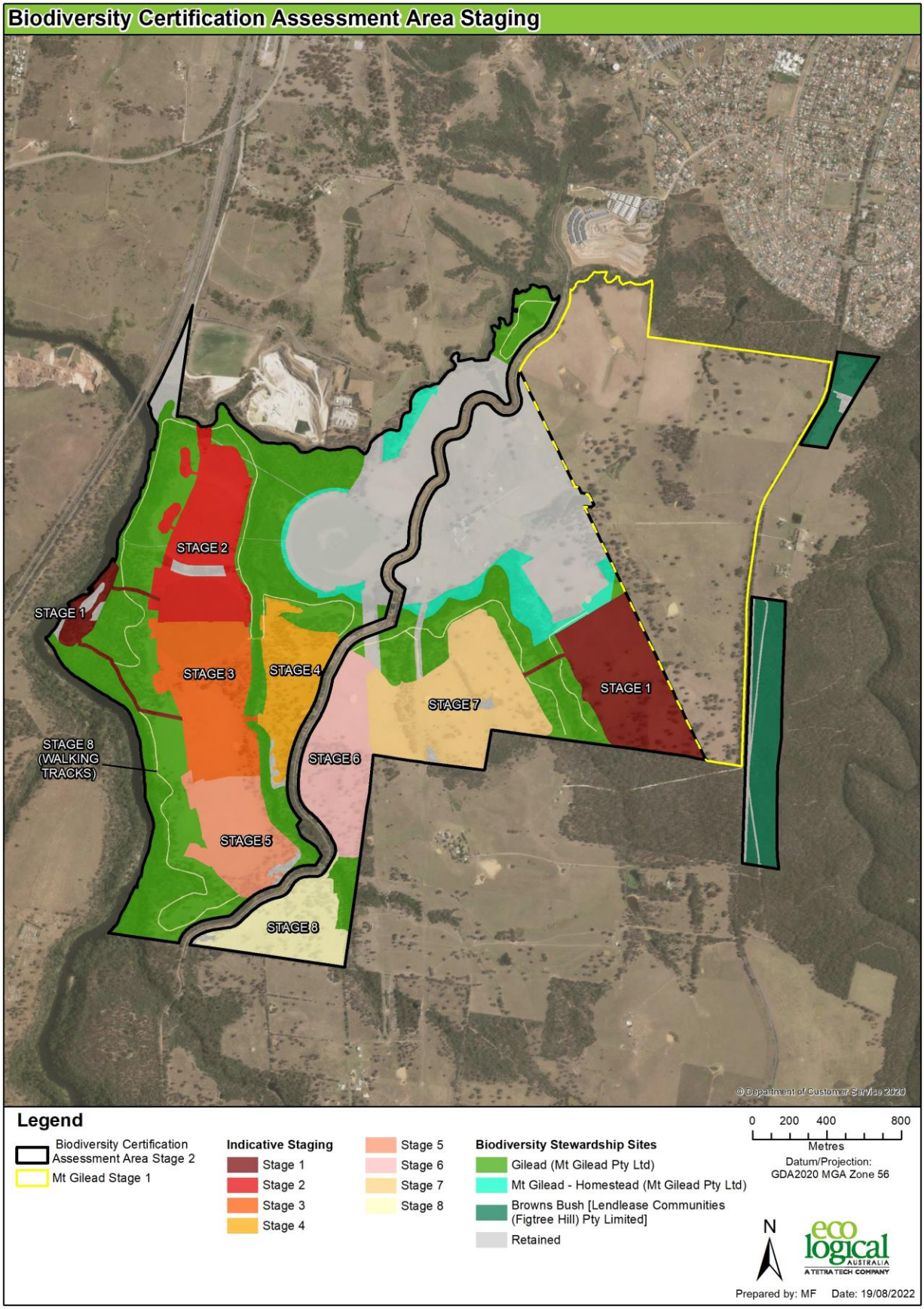


Figure 38:Indicative Staging of development

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	Longfinned eel			
Anguilla sp.	Shortfi			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	nEel			
Gambusia holbrooki	MosquitoFish			X
Amphibians				
Litoria dentata	BleatingTreeFrog			
Litoria fallax	EasternDwarfTreeF			

Scientific Name	CommonName	TSCAct	EPBCAct	Exotic
	rog			
Litoria latopalmata	BroadpalmedFrog			
Litoria lesueuri	Lesueur'sFrog			
Litoria peronii	Peron'sTreeFrog			
Litoria tyleri	Tyl			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	er's Tree Frog			
Litoria verreauxii	Verreaux's Frog			
Crinia signifera	Common Eastern Froglet			
Limnodynastes peronii	Strip			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	edMarshFrog			
Limnodynastes tasmaniensis	SpottedGrassFrog			
Uperoleia laevigata	SmoothToadlet			
Reptiles				
Amphibolurus muricatus	JackyLiza			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	rd			
Physignathus lesueurii	EasternWaterDragon			
Chelodina sp.	Long-NeckedTurtleSpeciesUnknown			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Cacophis squamulosus	Golden-crowned Snake			
Pseudechis porphyriacus	Red-bellied Black Snake			
Diplodactylus vittatus	Wood Gecko			
Phyllurus platurus	Br			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	oad-tailedGecko			
Ctenotus taeniolatus	Copper-tailedSkink			
Eulamprus quoyii	EasternWater-skink			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Eulamprus tenuis	Barred-sided Skink			
Lampropholis delicata	Dark-flecked Garden Sunskink			
Lampropholis guichenoti	Pale-fle			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	cked Garden Sunskink			
Varanus varius	Lace Monitor			
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			

Scientific Name			Common Name	TSC Act	EPBC Act	Exotic
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					
Eolophus roseicapillus	Galah					
Eurystomus orientalis	Dollarbird					
Falco cenchroides	Nankeen Kestrel					
Falco peregrinus	Peregrine Falcon					

Scientific Name			Common Name	TSC Act	EPBC Act	Exotic
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					

Scientific Name			Common Name	TSC Act	EPBC Act	Exotic
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					
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			

Scientific Name			Common Name	TSC Act	EPBC Act	Exotic
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/BrownAntec			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	hinus			
Bos taurus	European cattle			X
Equus caballus	Horse			X
Lepus capensis	Brown Hare			X
Oryctolagus cuniculus	Rabbit			X
Macropus giganteus	Eastern Grey			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	Kangaroo			
Macropus robustus	Common Wallaroo			
Wallabia bicolor	Swamp Wallaby			
Rattus fuscipes	Bush Rat			
Rattus rattus	Black Rat			X

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Petaurus breviceps	Sugar Glider			
Petaurus norfolcensis	Squirrel Glider	Vulnerable		
Trichosurus vulpecula	Common Brushtail Possum			
Phascolarctos cinereus	Koala	Vulne	Vulne	

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
		rable	rable	
Pseudocheirus peregrinus	Common Ringtail Possum			
Vombatus ursinus	Common Wombat			
Vulpes vulpes	European Fox			X
Mammals (flying - megachiropertran and microchripteran				

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	Vulnerable		
Ozimops (*Mormopterus) ridei*	South-eastern Free tail Bat			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
Micronomus (*Mormopterus*) *norfolkensis*	Eastern Coastal Free-tailed Bat	Vulnerable		
Austronomus australis	White-striped Free-tail-b			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	at			
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Vulnerable	
Rhinolophus megaphyllus	Eastern Horseshoe-bat			
Chalinolobus dwyeri	Large-ea	Vulnerab	Vulnerab	

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	redPiedBat	le	le	
Chalinolobus gouldii	Gould'sWattledBat			
Chalinolobus morio	ChocolateWattledBat			
Falsistrellus tasmaniensis	Easte	Vulne		

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	rnFalsePipistrelle	rable		
Miniopterus australis	LittleBentwing-bat	Vulnerable		
Miniopterus schreibersii oceanensis	EasternBentwing	Vulnerable		

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	-bat			
Myotis macropus	Southern Myotis	Vulnerable		
Nyctophilus spp.	long-eared bat			
Scoteanax rueppellii	Greater Broad-nosed B	Vulnerable		

Scientific Name	CommonName	TSCAct	EPBCAct	Exotic
	at			
Scotorepens orion	EasternBroad-nosedBat			
Vespadelus pumilus	EasternForestBat			
Vespadelus vulturnus	LittleForest			

Scientific Name	Common Name	TSC Act	EPBC Act	Exotic
	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 so urce 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

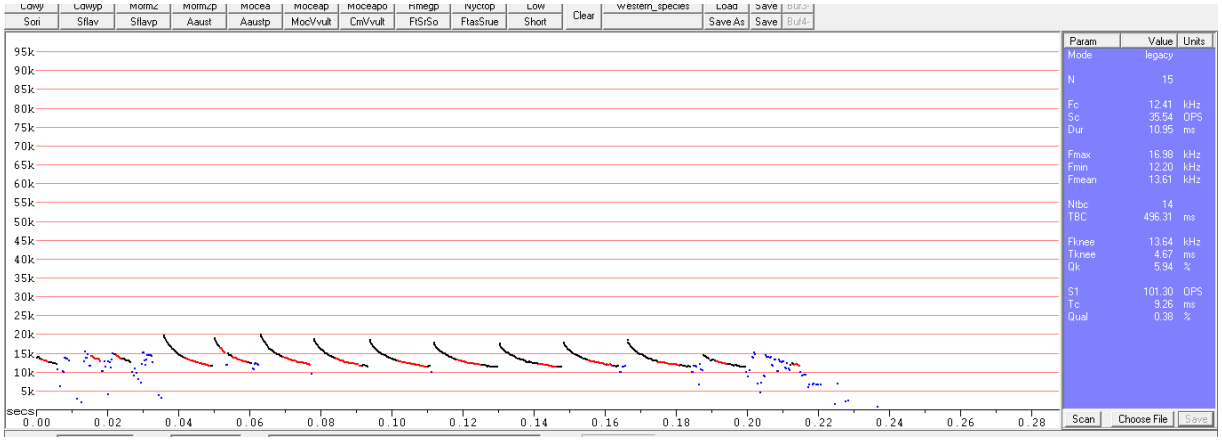

Figure 39: Call profile for *Austronomus australis* (White-striped Freetail Bat)

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

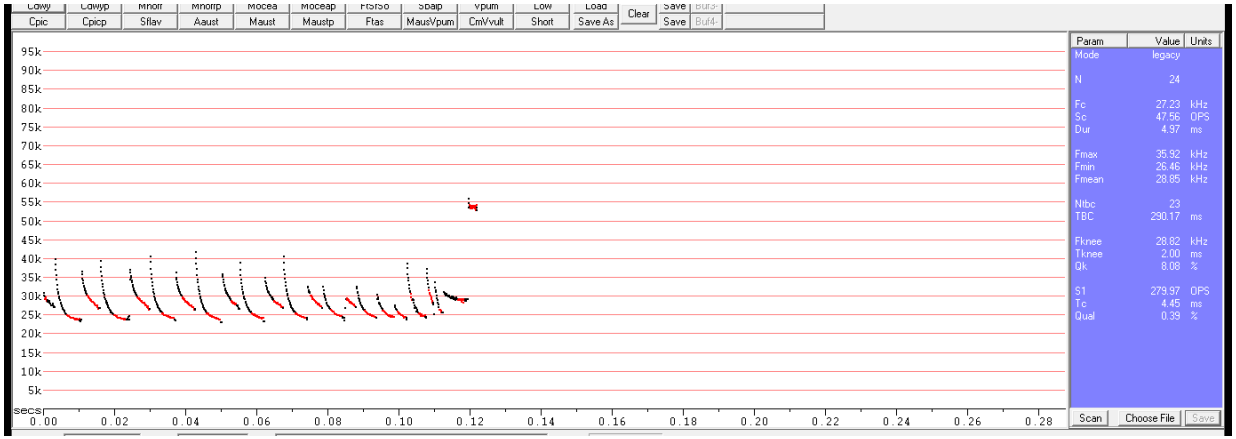

Figure 40: Call profile for *Chalinolobus dwyeri* (Large-eared Pied Bat)

Recorded at Site 6 which was set in a thin Ironbark woodland (SN81781) at 2011 (8.11 pm), 8 January 2017

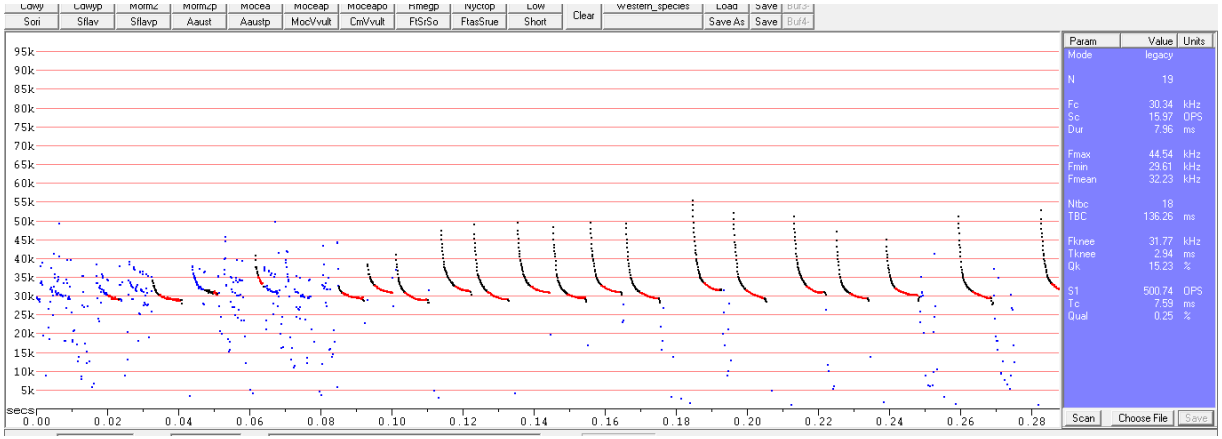

Figure 41: Call profile for *Chalinolobus gouldii* (Gould's Wattled Bat)

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

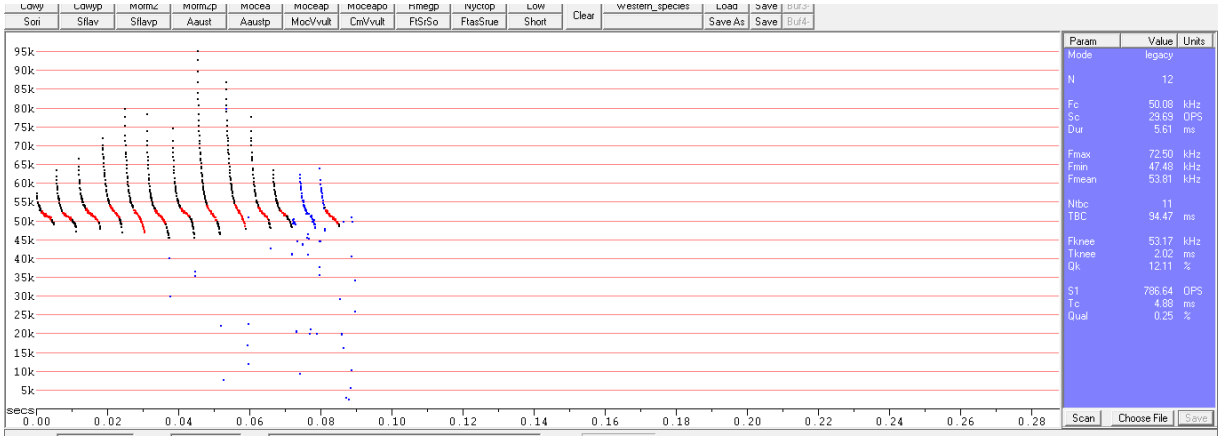

Figure 42: Call profile for *Chalinolobus morio* (Chocolate Wattled Bat)

Recorded at Site 3 which was set on edge of pasture habitat and creek (SN81997), at 0430 (4.30 am) 12 January 2017

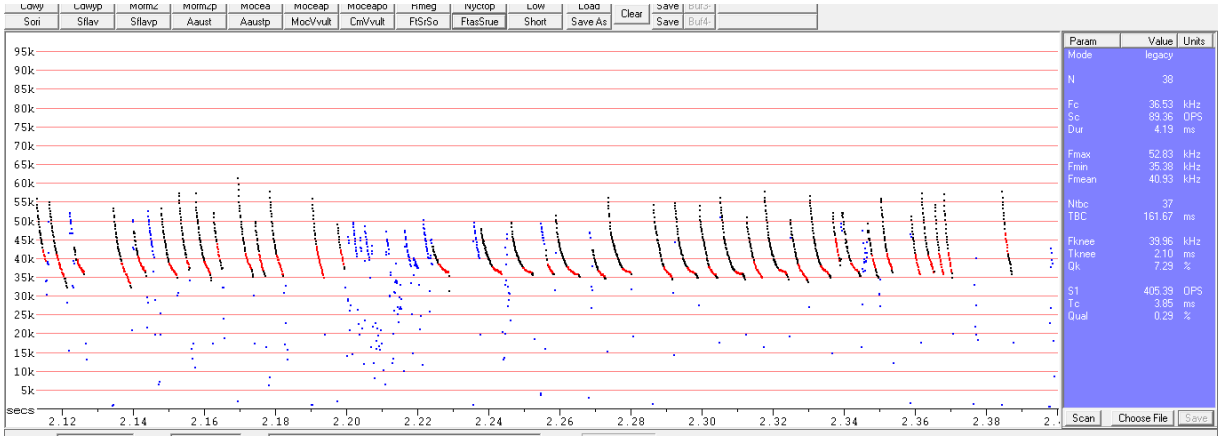

Figure 43: Call profile for *Falsistrellus tasmaniensis* (Eastern False Pipistrelle)

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

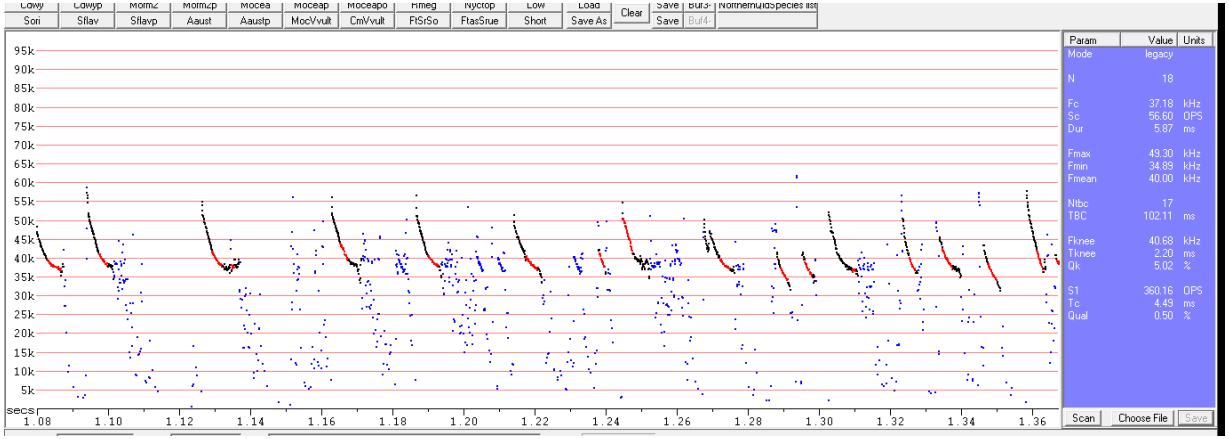

Figure 44: Possible call profile for *Falsistrellus tasmaniensis* (Eastern False Pipistrelle), *Scoteanax rueppellii* (Greater Broad-nosed Bat) and *Scotorepens orion* (Eastern Broad-nosed Bat)

Recorded at Site 1 set among weed infested Eucalyptus moluccana woodland (SN81081) at 2041 (8.41 pm), 12 January 2017

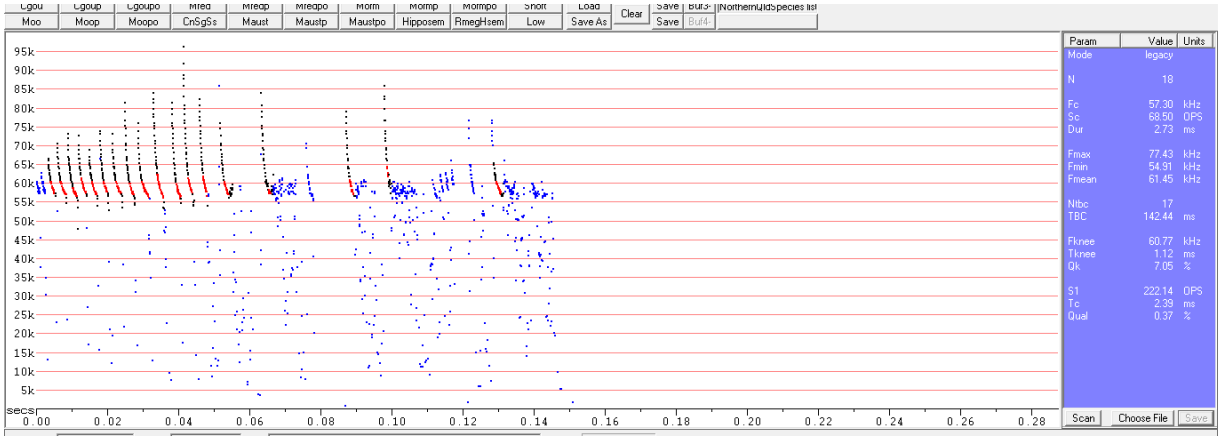

Figure 45: Call profile for *Miniopterus australis* (LIttle Bentwing Bat)

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

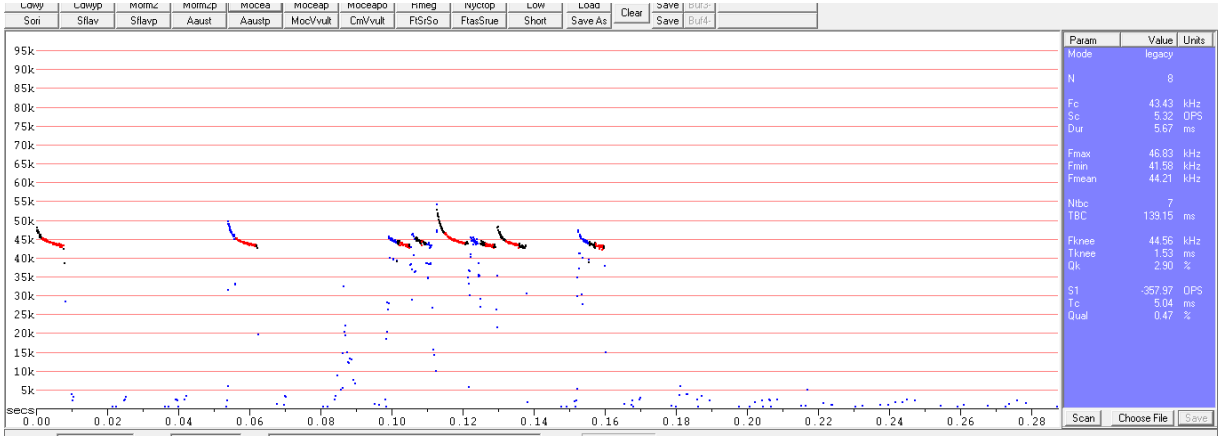

Figure 46: Call profile for *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat)

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

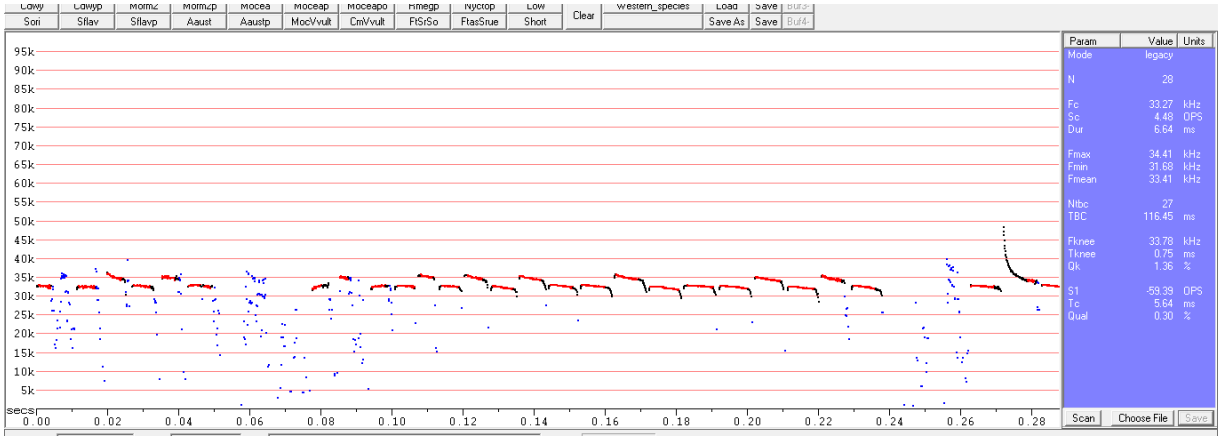

Figure 47: Call profile for *Mormopterus* (*Micronomus) norfolkensis* (Eastcoast Freetail Bat)

Recorded at Site 8 set open woodland among the conservation zone (SN81147) at 2011 (8.11 pm) 16 December 2016

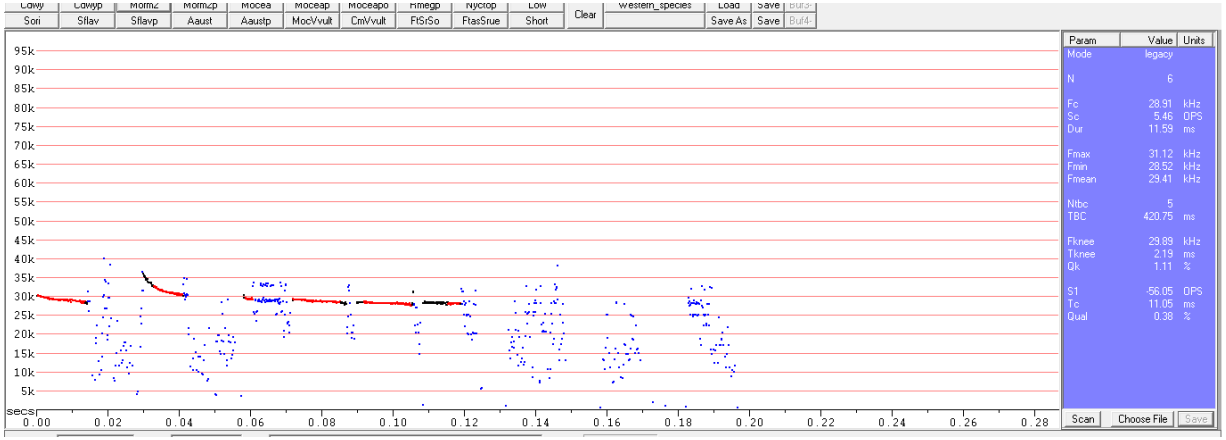

Figure 48: Call profile for *Mormopterus* (*Ozimops) ridei* (Eastern Freetail Bat)

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

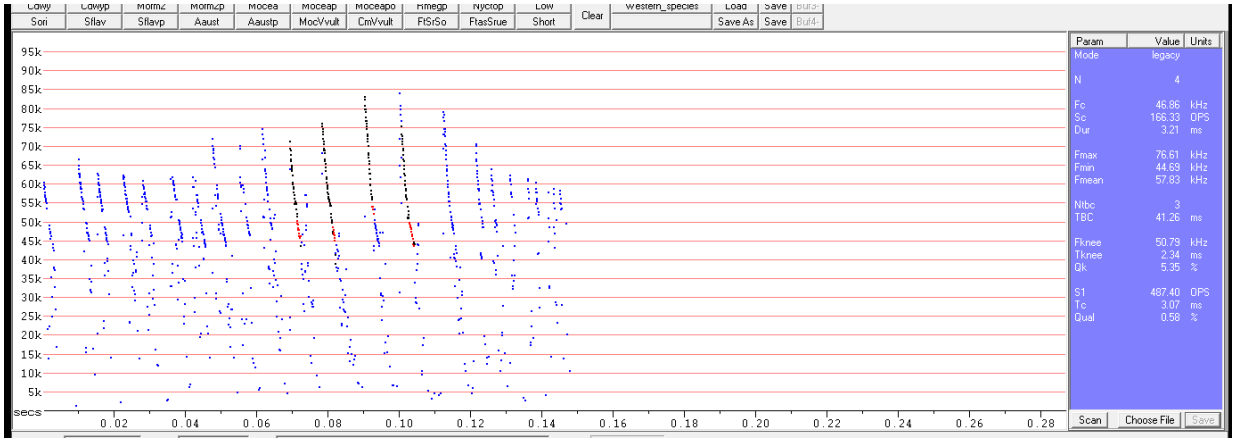

Figure 49: Call profile for *Myotis macropus* (Large-footed Myotis)

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

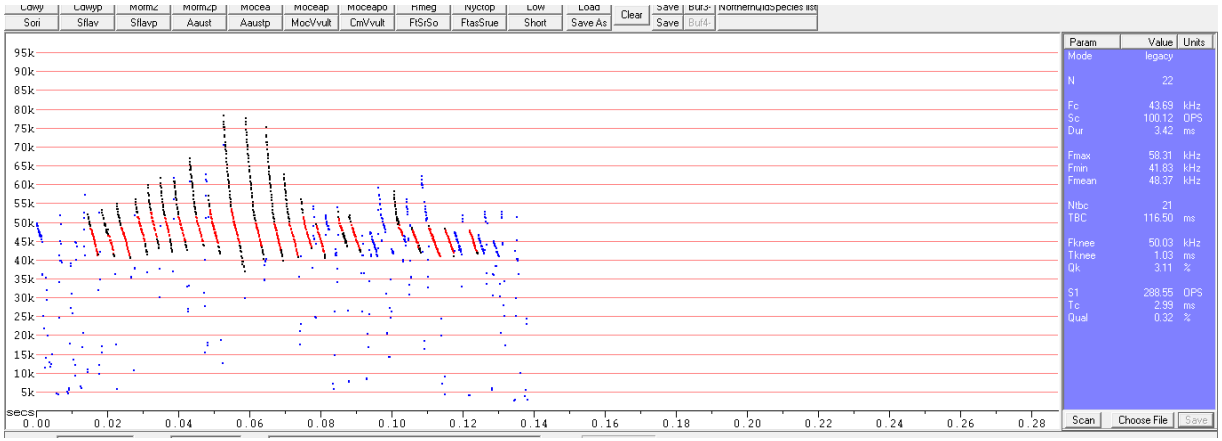

Figure 50: Call profile for *Nyctophilus spp.* (Long-eared Bat)

Recorded at Site 14 set among pasture surrounded by woodland (SN81997), at 2214 (8.14 pm), 14 December 2016

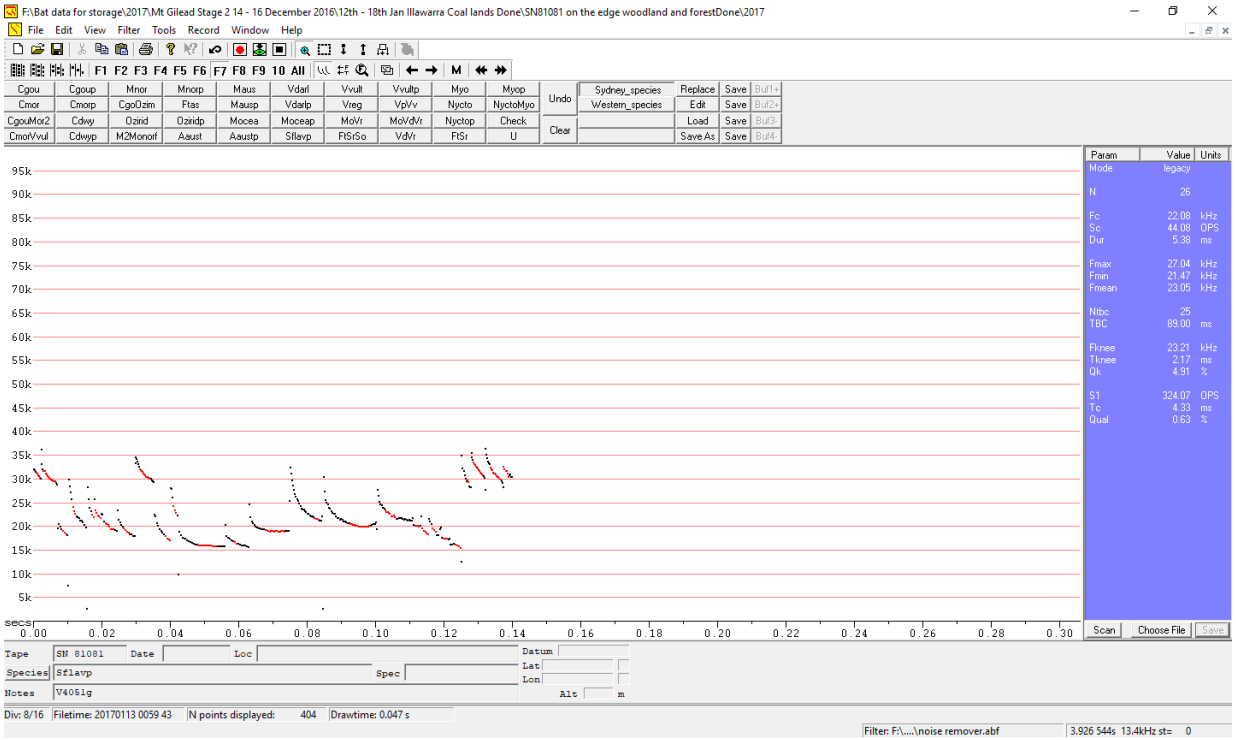

Figure 51: Potential call profile for *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) (lower frequency call) and *Chalinolobus gouldii* (Gould's Wattled Bat) / *Ozimops ridei* (Ride's Free-tailed Bat) call (higher frequency)

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

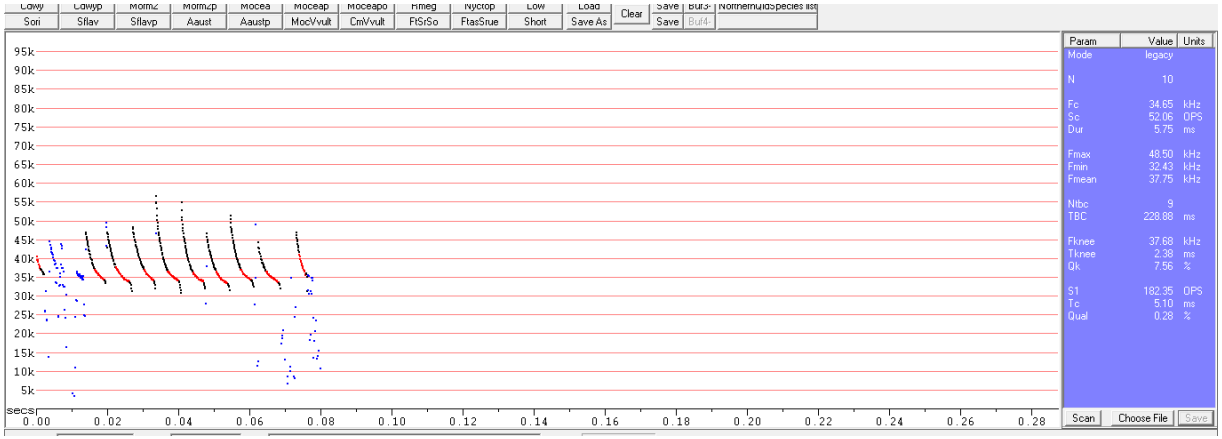

Figure 52: Call profile for *Scotorepens orion* (Eastern Broad-nosed Bat)

Recorded at Site 14 located in pasture that is surrounded by woodland (SN81997), at 2338 (11.38 pm) 14 January 2017

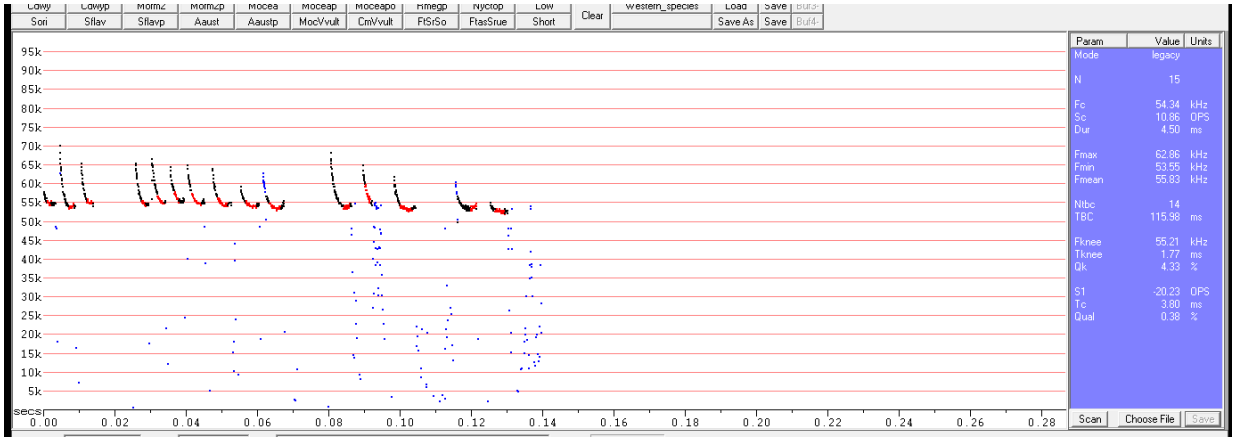

Figure 53: Call profile for *Vespadelus pumilus* (Eastern Forest Bat)

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

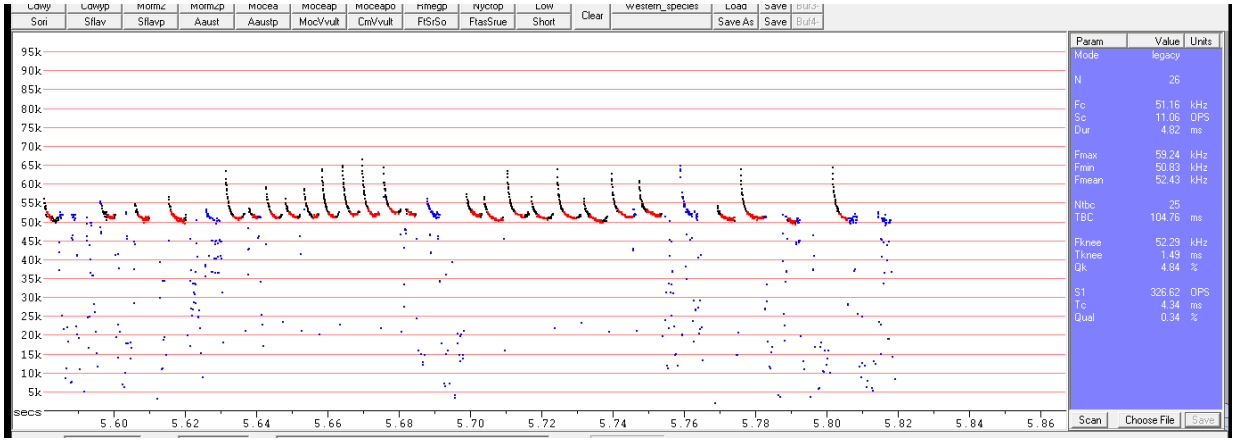

Figure 54: Possible call profile for *Vespadelus pumilus* (Eastern Forest Bat) and *Vespadelus vulturnus* (Little Forest Bat)

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

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

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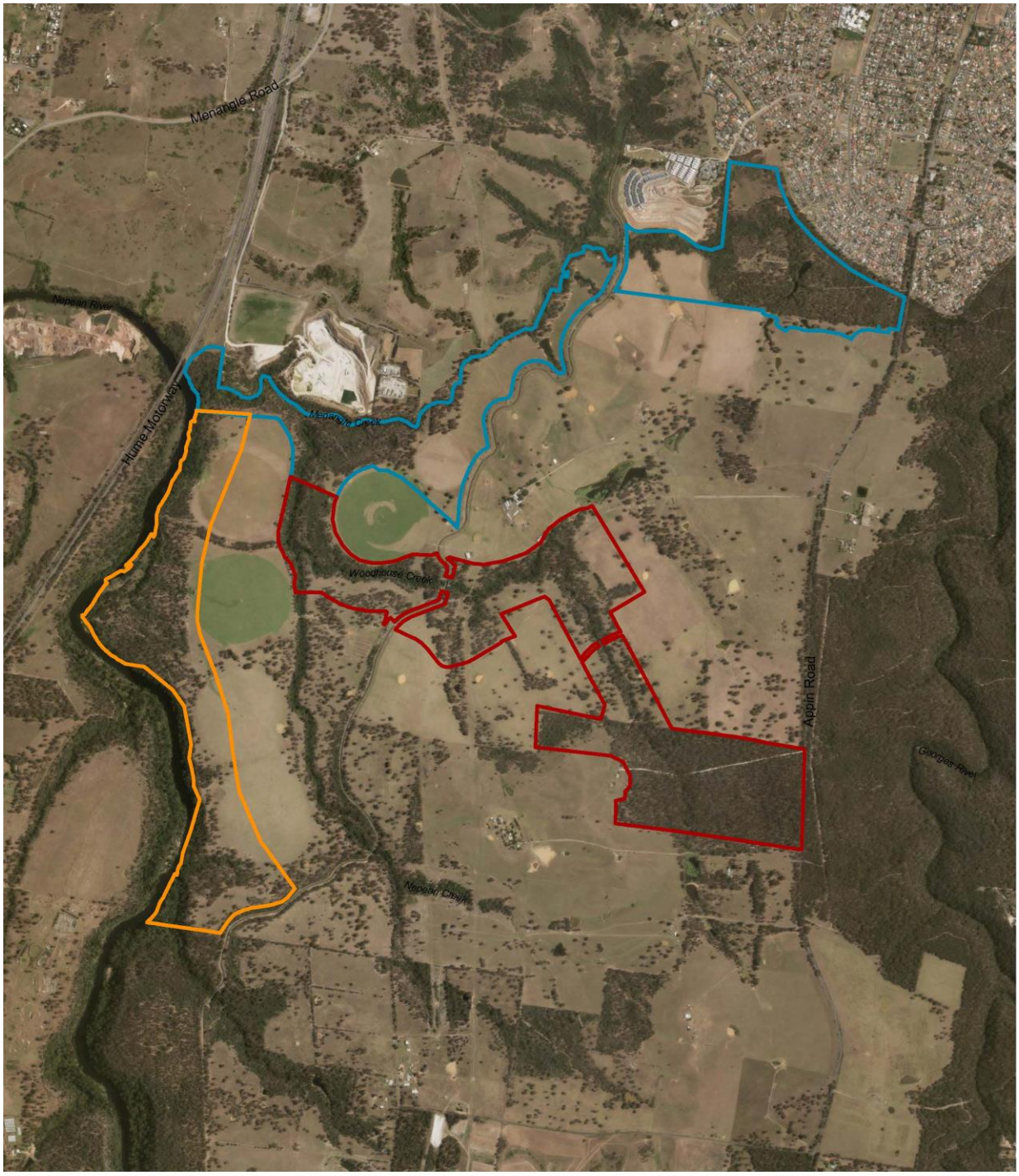

Indicative Koala Corridors - Gilead

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

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