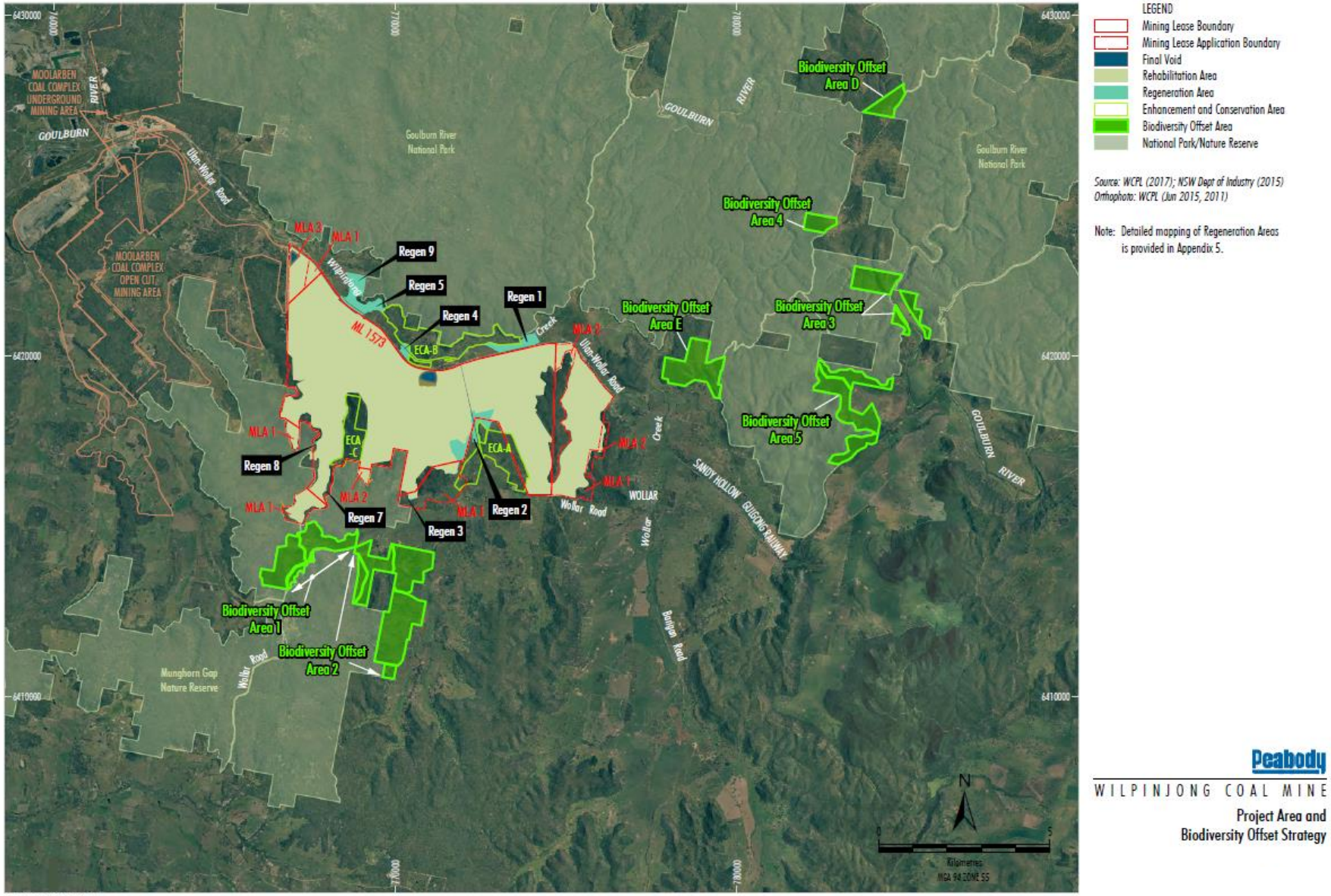
APPENDIX 5 – BIODIVERSITY

Biodiversity Offset Strategy


LEGEND
Mining Lease Boundary
Mining Lease Application Boundary
Final Void
Rehabilitation Area
Regeneration Area
Enhancement and Conservation Area
Biodiversity Offset Area
National Park/Nature Reserve
Source: WCPL (2017); NSW Dept of Industry (2015)
Orthophoto: WCPL (Jun 2015, 2011)
Note: Detailed mapping of Regeneration Areas is provided in Appendix 5.
MOOLARBEN COAL COMPLEX UNDERGROUND MINING AREA
MOOLARBEN COAL COMPLEX OPEN CUT MINING AREA
GOULBURN RIVER
Goulburn River National Park
Ulan-Wollar Road
Wilpinjong Creek
ML 1573
MLA 1
MLA 2
MLA 3
ECA-A
ECA-B
ECA-C
Regen 1
Regen 2
Regen 3
Regen 4
Regen 5
Regen 7
Regen 8
Regen 9
Biodiversity Offset Area 1
Biodiversity Offset Area 2
Biodiversity Offset Area 3
Biodiversity Offset Area 4
Biodiversity Offset Area 5
Biodiversity Offset Area D
Biodiversity Offset Area E
Munghorn Gap Nature Reserve
Wollar Road
WOLLAR
SANDY HOLLOW GULGONG RAILWAY
Bowman Road
Kilometres
MGA 94 ZONE 55
Peabody
WILPINJONG COAL MINE
Project Area and
Biodiversity Offset Strategy

Biodiversity Reports

Wilpinjong Coal Mine Stream Health Monitoring – Spring 2018

Prepared for
Wilpinjong Coal Pty Ltd

30 March 2019

DOCUMENT TRACKING

Item	Detail
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Project Number	18MUD-9579
Project Manager	Kalya Abbey Unit 1, Level 1, 79 Market St. Mudgee, 2850
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Approved by	Daniel Magdi
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Abbreviations

Abbreviation	Description
ANZECC	Australian and New Zealand Environment and Conservation Council
AUSRIVAS	Australian River Assessment System
DO	Dissolved oxygen
EC	Electrical conductivity
ELA	Eco Logical Australia
EPL	Environment Protection Licence
NP	National Park
RCE	Riparian, Channel and Environment
SHM	Stream Health Monitoring
SIGNAL	Stream Invertebrate Grade Number Average Level
SWMMP	Surface Water Management and Monitoring Plan
WCM	Wilpinjong Coal Mine
WCPL	Wilpinjong Coal Pty Ltd

1 Introduction

1.1 Background

The Wilpinjong Coal Mine (WCM) is located in the upper Hunter Valley, approximately 45 km north-east of Mudgee in New South Wales. The mine is owned and operated by Wilpinjong Coal Pty Ltd (WCPL), a wholly owned subsidiary of Peabody Energy Australia.

WCPL are required to undertake Stream Health Monitoring (SHM) as part of Appendix 2 of the Wilpinjong Water Management Plan (WCPL 2017). Eleven previous surveys have been undertaken, with the last occurring in spring 2017 (WCPL 2017)

1.2 Regional overview

Wilpinjong Creek is the main waterway flowing past the WCM. It is an intermittent creek with a narrow floodplain that has a history of cattle grazing. The main channel contains dense beds of *Phragmites* sp. (Common Reed) and *Typha* sp. (Bulrush) for most of the reach included in this assessment.

The northern edge of the floodplain is bordered by the Goulburn River National Park (NP). Wilpinjong Creek has three coal mines in its catchment, including Moolarben, Ulan, and Wilpinjong, with the latter being the most downstream. WCPL discharges water, treated by reverse osmosis, into Wilpinjong Creek at a point adjacent to the WCM.

Cumbo Creek flows north through land managed by WCPL, passing between Pit 3 and Pit 4. Cumbo Creek joins Wilpinjong Creek north of the eastern pit area.

Approximately 4.5 km downstream of where Wilpinjong Creek flows past WCM, it joins Wollar Creek, which continues another 13 km through the Goulburn River NP before it enters the Goulburn River.

1.3 Scope of works

Eco Logical Australia (ELA) was commissioned by WCPL to conduct the latest round of SHM. Monitoring included assessments of macroinvertebrate communities, basic water quality, habitat conditions, and channel conditions.

Appendix 2 of the WCPL Water Management Plan (2017) outlines the requirements for SHM along Wilpinjong, Cumbo and Wollar Creeks. These requirements include a survey of aquatic macroinvertebrates, a range of interpretive indices to evaluate environmental quality, a comparison of site indices against other sites and through time.

1.4 Previous aquatic ecology assessments

Surveys were conducted annually between 2010 and 2013 (Landline Consulting 2014). These were generally undertaken in September and October. Surveys recommenced in 2017, with an initial survey in January (ELA, 2017). Results from the 2010-2013 surveys indicate that Wilpinjong Creek is in relatively poor condition, suffering impacts from drought and long-term agricultural use. In January 2017, conditions appeared better, with improved water quality, and improved stream invertebrate grade number average level (SIGNAL2) scores. Many of the sites were still dry when sampled, and the number of invertebrate taxa was low at most sites.

2 Methods

2.1 Survey overview

The SHM spring survey was undertaken by ELA ecologists Cassandra Holt and Angelina Siegrist on 27, 29 and 30 November 2018.

The spring survey was undertaken at the 13-permanent monitoring sites specified in Appendix 2 of the WCPL Water Management Plan (WCPL 2017). These include two along Cumbo Creek, three along Wollar Creek, and eight along Wilpinjong Creek (**Table 1**, **Figure 1)**. Photographs of each site are included at **Appendix A**.

Table 1: 2018 monitoring sites

Creek	Site	Easting	Northing
Wilpinjong Creek	WC1	767680	6422970
	WC2	768490	6422490
	WC3	770080	6420730
	WC4	772270	6420330
	WC5	773980	6420420
	WC6	774580	6420860
	WC7	775100	6421060
	WC8	775860	6420820
Cumbo Creek	CC1	772710	6418130
	CC2	772980	6418950
Wollar Creek	WO1	777940	6418170
	WO2	777780	6418950
	WO3	777790	6420100

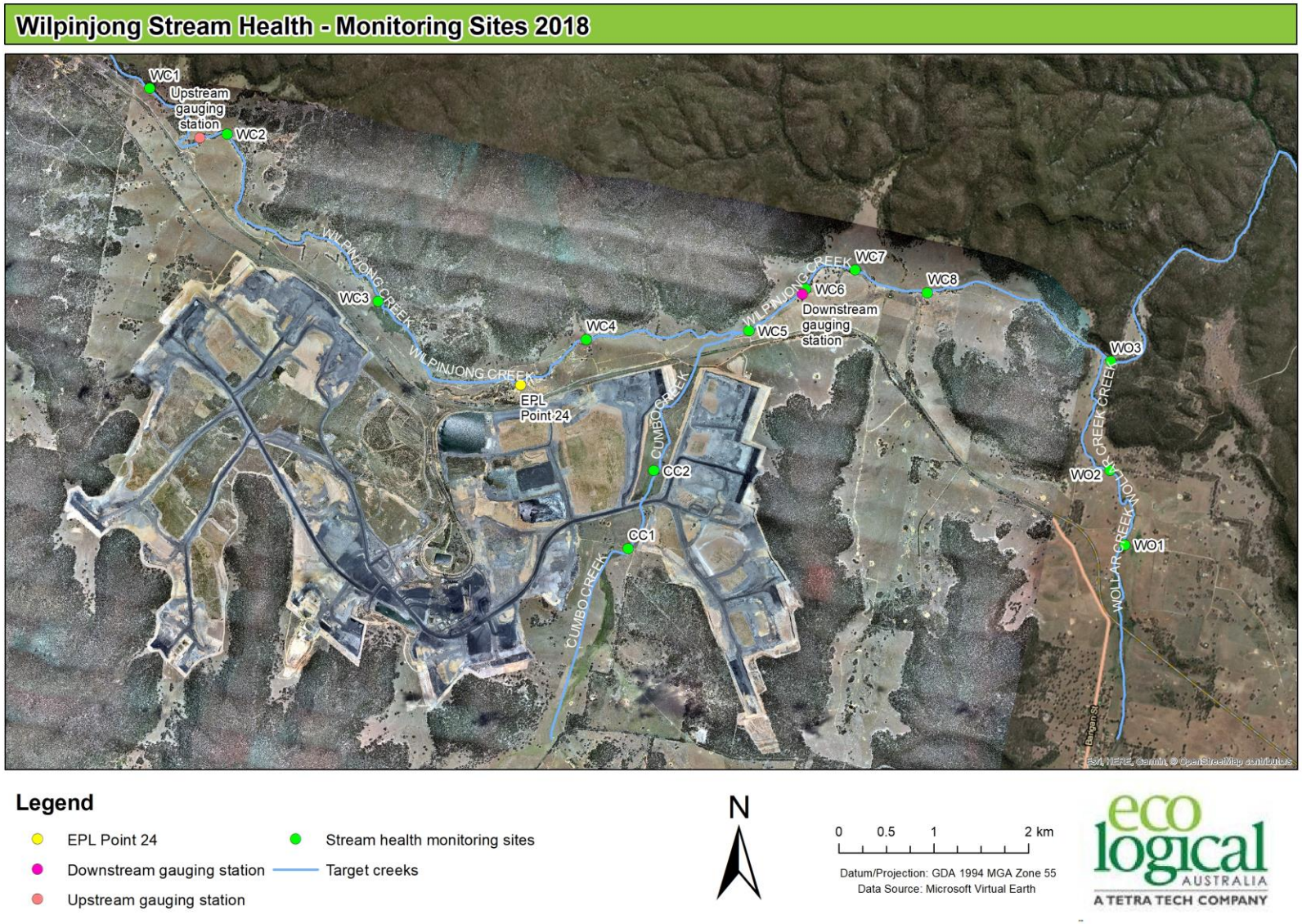

Figure 1: Monitoring sites along Wilpinjong, Wollar and Cumbo Creeks

2.2 Survey methods

2.2.1 Aquatic Habitat Assessment

Aquatic habitat assessments were based on the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI Fisheries 2013), which outlines the features important for fish habitat in freshwater, estuarine, and marine areas. Habitat assessments allow the significance of river reaches to be determined, regardless of whether target fish species are present permanently, or for brief periods of time.

Aquatic habitat variables (environmental data) were noted for each site, with observations made from the bank on the following characteristics:

- General signs of disturbance
- Habitat type
- Channel topography
- Current water level
- Bank and bed slope
- Degree of river shading
- Amount of detritus
- Macrophyte type and extent
- Riparian zone width
- Snags and large woody debris coverage
- Stream width and depth
- Surrounding land use
- Description of the natural substrate
- Extent of bank overhang
- Amount of trailing bank vegetation.

Riparian condition was assessed using a version of the Riparian, Channel and Environmental (RCE) inventory (Peterson 1992) that was modified for Australian conditions (Chessman *et al*. 1997). The modified RCE has 13 descriptors, each with a score from one (poor condition) to four (good condition).

Descriptors included width and condition of the riparian zone, surrounding land use, extent bank erosion, stream width, water depth, occurrence of pools, riffles and runs, sub-stratum type, presence of snags and woody debris, in stream and emergent macrophytes, algae, and barriers to fish passage. The total score for each site was derived by summing the score for each descriptor and calculating the result as a percentage of the highest possible score (up to 52).

Sites with a high RCE score indicate that the riparian zone is largely undisturbed, while those with a low score have undergone substantial modification. Based on the original classification established by Peterson (1992), site condition was rated as follows:

- Poor for RCE scores of 0-24%
- Fair for RCE scores of 25-43%
- Good for RCE scores of 44-62%
- Very good for RCE scores of 63-81%
- Excellent for RCE scores of 82-100%

2.2.2 Physico-chemistry

To complement biological data, physico-chemical parameters were measured at each site. Temperature, dissolved oxygen (DO), electrical conductivity (EC) and pH were measured with a YSI-556 meter, which was calibrated in the laboratory prior to the field survey. The DO probe was calibrated at the start of each survey day. A sample of water was collected and analysed for turbidity by Australian Laboratory Services (ALS).

2.2.3 Macroinvertebrate Community

Where sufficient water was present, three separate macroinvertebrate samples were collected at each site using the Australian Rivers Assessment System (AUSRIVAS) protocols (Turak *et al*. 2004). Samples were collected from 10 m of representative edge or riffle habitats using a standard AUSRIVAS kick net with 250 μm mesh. The largest pool was selected at sites WC6 and WC7 as 10 m of water was not available to sample. The net was bounced along the bottom to disturb resting invertebrates, and then rapidly passed again through the water column to collect them. Edge habitats were defined as adjacent to the creek bank in areas of little or no flow, including alcoves and backwaters, with abundant leaf litter, fine sediment deposits, macrophyte beds and overhanging bank vegetation (Turak *et al*. 2004).

Macroinvertebrate samples were live-sorted in the field for a minimum of 40 minutes. If new taxa were collected in the period from 30 to 40 minutes, picking continued for 10 minutes. If no new taxa were found after the additional 10 minutes, sorting stopped. The maximum sorting time was 60 minutes. All picked animals were preserved in 70% ethanol solution and transferred to the laboratory for identification. Specific care was taken to ensure cryptic, fast moving taxa were represented.

Macroinvertebrates were identified to family level, except for *Acarina, Nematoda, Decepoda, Crustacae, Collembola, Oligochaeta* and *Tricladida,* which were identified to order.

The Stream Invertebrate Grade Number- Average Level (SIGNAL) is a biotic index that allocates a value to each macroinvertebrate family based upon their sensitivity to pollution. A macroinvertebrate family with a value of ten indicates high sensitivity, while a value of one indicates low sensitivity (i.e. high pollution tolerance) (Chessman *et al*. 1997). The SIGNAL score for the entire site is calculated by summing the SIGNAL grades for each family collected at that site and then dividing by the total number of families collected. SIGNAL scores are used to grade water quality into the following categories:

- SIGNAL Score > 6: Healthy Habitat
- SIGNAL Score 5-6: Mild Pollution

- SIGNAL Score 4-5: Moderate Pollution
- SIGNAL Score < 4: Severe Pollution

2.3 Climate and flow

During the three days of monitoring, the weather was warm. There was rainfall on 28 of November measuring 16.8 mm (**Table 2**). In the six months leading up to sampling, temperatures were all slightly above the historic mean. Rainfall during June, September and November was below average, rainfall during October, August and July were above historical means.

Table 2: Temperature and rainfall data for the spring 2018 monitoring period

Date	Min. temp (°C)	Max. temp (°C)	Rainfall (mm)
27 Nov 2018	12.7	28.9	0
28 Nov 2018	15.7	22.1	16.8
29 Nov 2018	10.6	26.1	0
30 Nov 2018	13.5	27.6	0

Source: WCPL Weather Station Sentinex 34

Table 3: Temperature and rainfall data for the six months prior to monitoring

Month	2018			Historical means		
	Mean min. temp (°C)	Mean min. temp (°C)	Total Rainfall (mm)	Min. temp (°C)	Max. temp (°C)	Rainfall (mm)
Nov 2018	13.58	26.92	47.4	12.1	26.6	56.0
Oct 2018	11.46	24.20	56.8	10.0	23.9	48.5
Sep 2018	5.71	20.85	39.6	4.8	20.2	51.0
Aug 2018	1.58	16.90	43.8	0.8	16.1	25.5
July 2018	0.58	16.62	6.8	-0.6	15.8	6.5
June 2018	2.26	16.03	21.6	1.8	15.5	22.0

Source: 2018 data from the WCPL Weather Station Sentinex 34, historical data from the BoM weather stations at Mudgee Airport (temp) and Wollar (Barrigan St) weather station (rainfall)

Flow levels in Wilpinjong Creek since 2012 have averaged 3.1 ML/day downstream and 1.1 ML/day upstream of the Wilpinjong discharge point at Environment Protection Licence (EPL) point 24. Flow receded at both gauging stations throughout 2018, with no flow recorded at the upstream station in 2018. A high flow event occurred during spring 2016, although the long-term flow levels indicate Wilpinjong Creek has experienced mainly dry conditions over the last six years as seen in **Figure 2** and **Figure 3**.

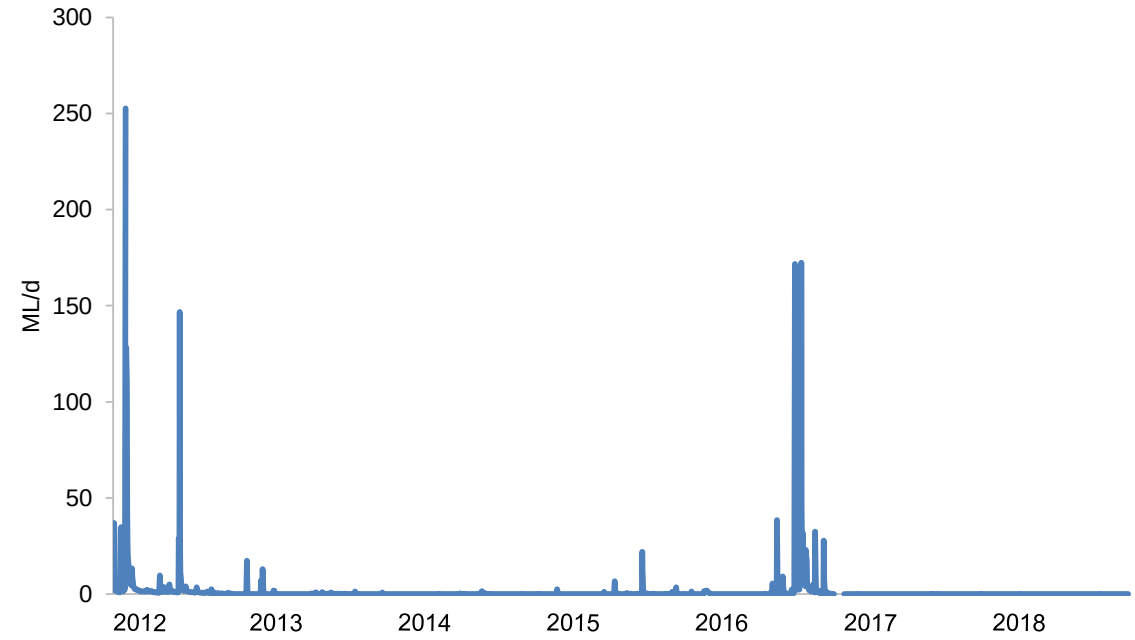

Figure 2: Stream flow upstream of the WCPL mine discharge point EPL Point 24 (1/2/2012 to 30/11/2018)

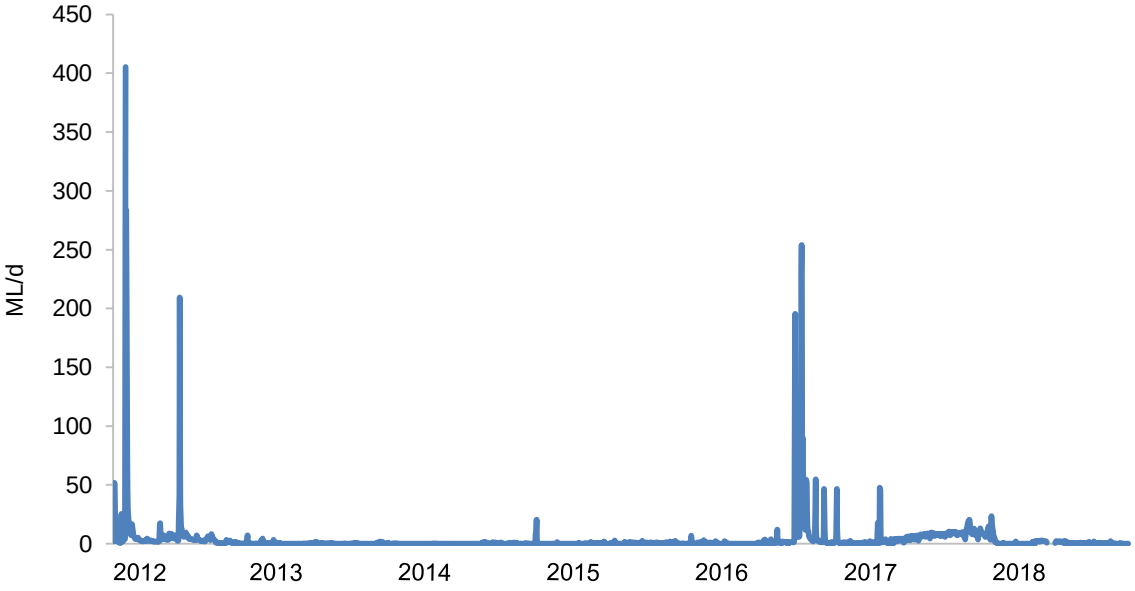

Figure 3: Stream flow downstream of the WCPL mine discharge point EPL Point 24 (1/2/2012 to 30/11/2018)

3 Results

3.1 Habitat assessment and RCE

Results of the habitat assessment, including water, substrate, vegetation, land use, and how these elements contribute to the RCE score are detailed below. A breakdown of how the 13 RCE parameters scored for each site is included in **Table 4.**

Table 4: Site by site results for the 13 RCE parameters

Descriptor	WC1	WC2	WC3	WC4	WC5	WC6	WC7	WC8	WO1	WO2	WO3	CC 1	CC 2
Land use pattern beyond immediate riparian zone	3	3	3	3	2	2	2	3	2	3	3	2	3
Width of riparian strip of woody vegetation	3	3	3	3	1	3	3	3	3	3	3	2	1
Completeness of riparian woody strip of vegetation	2	2	2	2	3	2	2	3	2	2	3	3	3
Vegetation of riparian zone within 10 m of channel	4	3	2	3	2	2	2	2	2	3	3	2	1
Stream bank	2	2	3	3	3	3	3	3	3	3	2	3	3
Bank undercutting	4	3	4	4	3	4	4	4	4	4	3	4	4
Channel form	2	3	3	3	3	3	3	3	2	3	3	2	3
Riffle/pool sequence	3	3	3	3	3	3	3	3	2	3	3	2	2
Retention devices in stream	1	1	2	1	1	1	2	2	1	2	3	3	1
Channel sediment accumulations	4	3	2	4	4	4	4	4	4	3	2	4	4
Stream bottom	1	2	2	2	2	2	3	1	2	1	3	2	1
Stream detritus	1	3	4	3	2	2	2	1	3	3	2	2	3
Aquatic vegetation	2	4	2	4	2	1	2	2	2	2	1	2	2
Total	**32**	**35**	**35**	**38**	**31**	**32**	**35**	**34**	**32**	**35**	**34**	**33**	**31**
Total %	**61.5**	**67.3**	**67.3**	**73.1**	**59.6**	**61.5**	**67.3**	**65.4**	**61.5**	**67.3**	**65.4**	**63.5**	**59.6**
Condition classification	**G**	**VG**	**VG**	**VG**	**G**	**G**	**VG**	**VG**	**G**	**VG**	**VG**	**VG**	**G**

Condition Classification: G - Good, VG – Very Good

Site WC1

This site is upstream of WCM within cleared pasture land along both sides of the bank. The stream bank is approximately 20 m wide and rose 1.5 m above the bed. There is an artificial dam present within the site. Erosion was present on parts of the bank possibly due to the movement of cattle, there was also a lack of groundcover along parts the bank which help to stabilise the bank.

Riparian vegetation consisted of mature and juvenile *Angophora floribunda* (Rough-barked Apple) and *Eucalyptus blakelyi* (Blakely's Red Gum) trees. The dominant shrub species was *Cassinia arcuata* (Sifton Bush). The trees, shrubs, grasses/sedges/ferns are 100% native. There are dense stands of macrophytes along the creek bed.

This site scored an RCE score of 61.5%, indicating that the riparian and channel condition is rated as 'Good'. The site had no logs or large boulders to act as retention devices, although there were dense stands of macrophytes present in the channel that would perform the same function. The site also had loose, mobile sediment along the stream bottom and had little organic detritus.

Site WC2

WC2 was dry when visited during November 2018. The northern bank of Wilpinjong Creek is severely eroded above a shelf of horizontal bedrock strata. The bank is approximately 20 m wide, with a height of 1 m tall. The site sites within cleared pasture land, which was present on both sides on the bank.

The dominant riparian vegetation included *Angophora floribunda* and *Eucalyptus melliodora* (Yellow Box). All vegetation species within the site were native. There is a bedrock outcrop extending from the northern bank.

The site scored an RCE index of 67.3%, which places it in the 'Very Good' category. There were few retention devices in the stream, and little or no macrophyte or algal growth along the creek bed.

Site WC3

WC3 was dry when visited during November 2018. The bank is 15 m wide and stood approximately 1.5 m above the sandy bed of the channel, and there was no woody vegetation on the western bank. The dominant substrate type consists of gravel and sand

Along the northern side of the bank there is cleared pastureland, along the southern side there is regenerating woodland. The channel bank is surrounded by *Phragmites australis*, although very little stands existed within the centre of the bank. The dominant riparian vegetation at the site included *Angophora floribunda* and *Eucalyptus blakelyi*.

This site had an RCE score of 67.3%, so is classified as being in the 'Very Good' condition. There was little in-stream detritus and no bank undercutting at the site, due to the gentle slope and the high abundance of vegetation along the bank.

Site WC4

This site is downstream of the Wilpinjong reverse-osmosis water discharge point, although was dry when visited during November 2018. The bed consists of a high abundance of bedrock. The bank is 30 m wide and 3 m in height. Along both banks the land use was cleared pasture.

Bedrock made up 15% of the site and was a dominant substrate within the creek, the other dominant substrate for approximately 50% of the creek was silt. In the northern side of the creek there was enough sediments to support dense stands of *Phragmites australis* (Common Reed) and *Typha orientalis* (Broadleaf Cumbungi). Other dominant riparian vegetation includes *Angophora floribunda*

and *Lomandra multiflora* (Many-flowered Mat-rush). Both banks are severely eroded due to a lack of vegetation stabilising the bank. The northern bank drops almost vertically to the bottom of the channel and the top is poorly vegetated with low numbers of juvenile *Angophora floribunda*.

This site scored 73.1% in the RCE index, so is classified as 'Very Good'. This site had the highest score out of all sites. The number of rock and log retention devices within the stream scored low, although stands of macrophytes scattered along the bed which perform a similar function. This site scored well due to there being no evidence of bank undercutting. It also scored well as there was little macrophytes growth along the majority of the creek bed.

Site WC5

This site was dry during the time of surveying in November 2018. The bank is 25 m wide, with an average bank height of 2 m. The land use at this site is agricultural with no canopy cover within 50 m.

The dominant substrate type along the stream bed is silt. There was some erosion on the southern bank where the soil is exposed, but it is mostly vegetated with a mixed native and exotic groundcover. The stream bed is dominated by *Typha orientalis*, while along the bank there is *Lomandra longifolia* (Spiny-headed Mat-rush). There is a mix of native and exotic grass species that may be stabilising the northern bank.

WC5 scored 59.6% in the RCE index, meaning it is classified as 'Good'. There was little woody vegetation in the riparian zone, as there was no shrub or canopy layer. The score for in-stream retention devices was also low, as no logs or rocks are present in the reach. While dense stands of macrophytes would act as retention devices in moderate and low flows.

Site WC6

Site WC6 has a small weir at the western end of the reach. Just downstream of the weir the stream flows across bedrock. There is a cleared mixed pasture along both sides of the creek and stock can access the water at this point along Wilpinjong Creek. During the survey the water contained a cow odour. During the survey there was a low flow level present within the stream.

The width of the bank is 15 m with a 4 m high bank. The southern bank has some exposed rock ledges and a short rocky side arm. The dominant riparian vegetation is *Eucalyptus blakelyi, Eucalyptus melliodora, Eucalyptus albens* (White Box) and *Lomandra longifolia*. Stands of macrophytes are located within the site, during times of survey the 2m pool of water was covered between 50 to 75% of filamentous algae.

The site scored 61.5% in the RCE index, giving it a classification of 'Good'. It scored high for as there was no bank undercutting, due to the ground cover along the northern bank. It also scored well as there was no evidence of loose sediment accumulations within the site. Although the site did score poorly on the lack of retention devices within the stream, as there was no logs or large rocks present. Although macrophytes present that would perform a similar function. This site also scored poorly on aquatic vegetation with substantial amounts of macrophyte and algal growth present at the site.

Site WC7

The creek bank at this site is 2 m tall and 20 m wide. During the time of survey there was a 3 m pool present, and water level was low. The land use along both sides of the bank is cleared mixed pasture. Stock have access to the creek and at the time of sampling there were piles of soil.

Both banks were vegetated with 15% exotic groundcover. The dominant riparian vegetation at the site is *Angophora floribunda, Eucalyptus blakelyi, Eucalyptus melliodora* and *Sporobolus sp*. There was little erosion along both sides of the bank due to the presence of native and exotic grasses.

WC7 scored 67.3% for the RCE index, giving it a classification of 'Very Good'. The site scored high as there was little erosion and no bank undercutting. It also scored high as there was little evidence of loose sediments within the water.

Site WC8

At the time of sampling, there was evidence of water inundation from a rainfall event within the previous 24 hours, causing some erosion. The creek bank is 1 m high and 15 m wide, the main substrate type was silt. During the time of survey there was a low flow level of the stream. The land use on both sides of the creek at this site is agricultural, however there is woody vegetation within 20 m of the creek on the southern side, while the northern bank immediately becomes pasture.

The dominant riparian vegetation within the channel is *Eucalyptus blakelyi, Eucalyptus albens* and *Angophora floribunda*. Nearly the whole reach is covered with dense *Phragmites australis* cover, although *Cyperus* sp., *Juncus* sp. and *Typha* sp. was also present.

WC8 scored 65.4% for the RCE index, giving it a classification of 'Very Good'. It scored high for a lack of channel sediment accumulations and an absence of evidence of bank undercutting. While this site scored poorly for a loose and mobile sediment along the stream bottom, as well as the high occurrence of stream detritus.

Site WO1

Site WO3 has a bank height of 1.5 m and 20 m wide. The land use along both sides of the bank is cleared pasture land. During the time of survey, the stream had a low flow level.

During the time of sampling there was *Typha* sp. and *Phragmites* sp. present within the site. The majority of the substrate is sand. There are dense stands of Typha located within portions of the creek. There is a considerable amount of shading along the channel although this is mostly provided an exotic willow, *Salix* sp.

This site scored 61.5% for the RCE index, giving it a classification of 'Good'. The site scored well on bank undercutting due to there being a good amount of groundcover which was stabilising the bank. The site also scored well on channel sediment accumulations. The lowest scoring parameters was the lack of retention devices within the stream, as there were no logs. Although the presence of native aquatic macrophytes would serve a similar purpose.

Site WO2

This site is on Wollar Creek, where the bank was 20 m wide and 2 m high. At the downstream end of the reach the creek passes under Mogo Road, a concrete creek-crossing. The creek would receive runoff from the road during rain events. Surveys were completed within 24 hours of a rainfall event, there was evidence of water inundation from this rainfall event.

At the time of sampling there was 7 m pool of water at WO2, there was 50% exotic groundcover along the bank. Some woody riparian vegetation is present including *Angophora floribunda*, E*ucalyptus blakelyi, Melaleuca* sp. and *Acacia* sp. There are also dense stands of *Typha* sp. and *Phragmites* sp. along the stream bank.

WO2 scored 67.3% for the RCE index, giving it a classification of 'Very Good'. It scored especially well on bank undercutting, as both banks slope gently and are stabilised by native and exotic groundcover.

Although it scored poorly as there was loose and mobile sediment being present along the stream bottom.

Site WO3

This site is along Wollar Creek, which had a moderate level flow at the time of sampling. Surveys occurred within 24 hours of a rainfall event, with evidence of water inundation. The total width of the bank is 25 m and 3 m high. At the downstream end of the reach the creek passes under Araluen Road, the creek would receive runoff from the road during rain events. This land along both sides of the bank has been partially cleared but transitions into native remnant vegetation.

There is a good canopy cover over the creek at this site, the overstory species are *Angophora floribunda* and *Eucalyptus blakelyi* and the banks are stabilised with a high abundance of exotic groundcover. Around the pool and along the reach there are variable amounts of dense *Typha* beds. The substrate is mainly silt, although there is cobble, pebble, gravel and sand present within the site.

WO1 scored 65.4% for the RCE index, giving it a classification of 'Very Good'. It scored well on-stream bank and undercutting, riffle/pool sequence. There was very little bare soil on either bank, meaning no erosion or bank undercutting. This site scored poorly on the aquatic vegetation present within the site, as there as algae present during the time of survey.

Site CC1

This site is located in Cumbo Creek. In the 24 hours before this survey there was a rainfall event and there was evidence of inflowing water. The land use along both sides of the site is pasture land and mining. The site is located at a point where an access track crosses Cumbo Creek and would receive runoff from this track during rain events.

Immediately beyond the riparian vegetation, there is mixed native and exotic pasture. The channel is dominated by *Typha* sp, *Cyperus* sp. *and Juncus* sp. There was one *Eucalyptus conica* (Fuzzy Box) located within the site. The substrate along the stream bed is mostly silt, although sand and gravel are also present.

This site scored 63.5% for the RCE index, giving it a classification of 'Very Good'. It scored especially high as there was no bank undercutting occurring as the channel was very shallow and the banks stabilised with a mix of native and exotic groundcover. It also scored well as there was no sediment accumulations along the stream.

Site CC2

Site CC2 was dry during the monitoring period. The land use on both sides of the stream is exotic pasture land and the channel is very wide and shallow, about 50 m wide with a bank height of 0.5 m. It mostly contains non-aquatic native and exotic grasses, with some *Juncus* sp. There is one canopy species *Eucalyptus conica* within the riparian zone. There would be no riffles during flow events.

This site scored 59.6% for the RCE index, giving it a classification of 'Good'. It was the lowest scoring of the sites overall, with poor scores for woody riparian vegetation, vegetation within 10 m of the channel, in-stream retention devices and loose and mobile sediment along stream bottom. Although this site scored well on the lack of channel sediment accumulation and no bank undercutting.

3.2 Water quality

The results of the water quality testing, including temperature, EC, DO, pH, and turbidity are detailed below. A breakdown of the results for each site is in **Table 5**. Note that there are no results for sites WC2, WC3, WC4, WC5 and CC2 as they were dry at the time of monitoring and no water samples could be taken.

Water temperatures at the time of sampling ranged between 17.43°C and 28.74°C. The warmest water was at site WC6, which was a small pool and sampled in the early-afternoon.

EC was high in the upper reaches of Wilpinjong Creek, with a maximum value of 2276 µS/cm at WC1. However, at WC6, downstream of the reverse osmosis discharge point, EC was 361 µS/cm. The lowest conductivity was 296 µS/cm at WC8, which was the only site within the Australian and New Zealand Environmental and Conservation Council (ANZECC) range. EC in Wollar Creek increased, with 3300 µS/cm measured at WO1, the highest reading during the survey.

Dissolved oxygen ranged between 34.5% saturation at WC1 to 173.5% saturation at WO1. There were no sites in Wilpinjong, Wollar and Cumbo Creeks that were within the recommended ANZECC range.

All sites had a pH between 7.07 and 10.81. Sites WC6 and WC7 were outside the ANZECC range. All sites within Wollar Creek and Cumbo Creek had pH values within the ANZECC range.

Turbidity was high in Wilpinjong Creek, with all sites above the ANZECC range. The highest being WC8 with 149 NTU. However, turbidity in Wollar Creek and Cumbo Creek were all within the recommended ANZECC Range. The lowest turbidity was measured at WO1 at 2 (**Table 5**).

Table 5: Physico-chemical results

Variable	ANZECC Range	WC1	WC2	WC3	WC4	WC5	WC6	WC7	WC8	WO1	WO2	WO3	CC1	CC2
Temperature (°C)		19.22	DRY	DRY	DRY	DRY	28.74	26.62	17.43	19.17	24.46	25.31	26.15	DRY
Conductivity (µS/cm)	30-350	2276					361	546	296	1410	1434	3300	3171	
DO (% saturation)	90-110	34.5					110.1	65.1	129.6	38.9	167.5	173.5	154.4	
DO (mg/L)		3.15					8.5	5.21	12.37	3.56	13.9	14.14	12.37	
pH	6.5-8.0	7.07					10.81	8.42	7.72	7.74	7.67	7.81	7.71	
Turbidity (NTU)	2-25	74.6					172	138	149	9.4	6.3	2.8	22.6	

Red cells indicate values outside the ANZECC range; green cells indicate values that are within the range.

3.3 Macroinvertebrate communities

3.3.1 Taxa richness

A total of 14 macroinvertebrate orders, comprising 21 taxa families, were collected from the 28 sites that had sufficient water for sampling. Taxa richness was highest at WO3 (21 taxa), and WC1 (18 taxa).

Taxa richness was lowest at WC7 with only 7 taxa identified. The most commonly occurring taxa were Crustacea and the hemipteran family Notonectidae both occurring at seven sites each.

3.3.2 SIGNAL

Pollution sensitivity ratings for each family/order were used to calculate the average SIGNAL score for each site. Where families/orders have no assigned sensitivity rating, they were not included in the averages, however are still represented in results for taxa richness. Average SIGNAL scores range from 2.0 to 3.3 (**Table 6**). All the sites had an average SIGNAL score of less than four, so they are classified as severely polluted.

Table 6: Results of the two macroinvertebrate indices

Measure	WC1	WC2	WC3	WC4	WC5	WC6	WC7	WC8	WO1	W02	W03	CC1	CC2
Taxa richness	18	n/a	n/a	n/a	n/a	11	5	15	15	10	21	13	n/a
Average SIGNAL score	2.88	n/a	n/a	n/a	n/a	3.00	2.00	2.50	3.31	3.33	3.00	2.90	n/a
SIGNAL pollution condition	S	-	-	-	-	S	S	S	S	S	S	S	-

SIGNAL2 pollution condition – Severe – S

4 Discussion

4.1 Habitat Assessment and RCE

All sites received either 'Good' or 'Very Good' classification for their RCE indices. This puts them in the mid-range for riparian and channel habitat quality. Conditions within Wilpinjong, Wollar and Cumbo Creeks were very similar and consistent. Compared to 2017 sites WC4 and WC5 are now dry, which is a change from last year. Many of the sites had less water, and none had more water than last year. This is a result of drought conditions and increased average temperatures compared to the historical means.

Lack of in-stream retention devices such as logs, and boulders was common at many sites, with mostly scores of one or two for this parameter. This is typical of streams in agricultural landscapes, as large debris is generally removed, and woody riparian vegetation that would provide fallen branches and logs is limited. In-stream retention devices help slow the movement of flow, which in turn reduces the water erosive power. Retention devices are also important for the accumulation of coarse particulate organic matter, an important energy source for macroinvertebrate communities, although there was aquatic vegetation at many sites, which can also provide a similar function in trapping organic matter.

Similarly, stream bottom also scored low, as there were loose and mobile sediments along the stream bottom at most sites. This is typical in a highly modified landscape where sites have reduced bank stability or increased bank erosion. Mobile sediments can accumulate in streams with low flow areas and have the potential to smother bottom dwelling macroinvertebrate communities and their habitats. The parameter aquatic vegetation received low scores in all but two sites.

4.2 Water quality

Water temperature overall was quite high (average temperature 23.4°C), which would be attributed to the generally small isolated pool sizes at many of the sites, the absence of riparian shading along most sites and the ambient temperature, as the sun would warm up the smaller pools. Because of this factor, the water temperature would be expected to fluctuate throughout the day and vary between pools at the same site. Increased water temperature decreases the waters ability to retain dissolved oxygen.

DO concentration was low at sites WC1, WC7 and WO1, this may be due to the high-water temperatures present within the small pools of water of these sites. Low oxygen concentrations provide anoxic conditions, which are detrimental to aquatic macroinvertebrates and fish. All other sites had DO concentration above the ANZECC guidelines. Sites WC8, CC1, WO2, and WO3 were surveyed 24 hours after a major rainfall event, which would aerate the water, and may have resulted in the high dissolved oxygen within these sites. The high DO concentrations may also have resulted from excessive algal photosynthesis.

As with water temperature, EC is high at all but one site. This is typical within small isolated pools in agricultural land, as cleared land can cause increased water runoff. EC may also be high in areas where salt bearing groundwater contributes to baseflow, especially during drought when there is not much rainfall to provide dilution. Within sites of high-water temperature and no riparian shading, evapo-concentration of minerals in the water can be high. There is also the potential for pollution from cattle to increase the electrical conductivity within the water.

Turbidity was within the ANZECC range at all sites within Wollar Creek and Cumbo Creek, although the Turbidity within all sites in Wilpinjong creek was over the ANZECC range. Turbidity is the measurement

of fine suspended sediment, as well as coloured dissolved components, in the water. Turbidity reduces the penetration of light within the water, which may reduce the ability for aquatic plants to photosynthesize. Increased turbidity will also impact on the breathing ability of fish.

The pH was within ANZECC range at nearly all the sites. However, the water located at sites WC6 and WC7 were basic.

4.3 Macroinvertebrate communities

Taxa richness was lower in the 2018 survey than in the previous 2017 survey, where 56 families were identified. Sites WC2, WC3, WC4 and WC5 were dry and not able to be tested. All sites have maintained the same SIGNAL2 pollution condition except for WC6 and WO3 which have changed from being classified as moderately polluted to severely polluted. All sites have a pollution condition classification of severe. These results may be due to decreased water levels within the pools across the sites.

Analysis of macroinvertebrates was simplified for the 2018 survey compared to previously due to time restraints and dry conditions preventing the collection of three replicate samples at each site. As such, the Shannon Index and evenness were not applied to the data.

5 Conclusions and recommendations

The habitat condition at all 13 sites were classified as either good or very good. The RCE parameters that have scored highly across all sites are bank undercutting and channel sediment accumulations. The two RCE parameters that scores poorly across all sites are stream bottom and aquatic vegetation.

The physico-chemical variables within most sites do not meet the ANZECC recommended range. DO saturation scored most poorly with no sites meet the guidelines. Conductivity also scored poorly with only site WC8 meeting the ANZECC guidelines. Turbidity was high within Wilpinjong creek although was within the ANZECC range at Wollar and Cumbo creek sites.

Aquatic health at sites along Wilpinjong Creek was generally poor, with the macroinvertebrate communities characterised by low diversity, and SIGNAL2 scores indicating severe pollution levels. Compared to previous survey rounds, the November 2018 results indicate a slight decrease in ecological health. This is likely a result of low rainfall and subsequent lower water levels.

Consistent annual monitoring may identify trends and potential impacts on macroinvertebrates, habitat and water quality. AUSRIVAS sampling protocols specify that monitoring should occur in both autumn and spring each year, and that the timeframe for sampling should be between 15 March to 15 June and 15 September to 15 December respectively. As there appears to have been little change between sampling events, only one event per year should be sufficient for monitoring stream health. However, the surveys should occur in September or October to be consistent with both the AUSRIVAS autumn and past surveys conducted in 2010-2013.

Climatic factors and flow regimes are a dominant influence on aquatic ecological communities. The lack of major flow events in Wilpinjong Creek since 2012 has potentially resulted more frequent periods of no flow or pool isolation.

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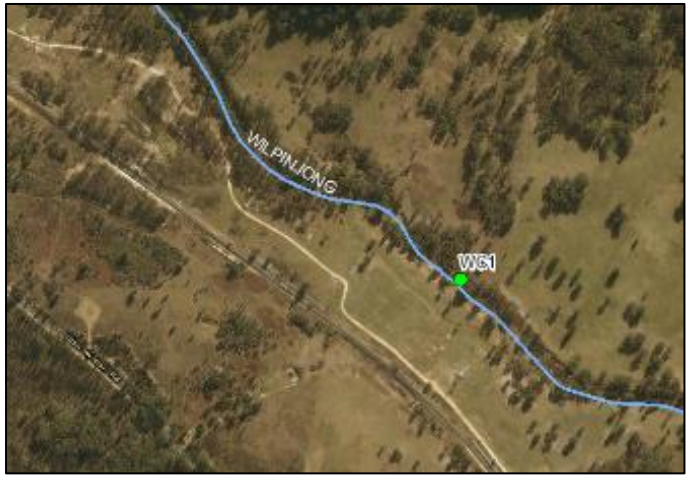
APPENDIX A – Site photos



Site WC1 (from left to right: site location, upstream, downstream (27/11/18))

Site WC2 (from left to right: site location, upstream, downstream (27/11/18))

Site WC3 (from left to right: site location, upstream, downstream (27/11/18))

Site WC4 (from left to right: site location, upstream, downstream (27/11/18))


Site WC5 (from left to right: site location, upstream, downstream (27/11/18))


Site WC6 (from left to right: site location, upstream, downstream (27/11/18))


Site WC7 (from left to right: site location, upstream, downstream (27/11/18))


Site WC8 (from left to right: site location, upstream, downstream (29/11/18))


Site WO1 (from left to right: site location, upstream, downstream (30/11/18))


Site WO2 (from left to right: site location, upstream, downstream (29/11/18))


Site WO3 (from left to right: site location, upstream, downstream (29/11/18))


Site CC1 (from left to right: site location, upstream, downstream (29/11/18))

Site CC2 (from left to right: site location, upstream, downstream (29/11/18))

APPENDIX B - MACROINVERTEBRATE DATA (PRESENCE AND ABSENCE)

Wilpinjong Creek

Order	Family	Signal Score	WC1	WC2	WC3	WC4	WC5	WC6	WC7	WC8
Acarina			0					0	0	2
Coleoptera	*Carabidae*	3	0					0	0	0
	Curculionidae	2	1					0	0	0
	Dytiscidae	2	3					1	0	2
	Elmidae	7	2					1	0	0
	Hydraenidae	3	1					0	0	0
	Hydrophilidae	2	1					0	0	11
Collembola			0					0	0	0
Crustacae			10					13	0	8
Decapoda			0					0	2	0
Diptera	*Ceratopogonidae*	4	1					3	0	5
	Chironomidae	3	9					0	5	8
	Culicidae	1	0	DRY	DRY	DRY	DRY	0	0	0
	Stratiomyidae	2	1					0	0	0
	Tabanidae	3	0					0	0	0
Ephemeroptera	*Baetidae*	5	4					5	0	0
	Leptophlebidae	8	0					0	0	0
Gastropoda	*Lymnaeidae*	1	1					0	0	0
	Physidae	1	3					0	0	0
	Planorbidae	2	0					0	0	0
Hemitptera	*Corixidae*	2	0					5	1	2
	Micronectidae	2	6					9	1	3
	Notonectidae	1	3					9	3	1
	Saldidae	1	0					2	0	0
	Veliidae	3	2					0	0	6

Order	Family	Signal Score	WC1	WC2	WC3	WC4	WC5	WC6	WC7	WC8
Nematoda			0					0	0	0
Odonata	*Aeshnidae*	4	0					0	0	1
	Coenagrionidae	2	6					2	0	2
	Corduliidae	5	0					0	0	0
	Lestidae	1	0					0	0	1
	Libellulidae	4	0					1	0	2
Oligochaeta			4					0	0	1
Trichoptera	*Ecnomidae*	4	0					0	0	0
	Leptoceridae	6	3					0	0	0
Tricladida			0					0	0	0

Wollar Creek

Order	Family	Subfamily	Signal Score	WO1	WO2	WO3
Acarina				0	0	0
Coleoptera	*Carabidae*		3	0	0	0
	Curculionidae		2	0	0	0
	Dytiscidae		2	0	0	5
	Elmidae		7	0	0	5
	Hydraenidae		3	0	0	0
	Hydrophilidae		2	1	0	5
Collembola				0	0	1
Crustacae				15	16	28
Decapoda				4	2	0
Diptera	*Ceratopogonidae*		4	3	2	3
	Chironomidae		3	4	8	6
	Culicidae		1	0	0	1
	Stratiomyidae		2	0	0	1
	Tabanidae		3	0	0	0
Ephemeroptera	*Baetidae*		5	1	1	2
	Leptophlebidae		8	1	0	0
Gastropoda	*Lymnaeidae*		1	0	0	0
	Physidae		1	3	0	1
	Planorbidae		2	0	0	0
Hemitptera	*Corixidae*		2	2	0	3
	Micronectidae		2	9	0	2
	Notonectidae		1	4	3	1
	Saldidae		1	0	0	1
	Veliidae		3	1	0	1
Nematoda				0	1	0
Odonata	*Aeshnidae*		4	0	0	3
	Coenagrionidae		2	5	5	0
	Corduliidae		5	0	3	1
	Lestidae		1	0	0	0
	Libellulidae		4	0	0	0
Oligochaeta				0	2	7
Trichoptera	*Ecnomidae*		4	1	0	0
	Leptoceridae		6	2	0	3
Tricladida				0	0	2

Cumbo Creek

Order	Family	Subfamily	Signal Score	CC1	CC2
Acarina				0	DRY
Coleoptera	*Carabidae*		3	1	
	Curculionidae		2	0	
	Dytiscidae		2	6	
	Elmidae		7	5	

Order	Family	Subfamily	Signal Score	CC1	CC2
	Hydraenidae		3	0	
	Hydrophilidae		2	4	
Collembola				2	
Crustacae				21	
Decapoda				0	
Diptera	*Ceratopogonidae*		4	3	
	Chironomidae		3	0	
	Culicidae		1	1	
	Stratiomyidae		2	3	
	Tabanidae		3	4	
Ephemeroptera	*Baetidae*		5	0	
	Leptophlebidae		8	0	
Gastropoda	*Lymnaeidae*		1	0	
	Physidae		1	0	
	Planorbidae		2	2	
Hemitptera	*Corixidae*		2	0	
	Micronectidae		2	0	
	Notonectidae		1	0	
	Saldidae		1	0	
	Veliidae		3	4	
Nematoda				1	
Odonata	*Aeshnidae*		4	0	
	Coenagrionidae		2	0	
	Corduliidae		5	0	
	Lestidae		1	0	
	Libellulidae		4	0	
Oligochaeta				0	
Trichoptera	*Ecnomidae*		4	0	
	Leptoceridae		6	0	
Tricladida				0	

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Results of microbat survey of disused oil shale mine adit, Slate Gully, Wilpinjong, New South Wales.

Dear Ian,

Following are the results of our latest survey of a disused oil shale mine adit at Slate Gully, Wilpinjong, New South Wales. Counts of bats exiting the adit were conducted from dusk on the evening of 4rd April 2018 using hand held counters. Following the counts a harp trap was placed at the adit mouth and bats re-entering the mine were captured from 9pm. Individuals of two species were captured, the Eastern Bent-wing Bat (*Miniopterus orianae oceanensis*) and Eastern Horseshoe Bat (*Rhinolophus megaphyllus*). Trapping of the adit was again undertaken from 4.00am until 6.00am on the morning of the 5th April. Bats were identified to species and sex and unmarked individuals had fur clipped.

The adit was again harp trapped on the evening of the 5th April to obtain an estimate of the number of individuals roosting within the disused workings. Weather conditions during the survey are detailed in *Table 1*.

Table 1
Weather conditions during the survey

Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
3/04/2017	15.3	26.5	0
4/04/2017	15.6	27.3	0
5/04/2017	16.4	29.0	0

Weather was moderate to warm with no rain during the survey. Minimum temperatures varied from 15.3 to 16.3°C while maximum temperatures varied from 26.5 to 29.0°C.

Two species of predominantly cave roosting microbats were roosting within the disused mine workings at the time of survey; the Eastern Bent-wing Bat (*Miniopterus orianae oceanensis*) and Eastern Horseshoe Bat (*Rhinolophus megaphyllus*). Neither species were breeding at the time of survey. The colony of Eastern Bent-wing Bats roosting within the workings at the time of survey consisted of a mixture of males, females that had not yet given birth to young and older females that had reared young during previous breeding events.

As seen in *Table 2*, the number of bats utilising the workings during the April survey was between 500 and 1000 individuals based on hand counts. Tallies of bats exiting the mine workings on the evening of 4th April with hand held counters were 640 and 705 individuals. These counts match well with equivalent counts obtained during the April 2017 survey (603 and 669). It was not possible to count all the bats exiting from one position so the true number of bats exiting would have been between 700 and 900 individuals. As with previous surveys, Eastern Bent-wing Bats made up the majority of total bats roosting within the workings during the April 2018 survey. 25 individuals captured had previously been banded during the surveys undertaken during 2017. The relatively low percentage of recaptured suggests that there is considerable movement of individuals to other roosts in the area. This pattern has been observed in the closely related Southern Bent-wing Bat (*Miniopterus orianae bassan*i) which occurs in eastern South Australia and western Victoria (Van Harten *et al* 2018). From harp trap captures, the number of Eastern Horseshoe Bats roosting within the workings would number between ten and twenty individuals. This is consistent with previous surveys of the adit. While the majority of individuals captured were males, some females were also captured.

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Best wishes

Glenn Hoye and Andrew Lothian

May2018 *Fly By Night Bat Surveys Pty Ltd*

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Results of a summer microbat survey of a disused oil shale mine adit during November 2018, Slate Gully, Wilpinjong, New South Wales.

Dear Ian,

Following are the results of our survey of a disused oil shale mine adit at Slate Gully, Wilpinjong, New South Wales. Counts of bats exiting the adit were conducted from dusk on the evening of 22nd November 2018 using hand held counters. Only nine individuals were counted exiting the adit from dusk. From their flight pattern, most of the individuals exiting were Eastern Horseshoe Bats (*Rhinolophus megaphyllus*) although a couple of individuals of the Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) also appeared to be present. Harp trapping of the adit was undertaken on the evening of 24th November from dusk until 9.30pm. Five bats were captured, two Eastern Bentwing-bats and three Eastern Horseshoe Bats. The two bentwing-bats captured were both pregnant females.

In contrast with the survey undertaken in mid December 2017, the Eastern Bentwing-bat was present. Both females captured were heavily pregnant. These females are most likely among the last of the females from the Slate Gully colony yet to migrate to their maternity roost. But it is also possible that the small number of pregnant females present in the workings originate from a

different over-wintering roost. They may be using Slate Gully as a stopover en route to their maternity site. No bent-wings were recorded during the summer survey undertaken slightly later in the year during 2017. Eastern Bentwing-bats move from overwintering roosts to maternity roosts around September to find caves with more favourable conditions for birthing young. The bulk of female Eastern Bentwing-bats that were present within the workings during the autumn and winter surveys are en route or have already arrived at their breeding sites. These would be located at known maternity roosts within limestone karst systems or may be present in other disused mine workings (Hoye & Hall 2008).

While a few bent-wings were present, the majority of the small number of bats present were Eastern Horseshoe Bats (*Rhinolophus megaphyllus*). The three individuals of this species captured consisted of two males and a non-breeding female. These findings support the results of the December 2017 survey that breeding by this species is not undertaken within these workings.

Continued monitoring of the roost following works to stabilise the adit opening and adjacent mining would be worthy of consideration to ensure it has no detrimental effects on microbat roosting within the workings. A clear picture of the use of the workings during autumn, winter and summer has emerged from monitoring of the Slate Gully mine over the past two years. A small number of both male and female Eastern Horseshoe Bats are present throughout the year. No breeding is undertaken within the workings by this species. Numbers of the Eastern Bentwing-bat fluctuate more widely throughout the year from none or a few individuals in the middle of summer to just over one thousand individuals in the autumn and winter months. While capture of individuals during previous monitoring has allowed the sexual composition of the colony to be determined as well as the breeding status of individuals, it is quite intrusive and is not generally required for future monitoring of the roost. Counts of individuals exiting the workings provides an unobtrusive means of monitoring use of the workings into the future. Counts during autumn would provide a means of estimating use of the workings on a yearly basis. Some additional counts undertaken in months not undertaken during previous monitoring would further delineate when microbat numbers change within the workings.

Weather Conditions during the Survey

Weather conditions during the survey are detailed in *Table 1*. Rainfall and maximum and minimum temperatures during the survey were recorded at Merriwa (Station No. 61287, Lat: 32.19° S Long: 150.17° E, Elevation: 375 m).

Table 1
Weather conditions during the survey

Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
21/11/2018	17.7	24.3	8.0
22/11/2018	16.8	23.2	1.0
23/11/2018	11.9	21.9	0.0
24/11/2018	10.8	25.1	0.0

Weather was mild with cool nights. A small amount of rain was experienced the day prior to the survey. Minimum temperatures varied from 10.8°C to 17.7°C while maximum temperatures varied from 21.9°C to 25.1°C.

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Best wishes

Glenn Hoye and Andrew Lothian

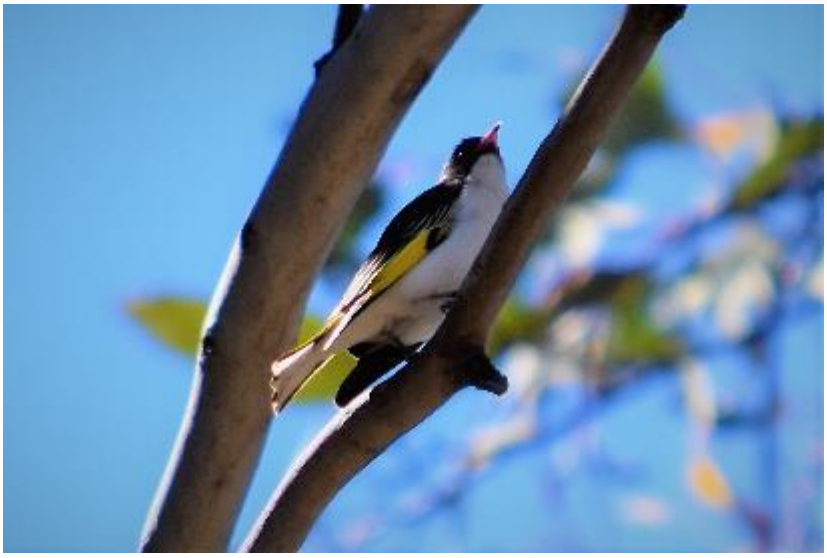
November 2018 *Fly By Night Bat Surveys Pty Ltd*

Wilpinjong Coal Mine

2018 Annual Biodiversity Monitoring Report

Prepared for
Wilpinjong Coal Pty Ltd

29 March 2019



DOCUMENT TRACKING

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Abbreviations

Abbreviation	Description
BC Act	*Biodiversity Conservation Act 2016*
BMP	Biodiversity Management Plan
BOA	Biodiversity Offset Area
DNG	Derived native grassland
EC	Exotic Cover
ECA	Enhancement and Conservation Area
EIS	Environmental Impact Statement
ELA	Eco Logical Australia Pty Ltd
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FL	Fallen Logs
IPT	Interim Performance Target
LFA	Landscape Function Analysis
LOI	Landscape Organisation Index
Microbat	Microchiropteran bat
ML	Mining Lease
MOP	Mine Operations Plan
NGC	Native Ground Cover
NGCG	Native Ground Cover Grass
NGCO	Native Ground Cover Other
NGCS	Native Ground Cover Shrub
NMC	Native Midstorey Cover
NOC	Native Overstorey Cover
NP	National Park
NPWS	National Parks and Wildlife Service
NR	Nature Reserve
NSR	Native Species Richness
NTH	Number of Trees with Hollows
OR	Overstorey Regeneration
PA	Project Approval
SSA	Soil Surface Assessment
SVS	Site Value Score

TARP	Trigger Action Response Plan
WCM	Wilpinjong Coal Mine
WCPL	Wilpinjong Coal Pty Ltd
WEP	Wilpinjong Extension Project
WSDSF	Western Slopes Dry Sclerophyll Forest
WSGW	Western Slopes Grassy Woodland

Summary of key findings

Biodiversity monitoring undertaken at the Wilpinjong Coal Mine (WCM) during 2018 represented the third year of monitoring for autumn, and the fourth year of monitoring for spring under the methodology prescribed in the WCM Biodiversity Management Plan. Monitoring is undertaken across the WCM Management Domains, including Biodiversity Offset Areas (BOAs), Enhancement and Conservation Areas (ECAs), regeneration and rehabilitation areas. A series of reference sites are also monitored to provide comparative results. Five new BOAs were added to the monitoring program in 2018. Monitoring consisted of:

- Vegetation monitoring – autumn and spring
- Winter bird monitoring
- Landscape Function Analysis (LFA) – spring
- General fauna monitoring – spring

Monitoring results are analysed and compared against completion criteria prescribed by the BMP to measure the progress of the Management Domains towards biodiversity targets.

Vegetation monitoring surveys occurred within all Management Domains and Reference sites during 2018. Four autumn sites and eight spring sites achieved the Interim Performance Target (IPT). The majority of sites' site value score improved in comparison to the 2017 results. Although no sites achieved all the site attribute scores, all sites achieved at least half the site attributes scores. This is an improvement from previous monitoring periods. 'Native overstorey cover', 'exotic cover' and 'number of trees with hollows' were consistently the highest performing site attributes, with all sites achieving these attribute targets.

Monitoring results from Reference Sites during both autumn and spring 2018 continue to add to the dataset to be used for comparison against vegetation monitoring results within the Management Domains. Ongoing monitoring data collected at the Reference Sites will be used to develop more relevant, locally based benchmark values against which future monitoring data would be analysed.

Landscape Organisation Index scores, developed through analysis of the LFA monitoring data, remain consistently high across the monitoring program, despite decreasing at most sites compared to 2017 results. Similarly, low levels of erosion observed throughout previous monitoring seasons (2007-2013) can be correlated with the high Soil Surface Assessment (SSA) Stability scores and the lack of any substantial erosion (as recorded in the erosion SSA assessment) recorded since 2015. This is consistent with 2018 results, with only one failing to meet the Stability Completion Criteria. Overall these combined data sets demonstrate that consistently stable landforms occur across the Wilpinjong Coal Mine Domains.

Fauna monitoring undertaken in 2018 recorded 134 fauna species, including 106 birds, 13 reptiles, 11 mammals (including 10 positively identified microbat species) and four frogs. This is an overall increase compared to 2017 results, with bird and amphibian diversity increasing. Eleven species listed under the NSW *Biodiversity Conservation Act 2016* and/or the Commonwealth *Environmental Protection and Biodiversity Act 1999* were recorded. *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) remained the most commonly occurring microbat species, whilst the *Pachycephala rufiventris* (Rufous Whistler) was the most commonly occurring bird species.

On-going monitoring is required to determine if the results are attributed to seasonal variation or are indicative of a long-term trend.

1 Introduction

Wilpinjong Coal Pty Ltd (WCPL), a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody), operates the Wilpinjong Coal Mine (WCM) situated approximately 40 km north-east of Mudgee, within the Mid-Western Regional Council Local Government Area.

Eco Logical Australia (ELA) was engaged by WCPL to undertake biodiversity monitoring of terrestrial flora, fauna and landscape stability during autumn, winter and spring 2018, consistent with the requirements and methods outlined in the WCM Biodiversity Management Plan (BMP) (WCPL 2017). This report summarises the results of the biodiversity monitoring undertaken during autumn, winter and spring 2018 and provides an analysis against the Interim Performance Targets (IPT) and Completion Criteria set out in the BMP (WCPL 2017). A comparative analysis against the baseline data is included where applicable to inform future monitoring and to promote progress towards achieving the IPTs and Completion Criteria.

Project Approval (PA) 05-0021 was granted by the Minister for Planning under Part 3A of the NSW *Environmental Planning and Assessment Act 1979* on 1 February 2006. Development Consent SSD-6764 was granted on 24 April 2017 for the Wilpinjong Extension Project (WEP) and will replace PA 05-0021 once activities under the WEP commence.

The WCM BMP (WCPL 2017) was prepared to fulfil the requirements of the PA and in accordance with the Environmental Impact Statement (EIS) and Statement of Commitments. The BMP details the management strategies, procedures, controls and monitoring programs required to manage biodiversity within the Management Domains, which include Enhancement and Conservation Areas (ECAs), Biodiversity Offset Areas (BOAs), and Regeneration and Rehabilitation Areas. The Management Domains are listed below in **Table 1-1** with locations shown in **Figure 1-1**.

All land within BOAs D and E has been transferred to the National Parks Estate and is now under the management of the NSW National Parks and Wildlife Service (NPWS). In accordance with Schedule 3, Condition 42 of the Development Consent, the WCPL BMP does not apply to BOAs if they are transferred into National Parks Estate (WCPL 2017). Monitoring was conducted at BOAs D and E in 2018 to continue to add to the dataset to be used for comparison with vegetation sites within the various Management Domains. However, these BOAs will be treated as a separate management domain to the new BOAs added to the monitoring program in 2018.

BOAs 1-5 were added to the monitoring program in winter 2018. It is understood that these will also be transferred into the National Parks Estate in accordance with Schedule 3, Conditions 32 and 35 of Development Consent SSD-6764.

1.1 Objective

The objective of the biodiversity monitoring at WCPL is to measure the progress of the Management Domains towards the relevant Completion Criteria prescribed in the BMP (WCPL 2017). Biodiversity monitoring includes assessment of native vegetation and habitat complexity, landscape stability and fauna diversity. Monitoring results from spring 2015 and autumn 2016 represent the baseline (Year 0) data for each monitoring site, with the 2018 results presented in this report representing Year 2 and Year 3 data for autumn and spring respectively.

Table 1-1: WCPL Management Domains

Management Domain	Area (ha)	Location Description
BOA-D	50.36	Located approximately 12 km north-east of Mining Lease (ML) 1573
BOA-E	160.18	Located approximately 3 km east of ML 1573
ECA-A	189.56	Located to the south-east of ML 1573
ECA-B	233.59	Located to the north of ML 1573
ECA-C	96.23	Located in the south-east portion of ML 1573
Regeneration Area 1	27.61	Located adjacent to the eastern boundary of the approved disturbance area
Regeneration Area 2	14.00	Located on the western side of ECA-A
Regeneration Areas 3, 7 and 8	1.28	Located adjacent to the south and south western boundary of the approved disturbance area
Regeneration Area 4	6.53	Located on the north side of the mine, between the approved disturbance boundary and ECA-B
Regeneration Area 5	23.66	Located towards the western end of ECA-B
Regeneration Area 9	27.57	Located towards the western end of ECA-B
Rehabilitation Areas	Variable	Includes areas within the approved disturbance area for the mine, including active and future mining areas, infrastructure areas and rehabilitation of disturbed areas that is undertaken on a progressive basis in accordance with the approved WCPL Mine Operations Plan (MOP) (WCPL 2014)
BOA-1	201.12	Located to the south-west of ML 1573
BOA-2	157.73	Located to the south of the ML 1573
BOA-3	128.45	Located to the north-west of ML 1573, access via the Wollara Downs property
BOA-4	39.02	Located to the north-west of ML 1573, access via Mogo Road
BOA-5	221.24	Located to the west of ML 1573, access via the Wollara Downs property

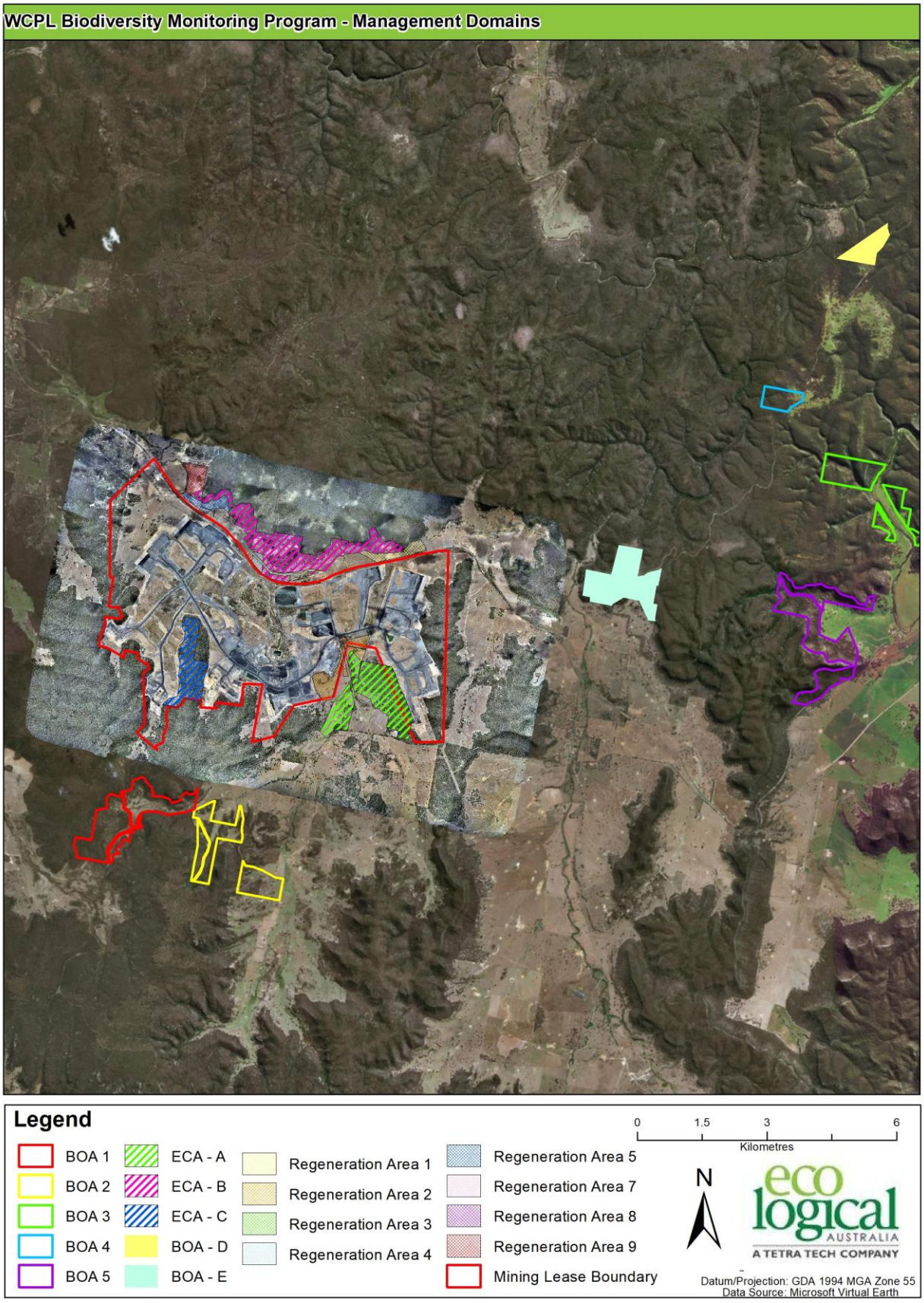

Figure 1-1: WCPL Management Domains

1.2 Previous monitoring

Biodiversity assessment and monitoring of the Management Domains was undertaken as part of the baseline studies and vegetation community mapping components of the EIS, as well as for the Rehabilitation Areas and ECAs under the rehabilitation monitoring requirements of the MOP (WCPL 2014). However, this data does not directly correlate with the performance criteria contained in the BMP (WCPL 2017), and therefore is unable to be used to measure the effectiveness of management practices to improve biodiversity values within the Management Domains.

The monitoring program outlined in the BMP (WCPL 2017) commenced in spring 2015. Monitoring undertaken during 2018 was consistent with the methods and approach described in the 2015, 2016 and 2017 annual monitoring reports (ELA 2016; ELA 2017; ELA 2018) and the BMP (WCPL 2017).

1.3 Assessment against Interim Performance Targets

The BMP (WCPL 2017) outlines IPTs that will be used to determine progression towards the Completion Criteria and overall mine closure objectives. The IPTs provide ongoing targets against which the progression of rehabilitation and regeneration activities can be assessed against over time. The Completion Criteria will be used to assess the success of establishment of rehabilitation and regeneration areas against the proposed final land use.

1.3.1 Vegetation

The BMP (WCPL 2017) defines IPTs and benchmark values (Completion Criteria) for low, moderate to good and high condition vegetation within each of the Keith Vegetation Classes (Western Slopes Dry Sclerophyll Forest (WSDSF) and Western Slopes Grassy Woodland (WSGW)).

Within this monitoring report, IPTs for years 1-5 have been used to assess the performance of individual floristic monitoring sites and to evaluate progress towards achieving benchmark condition. Sites established in 2018 used IPTs for Year 0. A colour coding system has been applied to all the Management Domain site attribute results, whereby:

- GREEN indicates site attributes that have met the relevant IPTs (indicating that no additional management intervention is required)
- AMBER indicates site attributes that have not met the relevant IPTs, but are within 50 - <100% of the IPTs and do not show a substantial decrease compared to the previous year's monitoring results (indicating a requirement to monitor closely, management intervention may be required)
- RED indicates site attributes that are <50% of the relevant IPTs or show a substantial decline compared to the previous year's monitoring results (indicating that management intervention is required).

A 'substantial decline' is defined as a relative decline of 50% or greater compared to the previous year's results (e.g. a decline from a value of 20 to a value of 10 or less).

Reference sites were assessed against the relevant Benchmark values, utilising the same colour coding system described above (replacing reference to IPTs with Benchmark values).

Sites which obtain a site value score lower than the IPT trigger the Native Vegetation and Habitat Complexity (BioMetric) Trigger Action Result Plan (TARP) outlined in Table 26 of the BMP (WCPL 2017).

1.3.2 Landscape Function Analysis (LFA)

The BMP (WCPL 2017) defines Completion Criteria for a self-sustaining landform as achievement of a score of 50 or more for each Soil Surface Assessment (SSA) Index. A ranking system has been applied in this report, with sites obtaining an SSA Index score of 50 or above (thereby meeting the Completion Criteria) colour coded green, and sites with a SSA score of less than 50 colour coded red.

The BMP (WCPL 2017) further states that incremental improvement (an increase of five or more index points annually) is anticipated, with achievement of Completion Criteria by Year 10. Where sites did not achieve the Completion Criteria score of 50 for a particular SSA index, the changes in this index from spring 2017 to spring 2018 have been assessed against the predicted annual increase. In these cases, sites that achieved the target increase of five points or more within an SSA index are colour coded green, and sites that did not achieve this annual increase are colour coded red. Failure to achieve an increase of 5% in the annual LFA scores represents a trigger for the Landscape Stability (LFA) TARP.

2 Methodology

The 2018 biodiversity monitoring program was undertaken in accordance with the methods and survey techniques prescribed in the BMP (WCPL 2017). As per the requirements of the BMP (WCPL 2017), the biodiversity monitoring program comprised the following components:

- Vegetation monitoring
- Landscape stability monitoring using LFA
- Terrestrial fauna monitoring.

Weather conditions during the autumn, winter and spring 2018 monitoring are presented in **Appendix A**.

Additional information on all vegetation, LFA and fauna monitoring sites can be found in **Appendix B**.

2.1 Vegetation monitoring (Biometric)

Autumn vegetation monitoring was undertaken between 30 April and 8 May 2018 by ELA ecologists Clare Duck, Tom Kelly and Angelina Siegrist. Spring vegetation monitoring was undertaken between 10 September and 19 November 2018 by ELA ecologists David Allworth, Elise Keane, Tom Kelly, Kate Maslen and Cheryl O'Dwyer.

Vegetation monitoring was undertaken across all Management Domains and 24 reference sites located within NPWS managed estates. The locations of vegetation monitoring sites are illustrated below in **Figure 2-1, Figure 2-2, Figure 2-3** and .

Changes to the monitoring program since 2017 include the addition of two new vegetation monitoring sites, BOA1_100 and BOA2_100. Reference site 13b, which was excluded from 2017 monitoring due to the site having been affected by fire, was once again monitored in autumn 2018. With the expansion of the mine operational area, sites R1_101 and R7_101 have been removed from the monitoring program

Vegetation monitoring was undertaken utilising the method of plot assessment prescribed in the BMP (WCPL 2017). Permanent Biometric plots, comprising a 20 m x 20 m (0.04 ha) plot nested within a 20 m x 50 m plot, were established in spring 2015, autumn 2016. and spring 2018 and were monitored in accordance with the methods described in Section 9.1 of the BMP (WCPL 2017). Within each plot, the following data was collected:

- native species richness, cover and abundance within the 20 m x 20 m plot
- native and exotic tree cover and native midstorey cover – at regular 5 m intervals along 50 m transect (10 points)
- native ground (grass, shrub, other) and exotic cover – at regular 1 m intervals along 50 m transect (50 points)
- habitat features (number of trees with hollows, length of fallen logs (FL)) and proportion of overstorey species regeneration – within 20 m x 50 m plot.

All vascular plants species were recorded and identified to the lowest taxonomic level possible, with samples of unknown species collected for further identification.

2.2 Landscape Function Analysis

LFA monitoring was undertaken between 10 September and 19 November 2018, by ELA ecologists David Allworth, Elise Keane, Tom Kelly, Kate Maslen and Cheryl O'Dwyer. LFA monitoring was undertaken in accordance with the methods prescribed in Tongway and Hindley (2005) and the BMP (WCPL 2017).

In total, LFA assessments were undertaken at 20 monitoring sites, including 10 within WCPL Management Domains and 10 reference sites located within NPWS managed estate (**Figure 2-3** and). LFA assessment was not conducted at site R1_100 and R5_C due to the expansion of the mining operational area and the conclusion of the cattle grazing monitoring.

At each LFA site, a 50 m transect line was established downslope between transect start and end markers. The majority of LFA transects directly correspond to the 50 m Biometric transect of the respective monitoring site. However, at several sites, the LFA transect does not align with the Biometric transect, predominantly due to the Biometric transect being established across slope rather than downslope in these locations. Along each LFA transect, LFA attributes were assessed to monitor the Landscape Organisation Index (LOI) and SSA.

2.2.1 Landscape organisation index

The LOI characterises and maps the spatial patterns of resource loss or accumulation at a site. The LOI provides a proportion of the transect occupied by patches (patches being landscape elements that are relatively permanent and provide stable, resource accumulating structures, such as grassy tussocks, ground cover and logs). A higher LOI implies a more stable transect that is less prone to erosion, with a LOI of 1.00 indicating that an entire transect is occupied by patches. The SSA is more in-depth, providing an index (0-100) of Stability, Soil Infiltration and Nutrient Cycling for the whole of landscape (transect). Table 20 in the BMP (WCPL 2017) summarises the SSA attributes that contribute to each of these indices.

According to the LFA method, patches are long-lived/term features that obstruct or divert water flow and/or collect/filter out material from runoff and where there is evidence of resource accumulation. Inter-patches are zones where resources such as water, soil materials and litter may be mobilised and freely transported either down slope when water is the active agent or down-wind when aeolian processes are active.

The following data was recorded for each patch/inter-patch along each transect:

- distance (m) from the start of the transect
- patch width (cm)
- patch/inter-patch identification.

The following patch types were defined and monitored across all monitoring sites and monitoring periods:

- bare soil
- litter (including annual plants)
- rock (<5 cm diameter)
- log (>10 cm diameter)
- ground cover (perennial)
- shrub/tree
- cryptogam
- any combinations of the above (e.g. ground cover – litter patch).

2.2.2 Soil surface assessment (SSA)

Each patch/inter-patch type identified in the landscape organisation data log was subject to a SSA. A subset of up to five occurrences of each patch/inter-patch type were monitored, and the following SSA attributes measured:

- rain splash protection
- perennial vegetation cover
- structural classification of vegetation, including the height of each canopy layer
- litter
- cryptogam cover
- crust brokenness
- soil erosion type and severity
- deposited materials
- soil surface roughness
- surface nature (resistance to disturbance)
- description of ephemeral drainage lines
- slake test
- soil texture.

Each of these parameters was assigned a simple score in the field. Data was entered into the LFA calculation spreadsheets and used to calculate stability, infiltration and nutrient cycling indices.

A self-sustaining landform is deemed to have been achieved when SSA scores of 50 or more are recorded (the LFA Completion Criteria, expected to be achieved by Year 10 of the management cycle). Incremental improvement toward that target is expected with each year of monitoring. Failure to achieve an increase of five in the annual LFA scores represents a trigger for implementation of the Landscape Stability LFA TARP described in Table 27 of the BMP (WCPL 2017). Comparative annual results have been colour-coded to provide a visual indicator, with green reaching or exceeding the incremental increase of five or more, and red showing an increase of less than five (or in some cases, a reduction from the previous year). Red coded cells indicate the TARP needs to be implemented. Results maintained at or above the Completion Criteria (50) have been coded green regardless of comparative incremental increase or decrease from previous monitoring.

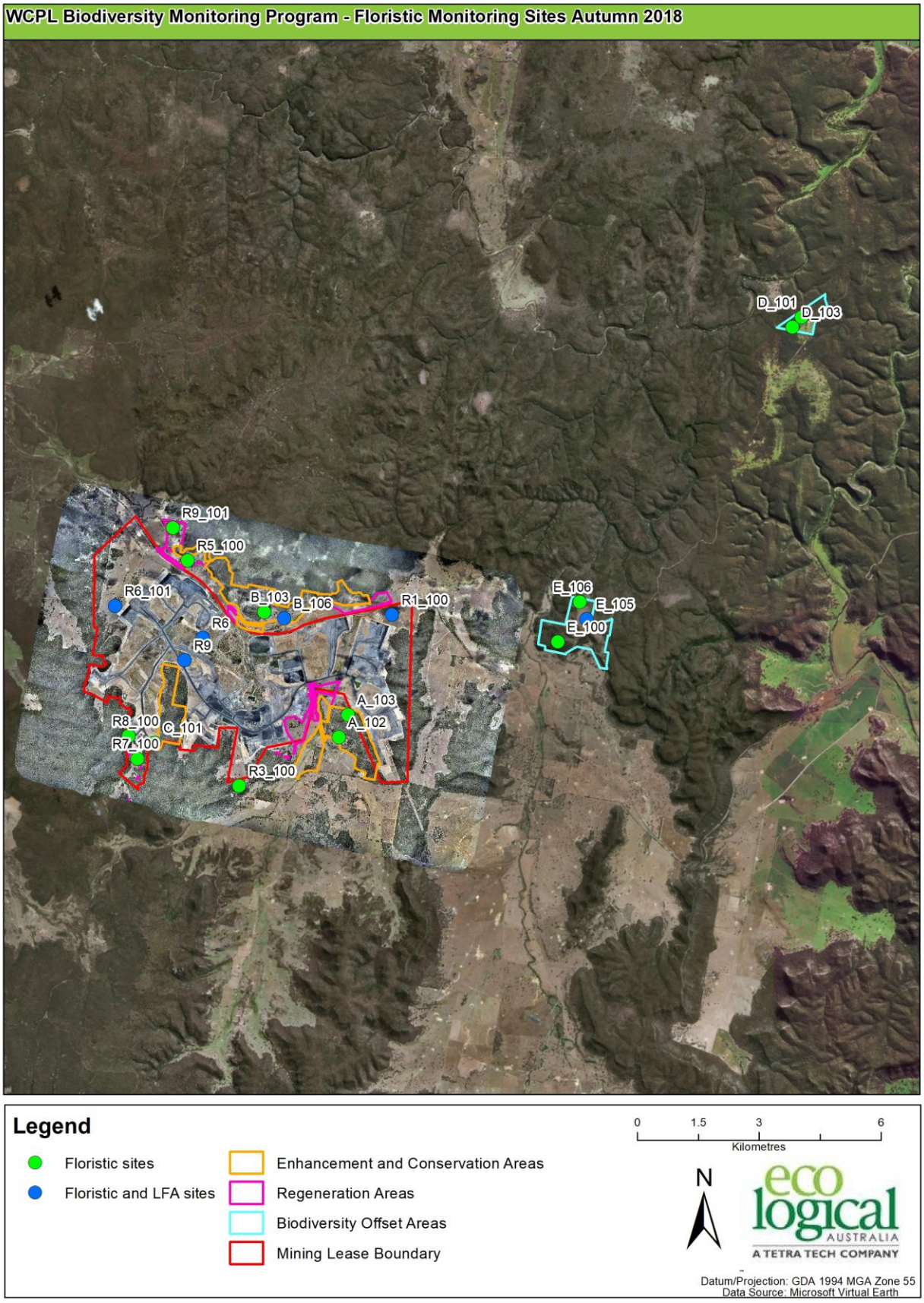

Figure 2-1: Autumn 2018 vegetation monitoring sites

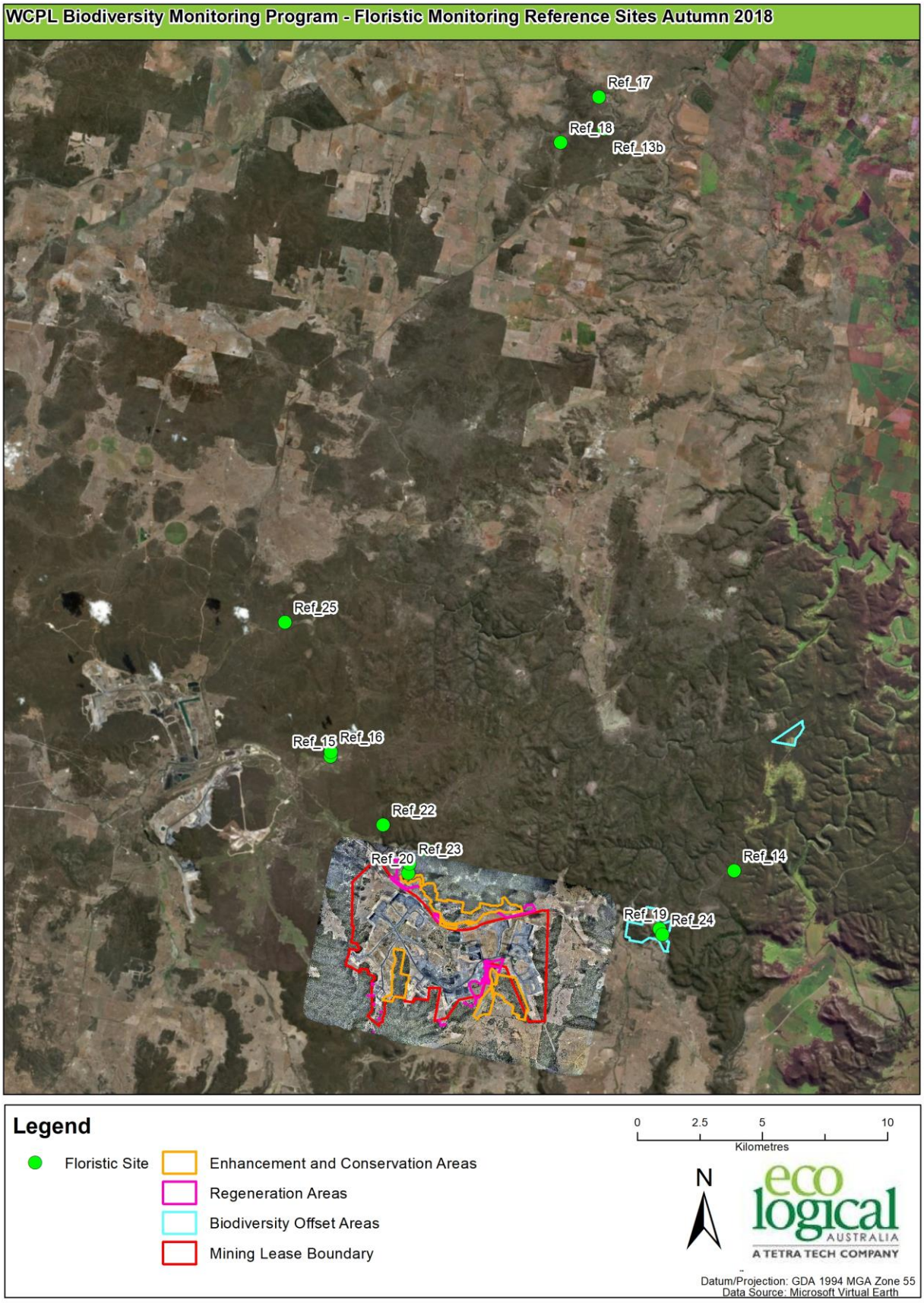

Figure 2-2: Autumn 2018 vegetation monitoring reference sites

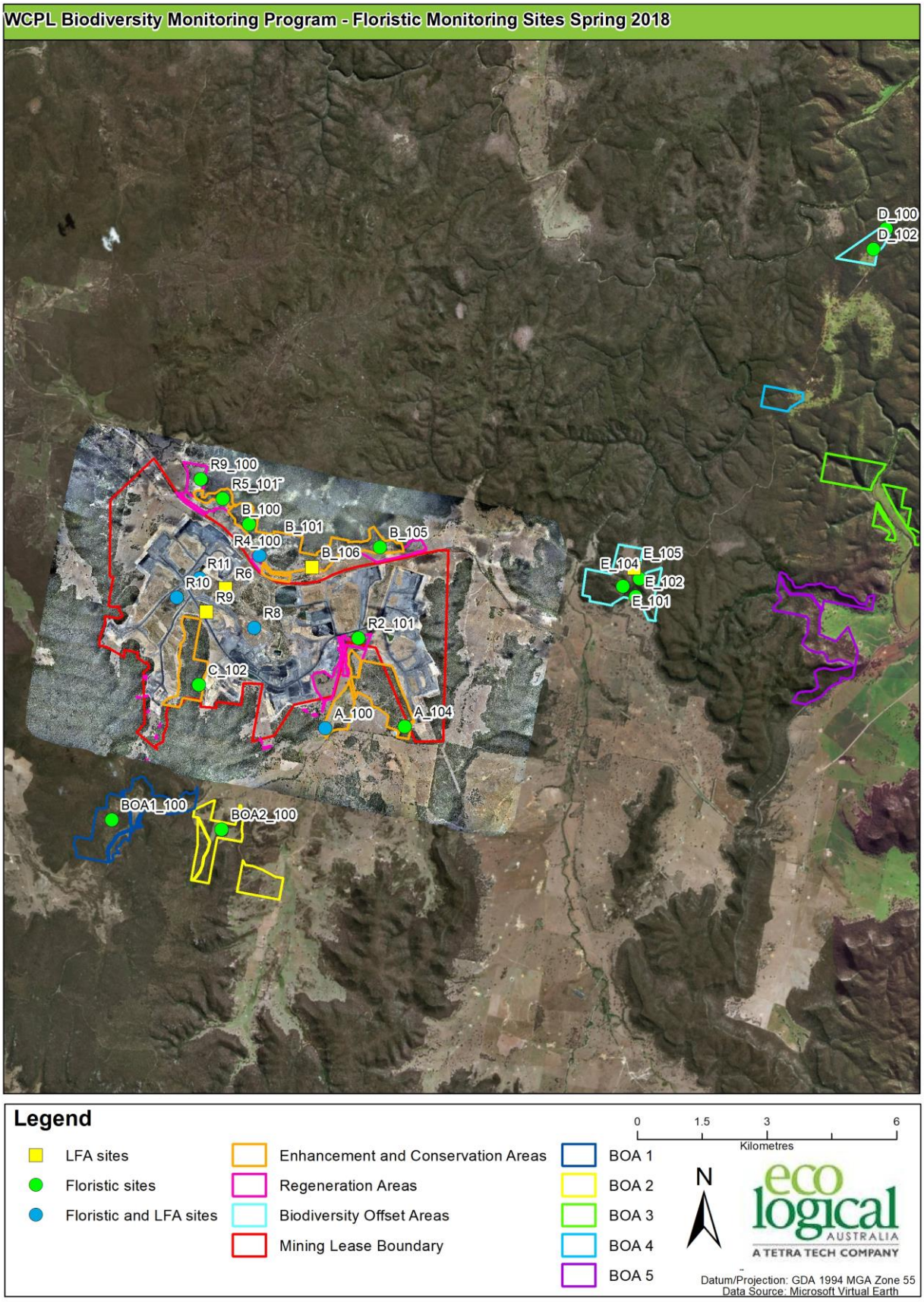

Figure 2-3: Spring 2018 vegetation and LFA monitoring sites

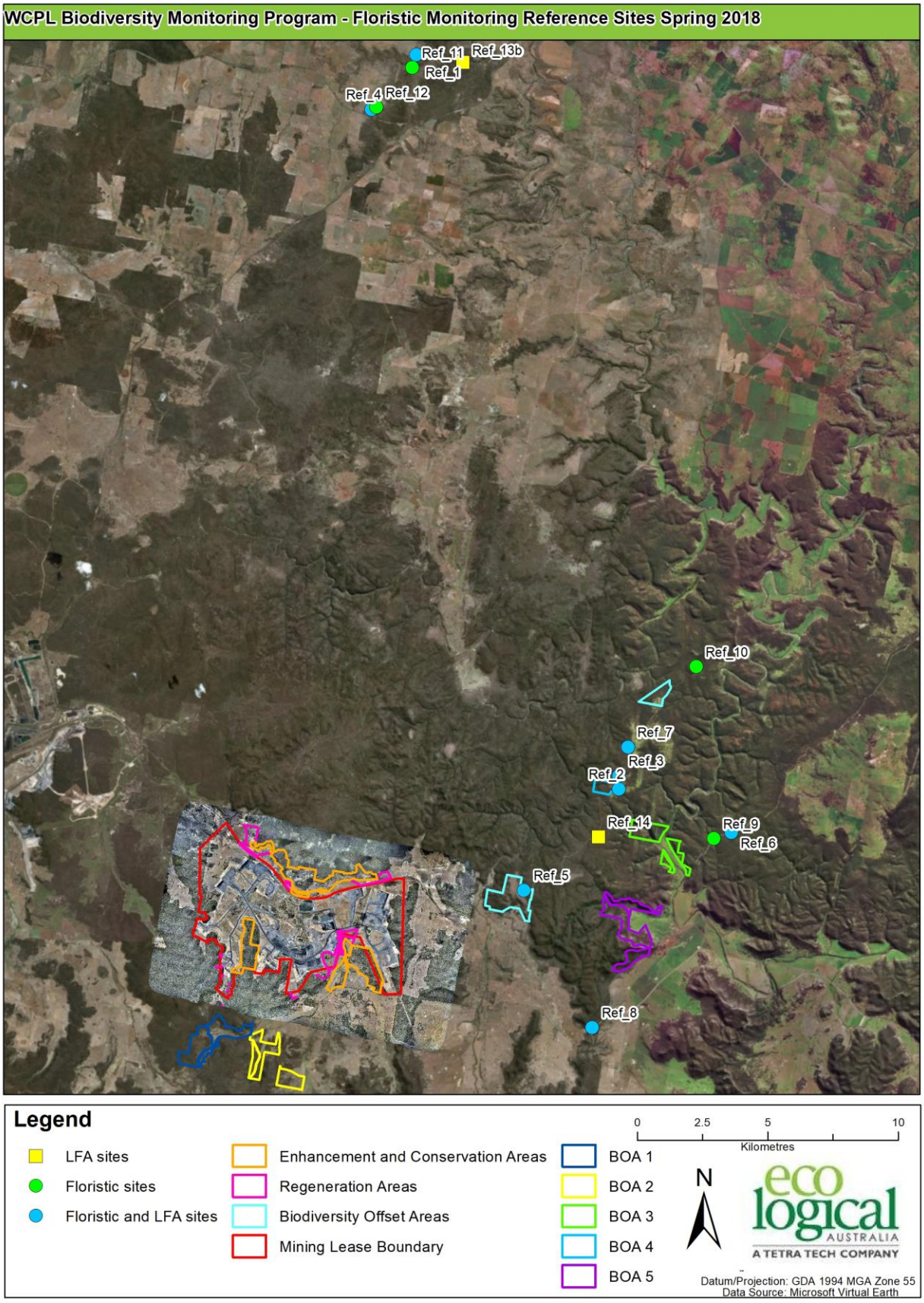

Figure 2-4: Spring 2018 vegetation and LFA reference sites

2.3 Fauna monitoring

2.3.1 Winter bird monitoring

Winter bird monitoring was undertaken at 19 general fauna monitoring sites and six diurnal bird monitoring sites from 9 to 13 July 2018, by ELA ecologists Cassandra Holt and Angelina Siegrist, shown below in **Figure 2-5**Error! Reference source not found.

During winter 2018, 13 new general fauna monitoring sites were established within the BOAs 1- to 5. Winter bird monitoring commenced at these sites from 31 July to 1 August 2018. Data collected at these sites forms baseline data and cannot be compared to previous data.

Bird surveys were conducted across two seasons to detect migratory species and specialist feeders. Winter surveys were undertaken to identify species that feed on the blossoms of winter-flowering eucalypts and lerps. The 37 monitoring sites are shown in **Figure 2-5.**

2.3.2 Spring fauna monitoring

Spring fauna monitoring was undertaken between 5 to 23 November 2018, by ELA ecologists Rodney Armistead, Cassandra Holt, Elise Keane, Tom Kelly, Kate Maslen, Nicole McVicar, Justin Russell and Angelina Siegrist.

Table 2-1 below outlines the methodology and survey effort for each target species and is based upon the methods prescribed within the BMP (WCPL 2017). During spring monitoring 2018, there were 23 general fauna monitoring sites, nine diurnal bird monitoring sites, and five reference sites. This includes the sites within BOAs 1 to 5 established in winter 2018. Data collected at these sites forms baseline data and cannot be compared to previous results. The locations of fauna monitoring sites are shown in **Figure 2-6**, with reference sites shown in **Figure 2-7**.

Microchiropteran bat (microbat) monitoring was undertaken at ten general fauna monitoring sites and five reference sites, as required by the BMP (WCPL 2017). Microbat analysis was undertaken by ELA ecologist Dr Rodney Armistead, with the analysis report provided in **Appendix G**.

Opportunistic fauna sightings, including fauna evidence such as scats and tracks, were also recorded, where identified across all fauna monitoring sites.

Table 2-1: Fauna monitoring methods summary (WCPL 2017)

Target species	Fauna site	Methodology	Total Survey Effort
Birds	General fauna	Bird census consisting of 10 minutes recording all birds seen/heard within 50 m radius of central plot point, and further 10 minutes recording all birds seen/heard within balance of a 2 ha plot.	80 minutes per site (20 minutes per survey, per person, per site), over one morning and one afternoon (37 sites).
Ground fauna (amphibians, mammals, reptiles)	General fauna	Pit fall/funnel trap line of 30 m drift fence and five 20 L buckets/10 funnel traps spaced 5 m apart covering both sides of the drift fence.	Twice daily inspections of traps (morning and afternoon) for five days/four nights (23 sites).
Bats	Bat	Automated ultrasonic acoustic recording to identify all bat species occurring.	Recording for 2 nights (6pm – 6am) (10 sites).

Target species	Fauna site	Methodology	Total Survey Effort
All	Opportunistic	Any sightings of fauna recorded whilst moving throughout the Project Area and located using a GPS.	Opportunistic
Mammals	Opportunistic	Opportunistic collection of scats and observations of tree scratching's, animal tracks and paw prints.	Opportunistic

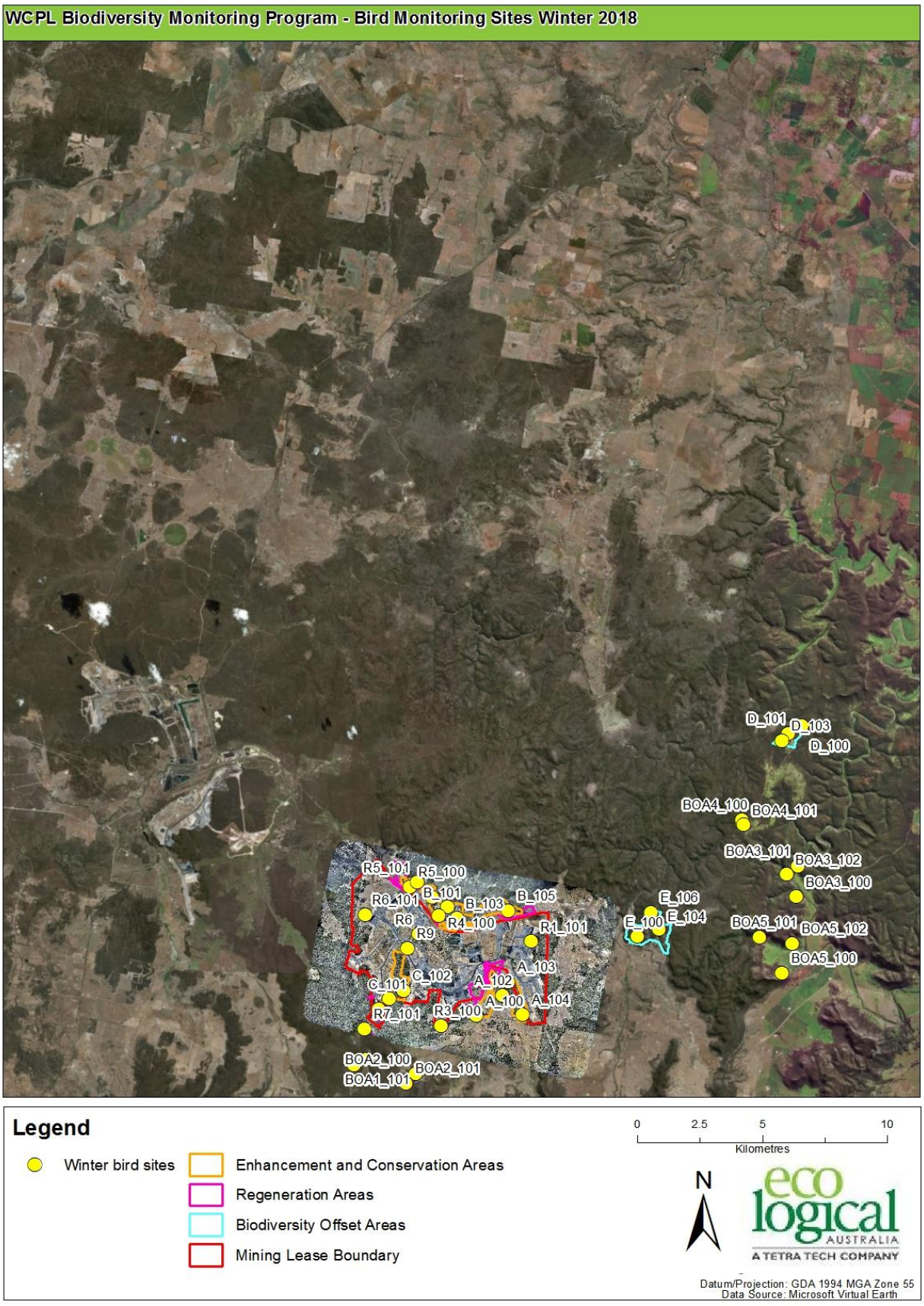

Figure 2-5: Winter 2018 bird monitoring site

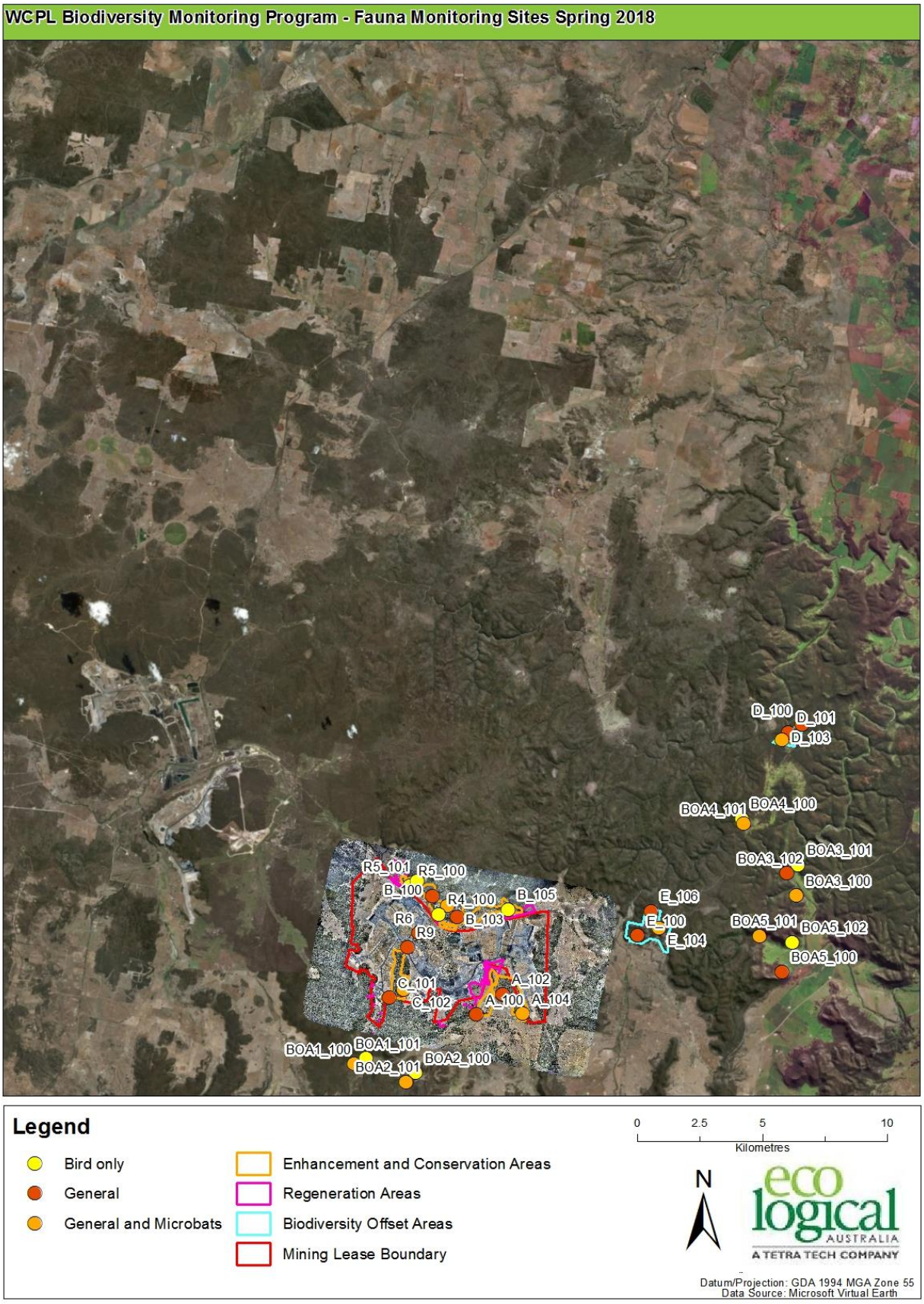

Figure 2-6: Spring 2018 fauna monitoring sites

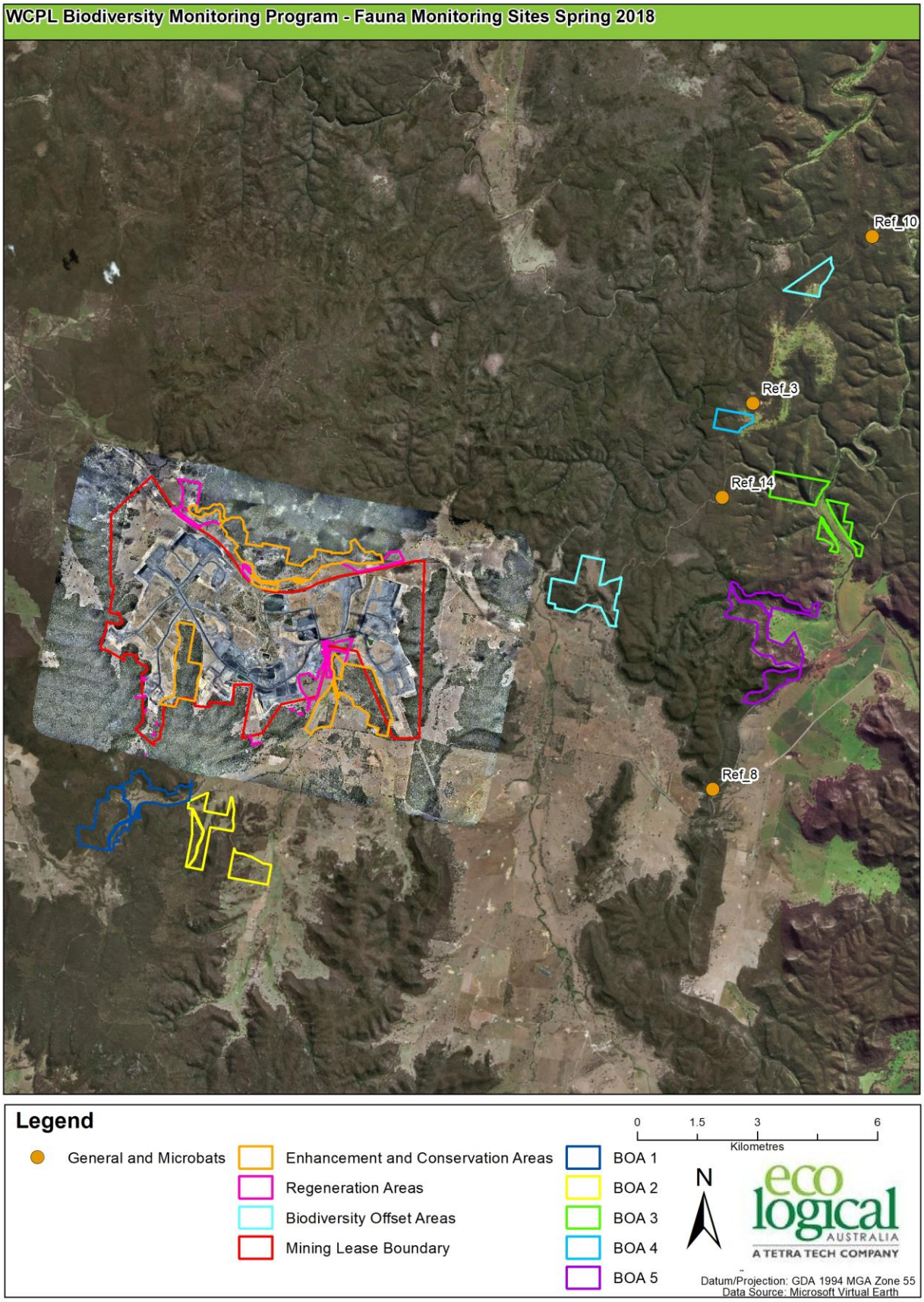

Figure 2-7: Spring 2018 fauna reference sites

3 Results and discussion

This section presents the 2018 monitoring results, including autumn and spring vegetation monitoring, winter bird monitoring, and spring LFA and fauna monitoring. Vegetation monitoring results are presented and discussed collectively for all Management Domains. LFA and fauna monitoring results are presented and discussed individually for each BOA, ECA, Regeneration and Rehabilitation Management Domains.

3.1 Vegetation monitoring

A total of 223 flora species were recorded across the Management Domains and Reference sites during autumn and spring 2018, consisting of 171 native species and 43 exotic species, with a further nine species unable to be identified as either native or exotic. A full list of all flora species recorded during autumn 2018 and spring 2018 surveys is included in **Appendix C**.

3.1.1 Assessment against Interim Performance Targets

Vegetation monitoring results are assessed against IPTs and Benchmark Targets (for Management Domains and Reference sites respectively (see **Appendix E**) and compared against the previous year's monitoring results to evaluate trends and progress towards achieving Completion Criteria, as set out in the BMP (WCPL 2017).

Site value scores were calculated for all 2018 monitoring sites to determine the vegetation condition for each site. Each site was then assessed relative to the IPT or Benchmark targets for the relevant condition within each Keith Vegetation Class as per the BMP (WCPL 2017). Both monitoring periods fall within the Year 1-5 IPTs, being Year 3 (autumn 2018 sites) and Year 4 (spring 2018 sites). However, the data collected from sites established in spring 2018 (BOA1_100 and BOA2_100) forms baseline data and as such results were ranked against the lower Year 0 (or baseline) IPTs.

Table 3-1 to **Table 3-4: Reference sites assessment against Benchmark Targets Year 4- spring 2018** present the individual site attribute and site value scores for each 2018 monitoring site. Site value scores which do not meet the IPT are highlighted in red, demonstrating these sites have triggered the Native Vegetation and Habitat Complexity (BioMetric) Trigger TARP detailed in Table 26 of the BMP (WCPL 2017). Amber is not applied to the site value score as anything below the IPT triggers the TARP. A colour coding system has been applied to all site attribute results.

- GREEN indicates site attributes that have met the relevant IPTs (indicating that no additional management intervention is required)
- AMBER indicates site attributes that have not met the relevant IPTs, but are within 50 - <100% of the IPTs and do not show a substantial decrease compared to the previous year's monitoring results (indicating a requirement to monitor closely, management intervention may be required)
- RED indicates site attributes that are <50% of the relevant IPTs or show a substantial decline compared to the previous year's monitoring results (indicating that management intervention is required).

Table 3-1: Assessment against Interim Performance Targets Year 3- autumn 2018

Management Domain	Vegetation Community	Site	Vegetation condition	SVS	Site attributes (% cover)									
					NSR	NOC	NMC	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
BOA	WSDSF	D_101	MOD-GOOD	52	27	27.5	7	0	0	14	0	0	1	42
	WSDSF	D_103	MOD-GOOD	43	19	7.5	36	0	14	0	0	0	1	0
	WSDSF	E_100	MOD-GOOD	64	30	23.5	14.5	4	0	4	0	0	1	112
	WSGW	E_105	LOW	23	24	0	0	24	0	16	28	0	0	0
	WSGW	E_106	MOD-GOOD	41	31	0.5	0	30	0	22	0	0	1	10
ECA	WSGW	A_102	MOD-GOOD	39	19	0	8.6	44	2	4	0	0	0	0
	WSGW	A_103	MOD-GOOD	61	27	11.6	1.4	12	2	2	0	1	0.33	19
	WSDSF	B_103	MOD-GOOD	56	35	35	5	4	6	0	0	0	0.5	28
	WSGW	B_106	LOW	20	17	0	0	24	0	30	8	0	0	0
	WSDSF	C_101	LOW	15	9	0	0	44	0	0	38	0	1	2
Regeneration Areas	WSGW	R1_100	LOW	7	7	0	0	6	0	0	34	0	0	0
	WSDSF	R3_100	LOW	14	16	0	0	62	0	0	18	0	0	0
	WSGW	R5_100	LOW	18	12	0	0	46	0	0	14	0	0	0
	WSGW	R6_101	LOW	9	10	0	0	24	0	0	12	0	0	0

Management Domain	Vegetation Community	Site	Vegetation condition	SVS	Site attributes (% cover)									
					NSR	NOC	NMC	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
	WSGW	R7_100	LOW	15	16	0	0	36	0	0	20	0	0	0
	WSDSF	R8_100	LOW	7	8	0	0	36	0	0	36	0	0	0
	WSGW	R9_101	LOW	19	20	0	0	50	0	4	12	0	0	0
Rehabilitation Areas	WSDSF	R6	LOW	13	15	1	2	0	0	0	46	0	0.75	0
	WSDSF	R9	LOW	32	20	0.1	22.3	0	0	0	18	0	1	37

SVS = Site Value Score, NSR = Native Plant Species Richness, NOC = Native Overstorey Cover, NMC = Native Midstorey Cover, NGCG = Native Ground Stratum Cover (grasses), NGCS = Native Ground Stratum Cover (shrubs), NGCO = Native Ground Stratum Cover (other), EC = Exotic Plant Cover, NTH = Number of Trees with Hollows, OR = Overstorey Regeneration and FL = Total Length of Fallen Logs

Table 3-2: Assessment against Interim Performance Targets Year 4 - spring 2018

Management Domain	Vegetation Community	Site	Vegetation condition	SVS	Site attributes (% cover)									
					NSR	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
BOA D and E	WSDSF	D100	MOD-GOOD	50	20	6	6.5	0	4	0	0	1	1	59
	WSGW	D102	MOD-GOOD	36	33	3.5	0	14	0	14	0	0	0	6*
	WSDSF	E101	MOD-GOOD	45	18	2	16	24	6	8	0	0	1	3
	WSGW	E102	LOW	17	17	26	0	0	0	0	17	0	0	0
	WSGW	E104	MOD-GOOD	45	28	10	0	22	0	4	0	0	1	0
BOA 1 to 5	WSDSF	BOA1_100	MOD-GOOD	54	26	16.5	39	2	4	0	0	0	0	94
	WSDSF	BOA2_100	HIGH	72	37	17	55	0	4	0	0	7	0	110
ECA	WSGW	A100	LOW	9	4	0	0	20	0	0	36	0	0	0
	WSGW	A104	HIGH	73	23	11.8	6.9	4	4	2	0	0	1	68
	WSGW	B100	MOD-GOOD	57	36	19	3	2	0	2	0	0	0.67	25
	WSGW	B101	LOW	23	19	0	0	30	0	8	2	0	0	0
	WSDSF	B105	LOW	17	16	0	0	36	0	0	14	0	0	0
	WSGW	C102	MOD-GOOD	63	34	11.7	2	0	4	0	0	1	0	50
Regeneration Areas	WSGW	R2_101	LOW	18	13	0	0	22	0	0	10	0	0	0
	WSGW	R4_100	LOW	9	7	0	0	8	0	0	12	0	0	0
	WSDSF	R5_101	LOW	17	17	0	0	44	0	0	8	0	0	0
	WSDSF	R9_100	LOW	23	27	0	7.7	26	0	4	4	0	0	0

Management Domain	Vegetation Community	Site	Vegetation condition	SVS	Site attributes (% cover)									
					NSR	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
Rehabilitation Areas	WSGW	R8	LOW	9	6	0	0	0	0	12	20	0	0	0
	WSGW	R10	LOW	13	14	0	0	0	0	0	40	0	0	15
	WSGW	R11	LOW	7	8	0	0.5	0	0	8	46	0	0	1

SVS = Site Value Score, NSR = Native Plant Species Richness, NOC = Native Overstorey Cover, NMC = Native Midstorey Cover, NGCG = Native Ground Stratum Cover (grasses), NGCS = Native Ground Stratum Cover (shrubs), NGCO = Native Ground Stratum Cover (other), EC = Exotic Plant Cover, NTH = Number of Trees with Hollows, OR = Overstorey Regeneration and FL = Total Length of Fallen Logs

* Substantial decline from 2017 monitoring which recorded 23m FL. Potential data recording error.

Table 3-3: Reference sites assessment against Benchmark Targets Year 3 - autumn 2018

Management Domain	Vegetation Community	Site	Vegetation condition	SVS	Site attributes (% cover)									
					NSR	NOC	NMC	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
Reference sites	WSDSF	Ref_13b	HIGH	72	25	24.5	8	4	0	20	0	3	0.5	58
	WSDSF	Ref_14	MOD-GOOD	54	29	25.5	12.5	2	2	2	0	0	0.83	35
	WSGW	Ref_15	MOD-GOOD	59	23	14.6	0	18	0	0	0	3	0	26
	WSGW	Ref_16	MOD-GOOD	51	32	14	0	18	2	2	0	0	0.33	43
	WSGW	Ref_17	MOD-GOOD	63	22	13	0	8	0	32	0	5	0.25	55
	WSGW	Ref_18	HIGH	86	28	21.5	5.5	24	0	2	0	2	0.5	80
	WSGW	Ref_19	MOD-GOOD	66	32	18.5	0	36	0	8	4	1	1	45
	WSDSF	Ref_20	MOD-GOOD	38	25	18	2.5	0	0	0	0	1	0	24
	WSDSF	Ref_21	MOD-GOOD	49	26	23	0.5	12	0	14	0	0	0.5	79
	WSDSF	Ref_22	MOD-GOOD	41	30	47	0.5	14	0	2	0	0	0.33	208
	WSGW	Ref_23	MOD-GOOD	43	23	21	0	12	0	28	0	0	0.66	3
	WSGW	Ref_24	HIGH	74	33	22.5	4	12	0	18	0	1	0.33	105

SVS = Site Value Score, NSR = Native Plant Species Richness, NOC = Native Overstorey Cover, NMC = Native Midstorey Cover, NGCG = Native Ground Stratum Cover (grasses), NGCS = Native Ground Stratum Cover (shrubs), NGCO = Native Ground Stratum Cover (other), EC = Exotic Plant Cover, NTH = Number of Trees with Hollows, OR = Overstorey Regeneration and FL = Total Length of Fallen Logs

Table 3-4: Reference sites assessment against Benchmark Targets Year 4- spring 2018

	Vegetation Community	Site	Vegetation condition Vegetation condition	SVS	Site attributes (% cover)									
					NSR	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH	OR	FL (M)
Management Domain	WSGW	Ref_1	MOD-GOOD	39	30	0	0	26	0	12	2	0	1	0
	WSDSF	Ref_2	MOD-GOOD	55	33	11	8.3	4	0	4	0	1	0.33	15
	WSDSF	Ref_3	MOD-GOOD	57	28	13.5	7	0	4	0	0	2	0.67	38
	WSGW	Ref_4	HIGH	84	28	19	2.5	8	0	2	0	5	1	36
	WSDSF	Ref_5	MOD-GOOD	59	35	14	9	2	4	6	0	0	0.75	53
	WSDSF	Ref_6	MOD-GOOD	66	23	8.1	10.3	12	10	2	0	2	0.60	38
	WSDSF	Ref_7	MOD-GOOD	47	27	7	4	2	2	6	0	1	0.75	38
	WSGW	Ref_8	HIGH	87	31	19.5	1.7	8	0	18	0	3	1	64
	WSDSF	Ref_9	MOD-GOOD	50	31	24.5	4.7	24	6	4	0	2	0.67	0
	WSDSF	Ref_10	MOD-GOOD	59	29	9.5	13.2	0	8	4	0	2	0	175
	WSGW	Ref_11	MOD-GOOD	55	33	14.5	0	20	0	4	0	1	0.50	5
	WSGW	Ref_12	HIGH	70	36	13.5	0	6	0	2	0	1	0.50	58

SVS = Site Value Score, NSR = Native Plant Species Richness, NOC = Native Overstorey Cover, NMC = Native Midstorey Cover, NGCG = Native Ground Stratum Cover (grasses), NGCS = Native Ground Stratum Cover (shrubs), NGCO = Native Ground Stratum Cover (other), EC = Exotic Plant Cover, NTH = Number of Trees with Hollows, OR = Overstorey Regeneration and FL = Total Length of Fallen Log

3.2 Discussion of vegetation monitoring results

A total of 321 flora species were recorded from all monitoring sites during 2018. This has declined since 2017, when 371 species were recorded. The full list of flora species recorded during 2018 is included in **Appendix C**.

3.2.1 Management Domains

Autumn 2018

Comparison of attributes from sites monitored during autumn 2018 (**Table 3-1** above) showed higher site value scores relative to the autumn 2017 results, with eleven of the 19 site value scores increasing, five remaining the same and only three decreasing. Despite this, 15 of the 19 sites did not meet their IPT and as such, trigger the Native Vegetation and Habitat Complexity (BioMetric) TARP. This includes all sites in low vegetation condition, which is defined in Table 10 of the BMP as sites with site value scores of less than 34 (WCPL 2017), making it impossible for sites to achieve the IPT of 34.

Consistent with 2017 monitoring, no sites met all the site attribute targets. Most sites (15 out of 19) did, however, meet the targets for seven or more of the ten site attributes. Consistent with previous monitoring, the BOA sites recorded the highest average site value scores, followed by the ECA sites. Regeneration and Rehabilitation sites recorded the lowest average scores for autumn. Native overstorey cover, exotic cover and number of trees with hollows were the highest performing site attributes for autumn 2018, with all sites meeting their targets for these attributes. This is largely consistent with previous monitoring; however, this is the first time all sites achieved the target for exotic cover. Despite improving compared to 2017 monitoring, fallen logs and overstorey regeneration remain the lowest performing site attributes.

Spring 2018

Eleven flora sites monitored during spring 2018 (**Table 3-2** above) recorded higher site value scores compared to 2017, whilst six sites decreased, and one site remained the same. Despite a general improvement, twelve of the 20 sites monitored failed to meet the IPT and therefore trigger the Native Vegetation and Habitat Complexity (BioMetric) TARP.

Whilst no site achieved all the site attribute targets, all sites achieved at least half. This is an improvement compared to last year, although it should be noted that monitoring at two of the lowest performing sites has been discontinued due to the conclusion of the cattle grazing monitoring. Consistent with 2017 and autumn 2018 results, native overstorey, exotic cover and number of hollow bearing trees were the highest performing site attributes, with all sites meeting their targets. This is an improvement in exotic cover compared to spring 2017. Native ground cover grass performance has improved compared to 2017, whilst native ground cover other performance has declined. Despite improving compared to 2017 monitoring, overstorey regeneration and fallen logs remained the lowest performing site attributes, with five and seven sites respectively achieving the targets.

The significant number of sites failing to meet the IPT may be correlated to the significant increases in IPT scores and several site attributes from management period Year 0 to Years 1-5. For example, the IPT for overstorey regeneration for low condition sites increases from 0% to 100% from Year 0 to Year 1. This increase is not reflective of the natural development of overstorey regeneration, and as such, it is expected to be several years until overstorey regeneration reaches its respective target. Furthermore, all sites in low condition vegetation failed to meet their IPT. This is likely due to the definition of low vegetation condition in Table 10 of the BMP as sites with site value scores of less than 34 (WCPL 2017), making it impossible for sites to achieve the Year 1-5 IPT of 34.

3.2.2 Reference sites

Reference sites monitored during 2018 are compared to the Benchmark targets for their respective vegetation community (**Table 3-3** and **Table 3-4: Reference sites assessment against Benchmark Targets Year 4- spring 2018**. Only two reference sites per season achieved their IPT in 2018. This is despite site value score in spring improving and no more reference sites being in low condition vegetation.

Consistent with monitoring in other Management Domains, exotic cover was the highest performing site attribute, with all reference sites achieving the benchmark. All reference sites monitored in autumn also met the benchmark for native over storey cover, however spring results were considerably more variable. Consistent with previous monitoring, native ground cover shrub and native mid storey cover were the most under-performing site attributes, with only four references sites achieving the benchmark. Similarly, only four reference sites achieved the benchmark for overstorey regeneration, however the majority of site were within the amber range, suggesting they are on the correct trajectory. Number of trees with hollows was variable between sites and seasons but had a high proportion of sites in red and amber.

3.2.3 Review of IPTs against Trigger Action Response Plans

As per the updated WCPL BMP (WCPL 2017), TARPs have been developed if IPTs are not being met. **Table 3-1** to **Table 3-4: Reference sites assessment against Benchmark Targets Year 4- spring 2018** identify those sites with SVS which don't meet the IPTs, colour-coded red. Table 26 of the BMP (WCPL 2017) details the TARPs to be implemented.

3.2.4 Multi-year comparisons

The results of key individual attributes have been graphed to illustrate the variability between 2015, 2016, 2017 and 2018 monitoring results for spring, and 2016, 2017 and 2018 monitoring results for autumn. The key attributes analysed include total native species richness, and the native vegetation structure attributes, including overstorey cover, midstorey cover and groundcover.

Species richness

Total species richness has been variable between sites and years. Spring species richness was highest in 2015 at 26 of the 39 sites (**Figure 3-1**), whilst autumn data was highest in 2017 at 15 of the 31 sites (**Figure 3-2**).

Native species richness for all sites is compared in **Figure 3-1**: Total species richness across all management domains - spring 2015-2018 is presented within **Figure 3-2.** Native species richness ranged from four species at site A_100, to 36 species at site B_100. Site A_100 has consistently had the lowest, or second lowest score in native species diversity from 2015 through to 2018. Spring 2018 saw 12 sites increase in native species richness compared to 2017. Similarly, in autumn, 10 sites improved compared to 2017 results. Autumn results appear to be more consistent between years than spring native species richness. BOA and ECA sites consistently recorded higher species richness compared to regeneration and rehabilitation sites. Reference sites performed better compared to sites within the Management Domains, with 23 being the lowest native species richness recorded in 2018. Native species richness at all sites within spring and autumn compared with the IPT is presented within **Figure 3-3**.

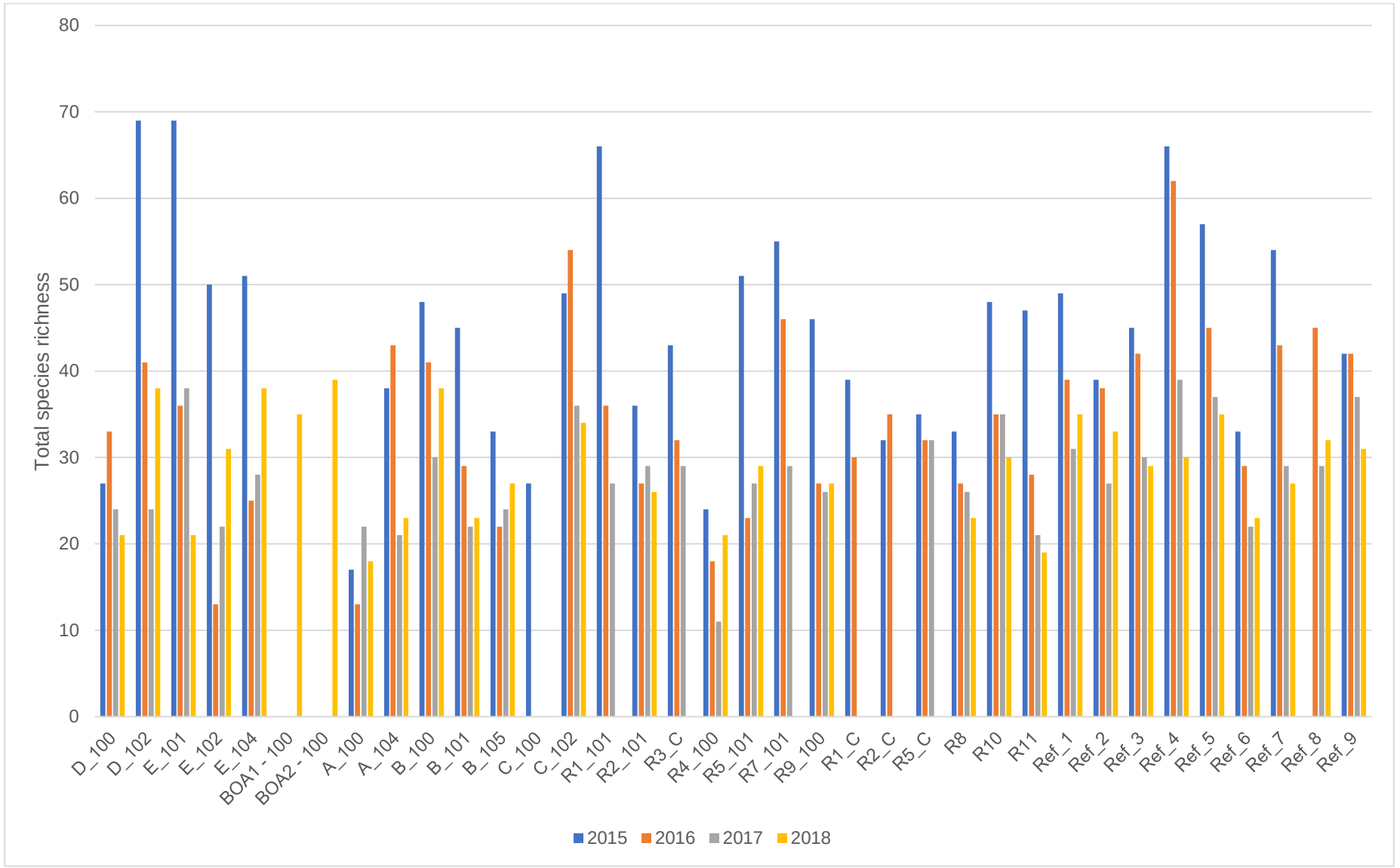

Figure 3-1: Total species richness across all management domains - spring 2015-2018

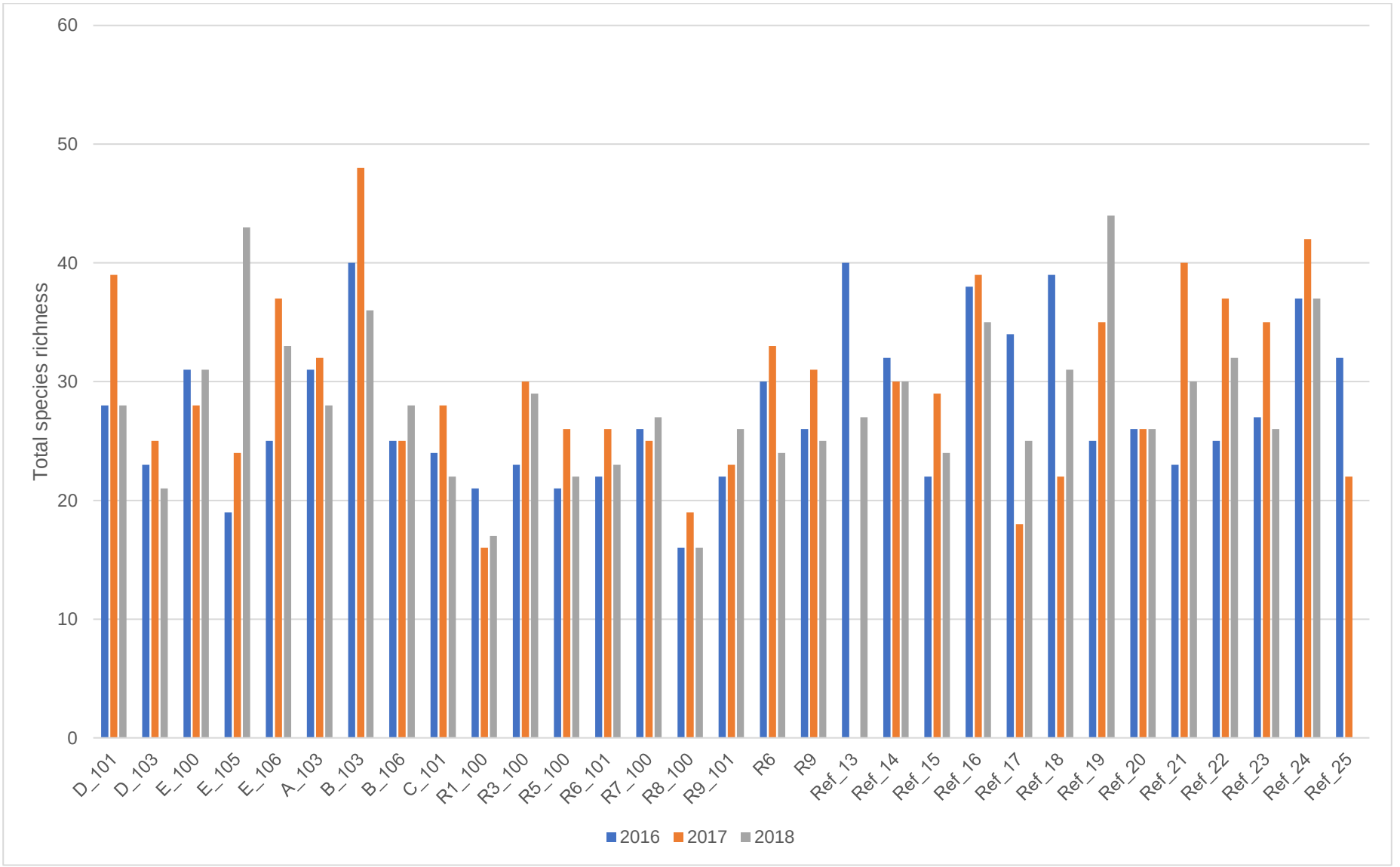

Figure 3-2: Total species richness across all management domains - autumn 2016-2018

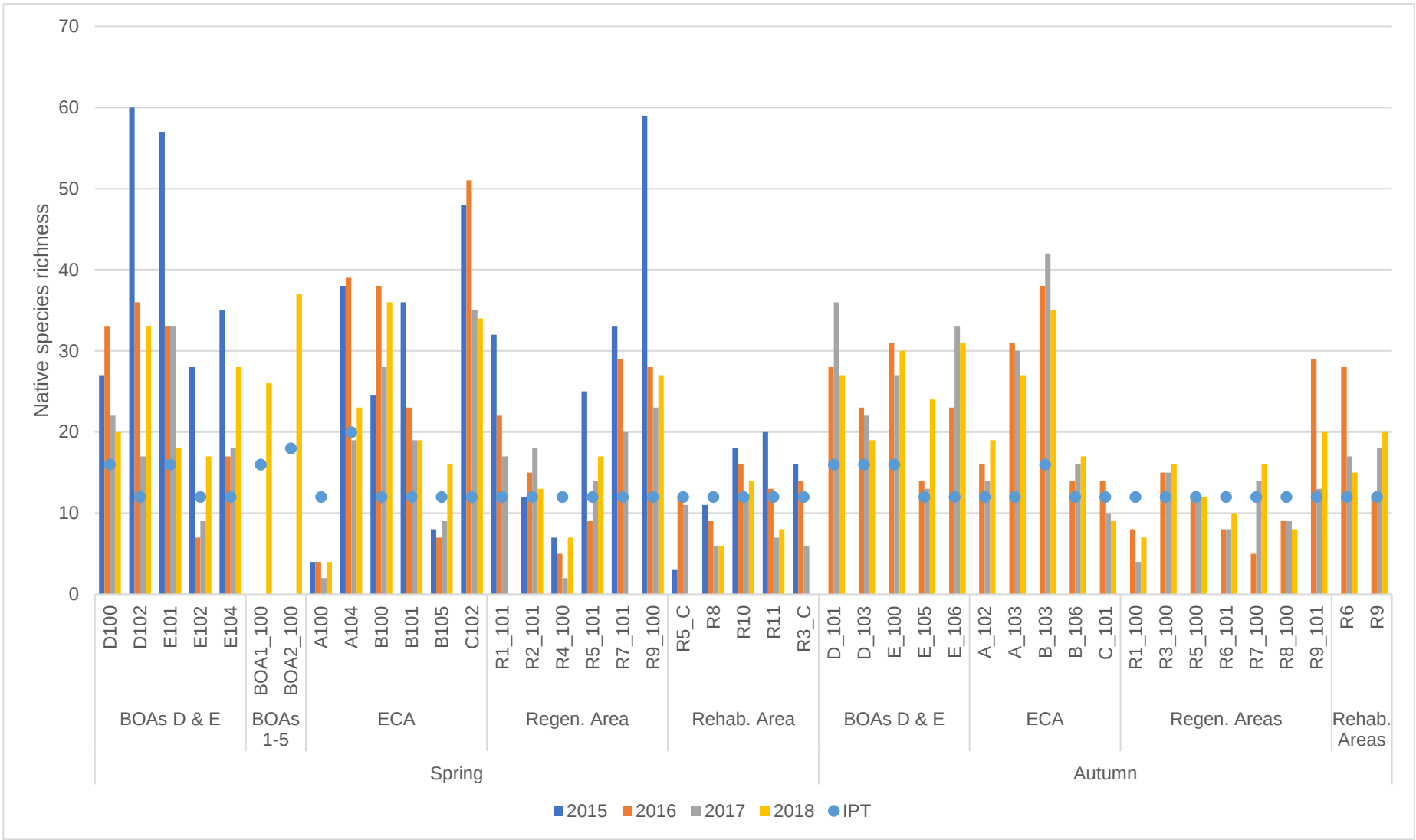

Figure 3-3: Native species richness at all sites – spring and autumn 2015-2018

Vegetation structure

Vegetation structure data recorded at the monitoring sites during autumn and spring 2018 monitoring (dominant species, height range and percentage foliage cover for all vegetation strata) is presented in **Appendix D**.

Comparison of vegetation structure attributes for the overstorey cover, midstorey cover and groundcover strata layers, compared to the IPT for year 1-5 and relevant vegetation condition, are illustrated below in **Figure 3-4**, **Figure 3-5** and **Figure 3-6**.

Consistently low scores for overstorey regeneration from 2016 to 2018 monitoring periods are likely attributable to the high level of natural ground layer competition found in grassy woodland communities, which can limit the ability for overstorey regeneration to develop. As expected, regeneration and rehabilitation sites do not yet have overstorey cover, however site R6 has registered one per cent overstorey cover for the first time in autumn 2018. Recruitment and establishment of overstorey species will be a slow process, which is reflected in the IPTs with low condition vegetation not expected to have native overstorey cover until Years 11-15.

Similarly, native midstorey cover is more common and generally higher in the BOA and ECA sites compared to the regeneration and rehabilitation sites. In autumn native midstorey cover was generally lower than previous monitoring, whilst in spring midstorey cover was generally higher than 2017 results.

Native ground cover in 2018 was generally lower than previous monitoring, with 23 of the 39 sites recording the lowest native ground cover since monitoring began. Results indicate that, although still present, exotic ground cover has also decreased compared to 2017 results. These results may be attributable to seasonal conditions, for example, prolonged dry periods.

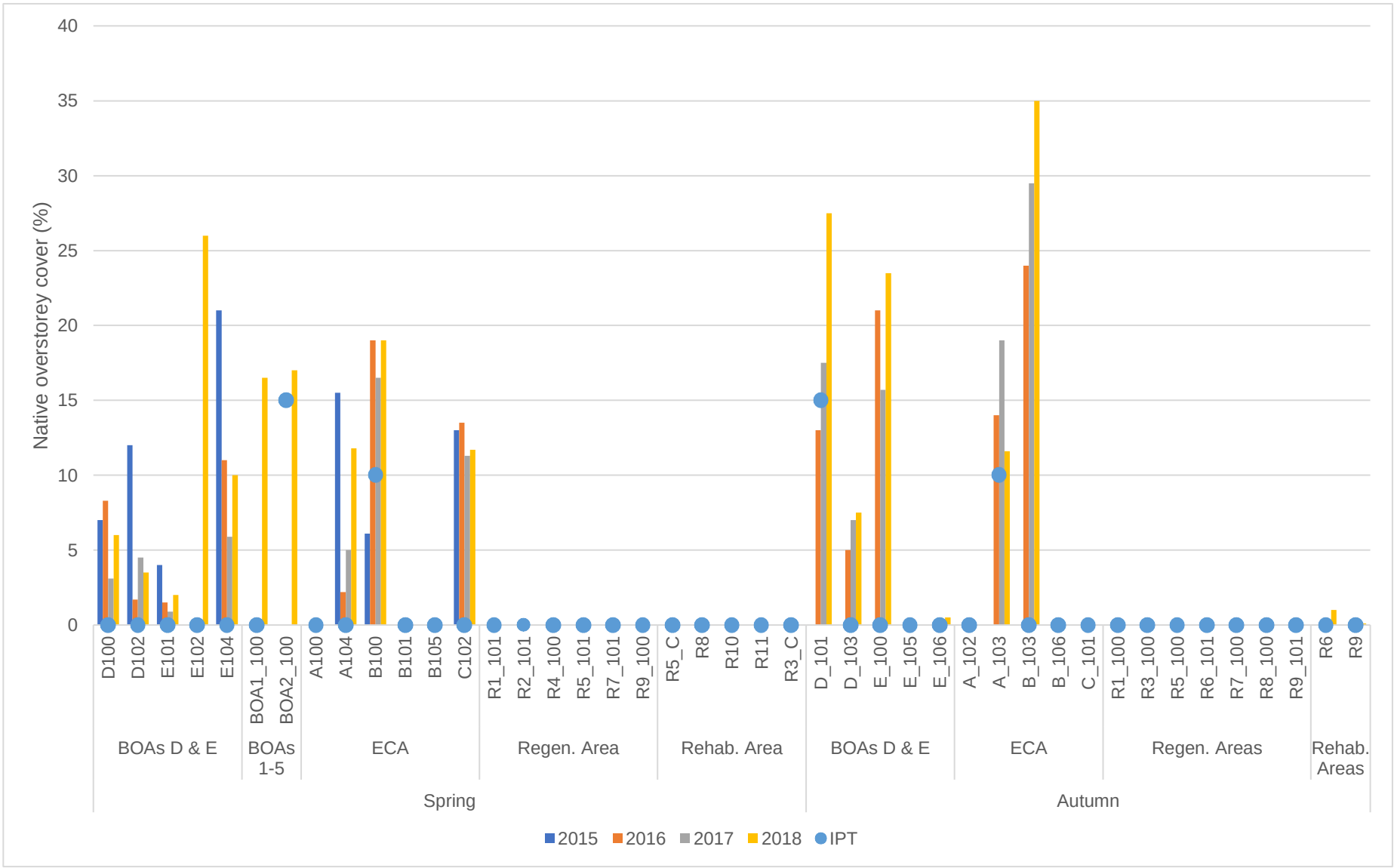

Figure 3-4: Native overstorey cover at all sites 2015-2018 compared against the 1-5-year IPT

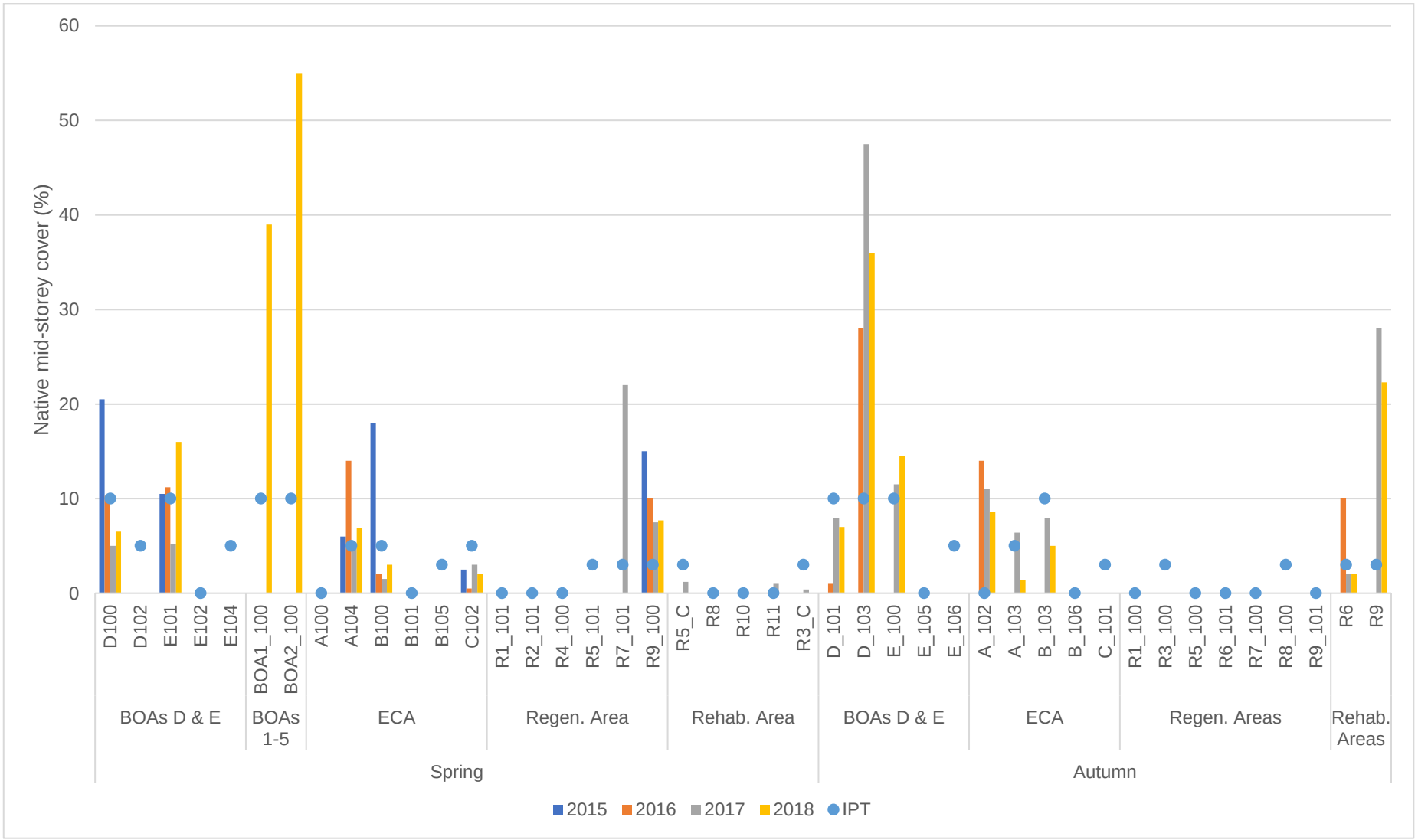

Figure 3-5: Native midstorey cover at all sites 2015-2018 compared against the 1-5-year IPT

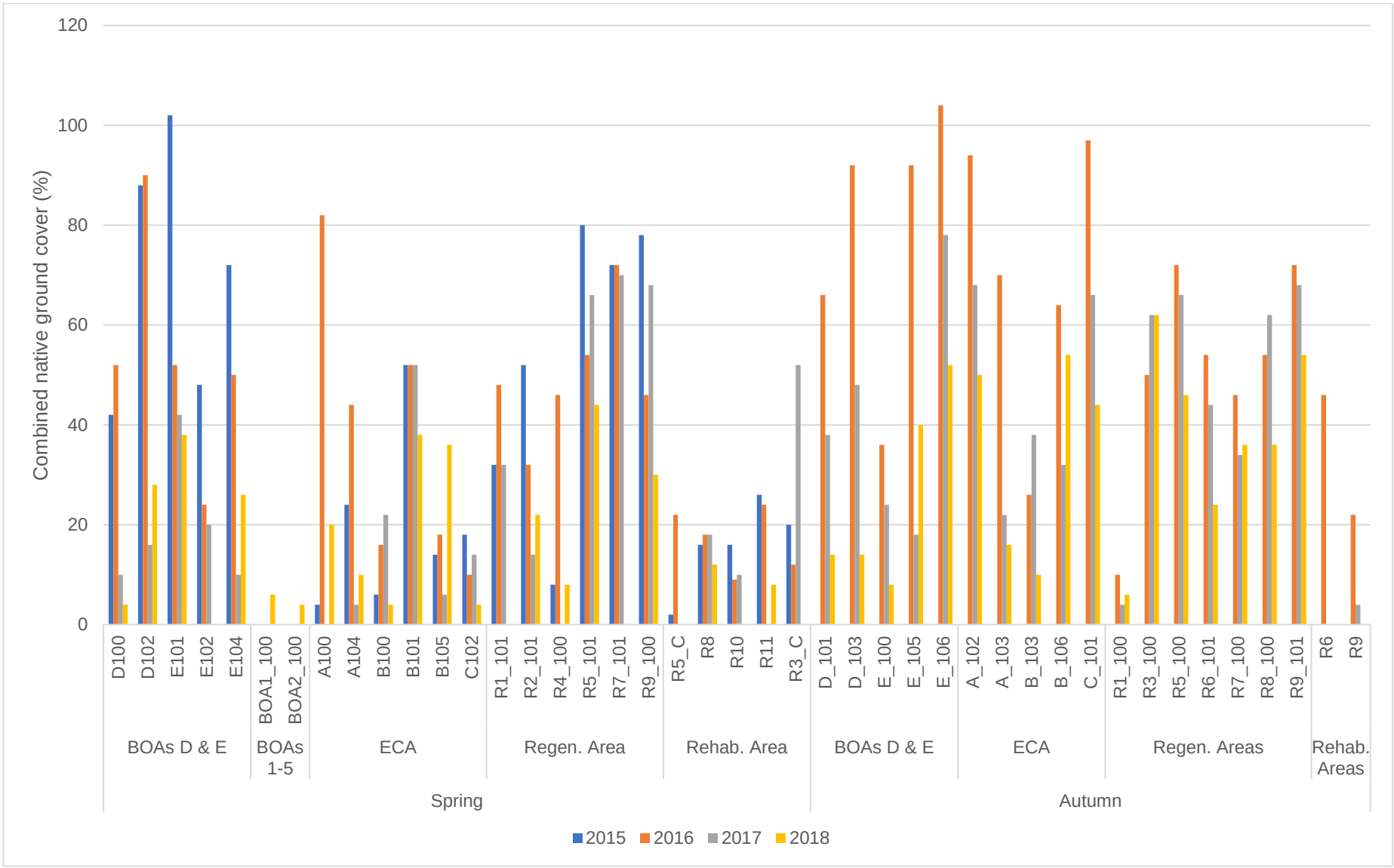

Figure 3-6: Combined native groundcover at all sites 2015-2018

Exotic flora species

Exotic species results were generally good across all Management Domain monitoring sites during 2018, with all sites achieving the exotic cover IPT for the first time since monitoring began. Exotic species diversity was highest at sites R8, R10 and E_105 in 2018, with 17, 16 and 15 species at each site respectively. This is consistent with previous results, with Rehabilitation sites consistently having the highest exotic species richness.

Exotic cover recorded at all sites except four sites (E_102, B_105, C_101 and R8_100) decreased from 2017 to 2018. Comparison of exotic cover attribute scores are illustrated below in **Figure 3-7**.

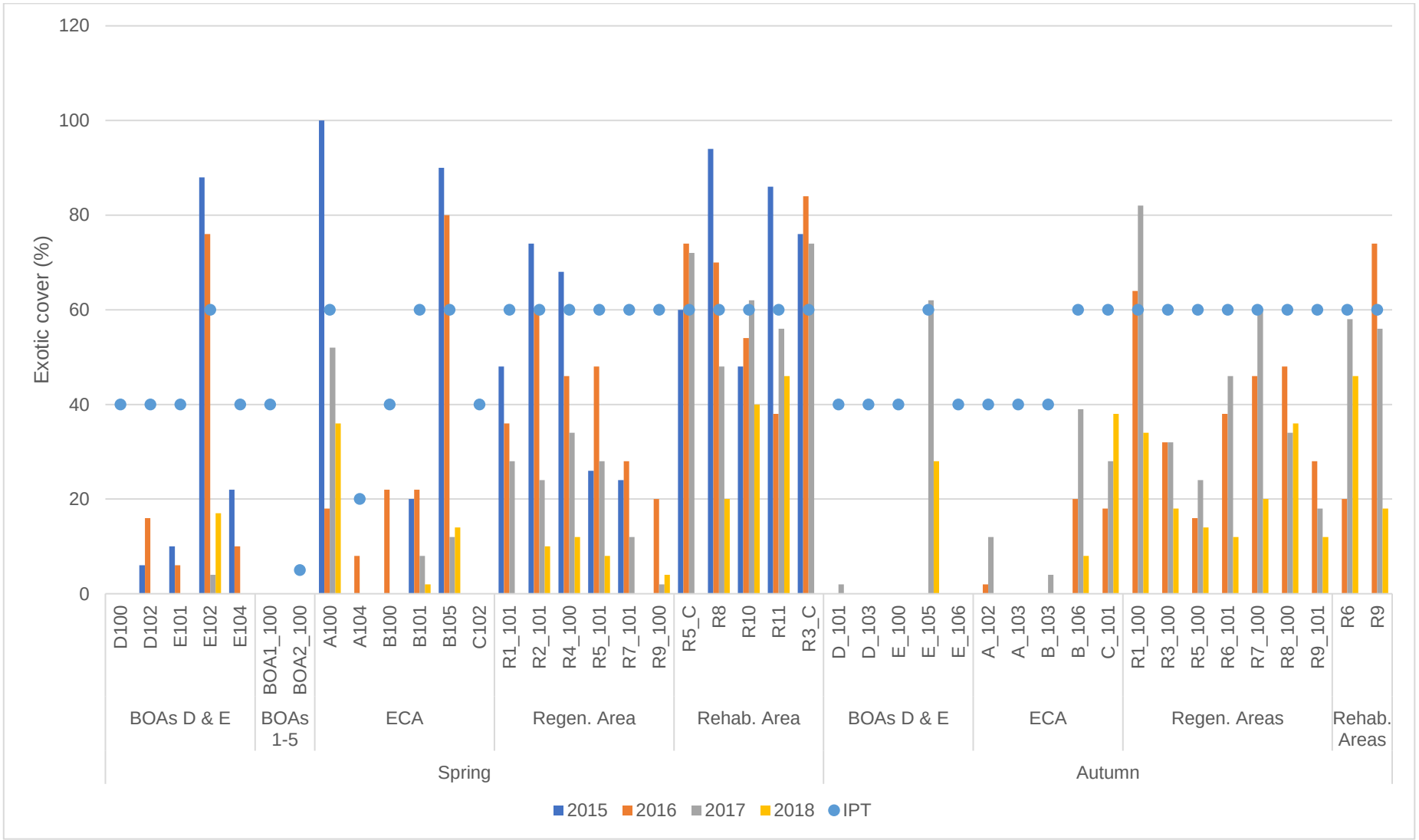

Figure 3-7: Exotic cover at all sites 2015-2018 compared against the 1-5-year IPT

Weeds classified as priority weeds under the Central Tablelands Regional Strategic Weed Management Plan 2017 – 2022 were identified at several monitoring sites across the Management Domains. These declared weeds and their site locations are presented below in **Table 3-5**.

Table 3-5: Declared weeds recorded in 2018

Scientific Name	Common Name	State Priority Weed	Regional Priority Weed	Site	Management domain
Heliotropium amplexicaule	Blue Heliotrope		Y	E_104	BOAs D & E
				R6_101	Regeneration Areas
Hypericum perforatum	St John's Wort		Y	B_101, C_101,	ECAs
				R3_100, R5_100, R6_101, R7_100, R8_100, R9_101	Regeneration Areas
				Ref_17, Ref19	Reference Areas
				R6, R9, R10, R11	Rehabilitation Areas
Opuntia sp.	Common Pear, Prickly Pear	Y		BOA1_100,	BOAs 1-5
				E_104, E-106,	BOAs D & E
				Ref_4, Ref_12, Ref_13b, Ref_15, Ref_16, Ref_18, Ref_19, Ref_24	Reference Areas
Rosa rubiginosa	Sweet Briar		Y	BOA1_100	BOAs 1-5
Xanthium spinosum	Bathurst Burr		Y	C_101	ECAs

3.3 Landscape Function Analysis

The LOI and SSA scores calculated from spring 2018 LFA monitoring are presented in **Table 3-6** to **Table 3-10** below. The results are presented as a comparison to the 2017 monitoring data to provide an assessment against the LFA completion criteria as described above in **Section 2.2.2.** It should be noted that there are several contributing factors in the data collection and calculation of scores which may result in minor inconsistencies from year to year. Attributes which are not meeting the annual incremental increase targets, and as such are marked in red, represent a trigger for the Landscape Stability (LFA) TARP outlined in Table 27 of the BMP (WCPL 2017).

3.3.1 Biodiversity Offset Areas

Site E_105 is the only LFA monitoring site within the BOA Management Domains. The LOI and SSA results for this site are presented in **Table 3-6**, with the spring 2017 monitoring results included to provide a comparative assessment to determine if sites are achieving the predicted annual incremental increase.

The LOI of 0.98 achieved at this site indicates that a high proportion of the transect continues to be occupied by patches of native perennial ground cover, leaf litter and rock. This is consistent between the 2017 and 2018 monitoring results. Stability continues to exceed the Completion Criteria (>50), with an increase of 9.7 from the spring 2017 monitoring results. Soil Infiltration and Nutrient Cycling are both below the annual incremental increase target, with Nutrient Cycling representing a reduction from the spring 2017 monitoring results.

Table 3-6: LOI and SSA results for BOA transects

Site	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient cycling
E_105	Spring 2018	0.98	63.5	38.7	34.0
	Spring 2017	1.00	53.8	45.2	33.3
	Annual incremental increase		9.7	-6.5	0.7

3.3.2 Enhancement and Conservation Areas (ECAs)

Two LFA monitoring sites are located within the ECA Management Domains, including site A_100 within ECA-A, and site B_106 within ECA-B. Both sites are located in regenerating vegetation.

The LOI and SSA results for these sites are presented in **Table 3-7**. During spring 2018 monitoring, site A_100 recorded a LOI of 1.00, being entirely covered by perennial ground cover and litter patches. This is consistent with previous results. Site B_106 recorded a LOI of 0.83, with extensive perennial ground cover and litter patches, and small patches of bare soil, which is an increase from 2017.

During spring 2018 monitoring, the Stability Completion Criteria was exceeded at B_106, and saw an increase compared to 2017 monitoring results. Stability at site A_100 decreased by four compared to 2017, bringing it below the Completion Criteria. The Soil Infiltration and Nutrient Cycling scores recorded during spring 2018 monitoring were below the Completion Criteria target of 50. Infiltration failed to achieve the annual incremental increase at both sites. Although Site A_100 achevied the annual incremental increase for Nutrient Cycling.

Table 3-7: LOI and SSA results for ECA transects

Site	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient Cycling
A_100	Spring 2018	1.00	49.9	44.5	36.7
	Spring 2017	1.00	53.9	45.5	33.8
	Annual incremental increase		-4	-1	2.9
B_106	Spring 2018	0.83	57.4	38.4	28.8
	Spring 2017	0.90	56.4	39.0	31.0
	Annual incremental increase		1	-0.6	-2.2

3.3.3 Regeneration Areas

One LFA monitoring site, R1_100, is located within the Regeneration Area Management Domains. The LOI and SSA results for this site is presented in **Table 3-8**.

During spring 2018 monitoring LOI decreased, with the transects being occupied with perennial groundcover and patches of litter, with 19 small patches of bare soil, which is up from 2017 results. The Soil Stability score exceeded the Completion Criteria, despite a small decrease compared to 2017. The Soil Infiltration score dropped under the Completion Criteria with a decrease of 14.3. The Nutrient Cycling scores once again failed to meet the Completion Criteria, experiencing a decrease compared to 2017 results.

Table 3-8: LOI and SSA results for Regeneration Area transects

Site	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient Cycling
R4_100	Spring 2018	0.76	52.9	36.2	30.1
	Spring 2017	100	55.9	50.5	41.7
	Annual incremental increase		-3	-14.3	-11.6

3.3.4 Rehabilitation Areas

Six LFA monitoring sites are located within the Rehabilitation Areas, including R6; R8; R9; R10; R11 and R13. The LOI and SSA results for the sites are presented in **Table 3-9**.

Spring 2018 monitoring results indicate that all Rehabilitation Area transects experienced a drop in LOI scores compared to spring 2017 results. Sites R6 and R10 have decreased to below 0.8, due to increase in patches of bare soil at these sites. The Soil Stability scores recorded at sites R6, R9, R10, R11 and R13 exceeded the Completion Criteria. Site R8 experienced a decline of -5.2 from spring 2017 results and has now dropped under the Completion Criteria. The Soil Infiltration and Nutrients scores for all the Rehabilitation Area transects were below the Completion Criteria. Site R8 meets the annual incremental increase for Infiltration, while sites R6, R8 and R13 have met the annual incremental increase for nutrient cycling.

Table 3-9: LOI and SSA results for Rehabilitation Area transects

Site	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient cycling
R6	Spring 2018	0.70	58.5	28.9	28.3
	Spring 2017	0.80	56.9	30.8	25.8
	Annual incremental increase		1.6	-1.9	2.5
R8	Spring 2018	0.93	48.0	35.3	28.3
	Spring 2017	0.95	53.2	31.4	24.2
	Annual incremental increase		-5.2	3.9	4.1
R9	Spring 2018	0.87	56.1	26.4	24.8
	Spring 2017	0.98	58.1	42.7	38.1
	Annual incremental increase		-2	-16.3	-13.3
R10	Spring 2018	0.64	52.0	25.1	22.8
	Spring 2017	0.69	56.6	28.8	22.1

Site	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient cycling
	Annual incremental increase		-4.6	-3.7	0.7
R11	Spring 2018	0.95	52.9	34.4	31.9
	Spring 2017	0.98	60.9	40.6	36.9
	Annual incremental increase		-8	-6.2	-5
R13	Spring 2018	0.87	51.5	32.0	30.7
	Spring 2017	0.91	57.9	33.7	28.1
	Annual incremental increase		-6.4	-1.7	2.6

3.3.5 Reference sites

During spring 2018 monitoring, ten LFA transects were undertaken at Reference sites to provide comparative data to assist in guiding management of WCPLs Management Domains. The LOI and SSA scores for the Reference Site transects are presented in **Table 3-10**.

During spring 2018 monitoring, high LOI scores (above 0.9) were recorded at all the Reference sites, indicating that most of the sites were close to being entirely occupied with patches and have a stable landform. The Soil Surface Stability scores recorded at all Reference sites were above the Completion Criteria. Soil Infiltration was below the Completion Criteria for all sites except Ref_7, however Ref_1, Ref_3, Ref_4, Ref_6, Ref_7 and Ref_8 all achieved the incremental increase target. Nutrient Cycling for all reference site were below the Completion Criteria, sites Ref_1, Ref_2, Ref_3, Ref_4, Ref_5, Ref_6, Ref_7 and Ref_8 achieved the incremental increase target.

Table 3-10: LOI and SSA results for Reference Sites

SITE	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient cycling
Ref_1	Spring 2018	0.95	54.9	43.2	34.3
	Spring 2017	0.80	56.7	39.6	32.1
	Annual incremental increase		-1.8	3.6	2.2
Ref_2	Spring 2018	0.92	62.6	38.9	38.1
	Spring 2017	1.00	54.3	40.5	35.2
	Annual incremental increase		8.3	-1.6	2.9
Ref_3	Spring 2018	0.91	59.4	48.5	41.7
	Spring 2017	0.97	56.9	39.6	34.7
	Annual incremental increase		2.5	8.9	7
Ref_4	Spring 2018	0.96	57.7	45.0	36.5
	Spring 2017	0.78	50.0	35.3	25.5
	Annual incremental increase		7.7	9.7	11
Ref_5	Spring 2018	0.99	65.1	41.1	36.8

SITE	Monitoring Season	Landscape Organisation Index	Soil Surface Assessment		
			Stability	Infiltration	Nutrient cycling
	Spring 2017	0.82	54.4	45.7	33.4
	Annual incremental increase		10.7	-4.6	3.4
Ref_6	Spring 2018	0.98	54.4	49.3	37.7
	Spring 2017	0.96	54.3	42.3	32.8
	Annual incremental increase		0.1	7	4.9
Ref_7	Spring 2018	0.97	60.0	50.6	42.0
	Spring 2017	0.89	54.3	45.1	34.1
	Annual incremental increase		5.7	5.5	7.9
Ref_8	Spring 2018	0.99	59.3	46.9	41.3
	Spring 2017	1.00	55.7	39.1	33.6
	Annual incremental increase		3.6	7.8	7.7
Ref_13b	Spring 2018	0.98	58.1	43.9	36.8
	Spring 2017	0.98	54.4	42.7	35.2
	Annual incremental increase		3.7	1.2	1.6
Ref_14	Spring 2018	1.00	54.9	39.3	38.5
	Spring 2017	1.00	59.3	43.1	38.8
	Annual incremental increase		-4.4	-3.8	-0.3

3.3.6 Discussion of LFA monitoring results

Most sites recorded relatively high LOI scores (>.80), indicating stable, functioning landform covered by patches at these sites. Although there has been a decrease in LOI scores below 0.80 at sites R6, R10 and R4_100, reflecting an increase in patches of bare soil compared to spring 2017 results, which represents a decreased stability within the landscape at these sites. However, LOI should be considered as an indicator only and correlation of these scores against vegetation and non-vascular ground cover data (for example, fallen logs) is important to gain a more detailed understanding of the overall functioning of the monitoring sites.

Within each of the Management Domains, the dominant patch types were groundcover, litter (with litter consisting of exotic annual species and/or leaf litter) and a mixture of groundcover and litter. The dense perennial groundcover at many monitoring sites is reflective of their vegetation type and condition, including regenerating DNG of grassy woodland communities.

All sites, except R8 and A_100, met the Completion Criteria target for stability, with 11 of the 20 sites experiencing an increase compared to 2017 monitoring results. The stability scores across the Management Domains monitoring sites were comparable to the Reference site scores. The changes in stability scores may be attributed to a range of factors, including changes in soil moisture levels affecting individual indicators (for example, surface resistance) or observer variation of field conditions.

Infiltration and Nutrient Cycling indices were lower, with no site achieving the Completion Criteria target within any of the Management domains. Although site R8 achieved the annual incremental increase for Infiltration, four sites A_100, R6, R8 and R13 all meet the annual incremental increase for nutrient cycling.

Similarly, several Reference sites failed to achieve the benchmark completion criteria, although six sites meet the annual incremental increase for infiltration and eight sites meet the annual incremental increase for nutrient cycling. Variations from the 2017 monitoring results may be a result of a reduction in grass cover due to drier field conditions in 2018, with the 2018 period experiencing 172.1 mm less rain than the historical average. Nutrient Cycling may be affected by perennial vegetation cover, litter cover and extent of decomposition, cryptogam cover and soil surface roughness. While many LFA sites have moderate to dense cover of perennial vegetation (grasses) and/or high litter cover, there was limited litter decomposition observed and largely flat soil micro topography. Low Soil Infiltration and Nutrient Cycling scores may be due to historical clearing and livestock usage across the BOAs, ECAs and Regeneration Sites. Low scores recorded within the Rehabilitation Sites may be due to the compacted artificial soils on which the Rehabilitation areas are located.

This decline in SSA scores within the Management Domains is consistent with results from the 2016 to 2017 monitoring periods, suggesting there may be a downward trend. Longer term data would be required to assess whether this reduction represents a short-term change (for example due to a reduction in grass cover from seasonal variance, data collection and calculation, observer variation) or an ongoing trend requiring management action.

3.3.7 Review of LFA results against Trigger Action Response Plans

As per the updated WCPL BMP (WCPL 2017), TARPs have been developed in the event that LFA results are not incrementally improving towards the respective Completion Criteria.

3.4 Fauna monitoring

Fauna monitoring was undertaken during winter and spring in 2018. Total species richness recorded in 2018 was 134 species, comprising 106 birds, four amphibians, 13 reptiles, 11 mammals (including ten positively identified microbat species) and four mammal species. A full list of all fauna species recorded during spring 2018 monitoring program is included in **Appendix E.**

3.4.1 Winter bird monitoring

A total of 76 species were identified during the 2018 winter bird monitoring across the existing and newly established sites. The data collected at the newly established sites forms baseline data and cannot be compared to previous year's data. A total of 61 species were identified at the existing fauna sites, this is a decrease compared to 2017 results when a total of 71 bird species were recorded.

Target eucalypt feed tree species were not yet in flower during the survey period. The survey methods were adept at detecting other species, including threatened species, however the decrease in bird species richness and abundance may be explained by the inopportune timing of the surveys, as this would also decrease the likelihood of detecting winter-feeding species. Winter-feeding specialists include *Anthochaera phrygia* (Regent Honeyeater) and *Lathamus discolor* (Swift Parrot), which are both listed as either critically endangered or endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the NSW *Biodiversity Conservation Act 2016* (BC Act).

Bird species richness at individual sites ranged from four species at sites R6 and R9 to 22 species at sites BOA2_101, BOA3_101 and BOA5_101. The most abundant species recorded was *Malurus cyaneus* (Superb Fairy-wren), with a total of 122 individuals recorded across the monitoring sites. This was closely followed by *Sturnus vulgaris* (Common Starling) with a total of 121 individuals recorded. This species was also the only introduced species recorded during the 2018 winter monitoring. The most commonly occurring species was *Manorina melanocephala* (Noisy Miner), which was recorded at 23 of the 38 monitoring sites.

Five species listed as vulnerable under the BC Act were identified, including *Chthonicola sagittata* (Speckled Warbler), *Climacteris picumnus victoriae* (Brown Treecreeper eastern subsp.), *Daphoenositta chrysoptera* (Varied Sittella), *Glossopsitta pusilla* (Little Lorikeet) and *Petroica boodang* (Scarlet Robin) (**Table 3-11**). At the previously established sites, the overall occurrence of threatened species has decreased since winter 2017 monitoring. However, the Scarlet Robin was not detected during winter 2017 monitoring.

Table 3-11: Winter bird monitoring - Threatened species

Scientific Name	Common Name	Site Recorded	BC Act Listing	EPBC Act Listing
Climacteris picumnus victoriae	Brown Treecreeper (eastern subsp.)	BOA1_100, BOA5_500, BOA5_101, D_103	V	-
Chthonicola sagittata	Speckled Warbler	A_102, B_105, BOA3_101, BOA4_100, BOA5_100, BOA5_101, BOA5_102, D_103, E_104, E_106, R7_100, R7_101	V	-
Glossopsitta pusilla	Little Lorikeet	BOA1_100		

Scientific Name	Common Name	Site Recorded	BC Act Listing	EPBC Act Listing
Daphoenositta chrysoptera	Varied Sittella	B_100, B_103, BOA5_100	V	-
Petroica boodang	Scarlet Robin	E_106	V	-

3.4.2 Spring fauna monitoring

The most commonly occurring bird species was *Pachycephala rufiventris* (Rufous Whistler), occurring at 31 of the 37 bird monitoring sites. Bird species richness ranged from 29 species at Ref_10 to five species at R6. *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) was the most commonly occurring microbat species, positively identified at 11 of the 15 microbat monitoring sites, and potentially occurring at a further three sites. Microbat species richness is calculated using only positively identified species and excludes species complexes (where the individual species is unable to be identified), to avoid over-estimating species richness. Microbat species richness ranged from zero species (A_104) to nine species (E_104).

Five introduced species, *Mus musculus* (House Mouse), *Sus scrofa* (pig) *Capra hircus* (Goat), Deer and *Oryctolagus cuniculus* (Rabbit), were recorded or evidence observed.

Six bird species and five microbat species listed as vulnerable under BC Act and / or the EPBC Act were recorded and are listed below in **Table 3-12**. Four more threatened bird species, including *Melithreptus gularis* (Black-chinned Honeyeater), *Stagonopleura guttata* (Diamond Firetail), *Neophema pulchella* (Turquoise Parrot) and *Daphoenositta chrysoptera* (Varied Sittella), were recorded opportunistically throughout the landscape.

Bird species diversity within all monitored sites is presented within **Figure 3-8.** Sites BOA 1 – 5 and Reference sites, commenced monitoring within 2018. Bird species diversity ranges from 5 in R6 to 26 in Ref_10. All sites except for R5_101 and A_100 saw a drop in the diversity within 2018.

Table 3-12: Threatened fauna recorded

Assemblage	Scientific Name	Common Name	Site Recorded	BC Act Listing	EPBC Act Listing
Birds	*Artamus cyanopterus*	Dusky Woodswallow	BOA5_100	V	-
	Calyptorhynchus lathami	Glossy Black-Cockatoo	D_103, Ref_10	V	-
	Chthonicola sagittata	Speckled Warbler	B_103, BOA5_102, R5_101	V	-
	Climacteris picumnus victoriae	Brown Treecreeper (eastern subsp.)	BOA1_100, D_101, Ref_2, Ref_8, Ref_14	V	-

Assemblage	Scientific Name	Common Name	Site Recorded	BC Act Listing	EPBC Act Listing
	Glossopsitta pusilla	Little Lorikeet	D_103	V	-
	Grantiella picta	Painted Honeyeater	B_100, BOA2_100, D_103, E_100, R5_101	V	-
Microbats	*Chalinolobus dwyeri*	Large-eared Pied Bat	BOA3_100, BOA4_101, BOA5_101, B_101, E_104	V	V
	Minioperus orianae oceanensis	Eastern Bentwing-bat	BOA1_100, BOA2_101*, BOA3_100, BOA4_101, BOA5_101, A_104*, B_101, C_102, D_103, E_104, Ref_2, Ref_3, Ref_8, Ref_10*, Ref_14*	V	
	Nyctophilus corbeni	Corben's Long-eared Bat	BOA1_100*, BOA2_101*, BOA3_100*, BOA5_101*, B_101*, C_102*, E_104*, Ref_3*, Ref_8*, Ref_14*	V	V
	Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	C_102*, Ref_14	V	
	Vespadelus troughtoni	Eastern Cave Bat	BOA2_101*, BOA3_100, BOA5_101, B_101, C_102*, D_103*, E_104, Ref_2*, Ref_3, Ref_8	V	

*Possible identification only. V = Vulnerable

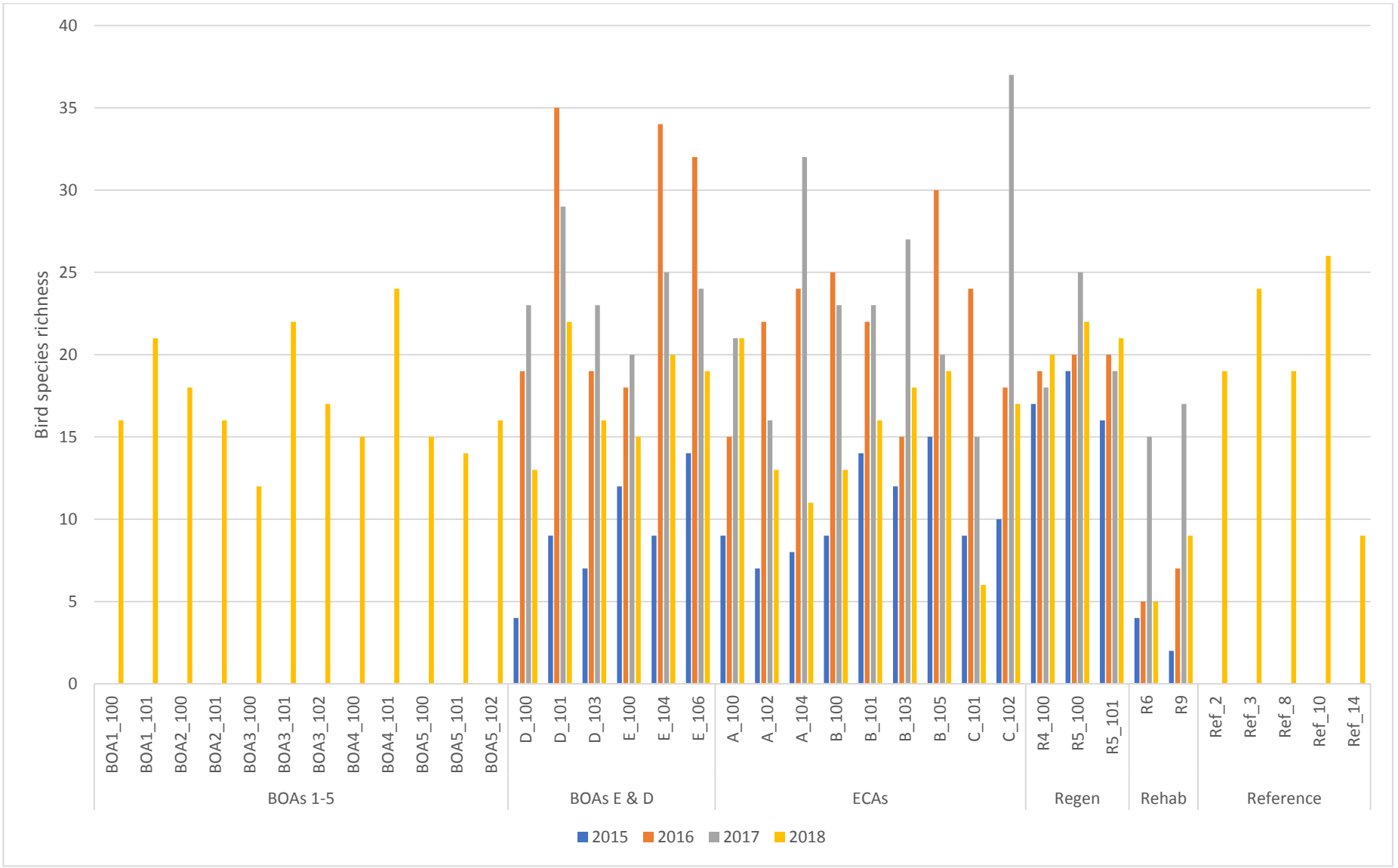

Figure 3-8: Bird species diversity at spring monitoring sites 2016 - 2018

3.4.3 Biodiversity Offset Areas 1 - 5

The results of microbat monitoring undertaken across BOA 1 to 5 during spring 2018 monitoring is presented below in **Table 3-13**. Total species diversity across BOAs 1 to 5 is 85 species, comprised of 66 birds, nine microbats, nine reptiles and one amphibian species. Three threatened microbat species were recorded across the BOAs, Large-eared Pied Bat, Eastern Bentwing-bat and Eastern Cave Bat. More detailed results from fauna monitoring are discussed per BOA below.

Table 3-13: Results of the microbat analysis for BOAs 1-5 spring 2018

Species Name	Common Name	BOA1_100	BOA2_101	BOA3_100	BOA4_101	BOA5_101
Austronomus australis	White-Striped Free-tailed Bat	X			X	
***Chalinolobus dwyeri*[1]**	**Large-eared Pied Bat**			X	X	X
Chalinolobus gouldii	Gould's Wattled Bat		P	X	X	X
Chalinolobus gouldii / *Ozimops* complex	Gould's Wattled Bat / Free-tailed Bat complex			X	X	X
Chalinolobus gouldii / *Scotorepens balstoni*	Gould's Wattled Bat / Inland Broad-nosed Bat			X		X
Chalinolobus morio	Chocolate Wattled Bat	P		X		X
Chalinolobus morio / ***Vespadelus troughtoni****	Chocolate Wattled Bat / **Eastern Cave Bat**		X	X		X
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	X	P	X	X	X
Miniopterus orianae oceanensis* and any or all of the following species, *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** and any or all of the following species, Large Forest Bat / Southern Forest Bat / Little Forest Bat	X	X	X	X	X
Nyctophilus spp. In this region *N. geoffroyi, N. gouldii* and the threatened ***N. corbeni*[1]** are likely to be present.	In this region Lesser, Gould's and the threatened **Corben's Long-eared Bat** are likely to be present.	P	X	X		X
Ozimops species complex. In this region the *O. petersi*, *O. ridei* and *O. planiceps.*	In this region the Inland, Ride's and South-eastern Free-tailed Bat are likely to be present.			X	X	X

Species Name	Common Name	BOA1_100	BOA2_101	BOA3_100	BOA4_101	BOA5_101
Rhinolophus megaphyllus	Eastern Horseshoe Bat			X	X	X
Scotorepens balstoni	Inland Broad-nosed Bat			X		X
Scotorepens greyii	Lesser Broad-nosed Bat			P		
Vespadelus darlingtoni	Large Forest Bat	P	P	P	P	P
Vespadelus regulus	Southern Forest Bat	P	P	P	P	P
Vespadelus troughtoni*	**Eastern Cave Bat**		P	X		X
Vespadelus vulturnus	Little Forest Bat	P	P	X	P	X
Species Diversity (Positive identification)		**2**	**3**	**14**	**8**	**14**
Species Diversity (Possible identification)		**5**	**6**	**3**	**3**	**2**

X = Definitely present, P = Possibly present, *** Threatened species listed under BC Act / [1] Threatened species listed under the EPBC Act**

Biodiversity Offset Area 1 (BOA 1)

BOA 1 is surrounded on three sides by Munghorn Gap Nature Reserve. There is evidence of past timber harvesting, the valley floor has been mostly cleared with remnants of *Angophora floribunda* (Rough-barked Apple) and *Eucalyptus blakelyi* (Blakely's Red Gum). There are no signs of recent livestock grazing (Peabody 2015).

BOA 1 is a management area which consists of two fauna sites, both located within a woodland / forested area. A total of 16 bird species were observed at BOA1_100, while at BOA1_101, 21 bird species were recorded. One reptile species *Anomalopus leuckartii (*Two-clawed Worm Skink) was observed at BOA1_100. Two microbat species were also positively identified at BOA1.

Biodiversity Offset Area 2 (BOA 2)

There are two woodland / forest sites located within BOA 2, BOA2_100 and BOA2_101. The western boundary adjoins Munghorn Gap Nature Reserve. Approximately 55% is vegetated, a large amount being advanced regeneration from prior clearing. There are several natural springs. BOA 2 has been recently grazed by livestock (Peabody 2015). One vulnerable species, the Painted Honeyeater, was observed at BOA2_100. At site BOA2_100, 18 bird species were observed, while at BOA2_101, 16 bird species were recorded.

BOA 2 had two vulnerable microbat species possibly present, the Eastern Bentwing-bat and the Eastern Cave Bat.

Biodiversity Offset Area 3 (BOA 3)

BOA 3 consists of high ridges and sandstone escarpments with numerous caves and shelters. This area is surrounded on three sides by the Goulburn River National Park. Approximately 75% is vegetated, most of which is largely undisturbed. There is an area of old growth dry rainforest dominated by *Backhousia myrtifolia* (Grey Myrtle). It is partially grazed by livestock in more cleared areas (Peabody 2015). There are three woodland / forest sites within this BOA.

Bird species diversity was highest at BOA3_101 with 22 species, BOA3_100 recorded 12 species and BOA3_102 recorded 17 species. Two reptile species, *Anilios nigrescens* (Blackish Blindsnake) and *Carlia tetradactyla* (Southern Rainbow Skink), were observed within BOA3_101 and BOA3_100 respectively.

BOA 3 recorded high microbat diversity, with eight species positively identified. This includes three species listed as vulnerable under the BC Act: Large-eared Pied Bat, Eastern Bentwing-bat and Eastern Cave Bat. The Large-eared Pied Bat is also listed as vulnerable under the EPBC Act.

Biodiversity Offset Area 4 (BOA 4)

BOA 4 is surrounded on three sides by the Goulburn River National Park. The land is generally flat with a central incised gully system extending to the west. There are low sandstone escarpments along this system. There are no signs of recent livestock grazing (Peabody 2015).

There are two woodland / forest sites located within this management area. There were 15 species of birds recorded at BOA4_100 and 24 species at BOA4_101. There were five reptile species and one amphibian species recorded across both sites.

BOA4_101 recorded a microbat species richness of five. This includes one vulnerable species listed under both the BC Act and EPBC Act, the Large-eared Pied Bat.

Biodiversity Offset Area 5 (BOA 5)

This area is surrounded on three sides by the Goulburn River National Park. Over 80% is vegetated, with evidence of some prior clearing and timber harvesting. This BOA consists of colluvial lower slopes surrounding an alluvial cultivated valley floor. It is partially grazed by livestock in more cleared areas (Peabody Energy 2015).

There are three woodland / forest sites located at both sites within this management domain. The Dusky Woodswallow, a vulnerable species under the BC Act, was recorded at BOA5_100. There were 15 species of bird recorded at BOA5_100, 14 at BOA5_101 and 16 at BOA5_10. Overall there were three reptile species recorded across all three sites.

BOA5_101 also recorded a high diversity of microbats, with eight species positively identified. This includes three species listed as vulnerable under the BC Act, the Large-eared Pied Bat, Eastern Bentwing-bat and Eastern Cave Bat. The Large-eared Pied Bat is also listed as vulnerable under the EPBC Act.

3.4.4 Biodiversity Offset Areas D and E

As per Section 5.1.1 of the BMP, BOAs D and E no longer require monitoring under the BMP (WCPL 2017), however results from 2018 monitoring are presented below.

The results of microbat monitoring undertaken across BOA-D and BOA-E during spring 2018 monitoring is presented below in **Table 3-14**. A total microbat species richness of nine was recorded across BOAs D and E. This includes three species listed as vulnerable under the BC Act, the Large-eared Pied Bat, Eastern Bentwing-bat and Eastern Cave Bat. The Large-eared Pied Bat is also listed as vulnerable under the EPBC Act. More detailed results from fauna monitoring are discussed per BOA below.

Table 3-14: Results of the microbat analysis for BOAs D and E spring 2018

Species Name	Common Name	D_103	E_104
Austronomus australis	White-Striped Free-tailed Bat		X
***Chalinolobus dwyeri**[1]*	**Large-eared Pied Bat**		X
Chalinolobus gouldii	Gould's Wattled Bat	P	X
Chalinolobus gouldii / *Ozimops* complex	Gould's Wattled Bat / Free-tailed Bat complex		X
Chalinolobus gouldii / *Scotorepens balstoni*	Gould's Wattled Bat / Inland Broad-nosed Bat		X
Chalinolobus morio	Chocolate Wattled Bat	P	X
Chalinolobus morio / ***Vespadelus troughtoni****	Chocolate Wattled Bat / **Eastern Cave Bat**	X	X
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	X	X
Miniopterus orianae oceanensis* and any or all of the following species, *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** and any or all of the following species, Large Forest Bat / Southern Forest Bat / Little Forest Bat	X	X
Nyctophilus spp. In this region *N. geoffroyi, N. gouldii* and the threatened ***N. corbeni**[1]* are likely to be present.	In this region Lesser, Gould's and the threatened **Corben's Long-eared Bat** are likely to be present.		X
Ozimops species complex. In this region the *O. petersi*, *O. ridei* and *O. planiceps.*	In this region the Inland, Ride's and South-eastern Free-tailed Bat are likely to be present.		X
Rhinolophus megaphyllus	Eastern Horseshoe Bat	X	X
Scotorepens balstoni	Inland Broad-nosed Bat		X
Vespadelus darlingtoni	Large Forest Bat		P
Vespadelus regulus	Southern Forest Bat		P
Vespadelus troughtoni*	**Eastern Cave Bat**	P	X

Species Name	Common Name	D_103	E_104
Vespadelus vulturnus	Little Forest Bat	P	X
Species Diversity (Positive identification)		4	15
Species Diversity (Possible identification)		4	2

X = Definitely present, P = Possibly present, *** Threatened species listed under BC Act / [1] Threatened species listed under the EPBC Act**

Biodiversity Offset Area D (BOA-D)

All sites occur in remnant eucalypt and *Callitris* dominated dry sclerophyll forest that contains a range of habitat features suitable for supporting various fauna assemblages.

A total of 35 fauna species were recorded within BOA-D during spring 2018, comprising 29 bird species, four reptile species and two microbat species. This is a decrease in diversity across the board compared to 2017. Similarly, all sites within BOA-D experienced a decrease in bird diversity compared to 2017 results. At site D_100 there was 13 individual bird species. D_101 recorded 22 individuals and D_103 recorded 16 species.

D_103 recorded three vulnerable bird species under the BC Act, whilst one threatened bird species was found within D_101.

The listed microbat species Eastern Bentwing-bat was positively identified. This suggests although microbat diversity is low, the habitat present within BOA D provides good habitat for selective species.

BOA D has abundant canopy and shrub layer foliage with minimal ground vegetation coverage. The presence of litter and fallen logs provides good habitat features for ground fauna. No surface water present. The site is adjacent to Goulburn River National Park and surrounded by significant tracts of remnant woodland.

Biodiversity Offset Area E (BOA-E)

Site E_100 is located within remnant dry sclerophyll forest, with sites E_104 and E_106 located in remnant grassy woodland communities. BOA-E contains a mix of canopy and shrub layer foliage and areas are dominated by groundcover vegetation. The site is located immediately south of Goulburn River National Park and is surrounded by significant patches of remnant native vegetation. Portions of this site contain litter, fallen logs and rock coverage which provides good habitat features for ground fauna. All three fauna monitoring sites contain substantial habitat features for a variety of fauna assemblages.

A total of 50 fauna species were recorded within BOA-E during spring 2018 monitoring, comprising of 35 bird species, 9 microbat species, 5 reptile species and 1 amphibian species. As with BOA D, this represents a decline across the board compared to 2017 results. Bird diversity has decreased at all sites compared to 2017 results. E_100 recorded 15 bird species, E_104 recorded 20 individuals and E_106 recorded 19 individual species.

One threatened bird species listed as vulnerable under the BC Act, the Painted Honeyeater, was recorded at E_100.

Three microbat species (Large-eared Pied Bat, Eastern Bentwing-bat and Eastern Cave Bat) listed under the BC Act were positively identified at site E_104. The Large-eared Pied Bat is also listed as vulnerable under the EPBC Act.

3.4.5 Enhancement and Conservation Areas

The results of microbat monitoring undertaken across ECA-A, ECA-B and ECA-C during spring 2018 monitoring is presented in

Table 3-15. Three listed microbat species were detected across the ECA areas. More detailed results from fauna monitoring are discussed per ECA below.

Bird diversity has declined at all ECA sites compared to spring 2017 results, except for site A_100 which has maintained the same diversity (**Figure 3-8**).

Table 3-15: Results of the microbat analysis for A_104, B_101 and C_102 spring 2018

Species Name	Common Name	A_104	B_101	C_102
Austronomus australis	White-Striped Free-tailed Bat		X	X
***Chalinolobus dwyeri*[1]**	**Large-eared Pied Bat**		X	
Chalinolobus gouldii	Gould's Wattled Bat		X	X
Chalinolobus gouldii / *Ozimops* complex	Gould's Wattled Bat / Free-tailed Bat complex		X	X
Chalinolobus gouldii / Scotorepens balstoni	Gould's Wattled Bat / Inland Broad-nosed Bat		X	X
Chalinolobus morio	Chocolate Wattled Bat		X	X
Chalinolobus morio / *Vespadelus troughtoni**	Chocolate Wattled Bat / Eastern Cave Bat		X	X
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**		X	X
Miniopterus orianae oceanensis* and any or all of the following species, *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** and any or all of the following species, Large Forest Bat / Southern Forest Bat / Little Forest Bat	X	X	X
Nyctophilus spp. In this region *N. geoffroyi, N. gouldii* and the threatened ***N. corbeni*[1]** are likely to be present.	In this region Lesser, Gould's and the threatened **Corben's Long-eared Bat** are likely to be present.		X	X
Ozimops species complex. In this region the *O. petersi*, *O. ridei* and *O. planiceps.*	In this region the Inland, Ride's and South-eastern Free-tailed Bat are likely to be present.		X	X
Rhinolophus megaphyllus	Eastern Horseshoe Bat		X	
Saccolaimus flaviventris*	**Yellow-bellied Sheathtail Bat**			P
Scotorepens balstoni	Inland Broad-nosed Bat		X	X
Vespadelus darlingtoni	Large Forest Bat		P	
Vespadelus regulus	Southern Forest Bat		P	P
Vespadelus troughtoni*	**Eastern Cave Bat**		X	P
Vespadelus vulturnus	Little Forest Bat		X	X
Species Diversity (Positive identification)		**1**	**15**	**12**
Species Diversity (Possible identification)			**2**	**3**

X = Definitely present, P = Possibly present, *** Threatened species listed under BC Act / [1] Threatened species listed under the EPBC Act**

Enhancement and Conservation Area A (ECA-A)

Sections of ECA – A contain low floristic and forage resource diversity as the site is situated in a cleared paddock with no canopy and/or minimal shrub layer foliage, although a small portion of the site has a high

abundance canopy coverage. Landscape features within ECA-A provide habitat for a range of fauna assemblages.

A total of 32 species were recorded within ECA-A during spring 2018 monitoring, comprising of 29 bird species, one introduced mammal species and two reptile species. This is a decrease compared to 2017 results.

The only microbat activity recorded at ECA-A in 2018 was unable to be identified due to difficulty identifying or separating confidently between species, but has the potential to be the listed species, Eastern Bentwing Bat.

Enhancement and Conservation Area B (ECA-B)

ECA-B is located immediately south of the Goulburn River National Park, providing enhanced habitat values for the area through landscape connectivity. Most of the sites have a dominant canopy coverage, with litter cover and the presence of fallen logs provides further habitat values for ground fauna. Parts of this area has been extensively cleared. A creek line borders the southern and western edges of the site which contain bulrushes and some canopy coverage.

B_105 is bordered by two creeks. These landscape features are likely to influence which species utilise and are recorded at this site, which is consistent with it having the highest bird diversity of the ECA-B sites in spring 2018.

A total of 54 species were recorded in ECA-B during spring 2018 monitoring, comprising 44 bird species, nine microbat species, and one amphibian species. This is a slight decline compared to 2017 data, however microbat diversity has seen an increase in the same period.

Three threatened microbat species were detected during spring 2018, these were the Large-eared Pied Bat, Eastern Bentwing-bat and Eastern Cave Bat. Two threatened bird species, Painted Honeyeater and the Speckled Warbler were also recorded across the ECA-B area. This suggests the site can support a variety of species, which may be attributed to the presence of water at the site.

Enhancement and Conservation Area C (ECA-C)

Across the monitoring sites within this domain, landscape features provide habitat for a range of fauna assemblages. ECA-C is located adjacent to Munghorn Gap Nature Reserve (NR), which provides enhanced habitat values for the area through landscape connectivity. Site C_101 is located within DNG, whilst site C_102 is located in remnant eucalypt/cypress pine forest.

A total of 25 species were recorded in ECA-C during spring 2018 monitoring, comprising of 18 bird species, 6 mammal species (all positively identified microbat species) and 1 amphibian species. Overall species richness was lower than during spring 2017 monitoring.

The threatened species Large-eared Pied Bat and Eastern Bentwing-bat were positively identified, whilst the listed species Yellow-bellied Sheath-tailed Bat and the Eastern Cave Bat were also possibly present. C_102 contains high floristic and forage resource diversity with abundant canopy, shrub and ground layer coverage. The site is located on a rocky ridge which combined with the presence of fallen logs and litter coverage provides good habitat features for ground fauna. While site C_101 contains low floristic and forage resource diversity as site has been cleared. Limited litter, fallen log and rock cover, with no surface water present was observed at this site at the time of the monitoring program.

3.4.6 Regeneration Areas

Two of the three regeneration sites monitored in spring 2018 recorded the highest bird diversity since monitoring commenced. Whilst the third site, R5_100, recorded its second highest result, with spring 2017 topping spring 2018 results (**Figure 3-8**). More detailed results from fauna monitoring are discussed per Regeneration Area below.

Regeneration Area 4

Regeneration Area 4 is located south of the Goulburn River National Park. Creek lines border the site to the north and east. Site R4_100 is located within a regenerating paddock, with cover dominated by the exotic grasses *Phalaris aquatica* and *Vulpia* sp., and a high abundance of exotic forbs.

A total of 20 bird species were recorded at R4_100 which is an increase from the 2017 results. No threatened fauna species were recorded within Regeneration Area 4 during the monitoring period.

Regeneration Area 5

Regeneration Area 5 is located immediately south of Goulburn River National Park, which provides enhanced habitat values for the area through landscape connectivity. The site is comprised of moderate floristic and forage resource diversity with a scattered canopy coverage on the edge of the site. Both sites in this Management Domain are located within DNG. R5_101 is in close proximity to an area of Rough-barked Apple Woodland and Yellow Box Woodland, while R5_100 is bordered by an ephemeral vegetated creek line.

Site R5_100 saw a decrease in bird diversity in 2018 with 3 less species being recorded during the spring 2018 monitoring. This is a slight decline compared to 2017 results of 34 species. Site R5_101 saw an increase in bird diversity, recording 21 different species in 2018. The Painted Honeyeater and Speckled Warbler, both listed as vulnerable under the BC Act, were recorded at R5_101. No other species were detected, as general fauna monitoring was not conducted in Regeneration Area 5.

3.4.6 Rehabilitation Areas

Sites R6 and R9 are surrounded by active mine operations which presents limitations to landscape connectivity and fauna dispersal. Both sites have a dense groundcover dominated by exotic pasture species. These sites are to be rehabilitated to a woodland community, with scattered eucalypt seedlings and saplings being present.

A total of 16 species were recorded within both these Management Domains, comprising of 13 birds, 2 amphibians and 1 reptile species. Overall this is a decrease in species richness compared to monitoring conducted in spring 2017, although bat data collection did not occur during 2018 monitoring.

Moderate floristic and forage resource diversity due to abundant shrub and ground vegetation cover and presence of litter and rock coverage. No surface water was present.

3.4.7 Reference sites

Species richness, ranged from two positively identified species at Ref_2 to seven species at Ref_8. This is a decrease from 2017 where microbat diversity ranged between seven and ten species. Four threatened species were detected across the reference sites. Both the Eastern Horseshoe bat and the Chocolate wattled bat were positively identified across four of five sites, making them the most commonly listed species detected across all reference sites.

Ref_10, Ref_2, Ref_3 and Ref_8 all recorded two reptile species within their sites, and Ref_14 detected three reptile species. There was a total of seven reptile species detected across all reference sites.

Results for the microbat analysis at the five reference sites is shown in **Table 3-16.**

Table 3-16: Results of the microbat analysis for the WCPL Reference Sites

Species Name	Common Name	Ref_2	Ref_3	Ref_8	Ref 10	Ref 14
Austronomus australis	White-Striped Free-tailed Bat		X		X	X
Chalinolobus dwyeri[*1]	Large-eared Pied Bat		X		X	
Chalinolobus gouldii	Gould's Wattled Bat	P	P	X		P
Chalinolobus gouldii / *Ozimops* complex	Gould's Wattled Bat / Free-tailed Bat complex		X	X		X
Chalinolobus gouldii / *Scotorepens balstoni*	Gould's Wattled Bat / Inland Broad-nosed Bat		X	X		
Chalinolobus morio	Chocolate Wattled Bat	X	X	X	P	X
Chalinolobus morio / *Vespadelus troughtoni**	Chocolate Wattled Bat / **Eastern Cave Bat**	X	X			
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	X	X	X	P	P
Miniopterus orianae oceanensis* and any or all of the following species, *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** and any or all of the following species, Large Forest Bat / Southern Forest Bat / Little Forest Bat	X	X	X	X	X
Nyctophilus spp. In this region *N. geoffroyi, N. gouldii* and the **threatened *N. corbeni****[1] are likely to be present.	In this region Lesser, Gould's and the threatened **Corben's Long-eared Bat** are likely to be present.		X	X		P
Nyctophilus spp. In this region *N. geoffroyi, N. gouldii* and the **threatened *N. corbeni****[1] are likely to be present.	In this region Lesser, Gould's and the threatened **Corben's Long-eared Bat** are likely to be present.					P
Ozimops (*Mormopterus*) *spp.*	Free-tailed Bat complex	X	X	X	X	X
Rhinolophus megaphyllus	Eastern Horseshoe Bat		X	X	X	X
Saccolaimus flaviventris*	**Yellow-bellied Sheathtail Bat**					X
Scotorepens balstoni	Inland Broad-nosed Bat		P	X	P	
Vespadelus regulus	Southern Forest Bat	P		P	P	
Vespadelus troughtoni*	**Eastern Cave Bat**	P	X	X		
Vespadelus vulturnus	Little Forest Bat	P	P	X	X	P

Species Name	Common Name	Ref_2	Ref_3	Ref_8	Ref 10	Ref 14
Species Diversity (Positive identification)		**5**	**12**	**12**	**6**	**7**
Species Diversity (Possible identification)		**4**	**3**	**1**	**4**	**5**

X = Definitely present, P = Possibly present, *** Threatened species listed under BC Act / [1] Threatened species listed under the EPBC Act**

3.4.8 Fauna discussion

The data collected at the sites established in 2018 (BOAs 1 to 5) and the Reference sites, forms baseline data and cannot be compared to previous data.

Overall species diversity across all management domains has increased. A total of 121 species were recorded within 2018. This comprises of 92 bird species,13 reptile species, 4 amphibian species and 12 mammal species (including 10 positively identified microchiropteran bat (microbat) species). A full list of all fauna species recorded during the winter and spring 2018 monitoring program is included in **Appendix F**.

Bird diversity has declined since 2017 monitoring across all sites except R4_100 and R5_101. This is likely due to rainfall and drier conditions experienced during the 2018 monitoring periods. Continued monitoring is recommended to determine if this is due to seasonal variation or if there is a continued trend. There is a positive trend within the regeneration areas with a gradual increase in bird species richness. Sites R4_100 and R5_101 both recorded their highest bird species richness in 2018, which may indicate that the quality of habitat within these sites is improving. Although on-going monitoring will be needed to determine if there is a continued trend.

Overall, reptile species recorded in 2018 was similar to the 2017 results. Ref_14 and BOA4_101 both had the highest reptile diversity, recording three different reptile species at each site. On-going monitoring will be needed to determine if there is a continued trend or seasonal variation.

Overall, amphibian diversity has increased across all fauna sites compared to 2017 results, with four different species recorded. Seven sites in total recorded at least one of the four recorded species. Site R6 had the highest species richness with two different species recorded at the site. High rainfall events create favourable conditions for amphibians, likely increasing abundance and activity, which in turn affects detectability. 2018 was a dry year so it is likely amphibian species richness will increase in wetter years.

Limitations

The 2018 monitoring program took place during a dry period. The months leading up to and during spring 2018 monitoring experienced below average rainfall. Drier conditions may have decreased foraging resource availability for birds, and therefore abundances could be potentially lower, with some species moving away to areas with more suitable conditions. Dry condition may also negatively impact on habitat quality and availability within streams and pools. A decline in available surface water could be expected to significantly impact amphibian activity and breeding cycles. Observer variation and human error can impact the consistency of data between seasons and years.

4 Recommendations and Conclusion

4.1.1 Vegetation

Vegetation monitoring was undertaken within all Management Domains and Reference sites prescribed by the WCPL BMP during 2018. Fifteen of the 19 autumn monitoring sites failed the meet the Year 1-5

IPT, triggering the Native Vegetation and Habitat Complexity (BioMetric) TARP (WCPL 2017). This includes all Regeneration and Rehabilitation sites. This is despite the majority of sites' site value scores improving compared to 2017. Similarly, despite no site meeting all ten site attribute benchmarks, there has been improvement compared to 2017, with 15 out of 19 sites meeting the targets for seven or more of the ten site attributes.

Results from spring are similar, with 12 of the 20 sites, including all Regeneration and Rehabilitation sites, failing to meet their IPT and triggering the Native Vegetation and Habitat Complexity (BioMetric) TARP (WCPL 2017). This is despite general improvements compared to 2017 results, with eleven of the 20 site value scores improving compared to last year.

Consistent with previous monitoring, native overstorey, exotic cover and number of trees with hollows are the site attributes that are continuing to perform well across the management domains. This includes the Regeneration and Rehabilitation areas, however the year 1-5 IPT for number of trees with hollows is zero, explaining the unusually high performance of this site attribute. Overstorey regeneration and fallen logs are consistently not meeting targets as these are attributes that naturally progress slowly through time. It is considered these sites require either the passage of time for natural development or management intervention in order to achieve this site attribute target.

The results collected at Reference Sites and BOAs D and E during both autumn and spring 2018 monitoring, continue to add to the dataset to be used for comparison with vegetation sites within the various Management Domains. The BMP suggests that baseline data collected from Year 0 monitoring at the Reference Sites will be used to develop more relevant, locally based benchmark values against which future monitoring data would be analysed.

ELA recommends that the IPT for low vegetation condition sites is updated. Low vegetation condition is defined in Table 10 of the BMP as sites with site value scores of less than 34 (WCPL 2017), which contradicts the Year 1-5 IPT, which is also 34. As a result, all sites in the low vegetation are currently failing to meet the IPT.

4.1.2 Landscape stability

Groundcover in the form of living flora species, litter and rock material has been monitored within ECAs since 2007, Rehabilitation Areas since 2009, Regeneration Areas (formerly Regrowth Areas) since 2011, and BOAs 1-5 since 2018. The LOI data captured during the 2015 – 2017 monitoring, demonstrated consistently high scores. Although 2018 data has demonstrated a decrease in LOI at most sites, only three sites have dropped below 0.8 indicating presence of bare soil at most sites remains low. All sites except for A_100 and R8 meet the stability Completion Criteria, this indicates that levels of erosion within the majority of sites are consistent with previous monitoring seasons. Infiltration and nutrient cycling within all management domains failed to meet the Completion Criteria, which is consistent with previous results. Therefore, it is recommended that LFA monitoring is continued at the same sites into the future. This will enable identification of long-term trends.

4.1.3 Fauna

Data collected from BOAs 1 to 5 forms baseline data and therefore cannot be compared to previous results. It is recommended monitoring is continued at all sites in future to increase the dataset and enable identification of long-term trends. It is also recommended that BOA_D and BOA_E remain within the monitoring program to be used as reference sites. Both these sites have been monitored since 2015 and provide a valuable dataset that can be used to provide information on long term trends at the sites.

Winter and spring results both saw a decrease in bird diversity compared to previous monitoring. Reptile diversity remained stable compared to 2017 results, whilst amphibian diversity increased. The

Regeneration areas appear to be showing a positive trend in bird diversity, with two of the three sites recording the highest species diversity in spring 2018. This may indicate foraging habitat for birds is improving within this management domain. However, on-going monitoring is required to determine if this is a long-term trend.

The varying weather conditions over the last four years of monitoring highlights limitations of the program, some of which can be addressed. Timing of both the bird surveys and fauna trapping surveys is a determinant of success. It is recommended winter bird monitoring is not commenced until flowering of key winter-flowering species is confirmed, to increase the likelihood of recording specialist feeders such as Regent Honeyeater and Swift Parrot. An additional method of herpetological survey may assist in increasing trap success during colder months; that is, placing sheets of metal on the ground at monitoring sites several months prior to spring. This may provide shelter for reptiles and amphibians, increasing detection rates in spring.

4.2 General recommendations

To inform the recommendations for the Management Domains, **Table 4-1** provides a review of the monitoring results and IPTs and provides recommendations to inform future monitoring and to meet the IPTs and progress towards the Completion Criteria.

An Annual Works Program (ELA 2018) has been developed separately to this Annual Monitoring Report to provide specific management actions to be considered in response to the findings of this report.

Table 4-1: Review of monitoring results and recommendations

Interim Performance Target	Comment from results	Recommendations
Vegetation		
IPTs are listed in the BMP for Western Slopes Dry Sclerophyll Forest and Western Slopes Grassy Woodlands based on vegetation condition. Biometric site attribute scores for the Management Domain monitoring sites (ECAs, BOAs, Regeneration and Rehabilitation Areas) were compared to the IPTs whilst Reference Sites were compared to Benchmark Targets.	Management Domain sites surveyed during spring 2018 monitoring demonstrated a high level of achievement for most IPTs. Although overstorey regeneration and fallen logs are the two attributes that are consistently falling, failing to meet the benchmark set at many of the sites, and more focus needs to be placed on these two site attributes.	Ongoing weed management is recommended across all Management Domains with a focus on the occurrences of Priority weeds. Targeted planting of native overstorey and midstorey species is recommended to accelerate the establishment of the mid and upper strata. These recommendations are in line with short term biodiversity management strategies outlined in the BMP. Ongoing monitoring of the Reference Sites to inform the development of more relevant, site-specific benchmarks. Refer to the TARP for specific actions in the event that the SVS is below the IPT
The management of Priority weeds is listed as a priority in the BMP in accordance with the legal responsibility of WCPL under the (now repealed) *Noxious Weeds Act 1993*.	Declared weed species were recorded in all Management Domains.	Targeted weed management is recommended. Priority weed locations have been noted and their presence should be reviewed during future monitoring periods.
Land Function Analysis (LFA)		
Completion criteria for SSA indices (Slope Stability, Soil Infiltration and Nutrient Cycling) are listed in the BMP as a minimum score of 50. The BMP also anticipates a minimal annual increase by 5% for these scores.	LOI values indicate stable, functioning landforms, was recorded at most the sites except for sites R6, R10 and R4_100 which received scores below 0.80. Overall there has been a decrease in LOI indicating increased amounts of bare soil at many sites. Slope Stability was above completion criteria for all sites except for R8. Soil	Management measures to be implemented as recommended in the BMP would be expected to improve LFA monitoring results over time. Annual improvement of less than 5% for any of the SSA indices triggers the requirement for further investigation. WCPL should review

Interim Performance Target	Comment from results	Recommendations
	Infiltration and Nutrient Cycling scores were more variable and below completion criteria at all sites except for Reference sites. Many Soil Infiltration and Nutrient Cycling scores reduced instead of recording the anticipated annual improvement of five.	past management measures in these areas and consult the BMP recommended management actions going forward. Continued monitoring of sites to provide longer term data and determine the effectiveness of management actions. Refer to the TARP for specific actions in the event that the sites do not meet either the completion criteria or the minimal annual increase by five.
Fauna		
Landforms and vegetation structure within WCPL Management Domains are inhabited or frequented by local fauna.	A broad variety of species were recorded in monitoring sites across the various Management Domains. These results demonstrated that the condition of landforms, vegetation structure and other habitat features at the monitoring sites, including the surrounding environment, were a key factor in determining species numbers and diversity.	Continue monitoring the fauna sites, targeting fauna groups such as birds and microbats. As discussed, birds and microbats are common and diverse throughout Australia. Due to the ease of surveying birds and microbats, they are regularly a focus of monitoring surveys and are analysed as an indicator of biodiversity. Comparison of bird and microbat assemblages can be undertaken and tracking of trends over time can indicate sites providing improved habitat. To continue to monitor sites BOA_D and BOA_E as future reference sites, as the database that has been collected provides evidence of long terms fauna trends Placement of permanent tiles to survey for reptiles and amphibians could improve survey results and provide greater species numbers and diversity at little cost and effort.
Introduced feral and pest species control is essential to environmental management works with targeted programs implemented.	There was only one introduced species recorded during fauna monitoring in spring 2018. Targeted monitoring of introduced species would be necessary to determine abundance and activity levels.	Ongoing management of introduced species is recommended. Management methods are to be implemented as per the BMP (including poison baiting of predators and ripping rabbit warrens) and recommendations from this report. Control of herbivore populations should be prioritised within regeneration and rehabilitation areas to

Interim Performance Target	Comment from results	Recommendations
		increase resilience. Ongoing control of introduced predators will reduce pressure on native species.

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Appendix A – Weather conditions

Table A-1: 2017 Monthly mean and historical average weather conditions

Month	2018			Historical Averages		
	Min Temp (°C)	Max Temp (°C)	Total Rainfall (mm)	Min Temp (°C)	Max Temp (°C)	Rainfall Mean (mm)
January	18.0	34.0	24.4	16.8	31.1	66.5
February	16.5	31.0	77	16.4	30.0	62.4
March	15.3	28.7	24.6	13.8	27.5	52.5
April	11.9	26.4	42.2	9.9	23.5	39.1
May	4.7	20.1	12.4	6.3	19.1	37.6
June	2.3	16.0	21.6	3.7	15.5	44.2
July	0.0	16.1	1.2	2.6	14.8	42.2
August	1.58	16.87	43.8	3.4	16.5	41.1
September	5.7	20.8	39.6	6.0	19.8	41.3
October	11.5	24.2	56.8	9.3	23.7	51.1
November	13.58	26.9	47.4	12.3	26.8	56.0
December	16.2	31.4	31	15.0	29.8	60.1

Source: WCPL (2018 data); Bureau of Meteorology, 2017 (Historical averages) Temperature data from Gulgong Post Office weather station number 62013. Rainfall from Wollar (Barrigan St) Weather station number:62032

Table A-2: Weather conditions during 2018 Biodiversity Monitoring Program

Date	Min Temp (°C)	Max Temp (°C)	Rainfall (mm)	Average Wind Speed (km/hr)
Autumn monitoring				
30/04/18	6.4	20.5	0	1.2
01/05/18	5.8	22.1	0	1
02/05/18	9.5	22.9	0	0.3
03/05/18	14.4	25	0	0.5
04/05/18	11.4	22.6	0	2.5
05/05/18	2.5	22.9	0	0.1
06/05/18	1.4	22	0	1
07/05/18	3.2	24.4	0	0.4
08/05/18	6.4	22.9	0	0.2
Winter bird monitoring				
09/07/18	1.7	15.8	0	1.2

Date	Min Temp (°C)	Max Temp (°C)	Rainfall (mm)	Average Wind Speed (km/hr)
10/07/18	-2	15.2	0	0.7
11/07/18	-1.4	16.5	0	0.7
12/07/18	-2.1	14.6	0	1.5
13/07/18	0.1	12.4	0	2.1
Spring monitoring				
05/09/18	9.6	18.1	0.2	3.2
06/09/18	9.4	19.8	13.6	0.8
07/09/18	9.3	16.3	11	1.1
08/09/18	6.7	20.7	0.6	0.4
09/09/18	2.8	19.1	0	2.5
10/09/18	5.9	22.8	0	0.4
11/09/18	5.2	25.7	0	0.3
12/09/18	5.7	27	0	1.5
13/09/18	7	26.6	0	0.8
14/09/18	8.2	27	0	0.9
15/09/18	4.1	29	0	3.2
16/09/18	4.8	15.9	0	2.6
17/09/18	-0.1	18.7	0	0.9
18/09/18	1.7	24.4	0	1.7
19/09/18	4.8	22.8	0	2.2
20/09/18	1	18.2	0	1.1
21/09/18	1.1	21.4	0	0.7
22/09/18	2	22.4	0	0.9
23/09/18	3.7	24.6	0	0.9
24/09/18	10.6	16.6	0	4.7

Source: WCPL

Table A3: Monthly Rainfall from 2013 - 2017 (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
2013	73.6	54.2	61.4	12.2	17.4	77.9	20.8	6.6	33.0	8.8	78.6	27.6	472.1
2014	15.6	60.0	112.6	62.8	13.8	29.8	28.6	28.8	14.6	15.4	24.4	126.7	533.1
2015	127.6	11.6	9.4	108.4	42.8	42.8	38.0	53.8	7.8	61.0	59.0	118.4	680.6
2016	152.1	7.2	23.5	14.8	66.8	104.2	101.1	40.9	198.7	86.6	51.9	90.6	938.4

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
2017	27.8	34.2	146	23	32.4	10.4	5.8	25.2	3	28.4	92.6	102.6	531.4
2018	24.4	77	24.6	42.2	12.4	21.6	1.2	43.8	39.6	56.8	47.4	91.2	482.2
Historical Mean	66.5	62.4	52.5	39.1	37.6	44.2	42.2	41.1	41.3	51.1	56	60.1	**590.6**

Source: WCPL and Bureau of Meteorology, 2017 (Historical averages) Wollar (Barrigan St) Weather station number:62032.

Appendix B – 2018 Biodiversity monitoring sites

Table B-1: Autumn 2018 Vegetation Monitoring Sites

Domain	Site	Management Domain	Condition	Keith Vegetation Class	Vegetation Community	Easting	Northing
BOA	D_101	BOA-D	Native vegetation	WSDSF	Narrow-leaved Ironbark Woodland	784318	6427419
	D_103	BOA-D	Native vegetation	WSDSF	Mugga Ironbark Woodland	784084	6427171
	E_100	BOA-E	Native vegetation	WSDSF	Narrow-leaved Ironbark - Brown Bloodwood - Dwyer's Red Gum Woodland	778311	6419426
	E_105	BOA-E	Regeneration	WSGW	White Box Grassy Woodland (regenerating)	779016	6419982
	E_106	BOA-E	Native vegetation	WSGW	White Box Grassy Woodland (DNG)	778855	6420402
ECA	A_102	ECA-A	Regeneration	WSGW	Box-Gum Grassy Woodland on Valley Floors (DNG)	772917	6417079
	A_103	ECA-A	Native vegetation	WSGW	Blakely's Red Gum Woodland	773142	6417621
	B_103	ECA-B	Native vegetation	WSDSF	Grey Gum - Narrow-leaved Stringybark Forest	771079	6420160
	B_106	ECA-B	Regeneration	WSGW	Yellow Box Woodland (DNG)	771570	6420003
	C_101	ECA-C	Regeneration	WSDSF	White Box Shrubby Woodland (DNG)	768365	6416938
Regeneration	R1_100	Regeneration Area 1	Regeneration	WSGW	Blakely's Red Gum Woodland (DNG)	774228	6420096
	R3_100	Regeneration Area 3	Regeneration	WSDSF	White Box Shrubby Woodland (DNG)	770462	6415880
	R5_100	Regeneration Area 5	Regeneration	WSGW	Rough-barked Apple Woodland (DNG)	769194	6421424
	R6_101	Regeneration Area 6	Regeneration	WSGW	Rough-barked Apple Woodland (DNG)	767412	6420304
	R7_100	Regeneration Area 7	Regeneration	WSGW	Yellow Box Woodland (DNG)	767957	6416541
	R8_100	Regeneration Area 8	Regeneration	WSDSF	Rough-barked Apple Woodland (DNG)	767740	6417104
	R9_101	Regeneration Area 9	Regeneration	WSGW	Rough-barked Apple Woodland (DNG)	768829	6422231

Domain	Site	Management Domain	Condition	Keith Vegetation Class	Vegetation Community	Easting	Northing
Rehabilitation	R6	Rehabilitation	Rehabilitation	WSDSF	NA	769566	6419516
	R9	Rehabilitation	Rehabilitation	WSDSF	NA	769120	6418969
	Ref_13b	Turrill SCA	Native vegetation	WSDSF	Narrow-leaved Ironbark Woodland	776969	6451669
	Ref_14	Goulburn River NP	Native vegetation	WSDSF	Ironbark Bloodwood Red Gum Woodland	782174	6421967
	Ref_15	Goulburn River NP	Native vegetation	WSGW	Blakely's Red Gum Woodland	766024	6426575
	Ref_16	Goulburn River NP	Native vegetation	WSGW	Blakely's Red Gum Woodland	766047	6426748
	Ref_17	Turill SCA	Native vegetation	WSGW	Blakely's Red Gum Woodland	776767	6452950
	Ref_18	Goulburn River NP	Native vegetation	WSGW	Rough-barked Apple Woodland	775232	6451125
	Ref_19	BOA-E	Native vegetation	WSGW	White Box Grassy Woodland	779189	6419668
	Ref_20	Goulburn River NP	Native vegetation	WSDSF	Grey Gum – Narrow-leaved Stringybark Forest	769129	6421893
	Ref_21	Goulburn River NP	Native vegetation	WSDSF	Rough-barked Apple Red Gum Forest	769832	6422848
	Ref_22	Goulburn River NP	Native vegetation	WSDSF	Grey Gum Rough-barked Apple Forest	768130	6423829
	Ref_23	Goulburn River NP	Native vegetation	WSGW	Yellow Box Grassy Woodland	769183	6422270
	Ref_24	BOA-E	Native vegetation	WSGW	White Box Shrubby Woodland	779295	6419440

Table B-2: Spring 2018 vegetation monitoring sites

Domain	Site	Management Domain/Location	Condition	Keith Vegetation Class	Vegetation Community	Easting	Northing
BOA	D_100	BOA-D	Native Vegetation	WSDSF	Narrow-leaved Ironbark - Box Woodland	784857	6427722
	D_102	BOA-D	Regeneration	WSGW	Grassy White Box Woodland	784563	6427262
	E_101	BOA-E	Regeneration	WSDSF	Shrubby regeneration	778761	6419564
	E_102	BOA-E	Regeneration	WSGW	Yellow Box Woodland	779053	6419319
	E_104	BOA-E	Native Vegetation	WSGW	Grassy White Box Woodland	779148	6419734
	BOA1_100	BOA_1	Native Vegetation	WSDSF	White Box Shrubby Woodland	766944	6414592
	BOA2_100	BOA_2	Native Vegetation	WSDSF	White Box Shrubby Woodland	769159	6413073
ECA	A_100	ECA-A	Regeneration	WSGW	DNG - other native (non-EEC)	771861	6416276
	A_104	ECA-A	Native Vegetation	WSGW	Narrow-leaved Ironbark Forest	773695	6416293
	B_100	ECA-B	Native Vegetation	WSGW	Sandstone Ranges Shrubby Woodland	770111	6420997
	B_101	ECA-B	Regeneration	WSGW	DNG - other native (non-EEC)	770542	6420592
	B_105	ECA-B	Regeneration	WSDSF	DNG - other native (non-EEC)	773141	6420468
	C_102	ECA-C	Native Vegetation	WSGW	Shrubby White Box Woodland	768940	6417281
Regeneration Area	R2_101	Regeneration Area 2	Regeneration	WSGW	DNG - other native (non-EEC)	772639	6418355
	R4_100	Regeneration Area 4	Regeneration	WSGW	DNG - other native (non-EEC)	770347	6420268

Domain	Site	Management Domain/Location	Condition	Keith Vegetation Class	Vegetation Community	Easting	Northing
	R5_101	Regeneration Area 5	Regeneration	WSDSF	DNG - other native (non-EEC)	769500	6421595
	R9_100	Regeneration Area 9	Regeneration	WSDSF	DNG - other native (non-EEC)	768975	6422067
Rehabilitation Area	R8	Rehabilitation Area	Rehabilitation – Grassland	WSGW	N/A	770231	6418596
	R10	Rehabilitation Area	Rehabilitation – Grassland	WSGW	N/A	768433	6419301
	R11	Rehabilitation Area	Rehabilitation – Grassland	WSGW	N/A	768896	6419664
Reference	Ref_1	Turill SCA	Native vegetation	WSGW	Blakely's Red Gum Grassy Woodland	775261	6451958
	Ref_2	Goulburn River NP	Native vegetation	WSDSF	Narrow-leaved Ironbark - Box Woodland	224152	6424015
	Ref_3	Goulburn River NP	Native vegetation	WSDSF	Grey Gum – Narrow-leaved Stringybark Forest	217853	6424354
	Ref_4	Turill SCA	Native vegetation	WSGW	Grassy White Box Woodland	773477	6449770
	Ref_5	WCPL Offset Area	Native vegetation	WSDSF	Ironbark Bloodwood Red Gum Woodland	779353	6419938
	Ref_6	Goulburn River NP	Native vegetation	WSDSF	Ironbark Bloodwood Red Gum Woodland	222265	6422430
	Ref_7	Goulburn River NP	Native vegetation	WSDSF	Narrow-leaved Ironbark - Box Woodland	218145	6425455
	Ref_8	Goulburn River NP	Native vegetation	WSGW	White Box Shrubby Woodland	781932	6414688
	Ref_9	Goulburn River NP	Native vegetation	WSDSF	Grey Gum – Narrow-leaved Stringybark Forest	221614	6422152

Domain	Site	Management Domain/Location	Condition	Keith Vegetation Class	Vegetation Community	Easting	Northing
	Ref_10	Goulburn River NP	Native vegetation	WSDSF	Narrow-leaved Ironbark - Box Woodland	220576	6428690
	Ref_11	Turill SCA	Native vegetation	WSGW	Blakely's Red Gum – White Box DNG	775036	6451459
	Ref_12	Turill SCA	Native vegetation	WSGW	Rough-barked Apple DNG	773663	6449945

Table B-3: LFA monitoring sites

Site	Management Domain	Easting	Northing	Zone	Type
A_100	ECA-A	771861	6416276	55H	BioMetric and LFA
B_106	ECA-B	771571	6420001	55H	LFA
E_105	BOA-E	779002	6419978	55H	LFA
R10	Rehabilitation Area	768433	6419301	55H	BioMetric and LFA
R11	Rehabilitation Area	768896	6419664	55H	BioMetric and LFA
R13	Rehabilitation Area	770872	6418901	55H	LFA
R4_100	Regeneration Area 4	770347	6420268	55H	BioMetric and LFA
R6	Rehabilitation Area	769562	6419517	55H	LFA
R8	Rehabilitation Area	770231	6418596	55H	BioMetric and LFA
R9	Rehabilitation Area	769118	6418973	55H	LFA
Ref_1	Turill SCA	775261	6451958	55H	BioMetric and LFA
Ref_13b	Turill SCA	777202	6449998	55H	LFA
Ref_14	Goulburn River NP	782171	6421993	55H	LFA
Ref_2	Goulburn River NP	224152	6424015	56H	BioMetric and LFA
Ref_3	Goulburn River NP	217853	6424354	56H	BioMetric and LFA
Ref_4	Turill SCA	773477	6449770	55H	BioMetric and LFA
Ref_5	WCPL Offset Area	779353	6419938	55H	BioMetric and LFA
Ref_6	Goulburn River NP	222265	6422430	56H	BioMetric and LFA
Ref_7	Goulburn River NP	218145	6425455	56H	LFA
Ref_8	Goulburn River NP	781932	6414688	55H	BioMetric and LFA

Table B-4: Fauna monitoring sites

Area	Site ID	Coordinates		Management Zone	Vegetation Class	Survey		
		Easting	Northing			Fauna	Bats	Birds only
ECA-A	A_100	771861	6416276	Regeneration (poor resilience)	Western Slopes Grassy Woodland	Y		
	A_102	772926	6417078	Regeneration (moderate resilience)	Western Slopes Grassy Woodland	Y		
	A_104	773695	6416293	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y	Y	
BOA-D	D_100	784857	6427722	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y		
	D_101	784306	6427422	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y		
	D_103	784083	6427173	Regeneration (moderate resilience)	Western Slopes Dry Sclerophyll Forest	Y	Y	
BOA-E	E_100	778299	6419408	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y		
	E_104	779148	6419734	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y	Y	
	E_106	778854	6420399	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y		
BOA-1	BOA1_100	766963	6414300	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y	Y	
	BOA1_101	767441	6414516	Regeneration (moderate resilience)	Western Slopes Grassy Woodland			Y
BOA-2	BOA2_100	769440	6413937	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y	Y	
	BOA2_101	769050	6413570	Native vegetation (good resilience)	Western Slopes Grassy Woodland			Y
BOA-3	BOA3_100	784649	6421025	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y	Y	
	BOA3_101	784714	6422246	Native vegetation (good resilience)	Western Slopes Grassy Woodland			Y

Area	Site ID	Coordinates		Management Zone	Vegetation Class	Survey		
		Easting	Northing			Fauna	Bats	Birds only
	BOA3_102	784258	6421909	Native vegetation (good resilience)	Dry Rainforest	Y		
BOA-4	BOA4_100	782475	6424100	Native vegetation (good resilience)	Western Slopes Grassy Woodland			Y
	BOA4_101	782527	6423888	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y	Y	
BOA-5	BOA5_100	784073	6417976	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y	Y	
	BOA5_101	783192	6419415	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y		
	BOA5_102	784493	6419150	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest			Y
ECA-B	B_100	770111	6420997	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y		
	B_101	770542	6420592	Regeneration (moderate resilience)	Western Slopes Grassy Woodland	Y	Y	
	B_103	771072	6420157	Native vegetation (good resilience)	Western Slopes Dry Sclerophyll Forest	Y		
	B_105	773141	6420468	Regeneration (moderate resilience)	Western Slopes Dry Sclerophyll Forest			Y
ECA-C	C_101	768377	6416929	Regeneration (moderate resilience)	Western Slopes Dry Sclerophyll Forest	Y		
	C_102	768940	6417281	Native vegetation (good resilience)	Western Slopes Grassy Woodland	Y	Y	
Regeneration Area 4	R4_100	770347	6420268	Regeneration (no resilience)	Western Slopes Grassy Woodland			Y
Regeneration Area 5	R5_100	769191	6421422	Regeneration (moderate resilience)	Western Slopes Grassy Woodland			Y
	R5_101	769500	6421595	Regeneration (moderate resilience)	Western Slopes Dry Sclerophyll Forest			Y
Regeneration Area 6	R6_101	767406	6420303	Regeneration (no resilience)	Western Slopes Grassy Woodland			

Area	Site ID	Coordinates		Management Zone	Vegetation Class	Survey		
		Easting	Northing			Fauna	Bats	Birds only
Rehabilitation	R6	769562	6419517	Rehabilitation - Woodland	Western Slopes Dry Sclerophyll Forest	Y		
	R9	769118	6418973	Rehabilitation - Woodland	Western Slopes Dry Sclerophyll Forest	Y		
Reference Sites	Ref_2	224153	6424016	Goulburn River NP	Western Slopes Dry Sclerophyll Forest	Y	Y	
	Ref_3	217853	6424354	Goulburn River NP	Western Slopes Grassy Woodland	Y	Y	
	Ref_5	779353	6419939	WCPL Offset Area	Western Slopes Grassy Woodland	Y	Y	
	Ref_8	781933	6414689	Goulburn River NP	Western Slopes Grassy Woodland	Y	Y	
	Ref_10	220576	6428690	Goulburn River NP	Western Slopes Grassy Woodland	Y	Y	
	Ref_14	782174	6421967	Goulburn River NP	Western Slopes Grassy Woodland	Y	Y	

Appendix C – Flora species list (autumn 2018 and spring 2018)

Family	Scientific Name	Native / Exotic
Amaranthaceae	*Alternanthera nana*	Native
Anthericaceae	*Arthropodium minus*	Native
Anthericaceae	*Laxmannia gracilis*	Native
Anthericaceae	*Thysanotus sp.*	Native
Apiaceae	*Daucus glochidiatus*	Native
Apiaceae	*Hydrocotyle laxiflora*	Native
Apiaceae	*Platysace ericoides*	Native
Apocynaceae	*Gomphocarpus sp.*	Exotic
Asphodelaceae	*Bulbine bulbosa*	Native
Asteraceae	*Arctotheca calendula*	Exotic
Asteraceae	*Asteraceae sp.*	Native/exotic
Asteraceae	*Calocephalus citreus*	Native
Asteraceae	*Calotis cuneifolia*	Native
Asteraceae	*Calotis lappulacea*	Native
Asteraceae	*Carthamus lanatus*	Exotic
Asteraceae	*Carthamus sp.*	Exotic
Asteraceae	*Cassinia arcuata*	Native
Asteraceae	*Cassinia cunninghamii*	Native
Asteraceae	*Cassinia quinquefaria*	Native
Asteraceae	*Cichorium intybus*	Exotic
Asteraceae	*Cirsium vulgare*	Exotic
Asteraceae	*Conyza sp.*	Exotic
Asteraceae	*Cotula australis*	Native

Family	Scientific Name	Native / Exotic
Asteraceae	*Cymbonotus lawsonianus*	Native
Asteraceae	*Euchiton sp.*	Native
Asteraceae	*Euchiton sphaericus*	Native
Asteraceae	*Gamochaeta calviceps*	Exotic
Asteraceae	*Gamochaeta sp.*	Exotic
Asteraceae	*Hypochaeris glabra*	Exotic
Asteraceae	*Hypochaeris radicata*	Exotic
Asteraceae	*Lagenophora stipitata*	Native
Asteraceae	*Olearia elliptica*	Native
Asteraceae	*Senecio quadridentatus*	Native
Asteraceae	*Sigesbeckia orientalis*	Native
Asteraceae	*Sigesbeckia sp.*	Native
Asteraceae	*Silybum marianum*	Exotic
Asteraceae	*Solenogyne bellioides*	Native
Asteraceae	*Solenogyne dominii*	Native
Asteraceae	*Solenogyne gunnii*	Native
Asteraceae	*Solenogyne sp.*	Native
Asteraceae	*Sonchus oleraceus*	Exotic
Asteraceae	*Sonchus sp.*	Exotic
Asteraceae	*Tagetes minuta*	Exotic
Asteraceae	*Taraxacum officinale*	Exotic
Asteraceae	*Triptilodiscus pygmaeus*	Native
Asteraceae	*Vittadinia cuneata*	Native
Asteraceae	*Vittadinia sp.*	Native
Asteraceae	*Vittadinia sulcata*	Native
Asteraceae	*Vittadinia muelleri*	Native

Family	Scientific Name	Native / Exotic
Asteraceae	*Xanthium spinosum*	Exotic
Boraginaceae	*Cynoglossum australe*	Native
Boraginaceae	*Echium plantagineum*	Exotic
Boraginaceae	*Echium vulgare*	Exotic
Boraginaceae	*Heliotropium amplexicaule*	Exotic
Brassicaceae	*Brassicaceae sp.*	Exotic
Brassicaceae	*Lepidium africanum*	Exotic
Brassicaceae	*Rapistrum rugosum*	Exotic
Cactaceae	*Opuntia sp.*	Exotic
Cactaceae	*Opuntia stricta*	Exotic
Campanulaceae	*Wahlenbergia gracilis*	Native
Campanulaceae	*Wahlenbergia granitica*	Native
Campanulaceae	*Wahlenbergia sp.*	Native
Caryophyllaceae	*Cerastium glomeratum*	Exotic
Caryophyllaceae	*Paronychia brasiliana*	Exotic
Caryophyllaceae	*Polycarpon sp.*	Exotic
Caryophyllaceae	*Stellaria media*	Exotic
Caryophyllaceae	*Stellaria pungens*	Native
Casuarinaceae	*Allocasuarina gymnanthera*	Native
Casuarinaceae	*Allocasuarina luehmannii*	Native
Chenopodiaceae	*Dysphania pumilio*	Native
Chenopodiaceae	*Einadia hastata*	Native
Chenopodiaceae	*Einadia nutans*	Native
Chenopodiaceae	*Einadia trigonos*	Native
Clusiaceae	*Hypericum gramineum*	Native
Clusiaceae	*Hypericum perforatum*	Exotic

Family	Scientific Name	Native / Exotic
Colchicaceae	*Wurmbea dioica*	Native
Convolvulaceae	*Convolvulus erubescens*	Native
Convolvulaceae	*Dichondra repens*	Native
Convolvulaceae	*Dichondra sp. A sensu*	Native
Crassulaceae	*Crassula sieberiana*	Native
Cucurbitaceae	*Cucumis myriocarpus subsp. leptodermis*	Exotic
Cupressaceae	*Callitris endlicheri*	Native
Cyperaceae	*Carex appressa*	Native
Cyperaceae	*Carex inversa*	Native
Cyperaceae	*Cyperus gracilis*	Native
Cyperaceae	*Cyperus sp.*	Native/exotic
Cyperaceae	*Fimbristylis dichotoma*	Native
Cyperaceae	*Gahnia aspera*	Native
Cyperaceae	*Gahnia sieberiana*	Native
Cyperaceae	*Lepidosperma gunnii*	Native
Cyperaceae	*Lepidosperma laterale*	Native
Dilleniaceae	*Hibbertia circumdans*	Native
Dilleniaceae	*Hibbertia obtusifolia*	Native
Dilleniaceae	*Hibbertia riparia*	Native
Epacridaceae	*Acrotriche rigida*	Native
Epacridaceae	*Melaleuca erubescens*	Native
Epacridaceae	*Melaleuca uncinata*	Native/exotic
Epacridaceae	*Melichrus erubescens*	Native
Epacridaceae	*Melichrus urceolatus*	Native
Epacridaceae	*Styphelia triflora*	Native
Ericaceae	*Astroloma humifusum*	Native

Family	Scientific Name	Native / Exotic
Ericaceae	*Leucopogon muticus*	Native
Ericaceae	*Lissanthe strigosa*	Native
Ericaceae	*Monotoca scoparia*	Native
Euphorbiaceae	*Euphorbia drummondii*	Native
Euphorbiaceae	*Phyllanthus hirtellus*	Native
Euphorbiaceae	*Phyllanthus occidentalis*	Native
Euphorbiaceae	*Phyllanthus virgatus*	Native
Fabaceae	*Acacia decora*	Native
Fabaceae	*Acacia difformis*	Native
Fabaceae	*Acacia doratoxylon*	Native
Fabaceae	*Acacia implexa*	Native
Fabaceae	*Acacia ixiophylla*	Native
Fabaceae	*Acacia leucolobia*	Native
Fabaceae	*Acacia linearifolia*	Native
Fabaceae	*Acacia montana*	Native
Fabaceae	*Acacia penninervis*	Native
Fabaceae	*Acacia sp.*	Native
Fabaceae	*Acacia terminalis*	Native
Fabaceae	*Acacia triptera*	Native
Fabaceae	*Acacia uncinata*	Native
Fabaceae	*Acacia verniciflua*	Native
Fabaceae	*Bossiaea buxifolia*	Native
Fabaceae	*Bossiaea sp.*	Native
Fabaceae	*Daviesia ulicifolia*	Native
Fabaceae	*Desmodium brachypodum*	Native
Fabaceae	*Desmodium sp.*	Native

Family	Scientific Name	Native / Exotic
Fabaceae	*Desmodium varians*	Native
Fabaceae	*Glycine clandestina*	Native
Fabaceae	*Glycine tabacina*	Native
Fabaceae	*Gompholobium huegelii*	Native
Fabaceae	*Hardenbergia violacea*	Native
Fabaceae	*Hovea lanceolata*	Native
Fabaceae	*Podolobium ilicifolium*	Native
Fabaceae	*Pultenaea microphylla*	Native
Fabaceae	*Swainsona galegifolia*	Native
Fabaceae	*Swainsona monticola*	Native
Fabaceae	*Swainsona sp.*	Native
Fabaceae	*Trifolium arvense*	Exotic
Fabaceae	*Trifolium campestre*	Exotic
Fabaceae	*Trifolium repens*	Exotic
Fabaceae	*Trifolium sp.*	Exotic
Fabaceae	*Trifolium subterraneum*	Exotic
Geraniaceae	*Erodium botrys*	Exotic
Geraniaceae	*Erodium cicutarium*	Exotic
Geraniaceae	*Erodium crinitum*	Native
Geraniaceae	*Geranium solanderi*	Native
Goodeniaceae	*Goodenia hederacea*	Native
Goodeniaceae	*Goodenia hederacea subsp. Hederacea*	Native
Goodeniaceae	*Goodenia ovata*	Native
Goodeniaceae	*Goodenia rotundifolia*	Native
Goodeniaceae	*Goodenia sp.*	Native
Haloragaceae	*Gonocarpus elatus*	Native

Family	Scientific Name	Native / Exotic
Haloragaceae	*Gonocarpus tetragynus*	Native
Haloragaceae	*Haloragis heterophylla*	Native
hormiaceae	*Dianella longifolia*	Native
hormiaceae	*Dianella revoluta*	Native
Iridaceae	*Patersonia sericea*	Native
Juncaceae	*Juncus sp.*	Native/exotic
Juncaceae	*Juncus usitatus*	Native
Lamiaceae	*Ajuga australis*	Native
Lamiaceae	*Marrubium vulgare*	Exotic
Lamiaceae	*Mentha diemenica*	Native
Lamiaceae	*Mentha satureioides*	Native
Lamiaceae	*Salvia verbenaca*	Exotic
Lauraceae	*Cassytha pubescens*	Native
Lomandraceae	*Lomandra confertifolia*	Native
Lomandraceae	*Lomandra filiformis*	Native
Lomandraceae	*Lomandra filiformis subsp. coriacea*	Native
Lomandraceae	*Lomandra filiformis subsp. filiformis*	Native
Lomandraceae	*Lomandra glauca*	Native
Lomandraceae	*Lomandra longifolia*	Native
Lomandraceae	*Lomandra multiflora*	Native
Lomandraceae	*Lomandra multiflora subsp. multiflora*	Native
Loranthaceae	*Amyema miquelii*	Native
Loranthaceae	*Amyema quandang*	Native
Loranthaceae	*Amyema sp.*	Native
Malvaceae	*Brachychiton populneus*	Native
Malvaceae	*Brachyloma daphnoides*	Native

Family	Scientific Name	Native / Exotic
Malvaceae	*Malva parviflora*	Exotic
Malvaceae	*Modiola caroliniana*	Exotic
Malvaceae	*Sida corrugata*	Native
Malvaceae	*Sida cunninghamii*	Native
Malvaceae	*Sida sp.*	Native
Myoporaceae	*Eremophila debilis*	Native
Myrtaceae	*Angophora floribunda*	Native
Myrtaceae	*Calytrix tetragona*	Native
Myrtaceae	*Corybas sp.*	Native
Myrtaceae	*Corymbia trachyphloia*	Native
Myrtaceae	*Eucalyptus albens*	Native
Myrtaceae	*Eucalyptus blakelyi*	Native
Myrtaceae	*Eucalyptus bridgesiana*	Native
Myrtaceae	*Eucalyptus crebra*	Native
Myrtaceae	*Eucalyptus dealbata*	Native
Myrtaceae	*Eucalyptus dwyeri*	Native
Myrtaceae	*Eucalyptus fibrosa*	Native
Myrtaceae	*Eucalyptus melliodora*	Native
Myrtaceae	*Eucalyptus moluccana*	Native
Myrtaceae	*Eucalyptus punctata*	Native
Myrtaceae	*Eucalyptus rossii*	Native
Myrtaceae	*Eucalyptus sideroxylon*	Native
Myrtaceae	*Eucalyptus sparsifolia*	Native
Myrtaceae	*Kunzea ambigua*	Native
Myrtaceae	*Leptospermum parvifolium*	Native
Myrtaceae	*Leptospermum polygalifolium*	Native

Family	Scientific Name	Native / Exotic
Myrtaceae	*Leptospermum sphaerocarpum*	Native
Myrtaceae	*Leptospermum trinervium*	Native
Myrtaceae	*Sannantha cunninghamii*	Native
Nyctaginaceae	*Boerhavia dominii*	Native
Orchidaceae	*Orchidaceae sp.*	Native
Orchidaceae	*Pterostylis sp.*	Native
Oxalidaceae	*Oxalis perennans*	Native
Oxalidaceae	*Oxalis sp.*	Native/exotic
Phyllanthaceae	*Poranthera corymbosa*	Native
Phyllanthaceae	*Poranthera microphylla*	Native
Pittosporaceae	*Bursaria spinosa*	Native
Plantaginaceae	*Plantago debilis*	Native
Plantaginaceae	*Plantago lanceolata*	Exotic
Poaceae	*Aristida ramosa*	Native
Poaceae	*Aristida sp.*	Native
Poaceae	*Aristida vagans*	Native
Poaceae	*Arundinella nepalensis*	Native
Poaceae	*Austrostipa scabra*	Native
Poaceae	*Austrostipa scabra subsp. Scabra*	Native
Poaceae	*Austrostipa sp.*	Native
Poaceae	*Austrostipa verticillata*	Native
Poaceae	*Bothriochloa macra*	Native
Poaceae	*Briza minor*	Exotic
Poaceae	*Bromus hordeaceus*	Exotic
Poaceae	*Cenchrus clandestinus*	Exotic
Poaceae	*Chloris gayana*	Exotic

Family	Scientific Name	Native / Exotic
Poaceae	*Chloris truncata*	Native
Poaceae	*Chloris ventricosa*	Native
Poaceae	*Cleistochloa rigida*	Native
Poaceae	*Cymbopogon refractus*	Native
Poaceae	*Cynodon dactylon*	Native
Poaceae	*Dichanthium sericeum*	Native
Poaceae	*Dichelachne micrantha*	Native
Poaceae	*Digitaria brownii*	Native
Poaceae	*Digitaria diffusa*	Native
Poaceae	*Digitaria eriantha*	Exotic
Poaceae	*Digitaria ramularis*	Native
Poaceae	*Digitaria sp.*	Native/exotic
Poaceae	*Echinopogon sp.*	Native
Poaceae	*Eleusine tristachya*	Exotic
Poaceae	*Enneapogon sp.*	Native
Poaceae	*Eragrostis brownii*	Native
Poaceae	*Eragrostis cilianensis*	Exotic
Poaceae	*Eragrostis curvula*	Exotic
Poaceae	*Eragrostis curvula var. Consol*	Exotic
Poaceae	*Eragrostis leptostachya*	Native
Poaceae	*Lolium perenne*	Exotic
Poaceae	*Lolium rigidum*	Exotic
Poaceae	*Microlaena stipoides*	Native
Poaceae	*Microlaena stipoides var. stipoides*	Native
Poaceae	*Panicum effusum*	Native
Poaceae	*Panicum sp.*	Native/exotic

Family	Scientific Name	Native / Exotic
Poaceae	*Paspalidium sp.*	Native
Poaceae	*Paspalum dilatatum*	Exotic
Poaceae	*Phalaris aquatica*	Exotic
Poaceae	*Phalaris sp.*	Exotic
Poaceae	*Rytidosperma pallidum*	Native
Poaceae	*Rytidosperma racemosum*	Native
Poaceae	*Rytidosperma sp.*	Native
Poaceae	*Setaria sp.*	Exotic
Poaceae	*Sporobolus creber*	Native
Poaceae	*Sporobolus elongatus*	Native
Poaceae	*Themeda triandra*	Native
Poaceae	*Vulpia sp.*	Exotic
Polygonaceae	*Acetosella vulgaris*	Exotic
Polygonaceae	*Polygonum aviculare*	Exotic
Polygonaceae	*Rumex brownii*	Native
Polygonaceae	*Rumex sp.*	Native/exotic
Portulaceae	*Portulaca sp.*	Native/exotic
Primulaceae	*Lysimachia arvensis*	Exotic
Proteaceae	*Grevillea sericea*	Native
Proteaceae	*Hakea dactyloides*	Native
Proteaceae	*Persoonia curvifolia*	Native
Proteaceae	*Persoonia linearis*	Native
Pteridaceae	*Cheilanthes sieberi*	Native
Pteridaceae	*Cheilanthes sieberi subsp. sieberi*	Native
Ranunculaceae	*Clematis aristata*	Native
Ranunculaceae	*Clematis glycinoides*	Native

Family	Scientific Name	Native / Exotic
Rhamnaceae	*Cryptandra spinescens*	Native
Rosaceae	*Acaena echinata*	Native
Rosaceae	*Acaena ovina*	Native
Rosaceae	*Acaena sp.*	Native
Rosaceae	*Rosa rubiginosa*	Exotic
Rubiaceae	*Asperula conferta*	Native
Rubiaceae	*Opercularia diphylla*	Native
Rubiaceae	*Opercularia hispida*	Native
Rubiaceae	*Pomax umbellata*	Native
Rubiaceae	*Richardia stellaris*	Exotic
Rubioideae	*Galium sp.*	Native/exotic
Rutaceae	*Boronia rubiginosa*	Native
Rutaceae	*Correa reflexa var. reflexa*	Native
Rutaceae	*Phebalium squamulosum*	Native
Rutaceae	*Phebalium squamulosum subsp. Lineare*	Native
Santalaceae	*Exocarpos cupressiformis*	Native
Santalaceae	*Exocarpos strictus*	Native
Sapindaceae	*Dodonaea viscosa*	Native
Sapindaceae	*Dodonaea viscosa subsp. cuneata*	Native
Sapindaceae	*Dodonaea triangularis*	Native
Scrophulariaceae	*Verbascum virgatum*	Exotic
Scrophulariaceae	*Veronica plebeia*	Native
Simaroubaceae	*Ailanthus altissima*	Exotic
Solanaceae	*Solanum campanulatum*	Native
Solanaceae	*Solanum prinophyllum*	Native
Solanaceae	*Solanum sp.*	Native/exotic

Family	Scientific Name	Native / Exotic
Stackhousiaceae	*Stackhousia monogyna*	Native
Stackhousiaceae	*Stackhousia sp.*	Native
Stackhousiaceae	*Stackhousia viminea*	Native
Thymelaeaceae	*Pimelea linifolia*	Native
Thymelaeaceae	*Pimelea sp.*	Native
Urticaceae	*Urtica incisa*	Native
Verbenaceae	*Verbena bonariensis*	Exotic
Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	Native
Zamiaceae	*Macrozamia communis*	Native
Zamiaceae	*Macrozamia secunda*	Native

Appendix D – Vegetation structure data

Table D-1: Autumn 2018 Vegetation Structure Data

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
BOA-D	D_101	U1	8	16	25	*Eucalyptus crebra, E. moluccana*
		M1	0.5	2	5	*Acacia montana, A. triptera*
		M2	0.3	0.8	3	*Acacia rigida*
		L1	0.01	0.3	7	*Gahnia aspera, Aristida vagans, Rytidosperma* sp.
	D_103	U1	5	10	7.5	*Eucalyptus sideroxylon, E. fibrosa, E. dwyeri*
		M1	1.5	4	30	*Allocasuarina gymnanthera, Melichrus erubescens, Melaleuca uncinata*
		M2	0.5	2	10	*Acacia triptera, Kunzea ambigua*
		L1	0.01	0.2	1	*Digitaria* sp., *Goodenia* spp.
BOA-E	E_100	U1	8	15	25	*Callitris endlicheri, Eucalyptus crebra, E. dealbata*
		M1	0.5	1.5		*Acacia triptera, A. rigida, Leucopogon muticus*
		L1	0.01	0.3	4	*Digitaria* sp., *Aristida ramosa, Microlaena stipoides*
		L2	0.01	0.2	4	*Goodenia hederacea, Cheilanthes sieberi, Lomandra confertifolia*
	E_105	L1	0.01	0.4	20	*Bothriochloa macra, Aristida ramosa, Sporobolus creber*
		L2	0.01	0.3	45	*Carthamus lanatus*, Erodium botrys*, Hypericum perforatum**
	E_106	U1	8	14	2	*Eucalyptus albens, E. blakelyi, Acacia implexa*
		M1	0.01	0.4	1	*Acacia rigida, A. doratoxylon*
		L1			30	*Aristida ramosa, A. vagans, Enneapogon* sp.
		L2			25	*Vittadinia muelleri, Calotis lappulacea, Lomandra confertifolia*
ECA-A	A_102	M1	1	2	20	*Cassinia arcuata*
		L1	0.1	0.3	15	*Aristida* spp., *Sporobolus creber*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
		L2	0.01	0.05	10	*Bothriochloa macra, Panicum effusum, Digitaria brownii*
	A_103	U1	5	8	15	*Eucalyptus melliodora, E. blakelyi*
		M1	0.5	1.5	10	*Cassinia arcuata*
		L1	0.01	0.1	5	*Aristida* spp., *Microlaena stipoides*
ECA-B	B_103	U1	12	20	35	*Angophora floribunda, Callitris endlicheri, Eucalyptus punctata, E. sparsifolia*
		M1	3	10	3	*Persoonia linearis, Acacia linearifolia*
		M2	0.1	0.7	15	*Goodenia ovata, Cassinia cunninghamii, Acacia rigida*
		L1	0.01	0.4	1	*Rytidosperma pallidum, Microlaena stipoides, Austrostipa scabra*
		L2	0.01	0.04	5	*Stellaria pungens, Goodenia ovata, Lomandra confertifolia*
	B_106	L1			25	*Panicum effusum, Aristida ramosa, Bothriochloa macra*
		L2			35	*Carex appressa, Hypochaeris radicata**
ECA-C	C_101	L1			0.2	*Calotis lappulacea, Urtica incisa*
		L2			70	*Microlaena stipoides, Erodium botrys**
Regeneration Area	R1_100	L1	0.2	1	2	*Verbena bonariensis*, Sporobolus creber, Carthamus lanatus*,*
		L2	0.05	0.2	40	*Paspalum dilatatum, Paspalidium* sp., *Digitaria brownii*
	R3_100	L1	0.05	0.2	0.3	*Marrubium vulgare*, Cheilanthes sieberi, Calotis* spp.
		L2	0.01	0.05	65	*Bothriochloa macra, Microlaena stipoides*
	R5_100	L1			50	*Aristida ramosa, Bothriochloa macra, Panicum effusum*
		L2			11	*Hypericum perforatum*, Cirsium vulgare*, Hypochaeris radicata**
	R6_101	M1	0.2	0.5	0.3	*Cassinia arcuata, Verbena bonariensis**

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
		L1			30	*Chloris truncata, Panicum effusum, Sporobolus elongatus, Trifolium repens**
	R7_100	L1	0.05	0.2	0.3	*Hypericum perforatum*, Aristida ramosa*
		L2	0.01	0.05	50	*Microlaena stipoides, Carthamus lanatus*, Silybum marianum**
	R8_100	L1	0.01	0.05	70	*Microlaena stipoides, Carthamus lanatus**
	R9_101	M1	0.1	1	1	*Cassinia arcuata*
		L1	0.01	0.4	52	*Sporobolus creber, Digitaria brownii, Chloris truncata*
		L2	0.01	0.4	14	*Hypericum perforatum*, Conyza* sp.*, *Gahnia aspera*
Rehabilitation Area	R6	U1	1.5	4	3	*Eucalyptus blakelyi, E. albens*
		M1	1	3	2	*Acacia linearifolia, A. ulicifolia*
		L1	0.1	0.4	40	*Eragrostis curvula*, Chloris gayana*, Paspalum dilatatum**
	R9	U1	2	4	2	*Acacia implexa, Eucalyptus blakelyi*
		M1	1.5	3	20	*Acacia verniciflua, A. implexa, Eucalyptus crebra*
		L1	0.05	0.4	20	*Digitaria eriantha*, Paspalum dilatatum**
Reference Sites	Ref_13b	U1	6	18	20	*Eucalyptus crebra, Callitris endlicheri*
		M1	1	5	8	*Cassinia arcuata, Acacia linearifolia*
		L1	0.01	1	20	*Gahnia aspera, Lomandra filiformis* subsp. *coriacea, Einadia hastata*
		L2	0.01	0.5	4	*Aristida* spp., *Rytidosperma* spp., *Austrostipa scabra*
	Ref_14	U1	6	14	25	*Corymbia trachyphloia, Eucalyptus fibrosa, E. crebra*
		M1	2	6	10	*Allocasuarina gymnanthera, Hakea* sp., *Persoonia linearis*
		M2	0.02	2	7	*Leucopogon muticus*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
		L1	0.01	0.4	7	*Pomax umbellata, Lomandra glauca, Lomandra multiflora*
	Ref_15	U1			10	*Eucalyptus melliodora*
		L1			10	*Aristida* spp., *Lomandra* spp.
		L2				*Austrostipa scabra*
	Ref_16	U1	15	20	10	*Eucalyptus melliodora, E. blakelyi*
		M1			9	*Allocasuarina luehmannii*
		L1	0.01	0.4	10	*Aristida ramosa, Rytidosperma* sp., *Austrostipa scabra, Lomandra multiflora*
	Ref_17	U1	8	18	15	*Eucalyptus blakelyi, E. melliodora, Casuarina cunninghamiana*
		M1	1	1.5	0.5	*Cassinia arcuata*
		L1	0.01	0.5	20	*Aristida* spp., *Rytidosperma* sp.
		L2	0.01	0.5	30	*Carex appressa, Lomandra confertifolia, Dichondra* sp. *A sensu*
	Ref_18	U1	8	12	20	*Angophora floribunda*
		M1	0.5	3	5	*Eucalyptus bridgesiana, Cassinia arcuata*
		L1	0.01	0.4	20	*Microlaena stipoides, Rytidosperma* sp., *Aristida* spp.
		L2	0.01	0.3	3	*Cheilanthes sieberi, Dichondra* sp. *A sensu, Carex inversa*
	Ref_19	U1	10	15	20	*Eucalyptus albens*
		M1	1	3	1	*Olearia elliptica*
		L1	0.01	0.2	35	*Aristida ramosa, Austrostipa scabra, Microlaena stipoides*
		L2	0.01	0.3	12	*Hypericum perforatum*, Dichondra repens, Mentha satureioides*
	Ref_20	U1	12	16	15	*Eucalyptus punctata, E. sparsifolia*
		M1	2.5	6	1	*Acacia linearifolia*
	Ref_20	M2	0.5	2.5	15	*Hovea lanceolata, Dodonaea triangularis, Cassinia cunninghamii*
		L1	0.01	0.7	2	*Digitaria* sp., *Cleistochloa rigida*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
		L2	0.01	0.5	1	*Lomandra confertifolia, Lepidosperma laterale, Einadia hastata*
	Ref_21	U1	12	18	25	*Angophora floribunda, Eucalyptus blakelyi*
		M1	0.3	2	1	*Acacia rigida, A. linearifolia*
		L1	0.01	0.2	20	*Microlaena stipoides, Echinopogon* sp.*, Rytidosperma* sp.
		L2	0.01	1	10	*Dichondra repens, Lomandra confertifolia, Desmodium varians*
	Ref_22	U1	15	20	40	*Angophora floribunda, Eucalyptus punctata, E. fibrosa*
		M1	2	5	1	*Persoonia linearis*
		L1	0.01	1	5	*Lomandra confertifolia, L. longifolia, Clematis aristata*
		L2	0.01	0.5	15	*Microlaena stipoides, Digitaria* sp.
	Ref_23	U1	12	18	10	*Eucalyptus melliodora*
		U2	8	12	15	*Eucalyptus melliodora, E. blakelyi*
		M1	0.3	0.6	0.1	*Lissanthe strigosa*
		L1	0.01	0.4	15	*Microlaena stipoides, Rytidosperma* sp.*, Aristida ramosa*
		L2	0.01	1	25	*Gahnia aspera, Desmodium varians, Calotis cuneifolia*
	Ref_24	U1	10	18	20	*Eucalyptus albens, Callitris endlicheri*
		M1	0.5	6	8	*Bursaria spinosa, Acacia implexa, A. linearifolia*
		L1	0.01	0.3	15	*Microlaena stipoides, Aristida ramosa, Austrostipa scabra*
		L2	0.01	0.3	15	*Dichondra repens, Lomandra multiflora, Glycine tabacina*

Table D - 2: Spring 2018 Vegetation Structure Data

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
	D_100	U1	6	16	6	*Eucalyptus crebra Callitris endlicheri*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
		M1	2	6	5	*Leptospermum parvifolium, Leptospermum polygalifolium Allocasuarina luehmannii*
		M2	0.5	2	5	*Acrotriche rigida, Leucopogon muticus,*
		L1	0.01	0.5	5	*Acrotriche rigida Gahnia aspera, Cheilanthes sieberi*
	D_102	U1	14	14		*Eucalyptus albens*
		M1	7	7		*Brachychiton populneus*
		L1	0.01	0.2	15	*Microlaena stipoides Aristida spp. Rytidosperma sp.*
		L2	0.01	0.3	15.1	*Gahnia aspera, dichondra repens, Desmodium sp.*
BOA-E	E_101	U1	10	18	2	*Callitris endlicheri, Eucalyptus dealbata*
		M1	0.5	5	25	*Eucalyptus dealbata, Cassinia arcuata, Acacia linearifolia*
		L1	0.01	0.3	30	*Aristida ramosa, Microlaena stipoides Rytidosperma sp.*
		L2	0. 1	0.5	8.1	*Cheilanthes sieberi, Gahnia seiberiana, Astroloma humifusum*
	E_102	L1			32	*Bothriochloa macra, Sporobolus creber, Erodium botrys, Oxalis sp.*
		L2			10	**Hypochaeris radicata, *Hypericum perforatum, *Vulpia sp.*
	E104	U1	6	14	10	*Eucalyptus albens*
		L1	0.01	0.3	22	*Aristida ramosa, Austrostipa scabra, Rytidosperma racemosum , **
		L2	0.01	0.1	6	*Dichondra repens, *Hypericum perforatum, Sida corrugata*
BOA-1	BOA1_ 100	U1	15	18	15	*Eucalyptus Albens*
		U2			2	*Brachychiton populneus*
		M1			3	*Bursaria spinosa*
		M2			3	*Cassinia quinquefaria*
		L1			1	*Rytidosperma sp.*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
		L2			1.1	*Bulbine bulbosa, Dichondra repens, Opuntia sp.*
BOA-2	BOA2_100	U1	15	18	15	*Eucalyptus albens*
		M1	1	2	10	*Cassinia quinquefaria, Acacia ixiophylla, Bursaria spinosa*
		L2	0.01	0.3	16	*Aristida sp., Rytidosperma sp., Dichondra repens*
ECA-A	A_100	L1	0.01	0.3	20	*Bothriochloa macra, *Paspalum dilatatum, Sporobolus creber*
		L2	0.01	0.5	21	*Plantago lanceolate, *Trifolium repens, * Trifolium subterraneum*
	A_104	U1	15	15		*Eucalyptus crebra*
		U2	2	8		*Callitris endlicheri,*
		M1	01	1.5		*Cassinia arcuata*
		M2	0.1	0.2		*, Lissanthe strigosa*
		L1	0.1	0.5		*Austrostipa scabra, Aristida vagans*
		L2	0.01	0.1		*Cheilanthes sieberi*
ECA-B	B_100	U1			20	*Eucalyptus melliodora, Eucalyptus blakelyi*
		M1			5	*Cassinia arcuata*
		L1			3	*Aristida ramosa, aristida vagans, Microlaena stipoides*
	B_101	L1			40	*Lomandra multiflora, Aristida ramosa*
		L2				*Cheilanthes sieberi, Hypochaeris radicata*
	B105	L1	0.1	0.5		*Aristida ramose, Microlaena stipoides Bothriochloa macra, Sporobolus creber ,*
		L2	0.01	0.1		**Hypochaeris radicata, *Taraxacum officinale, *Trifolium sp, *Modiola caroliniana.*
ECA-C	C_102	U1	15	20	15	*Eucalyptus albens, Callitris endlicheri Eucalyptus punctata*
		M1			3	*Acacia linearifolia, Callitris endlicheri*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
		L1	0.8	1.5	3	*Goodenia ovata, Acrotriche rigida, Cassinia cunninghamii, Lomandra confertifolia, Rytidosperma pallidum, Microlaena stipoides*
		L2	0.01	0.8	2	*Lomandra confertifolia, Rytidosperma pallidum, Microlaena stipoides*
Regeneration Area	R2_101	L1	N/A	N/A	25	*Arisida ramose, Cheilanthes sieberi, Cynodon dactylon .,*
		L2			5	**Hypochaeris radicata, *Taraxacum officinale .*
	R4_100	L1				*Sporobolus creber, Microlaena stipoides*
		L2	0.01	0.1		**Carthamus lanatus, *Hypochaeris radicata, *Echium plantagineum*
	R5_101	L1			40	*Aristida ramosa*
		L2			15	**Hypochaeris radicata,*
	R9_100	M1	0.5	1.5	20	*Cassinia arcuata*
		L1	0.1	0.5	10	*Aristida app., Gahnia aspera, Lomandra sp, Lomandra multiflora*
Rehabilitation Area	R8	L1	N/A	N/A		*Digitaria eriantha .,*
	R10	L1	0.01	.05	50	*Erodium crinitum, *Digitaria eriantha, *Hypochaeris radicata, Cynodon dactylon*
	R11	M1	0.5	1.8		*Cassinia acuate, Acacia decora*
		L1			60	*, *Digitaria eriantha, Erodium crinitum, Cenchrus clandestinus*
Reference Site	Ref_1	L1	0.01	0.2	20	*Bothriochloa macra, Aristida ramose, Aristida vagans, Microlaena stipoides*
		L2	0.01	0.2	5.8	*Lomandra confertifolia Vittadinia muelleri*
	Ref_2	U1	6	13	10	*Eucalyptus crebra, Eucalyptus moluccana*
		M1	0.5	2	15	*Cassinia quinquefaria, Acacia difformis*
		L1	0.01	0.3	5	*Austrostipa scabra, Aristida Spp. Microlaena stipoides*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
		L2	0.01	0.5	3	*, Gahnia aspera, Dichondra repens, Gahnia aspera*
	Ref_3	U1	6	13	15	*Eucalyptus fibrosa, Eucalyptus sparsifolia,*
		M1	2	6	1	*Allocasuarina gymnanthera, Cassinia quinquefaria*
		M2	0.5	2	4	*Dodonaea viscosa,., Acrotriche rigida, Cassinia quinquefaria*
		L1	0.01	0.1	0.1	*Aristida sp., Digitaria sp.*
		L2	0.01	0.5	1	*Lomandra sp, Dodonaea viscosa, Macrozamia communis*
	Ref_4	U1	8	20	20	*Eucalyptus albens*
		M1	6	6	1	*Brachychiton populneus*
		L1	0.01	0.2	8	*Aristisa ramose, Aristida vagans, Rytidosperma sp. Austrostipa scabra*
		L2	0.01	0.2	2.2	*Carex inversa, Einadia nutans, Lomandra confertifolia*
	Ref_5	U1	8	12	15	*Eucalyptus crebra, Corymbia trachyphloia, Acacia doratoxylon*
		M1	1	6	5	*Persoonia linearis Leucopogon muticus, Acacia doratoxylon*
		M2	0.5	1	6	*Acacia doratoxylon, Acrotriche rigida, Leucopogon muticus*
		L1	0.01	0.02	1	*Microlaena stipoides, Panicum effusum, Aristida ramose,*
		L2	0.01	0.5	3	*Cheilanthes sieberi, Lomandra multiflora, Dianella revoluta*
	Ref_6	U1			20	*Eucalyptus dwyeri, Eucalyptus fibrosa, Corymbia trachyphloia*
		M1			1	*Leptospermum trinervium, , Phebalium squamulosum, Dodonaea triangularis*
		M2			15	*Cleistochloa rigida*
		L1			2	*Phebalium squamulosum, Dodonaea triangularis, Lomandra filiformis subsp. filiformis*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
	Ref_7	U1	7	13	7	*Eucalyptus crebra, Eucalyptus albens, Eucalyptus punctata*
		M1	2	7	4	*Allocasuarina gymnanthera, Acacia doratoxylon*
		M2	0.5	2	6	*Dodonaea triangularis, Acacia triptera, Leucopogon muticus,*
		L1	0.01	0.1	2	*Microlaena stipoides, Rytidosperma sp. Digitaria diffusa*
		L2	0.01	0.5	2	*Dodonaea , Dichondra repens, Cheilanthes sieberi*
	Ref_8	U1	10	20	20	*Eucalyptus albens, Callitris endlicheri*
		M1	4	4	1	*Callitris endlicheri, spinose, acacia implexa*
		M2	0.5	4	4	*Cassinia quiquefaria, Bursaria Spinosa*
		L1	0.01	0.1	10	*Austrostipa scabra, Rytidosperma sp. Cymbopogon refractus*
		L2	0.01	0.4	20.1	*Gahnia aspera, Clematis glycinoides, Dichondra repens*
	Ref_9	U1	12	15	15	*Eucalyptus punctata, Eucalyptus sparsifolia, Eucalyptus fibrosa*
		U2	6	12	10	*Callitris endlicheri, Eucalyptus rossii, Eucalyptus fibrosa*
		M1	2	6	3	*Leptospermum spp. Persoonia linearis, Allocasuarina gymnanthera*
		M2	.05	2	5	*Leucopogon muticus, Acacia uncinata , Dodonaea triangularis.,*
		L1	.0.1	0.4	15	*Rytidosperma pallidum, Cleistochloa rigida*
		L2	0.01	0.5	5	*Lomandra confertifolia, Acrotriche rigida, Pomax umbellata*
	Ref_10	U1	8	12	10	*Eucalyptus albens, Eucalyptus crebra, Allocasuarina luehmannii*

Management Domain	Site number	Stratum	Lower height (m)	Upper height (m)	Percent cover (%)	Dominant species (*exotic)
		M1	2	8	3	*Callitris endlicheri, Persoonia linearis, Acacia linearifolia*
		M2	0.5	2	15	*Acrotriche rigida, Leucopogon muticus, Dodonea Triangularis*
		L1	0.01	0.5	10	*Acrotriche rigida, Lepidosperma laterale, Cheilanthes sieberi*
	Ref_11	U1	10	15	12	*Angophora floribunda, Eucalyptus bridgesiana*
		U2	2	8	3	*Angophora floribunda,*
		L1	0.01	0.2	20	*Microlaena stipoides, Rytidosperma sp. Digitaria diffusa*
		L2	0.01	0.3	4.01	*Lomandra multiflora Dichondra repens, Cheilanthes sieberi*
	Ref_12	U1	8	14	12	*Eucalyptus albens*
		L1	0.01	0.2	6	*Austrostipa Scabra, Aristida ramose, Rytidosperma sp*
		L2	0.01	0.2	2.5	*Lomandra confertifolia, Carex inversa, Einadia nutans*

Appendix E – Interim Performance Targets / Benchmark Values

Table E 1 Vegetation class benchmark condition state (WCPL 2017)

Vegetation Class	Site Attribute									
	NSR (count)	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH (count)	OR	FL (m)
Western Slopes Dry Sclerophyll Forests	≥32	15 - 40	10 - 55	3 - 10	5 - 15	5 - 25	<5%	≥3	1	≥70
Western Slopes Grassy Woodlands	<35	6 - 25	14 - 50	3 - 35	3 - 25	5 - 1 - 40	<5%	≥2	1	<66

Table E 2 Interim Performance Targets for Western Slopes Dry Sclerophyll Forests

Management Period	Interim Performance Target (site value score)	Site Attributes (% cover)									
		NSR (count)	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH (count)	OR	FL (m)
Low Condition Vegetation											
Year 0 (Baseline)	6	<8	0	0	1	0	0	60	0	0	0
Years 1-5	34	12	0	3-10	1-2	1-5	1-3	60	0	1	10
Benchmark	>78	≥32	15-40	10-55	3-10	5-15	5-25	<5	≥3	1	≥70
Moderate to Good Condition Vegetation											
Year 0 (Baseline)	34	12	0	10	<3	<5	<4	60	0	1	10
Years 1-5	45	16	0	10-55	3-10	5-15	5-25	40	0	1	10
Benchmark	>78	≥32	15-40	10-55	3-10	5-15	5-25	<5	≥3	1	≥70
High Condition Vegetation											
Year 0 (Baseline)	70	18-32	15-40	10-55	3 -10	5-15	5-25	≤5	0	1	≥70

Management Period	Interim Performance Target (site value score)	Site Attributes (% cover)									
		NSR (count)	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH (count)	OR	FL (m)
Years 1-20	70	18-32	15-40	10-55	3 -10	5-15	5-25	≤5	0	1	≥70
Benchmark	>78	≥32	15-40	10-55	3 -10	5-15	5-25	≤5	≥3	1	≥70

Table E 3 Interim Performance Targets for Western Slopes Grassy Woodlands

Management period	Interim Performance Target (Site value score)	Site Attributes (% cover)									
		NSR (count)	NOC	NMS	NGCG	NGCS	NGCO	EC	NTH (count)	OR	FL (m)
Low Condition Vegetation											
Year 0 (Baseline)	7	<9	0	0	5	0	0	60	0	0	0
Years 1-5	34	12	0	<4	60+	<2	<2	60	0	1	10
Benchmark	>78	≥23	10-45	5-60	5-45	2-10	5-35	<5	≥2	1	≥50
Moderate to Good Condition Vegetation											
Year 0 (Baseline)	34	12	0	≤3	60+	<2	<2	60	0	1	10
Years 1-5	45	12	0	5-60	45-60	<2	<2	40	0	1	10
Benchmark	>78	≥23	10-45	5-60	5-45	2-10	5-35	<5	≥2	1	≥50
High Condition Vegetation											
Year 0 (Baseline)	70	20-22	10-45	5-60	5-45	2-10	5-35	≤20	0	1	≥50
Years 1-20	70	20-23	10-45	5-60	5-45	2-10	5-35	≤20	0	1	≥50
Benchmark	>78	≥23	10-45	5-60	5-45	2-10	5-35	<5	≥2	1	≥50

Appendix F – Fauna species list

Species name	Common name	TSC Act	EPBC Act
Bird			
Acanthagenys rufogularis	Spiny-cheeked Honeyeater		
Acanthiza chrysorrhoa	Yellow-rumped Thornbill		
Acanthiza lineata	Striated Thornbill		
Acanthiza nana	Yellow Thornbill		
Acanthiza pusilla	Brown Thornbill		
Acanthiza reguloides	Buff-rumped Thornbill		
Acanthorhynchus tenuirostris	Eastern Spinebill		
Acrocephalus australis	Australian Reed Warbler		
Alisterus scapularis	Australian King-Parrot		
Anthochaera carunculata	Red Wattlebird		
Aquila audax	Wedge-tailed Eagle		
Ardea pacifica	White-necked Heron		
Artamus cyanopterus	Dusky Woodswallow	v	
Cacatua galerita	Sulphur-crested Cockatoo		
Cacomantis flabelliformis	Fan-tailed Cuckoo		
Cacomantis pallidus	Pallid Cuckoo		
Calyptorhynchus funereus	Yellow-tailed black cockatoo		
Calyptorhynchus lathami	Glossy Black-Cockatoo	v	
Chenonetta jubata	Australian Wood Duck		
Chrysococcyx basalis	Horsfield's bronze cuckoo		
Cincloramphus mathewsi	Rufous Songlark		
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	v	
Colluricincla harmonica	Grey Shrike-thrush		
Coracina novaehollandiae	Black-faced Cuckoo-shrike		
Coracina tenuirostris	Cicadabird		
Corcorax melanorhamphos	White-winged Chough		
Cormobates leucophaea	White-throated Treecreeper		
Corvus coronoides	Australian Raven		
Cracticus nigrogularis	Pied Butcherbird		
Cracticus tibicen	Australian Magpie		
Cracticus torquatus	Grey Butcherbird		
Dacelo novaeguineae	Laughing Kookaburra		

Species name	Common name	TSC Act	EPBC Act
Dicaeum hirundinaceum	Mistletoebird		
Dromaius novaehollandiae	Emu		
Elseyornis melanops	Black-fronted Dottrel		
Eolophus roseicapillus	Galah		
Eopsaltria australis	Eastern Yellow Robin		
Eurostopodus mystacalis	White-throated Nightjar		
Falco berigora	Brown Falcon		
Gavicalis virescens	Singing Honeyeater		
Geopelia humeralis	Bar-shouldered dove		
Geopelia placida	Peaceful dove		
Gerygone albogularis	White-throated Gerygone		
Glossopsitta concinna	Musk lorikeet		
Glossopsitta pusilla	Little Lorikeet	v	
Grallina cyanoleuca	Magpie-lark		
Grantiella picta	Painted Honeyeater	v	
Haliastur sphenurus	Whistling kite		
Hirundapus caudacutus	White-throated Needletail		
Hirundo neoxena	Welcome Swallow		
Lalage tricolor	White-winged triller		
Leucosarcia melanoleuca	Wonga Pigeon		
Lichenostomus chrysops	Yellow-faced Honeyeater		
Lichenostomus fuscus	Fuscous honeyeater		
Lichenostomus leucotis	White-eared Honeyeater		
Lichenostomus melanops	Yellow-tufted Honeyeater		
Lichenostomus penicillatus	White-plumed Honeyeater		
Malurus cyaneus	Superb Fairy-wren		
Manorina melanocephala	Noisy Miner		
Manorina melanophrys	Bell Miner		
Melithreptus brevirostris	Brown-headed Honeyeater		
Menura novaehollandiae	Superb Lyrebird		
Merops ornatus	Rainbow Bee-eater		
Microeca fascinans	Jacky Winter		
Myiagra inquieta	Restless Flycatcher		
Myiagra rubecula	Leaden Flycatcher		
Ocyphaps lophotes	Crested Pigeon		
Oriolus sagittatus	Olive-backed Oriole		

Species name	Common name	TSC Act	EPBC Act
Pachycephala pectoralis	Golden Whistler		
Pachycephala rufiventris	Rufous Whistler		
Pardalotus punctatus	Spotted Pardalote		
Pardalotus striata	Striated Pardalote		
Petrochelidon nigricans	Tree Martin		
Petroica goodenovii	Red-capped Robin		
Phaps chalcoptera	Common Bronzewing		
Philemon corniculatus	Noisy Friarbird		
Platycercus eximius	Eastern Rosella		
Pomatostomus superciliosus	White-browed Babbler		
Psephotus haematonotus	Red-rumped Parrot		
Psophodes olivaceus	Eastern Whipbird		
Ptilonorhynchus violaceus	Satin Bowerbird		
Pyrrholaemus sagittatus	Speckled Warbler	v	
Rhipidura albiscapa	Grey Fantail		
Rhipidura leucophrys	Willy Wagtail		
Scythrops novaehollandiae	Channel-billed Cuckoo		
Sericornis frontalis	White-browed Scrubwren		
Smicrornis brevirostris	Weebill		
Strepera graculina	Pied Currawong		
Taeniopygia bichenovii	Double-barred Finch		
Todiramphus sanctus	Sacred Kingfisher		
Vanellus miles	Masked Lapwing		
Amphibian			
Crinia signifera	Common eastern froglet		
Litoria peronii	Peron's tree frog		
Lymnodynastes dumerilii	Eastern banjo frog		
Lymnodynastes tasmaniensis	Spotted marsh frog		
Mammal			
Mus musculus	House Mouse		
Reptile			
Amphibolurus muricatus	Jacky dragon		
Anilios nigrescens	Blackish Blindsnake		
Anomalopus leuckartii	Two-clawed worm-skink		
Carlia tetradactyla	Southern rainbow skink		
Delma plebeia	Leaden delma		

Species name	Common name	TSC Act	EPBC Act
Diplodactylus vittatus	Wood gecko		
Diporiphora nobbi	Nobby dragon		
Furina diadema	Red-naped Snake		
Liopholis whitii	White's skink		
Lygisaurus foliorum	Tree-base Litter-skink		
Morethia boulengeri	Boulenger's Snake-eyed Skink		
Parasuta dwyeri	Dwyer's snake		
Pogona barbata	Common bearded dragon		
Microbat			
Austronomus australis	White-Striped Free-tailed Bat		
Chalinolobus dwyeri	Large-eared Pied Bat	v	v
Chalinolobus gouldii	Gould's Wattled Bat		
Chalinolobus morio	Chocolate Wattled Bat		
Miniopterus orianae oceanensis	Eastern Bentwing-bat	v	
Ozimops (Mormopterus) spp.	Free-tailed Bat complex		
Rhinolophus megaphyllus	Eastern Horseshoe Bat		
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	v	
Scotorepens balstoni	Inland Broad-nosed Bat		
Vespadelus troughtoni	Eastern Cave Bat	v	
Vespadelus vulturnus	Little Forest Bat		

V = vulnerable

Appendix G – Microbat analysis report

Wilpinjong Microbat Monitoring Ultrasonic Analysis Report – Spring 2018

Report completed 15 January 2019.

ELA was engaged by Peabody Energy. Inc to analyse ultrasonic microchiropteran bat call data collected from several survey sites associated with Wilpinjong Mine offset areas, near to Mudgee, NSW (the study area).

The data presented in this report forms part of an ongoing long-term annual biodiversity monitoring program.

This report outlines the methodology used and results of the data analysis.

Methods

A mixture of Anabat and Song Meter (SM) recorders were used to record microbat calls at 15 survey sites located within the Wilpinjong study area. The total survey effort whilst collecting this data was equivalent to 30 detector nights.

The data was collected passively at each survey site for a period ranging between one and three survey nights. These surveys were conducted between 5 and 21 November 2018. The survey site identifier, survey dates, number of survey nights, critical landforms, general vegetation communities and structure have been briefly described below.

- Site BOA 1_100: Anabat recorder #3 (SN485505) was set to record microbat calls among *Eucalyptus albens* (White Box) shrubby woodland on upper slope with a few scattered hollow bearing trees (HBT) nearby, between 5 and 6 November (two survey nights).
- Site BOA 2-101: Anabat recorder #4 (485466) was set to record microbat calls among *Angophora floribunda* (Rough-barked Apple) alluvial grassy woodland with a few scattered HBTs nearby, between 5 and 6 November (two survey nights).
- Site BOA 3_100: Anabat recorder #2 (SN82115) was set to record microbat calls between 14 and 15 November (two survey nights). This survey site is located among open woodland, is located approximately 175m away from a series of sandstone cliffs and 200 m from the Goulburn River.
- Site BOA 4_101: Anabat recorder #4 (485466) was set to record microbat calls within an Ironbark – Black Cypress Pine shrubby woodland on a sandstone ridge with abundant HBTs, between 14 and 15 November (two survey nights).
- Site BOA 5_101: Song Meter (SM2-3) was set to record microbat calls in a partly cleared *A. floribunda* alluvial grassy woodland that contains a few scattered HBTs on 12 November (one survey night only). This site is located approximately 300m away from a sandstone cliff.

- Site A_104: Anabat recorder #2 (SN82115) was set to record microbat calls among a remnant Ironbark – *Callitris* spp. (Cypress Pine) open shrubby woodland with abundant hollow-bearing trees (HBTs) between 7 and 9 November and again on the 8 November 2018 for a single survey night (total effort of three survey nights).

- Site B_101: Anabat recorder #2 (SN82115) was set to record microbat calls among cleared grassland, shrubland with isolated paddock trees, some of which contain hollows. The SM was positioned approximately 100 m away from the nearest patch of remnant woodland and was set to record between 19 and 20 November 2018 (two survey nights)

- Site C_102: Canberra anabat (SN82241) was set to record calls microbat calls among remnant *E. albens* dominated shrubby woodland on a steep slope between 19 and 20 November 2018 (two survey nights). A sandstone escarpment is located approximately 50 m up slope from this survey site.

- Site D_103: Song Meter (SM2.2) was set to record microbat calls among remnant ironbark shrubby / heathy woodland between 19 and 20 November 2018 (two survey nights). Some of the trees at this site do contain hollows.

- Site E_104: Canberra anabat (SN82241) was set to record calls microbat calls between 1 and 15 November 2018 (two survey nights). This anabat was set among remnant and partly cleared *E. albens* grassy woodland. Some of the trees present nearby do contain hollows.

- Site Ref_2: A Song Meter (SM2.2) was set to record calls microbat calls among remnant Western Grey Box grassy woodland with HBTs between 14 and 15 November 2018 (two survey nights).

- Site Ref_3: Anabat Recorder #4 (485466) was set to record calls microbat calls among remnant Bloodwood / Ironbark woodland with abundant HBTs and directly adjacent to sandstone caves and escarpment between 19 and 20 November 2018 (two survey nights).

- Site Ref_8: Anabat recorder #2 (SN82115) was set to record calls microbat calls among remnant *E. albens* / *Callitris* spp. pine shrubby woodland with abundant HBTs. This survey site is located near to a railway easement and near to the base of sandstone escarpment between 12 and 13 November 2018 (two survey nights)

- Site Ref_10: Anabat recorder #3 (SN485505) was set to record calls microbat calls among remnant *E. albens* / Ironbark shrubby woodland with abundant HBTs between 19 and 20 November 2018 (two survey nights).

- Site Ref_14: Anabat recorder #3 (SN485505) was was set to record calls microbat calls among remnant Bloodwood / Scribbly Gum shrubby woodland with abundant between 14 and 15 November 2017 (two survey nights)

Please note, a more in-depth description of the vegetation community and structure that is present at the survey sites will be provided in the main biodiversity report that will be presented to Peabody Energy. Inc.

Data Analysis

Bat calls were analysed by Rodney Armistead from ELA using the program AnalookW (Version 4.2n 16 March 2017, 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 Sydney Basin, NSW (which is available at http://www.forest.nsw.gov.au/research/bats/default.asp). Rodney has over five years of experience in the identification of ultrasonic call recordings. This report and a sample of the calls was reviewed by Greg Ford the Principal Ecologist from Balance! Environmental, who has over 25 years of experience in the identification of ultrasonic call recordings.

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 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
- Calls made by bats which cannot be used for identification purposes such as social calls, short and low-quality calls, cruise and approach phase calls were labelled as unidentifiable.
- Sequences of inferior quality were labelled as unidentifiable as it is not possibly to be identified to microbat species making the call. These calls were however 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 three *Nyctophilus* species that could occur in the study area. Two species; *N. geoffroyi* (Lesser Long-eared Bat) and *N. gouldii* (Gould's Long-eared Bat) are relatively common and widely distributed across NSW, but the third, ***N. corbeni*** **(Corben's Long-eared Bat)** is listed as vulnerable under the NSW *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). According to Churchill (2008), Penny et al. (2011) and the Department of the

Environment and Energy (DoEE) Species Profile and Threats Database **Corben's Long-eared Bat** and potential habitat for this species is likely to occur within the locality of the study area. Whilst we cannot reliably identify which *Nyctophilus* species is responsible for the recorded calls in the current data set, consequently we also cannot discount the possibility that some of these recorded *Nyctophilus* calls are being made by **Corben's Long-eared Bat**. Therefore, where *Nyctophilus* spp. calls were recorded, we have included **Corben's Long-eared Bat** as potentially being present within the Wilpinjong study area. To confirm the presence / absence of this species at any of the Wilpinjong sites would require use of mist or harp traps to conduct live capture and release. These surveys would need to fulfil the survey requirements present in Commonwealth of Australia (2010) Survey Guidelines for Australia's threatened bats. For further information regarding the distribution of this species, please refer to the following link, http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=83395 to confirm.

- 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 G 1: below. All Free-tailed Bats in the new genus *Ozimops* potentially occurring within the Wilpinjong study area will therefore be referred to as *Ozimops* species complex. This species grouping includes *Ozimops petersi* (Inland Free-tailed Bat), *O. planiceps* (Southern Free-tailed Bat) and *O. ridei* (Ride's Free-tailed Bat)
- Sequences not attributed to microbat echolocation calls (e.g. insect buzzes, wind, or any other unknown factor) were dismissed from the analysis.

Table G 1: 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**

Results

Data summary and species diversity

There were 6,679 call sequences recorded during this survey. Of these, 4,375 (65.50%) were deemed to be useful because the call profile was of sufficient quality or length to enable positive identification of a bat to genus or species. The remaining 2,304 (34.49%) call sequences were either too short or of low quality, thus preventing positive identification of bat species.

There were at least 13 and up to 19 species recorded in this survey (Table G 2 and Table G 3). Up to five species listed as vulnerable under the NSW BC Act were recorded (Table G 2 and Table G 3). The vulnerable species that were confidently identified as being present within the Wilpinjong study area include;

- ***Chalinolobus dwyeri* (Large-eared Pied Bat)**
- ***Miniopterus orianae oceanensis* (Eastern Bentwing-bat)**
- ***Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat)**
- ***Vespadelus troughtoni* (Eastern Cave Bat)**

One other threatened species, ***Nyctophilus corbeni* (Corben's Long-eared Bats)** was recorded as being potentially present.

As stated above, the calls of *Nyctophilus* spp. cannot be used to identify individual species. **Corben's Long-eared Bat** is known to occur in the area where surveys were undertaken, and it has therefore been assumed, that this threatened species may be present within Wilpinjong study area.

Large-eared Pied Bat and **Corben's Long-eared Bat** are also listed as vulnerable under the EPBC Act). The Large-eared Pied Bat is also listed as vulnerable under the EPBC Act. During the 2018 surveys, calls attributed to Large-eared Pied Bat were recorded at seven of the 15 survey sites including BOA3_100, BOA4_101, BOA5_101, B-101, E_104, Ref 3 and Ref 10 (Table G 2 Spring monitoring microbat species list derived from ultrasonic call results for the Wilpinjong Mine area.Table G 3 Spring monitoring microbat species list derived from ultrasonic call results for the Wilpinjong Mine area. Whist, calls attributes to be *Nyctophilus* spp., and therefore possibly **Corben's Long-eared Bat** were recorded at BOA1_100, Ref 14 (possibly present only) and BOA2-101, BOA3_100, BOA5_101, C_102, B-101, E_104, Ref 3 and Ref 8.

The most widespread species included *C. gouldii* (Gould's Wattled Bat), *C. morio* (Chocolate Wattled Bat), **Eastern Bentwing-bat**, *Rhinolophus megaphyllus* (Eastern Horseshoe Bat) and members of the Ozimops complex. Definite and possible calls attributed to these species were recorded at between 10 and 14 of the 15 survey sites (Table G 2 Spring monitoring microbat species list derived from ultrasonic call results for the Wilpinjong Mine area.Table G 3 Spring monitoring microbat species list derived from ultrasonic call results for the Wilpinjong Mine area. Whilst in contrast, calls that were attributed **Yellow-bellied Sheathtail Bat** were attributed to one definite that was recorded Ref 14, as well as one potential call from C_102.

Activity

General microbat activity was very high at BOA3-101 with at least one call being recorded every minute on average throughout the survey period. Sites BOA3_100, B-101, and E_104 recorded high levels of activity with at least one call being recorded every two minutes on average throughout the sampling period. Sites BOA4_101, BOA5_101, Reference 2 and Reference 8 recorded moderate levels of activity with calls recorded more often than every ten minutes but less often than every two minutes on average throughout the survey period. Activity levels at BOA1_100, BOA2_101, D_103, Ref 10 and Ref 14 were very low with calls recorded less often than every ten minutes, on average, throughout the survey period.

Long sequences and feeding buzzes were observed in the data set, particularly among the Gould's Wattled Bat, Chocolate Wattled Bat, **Eastern Bentwing-bat** and *Vespadelus spp.* (Forest Bat) complex species at BOA_101, BOA5_100, C-102 and Reference 8. While feeding buzzes were observed among those calls attributed to **Large-eared Pied Bat** and *Ozimops* spp. at sites BOA3_100, BOA_101, B_101, E-104, and Ref 2. Feeding buzzes indicate that bats were actively foraging at these sites. There were mixed levels of foraging activity recorded at the remaining sites within the data analysed. This may indicate that bats were predominantly commuting through these areas or that the weather conditions were not as favourable for the recording of the lower intensity feeding calls.

The calls recorded at BOA_101, BOA5_100 and C-102 were general short and difficult to interpret calls.

Survey Limitations

The calls of Gould's Wattled Bat, *Scotorepens balstoni* (Inland Broad-nosed Bat) and the *Ozimops* species complex (Free-tailed Bats) can be difficult to separate. Calls were identified as *Ozimops* species complex when the call shape was flat (slope S1 of less than 100 OPS generally) and the frequency was between 24 – 36 kHz. Gould's Wattled Bat was distinguished by a frequency of 27.5 – 32.5 kHz and alternation in call frequency between pulses. Inland Broad-nosed Bat calls have a slope of greater than 200 OPS, are non-alternating and fall between 29 and 34 kHz. When no distinguishing characteristics were present calls were assigned to multi-species groups.

Calls of *Scotorepens greyii* (Little Broad-nosed Bat) and *Vespadelus darlingtoni* (Large Forest Bat) overlap in this geographic region at frequencies of between 40 and 41 kHz. Inland Broad-nosed Bat calls can be distinguished at overlapping frequencies by the presence of an upsweeping tail. Calls of Large Forest Bat can be distinguished by the absence of a tail, and the presence of a long characteristic section.

In this geographic region, calls of Eastern Bentwing-bat overlap in frequency with those of Southern Forest Bat, Large Forest Bat and Little Forest Bat between 40 and 48.5 kHz. Eastern Bentwing-bat calls were distinguished by a down-sweeping tail, drop of more than 2 kHz in the pre-characteristic section, and the pulse shape and time between calls was variable (43 – 48.5 kHz). Little Forest Bat and Southern Forest Bat calls are curved, both have a regular pulse shape and up-sweeping tails. Large Forest Bat calls are curved, often have no tail but can have up-sweeping tails and commonly have a long characteristic section. Little Forest Bat (42.5 – 49 kHz) was only

able to be distinguished from Southern Forest Bat (43 – 46 kHz) at frequencies between 47 – 48.5 kHz. Large Forest Bat can only be distinguished from Little and Southern Forest Bats at frequencies below 42.5 kHz (however at this frequency can be confused with Little Broad-nosed Bat, as discussed above). When no distinguishing characteristics were present calls were assigned to multi-species groups.

Calls of Eastern Cave Bat and *Chalinolobus morio* (Chocolate Wattled Bat) overlap in the range 48 – 53 kHz. Chocolate Wattled Bat calls have a down-sweeping tail whereas Eastern Cave Bat and Little Forest Bat calls have an up-sweeping tail. Calls of the Eastern Cave Bat were separated from those of Little Forest Bat at frequencies above 49 kHz. When no distinguishing characteristics were present calls were assigned to multi-species groups or characterized as unidentifiable.

The calls of *Myotis macropus* (Southern Myotis) and the *Nyctophilus* group of species are difficult to separate. There are no known records of Myotis west of the Great Dividing Range including this region. Suitable water sources required by Myotis for feeding are absent from the study area. All vertical shaped calls were therefore identified as *Nyctophilus* spp.

Table G 2 Spring monitoring microbat species list derived from ultrasonic call results for the Wilpinjong Mine area.

Species Name	Common Name	Survey sites									
		BOA1_100	BOA2_101	BOA3_100	BOA4_101	BOA5_101	A_104	B_101	C_102	D_103	E_104
Austronomus australis	White-Striped Free-tailed Bat	X			X			X	X		X
***Chalinolobus dwyeri*[1]**	**Large-eared Pied Bat**			X	X	X		X			X
Chalinolobus gouldii	Gould's Wattled Bat		P	X	X	X		X	X	P	X
Chalinolobus gouldii / *Ozimops* complex	Gould's Wattled Bat / Free-tailed Bat complex			X	X	X		X	X		X
Chalinolobus gouldii / *Scotorepens balstoni*	Gould's Wattled Bat / Inland Broad-nosed Bat			X		X		X	X		X
Chalinolobus morio	Chocolate Wattled Bat	P		X		X		X	X	P	X
Chalinolobus morio / ***Vespadelus troughtoni****	Chocolate Wattled Bat / **Eastern Cave Bat**		X	X		X		X	X	X	X
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	X	P	X	X	X		X	X	X	X
Miniopterus orianae oceanensis* and any or all of the following species, *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** and any or all of the following species, Large Forest Bat / Southern Forest Bat / Little Forest Bat	X	X	X	X	X	X	X	X	X	X
Nyctophilus spp. In this region *N. geoffroyi, N. gouldii* and the threatened ***N. corbeni**[1]* are likely to be present.	In this region Lesser, Gould's and the threatened **Corben's Long-eared Bat** are likely to be present.	P	X	X		X		X	X		X
Ozimops species complex. In this region the *O. petersi*, *O. ridei* and *O. planiceps.*	In this region the Inland, Ride's and South-eastern Free-tailed Bat are likely to be present.			X	X	X		X	X		X
Rhinolophus megaphyllus	Eastern Horseshoe Bat			X	X	X		X		X	X

Species Name	Common Name	Survey sites									
		BOA1_100	BOA2_101	BOA3_100	BOA4_101	BOA5_101	A_104	B_101	C_102	D_103	E_104
Saccolaimus flaviventris*	**Yellow-bellied Sheathtail Bat**								P		
Scotorepens balstoni	Inland Broad-nosed Bat			X		X		X	X		X
Scotorepens greyii	Lesser Broad-nosed Bat			P							
Vespadelus darlingtoni	Large Forest Bat	P	P	P	P	P		P			P
Vespadelus regulus	Southern Forest Bat	P	P	P	P	P		P	P		P
Vespadelus troughtoni*	**Eastern Cave Bat**		P	X		X		X	P	P	X
Vespadelus vulturnus	Little Forest Bat	P	P	X	P	X		X	X	P	X

X = Definitely present, P = Possibly present, *** Threatened species listed under BC Act / [1] Threatened species listed under the EPBC Act**

Table G 3 Spring monitoring microbat species list derived from ultrasonic call results for the Wilpinjong Mine area.

Species Name	Common Name	Survey sites				
		Ref 2	Ref 3	Ref 8	Ref 10	Ref 14
Austronomus australis	White-Striped Free-tailed Bat		X		X	X
Chalinolobus dwyeri[*1]	Large-eared Pied Bat		X		X	
Chalinolobus gouldii	Gould's Wattled Bat	P	P	X		P
Chalinolobus gouldii / *Ozimops* complex	Gould's Wattled Bat / Free-tailed Bat complex		X	X		X
Chalinolobus gouldii / *Scotorepens balstoni*	Gould's Wattled Bat / Inland Broad-nosed Bat		X	X		
Chalinolobus morio	Chocolate Wattled Bat	X	X	X	P	X
Chalinolobus morio / ***Vespadelus troughtoni****	Chocolate Wattled Bat / **Eastern Cave Bat**	X	X			
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	X	X	X	P	P
Miniopterus orianae oceanensis* and any or all of the following species, *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** and any or all of the following species, Large Forest Bat / Southern Forest Bat / Little Forest Bat	X	X	X	X	X
Nyctophilus spp. In this region *N. geoffroyi, N. gouldii* and the threatened ***N. corbeni**[*1]* are likely to be present.	In this region Lesser, Gould's and the threatened **Corben's Long-eared Bat** are likely to be present.		X	X		P
Nyctophilus spp. In this region *N. geoffroyi, N. gouldii* and the threatened ***N. corbeni**[*1]* are likely to be present.	In this region Lesser, Gould's and the threatened **Corben's Long-eared Bat** are likely to be present.					P
Ozimops (*Mormopterus*) *spp.*	Free-tailed Bat complex	X	X	X	X	X
Rhinolophus megaphyllus	Eastern Horseshoe Bat		X	X	X	X
Saccolaimus flaviventris*	**Yellow-bellied Sheathtail Bat**					X
Scotorepens balstoni	Inland Broad-nosed Bat		P	X	P	
Vespadelus regulus	Southern Forest Bat	P		P	P	
Vespadelus troughtoni*	**Eastern Cave Bat**	P	X	X		
Vespadelus vulturnus	Little Forest Bat	P	P	X	X	P

X = Definitely present, P = Possibly present, *** Threatened species listed under BC Act / [1] Threatened species listed under the EPBC Act**

Site by site table data

The following tables provide a summary of the attributes outlined below:

- site by site variations in species richness and diversity
- definite, potential and possible calls for each species
- species by species activity levels based on the number of calls recorded across all species and by individual species
- site specific percentage / ratio of useful calls and un-interpretable calls

Table G 4: Microbat calls for Wilpinjong Mine BOA1_100 that were recorded between 5 and 6 November 2018

Species Name	Common name	Definitely present	Potentially present	Total
Austronomus australis	White-striped Free-tailed Bat	2	0	2
Chalinolobus morio	Chocolate Wattled Bat	0	6	6
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	4	11	15
Miniopterus orianae oceanensis* / *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 42.5 – 44 kHz)	**Eastern Bentwing-bat** / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	7
Miniopterus orianae oceanensis* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	36
***Nyctophilus* spp.*[1]**	**Long-eared Bat**	0	1	1
Vespadelus vulturnus	Little Forest Bat	0	2	2
Unidentifiable calls				84
Identifiable calls				69
Total Calls				153
Percentage usable calls				45.09

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

Table G 5: Microbat calls for Wilpinjong Mine BOA2_101 that were recorded between 5 and 6 November 2018

Species Name	Common name	Definitely present	Potentially present	Total
Chalinolobus gouldii	Gould's Wattled Bat	0	1	1
Chalinolobus morio	Chocolate Wattled Bat	2	10	12
Chalinolobus morio / ***Vespadelus troughtoni****	Chocolate Wattled Bat / **Eastern Cave Bat**	0	0	6
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	0	2	2
Miniopterus orianae oceanensis* / *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 42.5 – 44 kHz)	**Eastern Bentwing-bat** / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	1
Miniopterus orianae oceanensis* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	15
***Nyctophilus* spp.*[1]**	**Long-eared Bat**	2	5	7
Vespadelus vulturnus	Little Forest Bat	0	3	3
Unidentifiable calls				37
Identifiable calls				47
Total Calls				84
Percentage usable calls				55.95

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

Table G 6: Microbat calls for Wilpinjong Mine BOA3_100 that were recorded between 14 and 15 November 2018

Species Name	Common name	Definitely present	Potentially present	Total
***Chalinolobus dwyeri**[1]*	**Large-eared Pied Bat**	43	8	51
Chalinolobus gouldii	Gould's Wattled Bat	11	14	25
Chalinolobus gouldii / *Ozimops* (*Mormopterus*) *complex*	Gould's Wattled Bat / Free-tailed Bat complex	0	0	1
Chalinolobus gouldii / *Scotorepens balstoni*	Gould's Wattled Bat / Inland Broad-nosed Bat	0	0	1
Chalinolobus morio	Chocolate Wattled Bat	16	40	56
Chalinolobus morio / *Vespadelus troughtoni*	Chocolate Wattled Bat / Eastern Cave Bat	0	0	43
***Miniopterus orianae oceanensis**	**Eastern Bentwing-bat**	119	101	220
***Miniopterus orianae oceanensis** / *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 42.5 – 44 kHz)	**Eastern Bentwing-bat** / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	3
***Miniopterus orianae oceanensis** / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	30
***Miniopterus orianae oceanensis** / *Vespadelus vulturnus*	**Eastern Bentwing-bat** / Little Forest Bat	0	0	606
***Nyctophilus* spp.*[1]**	**Long-eared Bat**	9	1	10
Ozimops (*Mormopterus*) complex	Free-tailed Bat Complex	0	0	6
Rhinolophus megaphyllus	Eastern Horseshoe Bat	55	0	55
Scotorepens balstoni	Inland Broad-nosed Bat	1	1	2
Scotorepens greyii / *Vespadelus darlingtoni*	Large Forest Bat	0	0	4
Vespadelus regulus / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	Southern Forest Bat / Little Forest Bat	0	0	1
***Vespadelus troughtoni** (defined by curved calls with Fc between 49 – 54 kHz)	**Large Forest Bat**	7	11	18
Vespadelus vulturnus	Little Forest Bat	16	17	32
Unidentifiable calls				258

Species Name	Common name	Definitely present	Potentially present	Total
Identifiable calls				1164
Total Calls				1422
Percentage usable calls				81.86

*** Threatened species listed under BC Act and 1 Threatened species listed under the EPBC Act**

Table G 7: Microbat calls for Wilpinjong Mine BOA4_101 that were recorded between 14 and 15 November 2018

Species Name	Common name	Definitely present	Potentially present	**Total**
Austronomus australis	White-striped Free-tailed Bat	4	0	4
***Chalinolobus dwyeri**[1]**	**Large-eared Pied Bat**	12	1	13
Chalinolobus gouldii	Gould's Wattled Bat	2	4	6
Chalinolobus gouldii / *Ozimops* (*Mormopterus*) *complex*	Gould's Wattled Bat / Free-tailed Bat complex	0	0	2
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	6	18	24
Miniopterus orianae oceanensis* / *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 42.5 – 44 kHz)	**Eastern Bentwing-bat** / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	3
Miniopterus orianae oceanensis* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	82
Ozimops (*Mormopterus*) complex	Free-tailed Bat Complex	0	0	1
Rhinolophus megaphyllus	Eastern Horseshoe Bat	5	0	5
Unidentifiable calls				152
Identifiable calls				140
Total Calls				292
Percentage usable calls				47.94

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

Table G 8: Microbat calls for Wilpinjong Mine BOA5_101 that were recorded between 12 November 2018.

Species Name	Common name	Definitely present	Potentially present	Possible
***Chalinolobus dwyeri**[1]**	**Large-eared Pied Bat**	1	2	3
Chalinolobus gouldii	Gould's Wattled Bat	6	10	16

Chalinolobus gouldii / Ozimops complex	Gould's Wattled Bat / Free-tailed Bat complex	0	0	1
Chalinolobus gouldii / Scotorepens balstoni	Gould's Wattled Bat / Inland Broad-nosed Bat	0	0	3
Chalinolobus morio	Chocolate Wattled Bat	2	12	14
Chalinolobus morio / Vespadelus troughtoni	Chocolate Wattled Bat / Eastern Cave Bat	0	0	48
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	15	9	24
Miniopterus orianae oceanensis* / *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus* (*Vespadelus* spp. complex is defined by curved calls with Fc between 42.5 – 44 kHz)	**Eastern Bentwing-bat** / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	2
Miniopterus orianae oceanensis* / *Vespadelus regulus / Vespadelus vulturnus* (*Vespadelus* spp. complex is defined by curved calls with Fc between 44 – 46 kHz)	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	44
***Nyctophilus* spp.*[1]**	**Long-eared Bat**	2	0	2
Ozimops (*Mormopterus*) complex	Free-tailed Bat Complex	0	0	6
Rhinolophus megaphyllus	Eastern Horseshoe Bat	5	0	5
Scotorepens balstoni	Inland Broad-nosed Bat	1	1	2
Vespadelus troughtoni	Eastern Cave Bat	9	15	24
Vespadelus vulturnus	Little Forest Bat	2	7	9
Unidentifiable calls				294
Identifiable calls				203
Total Calls				497
Percentage usable calls				40.84

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

Table G 9: Microbat calls for Wilpinjong Mine Site A_104 that were recorded between 2 and 4 and then on the 8 November 2018.

Species Name	Common name	Definitely present	Potentially present	Total
No micro bat call data was recorded, may even remove this table.				

Table G 10: Microbat calls for Wilpinjong Mine Site B_101 recorded between 19 and 20 November 2018.

Species Name	Common name	Definitely present	Potentially present	Total
Austronomus australis	White-striped Free-tailed Bat	4	1	5
***Chalinolobus dwyeri**[1]*	**Large-eared Pied Bat**	26	2	28
Chalinolobus gouldii	Gould's Wattled Bat	31	24	55
Chalinolobus gouldii / *Ozimops* (*Mormopterus*) *complex*	Gould's Wattled Bat / Free-tailed Bat complex	0	0	19
Chalinolobus gouldii / *Scotorepens balstoni*	Gould's Wattled Bat / Inland Broad-nosed Bat	0	0	17
Chalinolobus morio	Chocolate Wattled Bat	8	17	25
Chalinolobus morio / *Vespadelus troughtoni*	Chocolate Wattled Bat / Eastern Cave Bat	0	0	110
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	13	29	42
Miniopterus orianae oceanensis* / *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 42.5 – 44 kHz)	**Eastern Bentwing-bat** / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	1
Miniopterus orianae oceanensis* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	13
Miniopterus orianae oceanensis* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** / Little Forest Bat	0	0	181
***Nyctophilus* spp.*[1]**	**Long-eared Bat**	1	2	3
Ozimops (*Mormopterus*) complex	Free-tailed Bat Complex	0	0	67
Rhinolophus megaphyllus	Eastern Horseshoe Bat	1	0	1
Saccolaimus flaviventris*	**Yellow-bellied Sheathtail Bat**	1	0	1
Scotorepens balstoni	Inland Broad-nosed Bat	12	4	16
Vespadelus regulus / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	Southern Forest Bat / Little Forest Bat	0	0	1
Vespadelus troughtoni* (defined by curved calls with Fc between 49 – 54 kHz)	**Large Forest Bat**	38	31	69
Vespadelus vulturnus	Little Forest Bat	28	19	47
Unidentifiable calls				152

Species Name	Common name	Definitely present	Potentially present	Total
Identifiable calls				701
Total Calls				853
Percentage usable calls				82.18

*** Threatened species listed under BC Act and [1] Threatened species listed under the EPBC Act**

Table G 11: Microbat calls for recorded at Wilpinjong Mine Site C_102 between 19 and 20 November 2018.

Species Name	Common name	Definitely present	Potentially present	Total
Austronomus australis	White-striped Free-tailed Bat	2	1	3
Chalinolobus gouldii	Gould's Wattled Bat	2	5	7
Chalinolobus gouldii / *Ozimops* (*Mormopterus*) *complex*	Gould's Wattled Bat / Free-tailed Bat complex	0	0	5
Chalinolobus gouldii / *Scotorepens balstoni*	Gould's Wattled Bat / Inland Broad-nosed Bat	0	0	1
Chalinolobus morio	Chocolate Wattled Bat	7	7	14
Chalinolobus morio / *Vespadelus troughtoni*	Chocolate Wattled Bat / Eastern Cave Bat	0	0	8
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	10	13	23
Miniopterus orianae oceanensis* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	11
Miniopterus orianae oceanensis* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** / Little Forest Bat	0	0	90
***Nyctophilus* spp.*[1]**	**Long-eared Bat**	1	0	1
Ozimops (*Mormopterus*) complex	Free-tailed Bat Complex	0	0	15
Scotorepens balstoni	Inland Broad-nosed Bat	2	0	2
Vespadelus regulus / *Vespadelus vulturnus*	Southern Forest Bat / Little Forest Bat	0	0	2
Vespadelus troughtoni* / *Vespadelus vulturnus* (defined by curved calls with Fc between 48 – 50 kHz)	**Eastern Cave Bat** / Little Forest Bat	0	0	1
Vespadelus vulturnus	Little Forest Bat	4	3	7
Unidentifiable calls				210
Identifiable calls				190

Species Name	Common name	Definitely present	Potentially present	Total
Total Calls				400
Percentage usable calls				47.5

*** Threatened species listed under BC Act**

Table G 12: Microbat calls for recorded at Wilpinjong Mine Site D_103 between 19 and 20 November 2018.

Species Name	Common name	Definitely present	Potentially present	Total
Chalinolobus gouldii	Gould's Wattled Bat	0	1	1
Chalinolobus morio	Chocolate Wattled Bat	0	3	3
Chalinolobus morio / ***Vespadelus troughtoni****	Chocolate Wattled Bat / **Eastern Cave Bat**	0	0	1
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	1	4	5
Miniopterus orianae oceanensis* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** / Little Forest Bat	0	0	16
Rhinolophus megaphyllus	Eastern Horseshoe Bat	2	0	2
Unidentifiable calls				54
Identifiable calls				28
Total Calls				82
Percentage usable calls				34.14

*** Threatened species listed under BC Act**

Table G 13: Microbat calls for recorded at Wilpinjong Mine Site E_104 between 19 and 20 November.

Species Name	Common name	Definitely present	Potentially present	Total
Austronomus australis	White-striped Free-tailed Bat	4	0	4
Chalinolobus dwyeri*	**Large-eared Pied Bat**	2	0	2
Chalinolobus gouldii	Gould's Wattled Bat	1	5	6
Chalinolobus gouldii / *Scotorepens balstoni*	Gould's Wattled Bat / Inland Broad-nosed Bat	0	0	10
Chalinolobus morio	Chocolate Wattled Bat	8	27	35
Chalinolobus morio / *Vespadelus troughtoni*	Chocolate Wattled Bat / Eastern Cave Bat	0	0	6
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	120	58	178
Miniopterus orianae oceanensis* / *Vespadelus regulus* / *Vespadelus*	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	17

Species Name	Common name	Definitely present	Potentially present	Total
vulturnus (defined by curved calls with Fc between 44 – 46 kHz)				
Miniopterus orianae oceanensis* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** / Little Forest Bat	0	0	449
***Nyctophilus* spp.*[1]**	**Long-eared Bat**	1	1	2
Ozimops complex	Free-tailed Bat Complex	0	0	9
Rhinolophus megaphyllus	Eastern Horseshoe Bat			
Scotorepens balstoni	Inland Broad-nosed Bat	2	4	6
Vespadelus darlingtoni / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 42.5 – 44 kHz)	Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	1
Vespadelus regulus / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	Southern Forest Bat / Little Forest Bat	0	0	2
Vespadelus troughtoni* (defined by curved calls with Fc between 49 – 54 kHz)	**Large Forest Bat**	6	3	9
Vespadelus vulturnus	Little Forest Bat	9	19	28
Unidentifiable calls				233
Identifiable calls				767
Total Calls				998
Percentage usable calls				76.85

*** Threatened species listed under BC Act - 1 Threatened species listed under the EPBC Act**

Table G 14: Microbat calls for recorded at Wilpinjong Mine Ref 2 between 14 and 15 November 2018

Species Name	Common name	Definitely present	Potentially present	Total
Chalinolobus gouldii	Gould's Wattled Bat	0	2	2
Chalinolobus morio	Chocolate Wattled Bat	1	6	7
Chalinolobus morio / *Vespadelus troughtoni*	Chocolate Wattled Bat / Eastern Cave Bat	0	0	8
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	7	13	20
Miniopterus orianae oceanensis* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	4
Miniopterus orianae oceanensis* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** / Little Forest Bat	0	0	121
Ozimops (*Mormopterus*) complex	Free-tailed Bat Complex	0	0	1
Vespadelus troughtoni*	**Eastern Cave Bat**	0	1	1
Unidentifiable calls				282
Identifiable calls				164
Total Calls				446
Percentage usable calls				36.77

*** Threatened species listed under BC Act**

Table G 15: Microbat calls for recorded at Wilpinjong Mine Ref 3 between 19 and 20 November 2018.

Species Name	Common name	Definitely present	Potentially present	Total
Austronomus australis	White-striped Free-tailed Bat	13	0	13
***Chalinolobus dwyeri**[1]*	**Large-eared Pied Bat**	11	1	12
Chalinolobus gouldii	Gould's Wattled Bat	0	8	8
Chalinolobus gouldii / *Ozimops* (*Mormopterus*) *complex*	Gould's Wattled Bat / Free-tailed Bat complex	0	0	1
Chalinolobus gouldii / *Scotorepens balstoni*	Gould's Wattled Bat / Inland Broad-nosed Bat	0	0	2
Chalinolobus morio	Chocolate Wattled Bat	9	44	53
Chalinolobus morio / *Vespadelus troughtoni*	Chocolate Wattled Bat / Eastern Cave Bat	0	0	10

Species Name	Common name	Definitely present	Potentially present	Total
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	43	53	96
Miniopterus orianae oceanensis* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	6
Miniopterus orianae oceanensis* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** / Little Forest Bat	0	0	330
***Nyctophilus* spp.*[1]**	**Long-eared Bat**	0	2	2
Ozimops (*Mormopterus*) complex	Free-tailed Bat Complex	0	0	7
Rhinolophus megaphyllus	Eastern Horseshoe Bat	3	0	3
Scotorepens balstoni	Inland Broad-nosed Bat	0	1	1
Vespadelus troughtoni* (defined by curved calls with Fc between 49 – 54 kHz)	**Large Forest Bat**	1	2	3
Vespadelus vulturnus	Little Forest Bat	0	11	11
Unidentifiable calls				311
Identifiable calls				558
Total Calls				869
Percentage usable calls				64.21

*** Threatened species listed under BC Act and 1 Threatened species listed under the EPBC Act**

Table G 16: Microbat calls for recorded at Wilpinjong Mine Site Ref_8 recorded between 11 and 12 November 2018.

Species Name	Common name	Definitely present	Potentially present	Total
Chalinolobus gouldii	Gould's Wattled Bat	52	10	62
Chalinolobus gouldii / *Ozimops* (*Mormopterus*) *complex*	Gould's Wattled Bat / Free-tailed Bat complex	0	0	5
Chalinolobus gouldii / *Scotorepens balstoni*	Gould's Wattled Bat / Inland Broad-nosed Bat	0	0	6
Chalinolobus morio	Chocolate Wattled Bat	1	2	3
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	1	9	10

Species Name	Common name	Definitely present	Potentially present	Total
Miniopterus orianae oceanensis* / *Vespadelus darlingtoni* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 42.5 – 44 kHz)	Eastern Bentwing-bat / Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	1
Miniopterus orianae oceanensis* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	14
Miniopterus orianae oceanensis* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** / Little Forest Bat	0	0	35
***Nyctophilus* spp.*[1]**	**Long-eared Bat**	2	3	5
Ozimops (*Mormopterus*) complex	Free-tailed Bat Complex	0	0	4
Rhinolophus megaphyllus	Eastern Horseshoe Bat	39	3	42
Scotorepens balstoni	Inland Broad-nosed Bat	3	1	4
Vespadelus regulus / *Vespadelus vulturnus*	Large Forest Bat / Southern Forest Bat / Little Forest Bat	0	0	2
Vespadelus troughtoni* (defined by curved calls with Fc between 49 – 54 kHz)	**Large Forest Bat**	3	0	3
Vespadelus vulturnus	Little Forest Bat	10	4	14
Unidentifiable calls				175
Identifiable calls				210
Total Calls				385
Percentage usable calls				55.05

*** Threatened species listed under BC Act**

Table G 17: Microbat calls for recorded at Wilpinjong Mine Site Ref_10 recorded between 19 and 20 November 2018.

Species Name	Common name	Definitely present	Potentially present	Total
Austronomus australis	White-striped Free-tailed Bat	11	2	13
***Chalinolobus dwyeri*[x1]**	**Large-eared Pied Bat**	1	0	1
Chalinolobus morio	Chocolate Wattled Bat	0	2	2
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	0	4	4
Miniopterus orianae oceanensis* / *Vespadelus regulus* / *Vespadelus vulturnus* (defined by curved calls with Fc between 44 – 46 kHz)	**Eastern Bentwing-bat** / Southern Forest Bat / Little Forest Bat	0	0	3
Miniopterus orianae oceanensis* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** / Little Forest Bat	0	0	47
Ozimops (*Mormopterus*) complex	Free-tailed Bat Complex	0	0	1
Rhinolophus megaphyllus	Eastern Horseshoe Bat	1	0	1
Vespadelus vulturnus	Little Forest Bat	3	4	7
Unidentifiable calls				29
Identifiable calls				80
Total Calls				108
Percentage usable calls				74.07

*** Threatened species listed under BC Act and 1 Threatened species listed under the EPBC Act**

Table G 18: Microbat calls for recorded at Wilpinjong Mine Site Ref_14 recorded between 14 and 15 November 2018.

Species Name	Common name	Definitely present	Potentially present	Total
Austronomus australis	White-striped Free-tailed Bat	5	0	5
Chalinolobus gouldii	Gould's Wattled Bat	0	3	3
Chalinolobus gouldii / *Ozimops* (*Mormopterus*) complex	Gould's Wattled Bat / Free-tailed Bat complex	0	0	6
Chalinolobus morio	Chocolate Wattled Bat	1	2	3
Miniopterus orianae oceanensis*	**Eastern Bentwing-bat**	0	1	1

Species Name	Common name	Definitely present	Potentially present	Total
Miniopterus orianae oceanensis* / *Vespadelus vulturnus*	**Eastern Bentwing-bat** / Little Forest Bat	0	0	15
***Nyctophilus* spp.*[1]**	**Long-eared Bat**	0	1	1
Ozimops (*Mormopterus*) complex	Free-tailed Bat Complex	0	0	9
Rhinolophus megaphyllus	Eastern Horseshoe Bat	10	0	10
Saccolaimus flaviventris*	**Yellow-bellied Sheathtail Bat**	1	0	1
Unidentifiable calls				36
Identifiable calls				54
Total Calls				90
Percentage usable calls				60

*** Threatened species listed under BC Act**

Call profiles

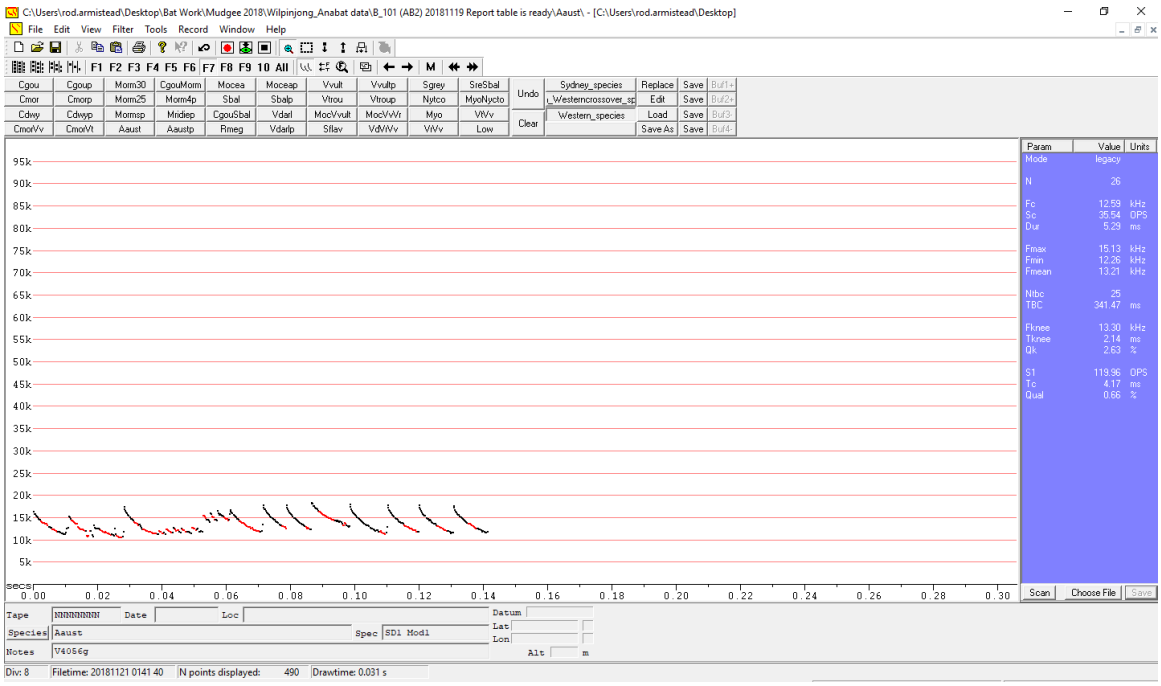

Figure G 1: Call profile for *Austronomus australis* (White-striped Free-tailed Bat) recorded at B_101 at 0141 (1.41 am) on 21 November 2018.

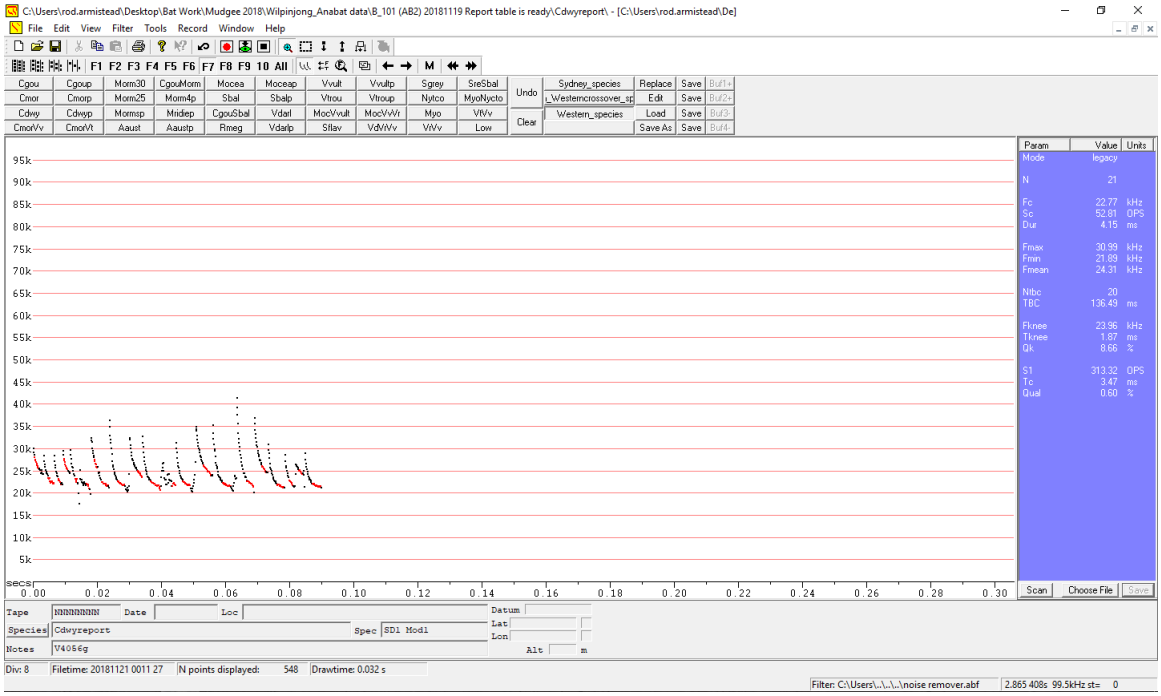

Figure G 2: Call profile for ***Chalinolobus dwyeri*** **(Large-eared Pied Bat)** recorded at B_101 at 0011 (12.11 am) on 21 November 2018.

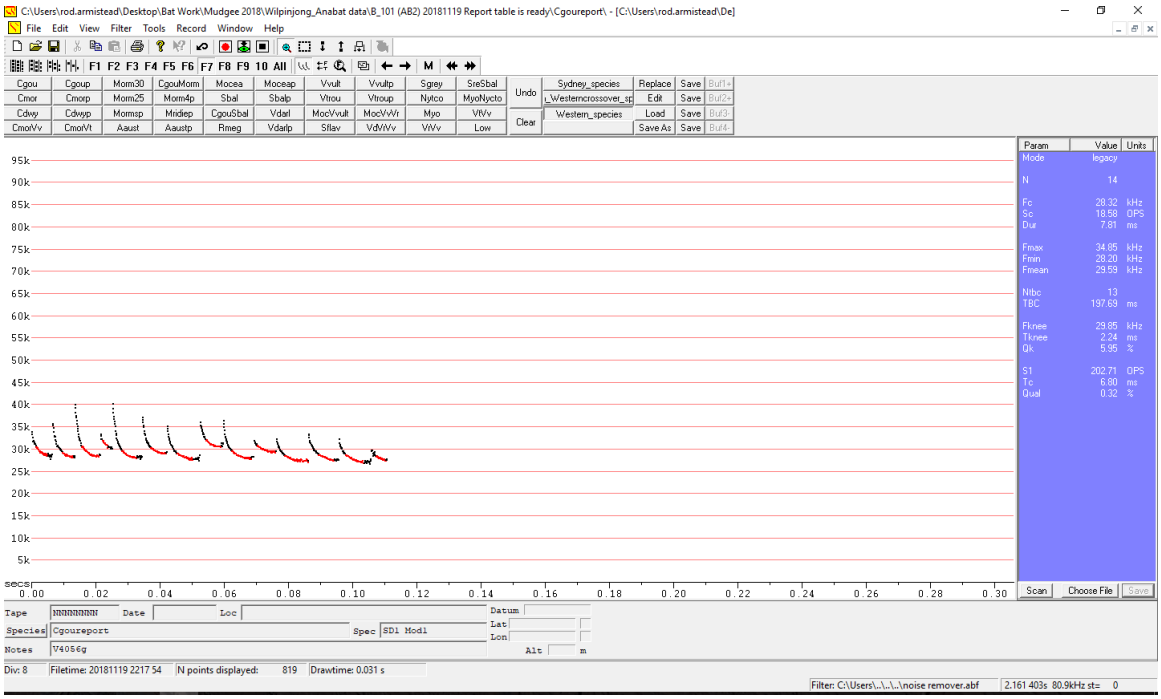

Figure G 3: Call profile for *Chalinolobus gouldii* (Gould's Wattled Bat) recorded at B_101 at 2217 (10.17 pm) on 19 November 2018.

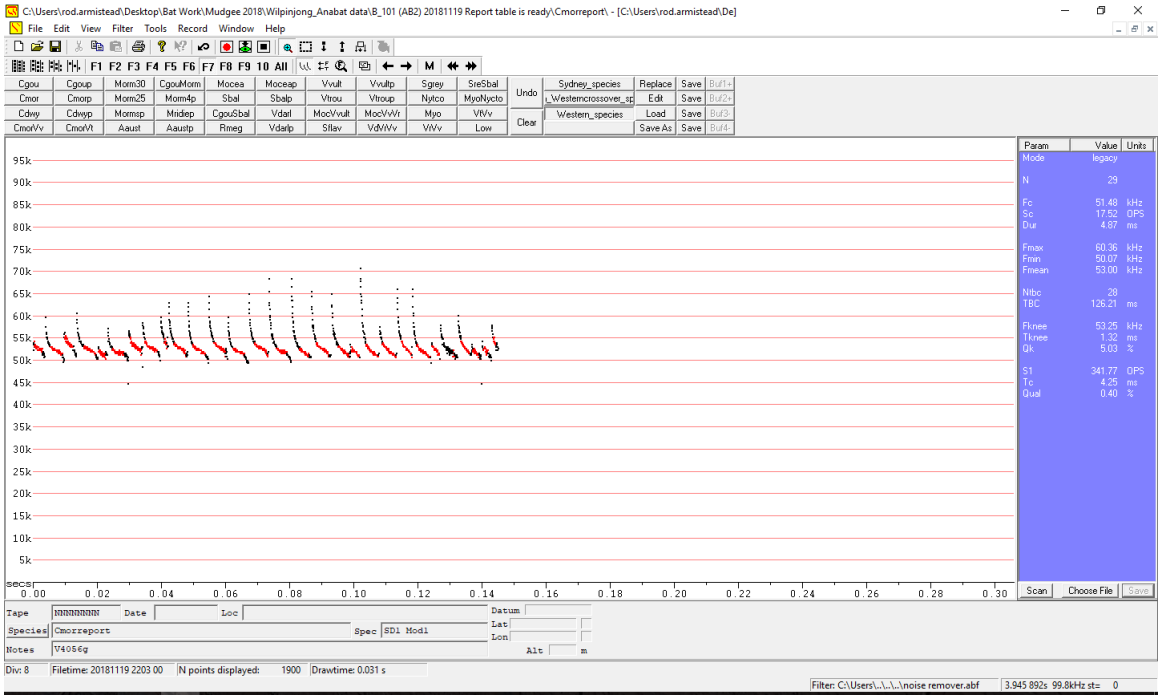

Figure G 4: Call profile for *Chalinolobus morio* (Chocolate Wattled Bat) recorded at B_101 at 2203 (10.03 pm) on 19 November 2018.

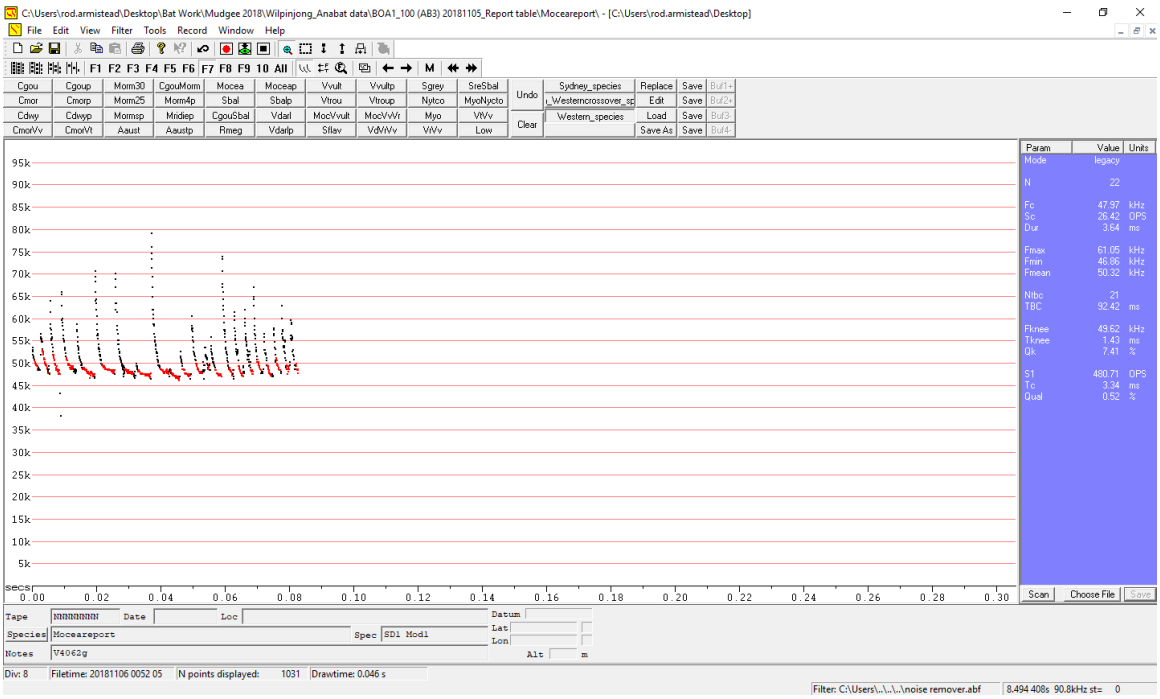

Figure G 5 Call profile for ***Miniopterus orianae oceanensis*** **(Eastern Bentwing-bat)** recorded at BOA1_100 at 0052 (12.52 am) on 06 November 2018.

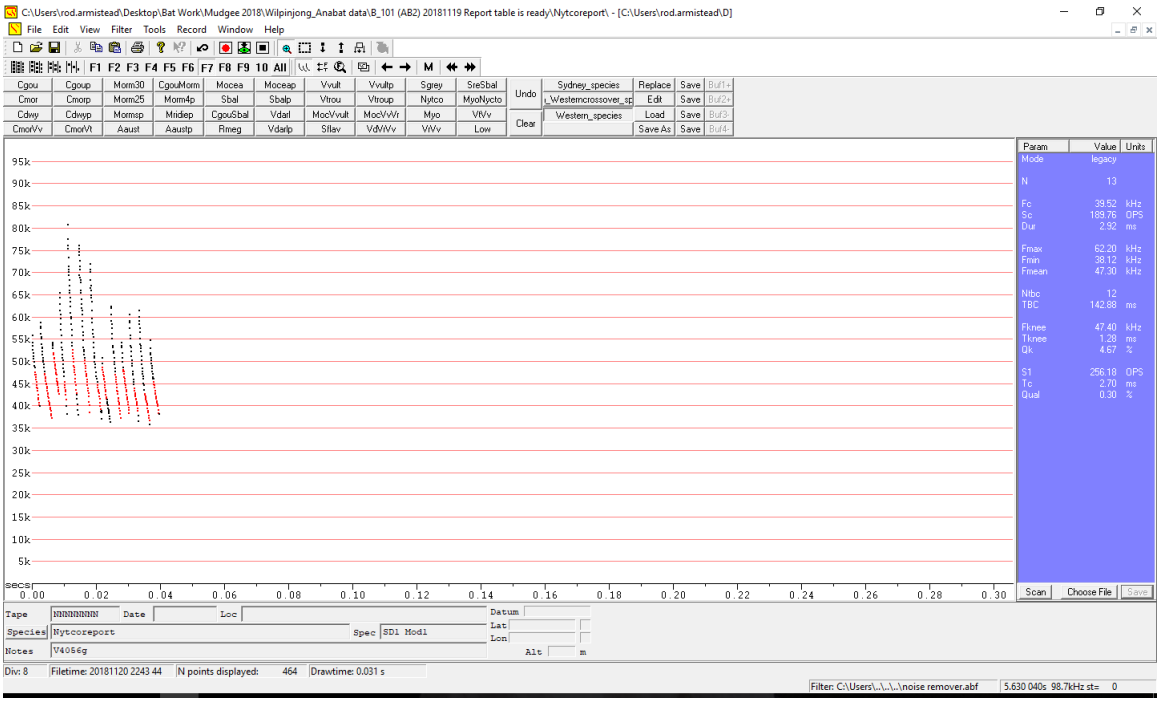

Figure G 6: Call profile for *Nyctophilus* spp. recorded at B_101 at 2243 (10.43 pm) on 20 November 2018.

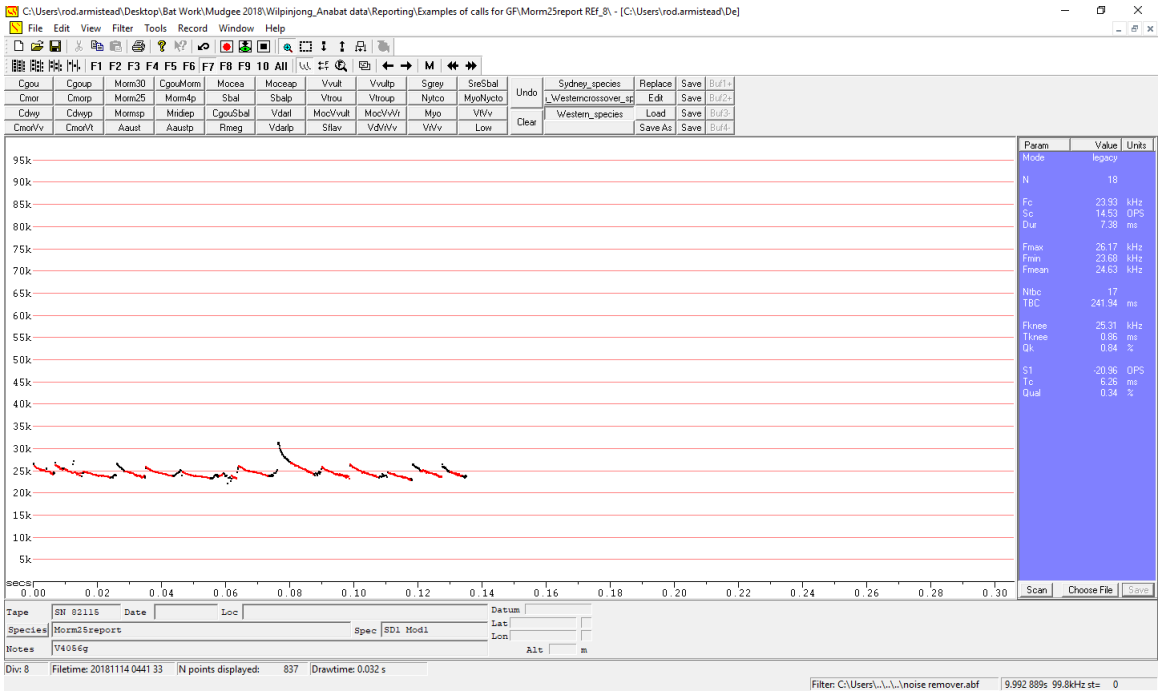

Figure G 7 Call profile for *Ozimops* spp. complex recorded at Reference 8 at 0441 (4.41 am) on 14 November 2018.

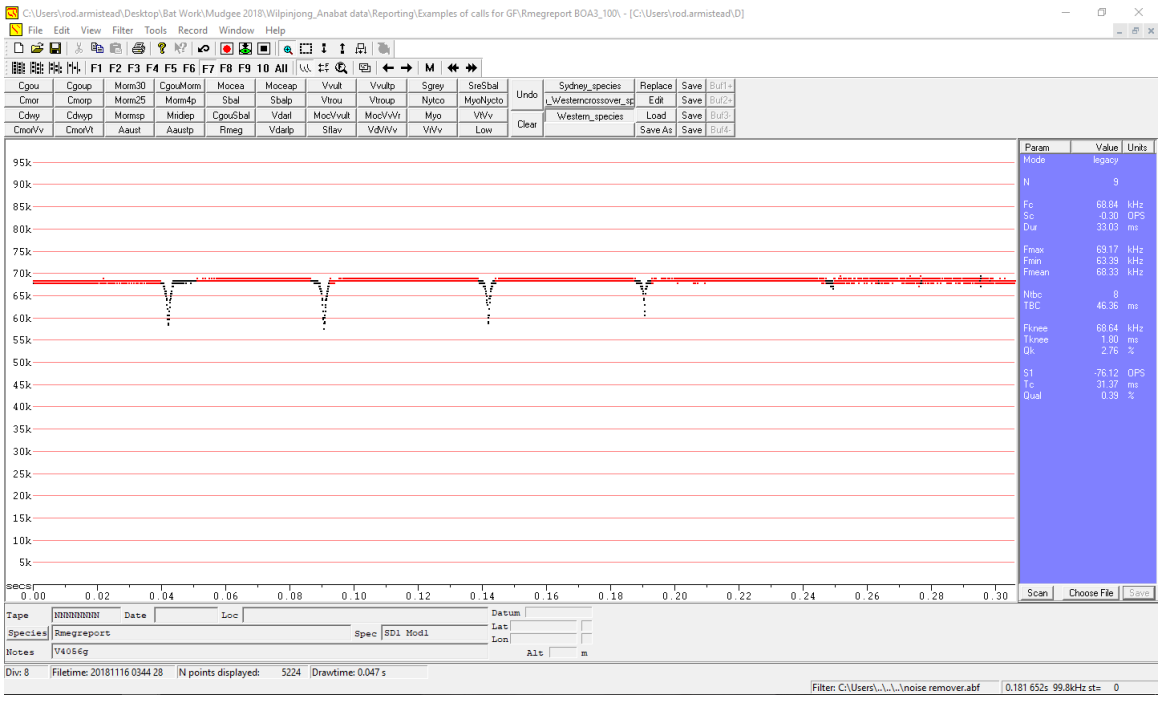

Figure G 8: Call profile for *Rhinolophus megaphyllus* (Eastern Horseshoe Bat) recorded at BOA3_100 at 0344 (3.44 am) on 16 November 2018.

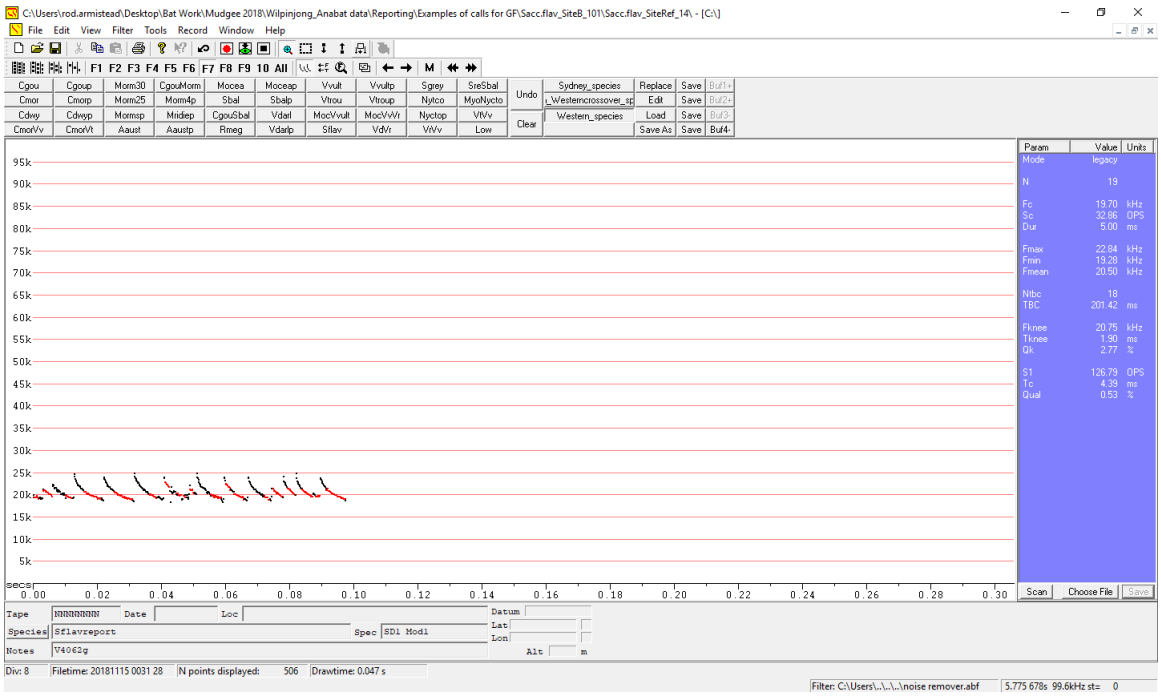

Figure G 9: Call profile for *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) recorded at Ref 14 at 0031 (12.31 am) on 15 November 2018.

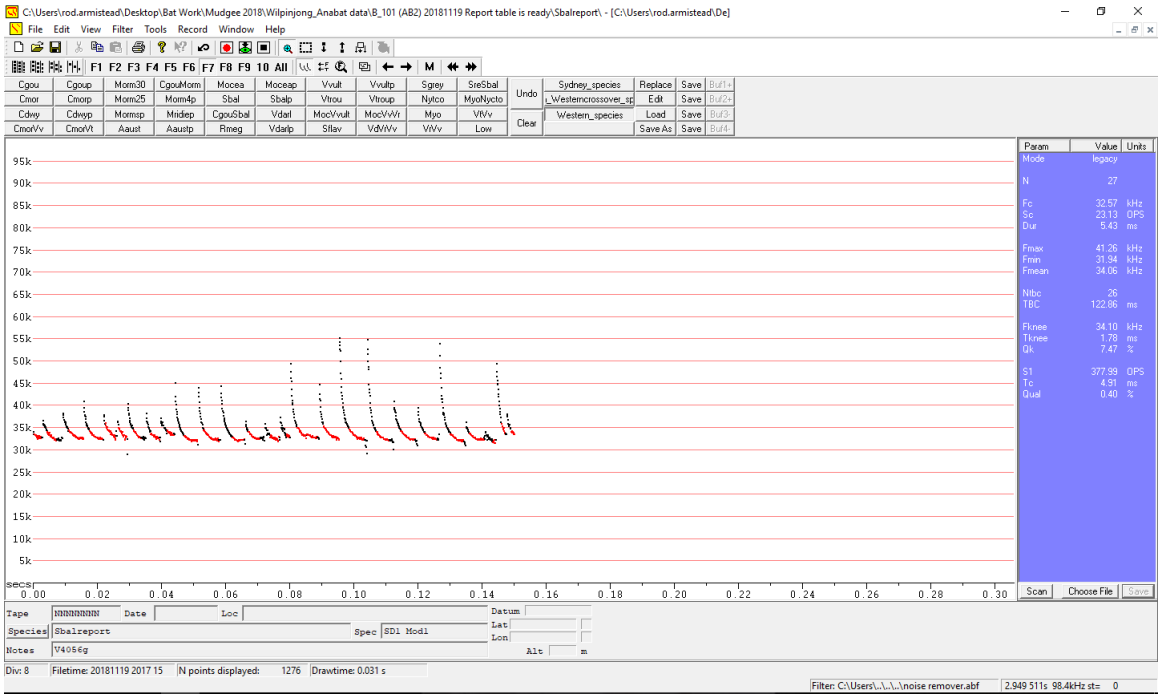

Figure G 10: Call profile for *Scotorepens balstoni* (Inland Broad-nosed Bat) recorded at B_101 at 2017 (8.17 pm) on 19 November 2018.

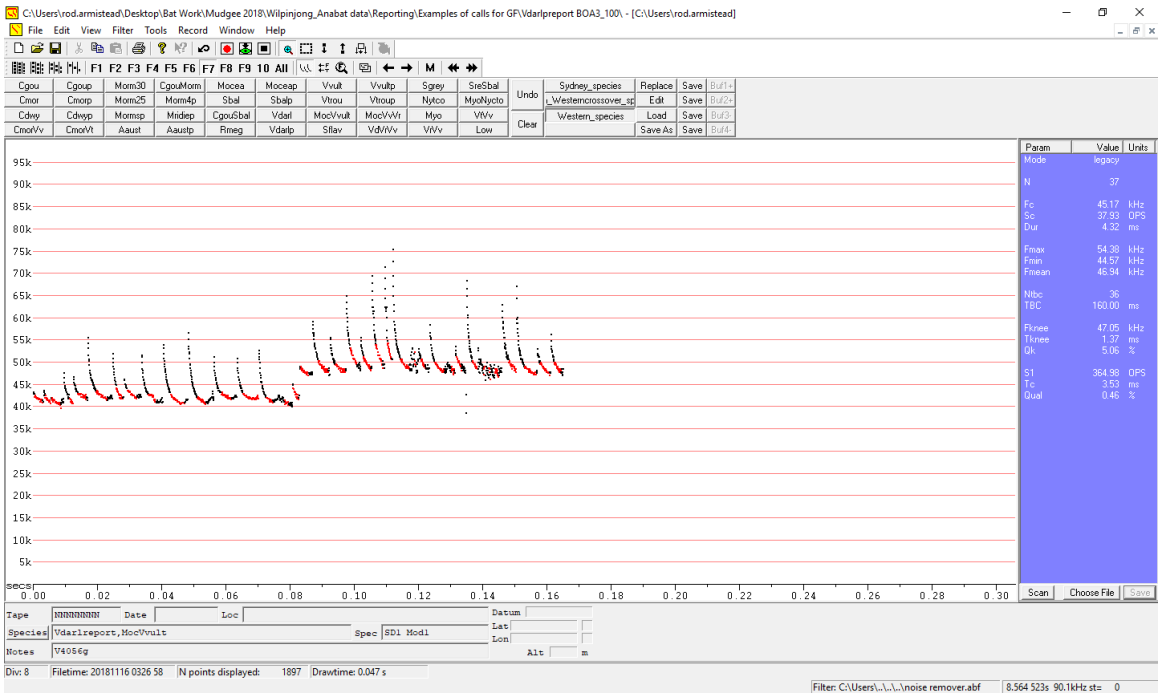

Figure G 11: Call profile for *Scotorepens greyii* (Little Broad-nosed Bat) / *Vespadelus darlingtoni* (Large Forest Bat) / (lower frequency call) with a ***Miniopterus orianae oceanensis*** **(Eastern Bentwing-bat)** / *Vespadelus vulturnus* (Little Forest Bat) (higher frequency call) recorded at BOA3_100 at 0326 (3.26 am) on 16 November 2018.

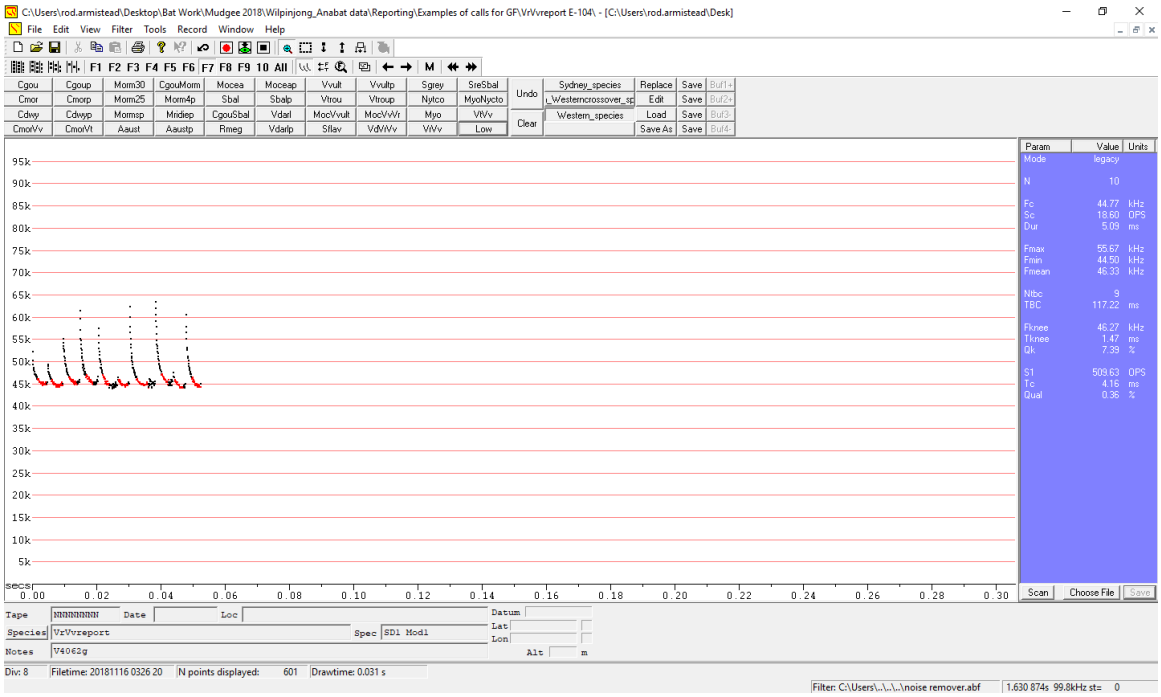

Figure G 12: Call profile for *Vespadelus regulus* (Southern Forest Bat) / *Vespadelus vulturnus* (Little Forest Bat) recorded at 0326 (3.26 am) on 16 November 2018.

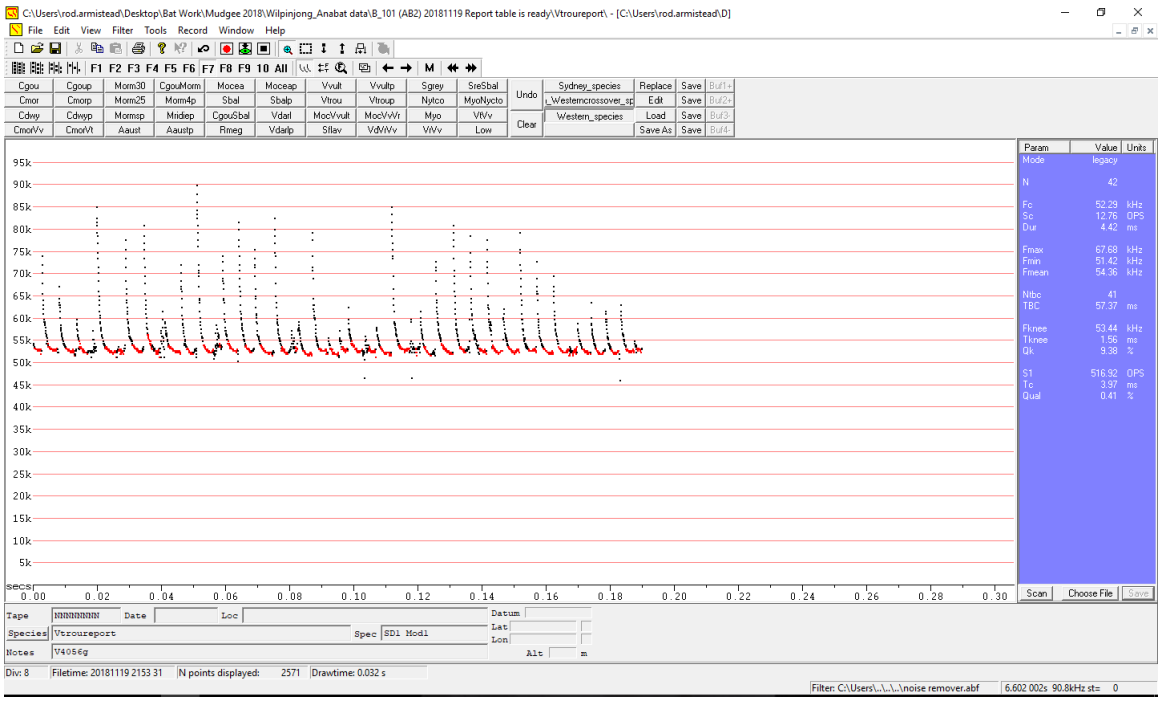

Figure G 13: Call profile for ***Vespadelus troughtoni* (Eastern Cave Bat)** recorded at B_101 at 2153 (9.53 pm) on 19 November 2018**.**

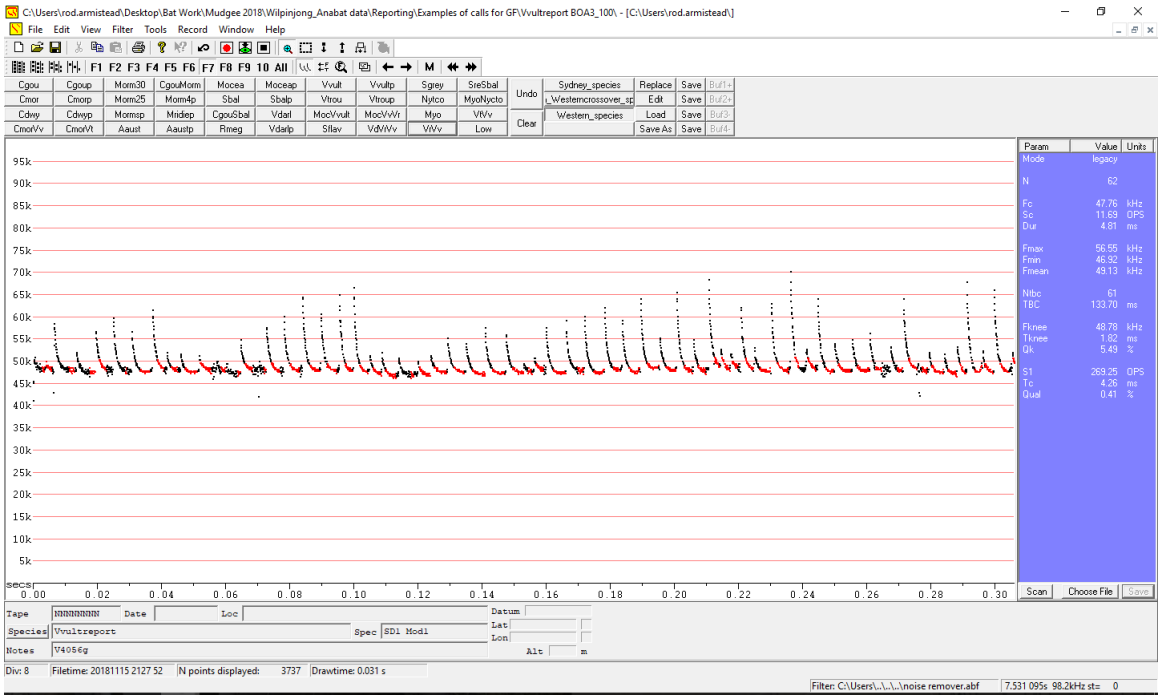

Figure G 14: Call profile for *Vespadelus vulturnus* (Little Forest Bat) recorded at BOA3_100 at 2127 (9.27 pm) on 15 November 2018.

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18th June, 2018

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Results of microbat survey of disused oil shale mine adit, Slate Gully, Wilpinjong, New South Wales.

Dear Ian,

Following are the results of our latest survey of a disused oil shale mine adit at Slate Gully, Wilpinjong, New South Wales. Counts of bats exiting the adit were conducted from dusk on the evening of 6th June 2018 using hand held counters. Following the counts a harp trap was placed at the adit mouth and bats re-entering the mine were captured from 6.20pm. Individuals of two species were captured, the Eastern Bent-wing Bat (*Miniopterus orianae oceanensis*) and Eastern Horseshoe Bat (*Rhinolophus megaphyllus*). Trapping of the adit was again undertaken from 4.00am until 6.00am on the morning of the 7th June. Bats were identified to species and sex and individuals that had not been banded on previous surveys had their forearm marked with a permanent marking pen. The adit was again harp trapped on the evening of the 7th June to obtain an estimate of the number of individuals roosting within the disused workings. Weather conditions during the survey are detailed in *Table 1*.

Weather was moderate to warm with no rain during the survey. Minimum temperatures varied from 2.1 to 8.6°C while maximum temperatures varied from 16.5 to 18.8°C.

Table 1
Weather conditions during the survey

Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
5/06/2018	2.1	16.5	0
6/06/2018	8.6	17.5	0
7/06/2018	8.2	18.8	0

The two species of predominantly cave roosting microbats previously recorded from the mine workings were again recorded during the current survey, the Eastern Bent-wing Bat (*Miniopterus orianae oceanensis*) and Eastern Horseshoe Bat (*Rhinolophus megaphyllus*). As expected, neither species were breeding at the time of survey. The colony of Eastern Bent-wing Bats roosting within the workings at the time of survey consisted of a mixture of males, females that had not yet given birth to young and older females that had reared young during previous breeding events. Eastern Bent-wing bats again made up the bulk of the bats present within the workings with 505 individuals captured compared with 16 Eastern Horseshoe Bats. As with previous surveys, a small number of Eastern Horseshoe bats were present (<50 individuals). The majority of individuals captured were male, but a smaller number of females were also present. Results to date indicate that a small colony of males and non-breeding females exists in the workings throughout the year.

The tally of bats exiting the mine workings on the evening of 6th June with a hand held counter was 1029 individuals. This indicates that the number of bats utilising the workings during the June survey was just over 1000 individuals. These numbers are the highest recorded from the workings to date. Previous counts have been in the range of 600 to 800 individuals. This increase in the number of individuals counted may be due to a number of factors. Diurnal roosts of the Eastern Bent-wing Bat can exhibit wide fluctuations in the number of individuals present, particularly when dispersing individuals are passing through an area en route to another roost. They also can undergo high turnover of individuals as bats move between roosts to socialise etc. The 2018 winter survey was approximately one month earlier than the survey undertaken during the winter of 2017. Milder temperatures during the current survey may also have allowed more bats to forage.

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Best wishes

Glenn Hoye and Andrew Lothian

June 2018 *Fly By Night Bat Surveys Pty Ltd*

BMP 3 Year Schedule: Assessment of Actions

Management Strategy	Objectives	2018	Assessment of Actions
Cultural Heritage Management	Identification of cultural heritage sites within the Biodiversity Offset Areas to avoid potential harm	Undertake Due Diligence cultural heritage surveys in accordance with Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW within areas of proposed disturbance of the 2 Biodiversity Offset Areas to identify cultural heritage sites	Not Triggered in 2018. No disturbance activities during the 2018 reporting period. There was a scheduled survey of the WEP Offset Areas (1-5) undertaken by South East Archaeological (SEA) and the RAPs in 2018.
	Cultural heritage items within the approved disturbance area, ECAs, Regeneration and Rehabilitation Areas are managed in accordance with the WCPL ACHMP (within DA boundaries) and Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW for areas elsewhere	Continue implementation of WCPLs ACHMP, Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW and WCPLs GDP Process	
Fencing, Gates and Signage	Clearly delineate all Biodiversity Offset Areas, ECAs and Regeneration Areas	Undertake annual security inspection. Schedule and undertake necessary repairs	Inspections ongoing throughout the 2018 reporting period. All stock excluded. Repair of fences and gates ongoing as required.
	Prevent unauthorised human access to all Management Domains		
	Exclude livestock from areas of native regeneration (unless being used as within management program i.e. crash grazing)		
	Access to the Management Domains is retained for maintenance and safety purposes		
Access Tracks	Reduce and rehabilitate unnecessary access tracks in all Biodiversity Offset Areas , ECAs and Regeneration Areas	Undertake quarterly rehabilitation inspection. Schedule and undertake necessary repairs	Inspections ongoing throughout the 2018 reporting period. Repair and maintenance of access tracks ongoing as required.
	Provide safe, unimpeded access for monitoring and maintenance, bushfire management, and asset protection in all Biodiversity Offset Areas, ECAs and Regeneration Areas	Undertake annual access track inspection. Schedule and undertake necessary repairs	Bushfire management plan review completed in 2018 which included a detailed review by bushfire ecologist in November 2017. Finalising of the revised BFMP is scheduled in early 2019.
Waste Management	All Biodiversity Offset Areas, ECAs and Regeneration Areas are free of waste, disused buildings and redundant farm equipment	Undertake quarterly waste inspections. Schedule and commission removal of all additional waste Include disused building sites on quarterly rehabilitation inspection. Schedule and undertake necessary repairs.	Inspections ongoing throughout the 2018 reporting period. Removal of building wastes continued in 2018 and focussing on the additional Offset Areas.
Erosion, Sedimentation and Soil Management	Erosion, sediment or soil (i.e. Salinity) risks are identified and mapped in all Biodiversity Offset Areas, ECAs and Regeneration Areas	Undertake quarterly erosion, sediment and soil inspections. Update GIS database with necessary changes	Inspections ongoing throughout the 2018 reporting period, which included use of LFA in accordance with the BMP.

BMP 3 Year Schedule: Assessment of Actions

Management Strategy	Objectives	2018	Assessment of Actions
	A risk based monitoring and management plan is developed for erosion, sediment and soil risks in all Biodiversity Offset Areas, ECAs and Regeneration Areas	Continue to implement WCPLs Erosion and Sediment Control Plan Undertake quarterly erosion, sediment or soil inspections. Schedule and undertake necessary repairs	
Grazing and Stock Management	Exclude livestock from areas of native regeneration in all Biodiversity Offset Areas, ECAs and Regeneration Areas (unless being used as within management program)	Undertake annual security inspection. Schedule and undertake necessary repairs	Inspections ongoing throughout the 2018 reporting period. All stock excluded. Lessee inspections of fences prior to stocking to ECAs and Regen Areas.
	Consider livestock as a rehabilitation management tool	Review rehabilitation performance towards completion criteria. If deemed appropriate, seek technical advice regarding the use of livestock as a rehabilitation management tool	Focus on the development of BVT performance and completion for 2019. Livestock unlikely to be use due to the revised requirement for native vegetation as opposed to previous agricultural land use.
Seed Collection and Propagation	All seed collectors are appropriately qualified and trained	Confirm training records for engaged seed collectors	Hunter Ecological is confirming seed species mix appropriate required BVTs (this was completed in 2018) Scope of works to be developed for seed collection subject to BVT seed mix confirmation. Tender prepared for seed collection in 2019.
	Local species are included in revegetation and rehabilitation seed mixes		As Above
	Locally sourced seed is available for revegetation and rehabilitation works within all Management Domains	Implement seed collection and propagation procedure opportunistically	
Habitat Augmentation	Habitat augmentation opportunities are identified and assessed Habitat within poor and moderate resilience areas within Biodiversity Offset Areas, ECAs, and Regeneration and Rehabilitation Areas is enhanced	Implement recommendations from the habitat augmentation assessment	The BMP monitoring includes assessment of native vegetation and habitat complexity. The assessments are annually and reviewed accordingly. WCPL developed a *habitat augmentation procedure* to be implemented from 2019.
Revegetation and Regeneration	Increase overall native plant species richness to meet Interim Performance Targets in Biodiversity Offset Areas, ECAs and Regeneration and Rehabilitation Areas	Undertake quarterly revegetation and regeneration inspections. Schedule and undertake necessary maintenance including reapplication of seed or	The BMP monitoring includes assessment of native vegetation and habitat complexity. The assessments are annually and reviewed

BMP 3 Year Schedule: Assessment of Actions

Management Strategy	Objectives	2018	Assessment of Actions
		supplementary tree and shrub planting.	accordingly. No planting in ECAs and/or BOAs was undertaken due to the dry conditions and will be reassessed in 2019.
Weed Management	Noxious and environmental weeds are identified and mapped in all Biodiversity Offset Areas, ECAs and Regeneration Areas	Undertake quarterly weed inspections. Update GIS database with necessary changes	Weed spraying undertaken in portions of BOAs, ECAs and Regen Area (refer to 2018 Spray Map – Appendix 5). In 2018 target weed spraying was completed based o internal and MWRC inspections from previous seasons. Lessees across the broader company landholdings also undertake ongoing weed management.
	A risk based weed management program is developed for all Biodiversity Offset Areas, ECAs and Regeneration Areas	Implement weed management program Undertake quarterly weed inspections. Schedule and undertake necessary weed treatment	
	Reduced presence of noxious and environmental weeds	Implement weed management program Specific Actions include: Targeted spraying of prickly pear and garden escapes around the disused dwelling in Biodiversity Offset Area-D Targeted spraying of blackberry and *Juncus acutus* (Spiny Rush) along Cumbo Creek within ECA-A and Regeneration Area 2 Targeted spraying of blackberry and *Juncus acutus* (Spiny Rush) along Wilpinjong Creek within ECA-B and Regeneration Areas 1 and 5	
Vertebrate Pest Management	Vertebrate pest species and their presence is known within the Biodiversity Offset Areas, ECAs and Regeneration and Rehabilitation Areas		Monitoring for pests species include in annual biodiversity monitoring program. In 2018, targeted pest species management included feral pig trapping in ECA 'A' and 'D', fox and wild dog control was undertaken in Spring and Autumn in conjunction with the local wild dog group. Aerial dog bating and trapping campaign between Pit 3/7 and Slate Gully 2018. This program was undertaken in consultation with Local Land Services (LLS) as a result of know wild dog activity in the local area. Lessees across the broader company landholdings also undertake ongoing vertebrate pest management.
	Control vertebrate pest species likely to pose a threat to the Biodiversity Offset Areas, ECAs and Regeneration and Rehabilitation Areas	Implement vertebrate pest management program	

BMP 3 Year Schedule: Assessment of Actions

Management Strategy	Objectives	2018	Assessment of Actions
Bushfire Management	Maintain the environmental and habitat features of the Biodiversity Offset Areas, ECAs and Regeneration and Rehabilitation Areas	Implement WCPL Bushfire Management Maintain APZs	Bushfire management plan review completed in 2019 which included a detailed review by bushfire ecologist in November 2017. BFMP implementation ongoing in 2019.
Biodiversity Monitoring	Monitor biodiversity within the Biodiversity Offset Areas, ECAs and Regeneration and Rehabilitation Areas to assess progress against completion criteria	Implement Biodiversity Monitoring Program and analyse results against the completion criteria and undertake corrective actions where required.	The BMP monitoring includes assessment of native vegetation and habitat complexity. The assessments are annually and reviewed accordingly.
Inspections and Document Control	Ensure implemented management actions are successful in progressing towards completion criteria	Undertake and document inspections	This Annual Review. BVT performance and completion criteria relevant to the rehabilitation areas are still being developed in accordance with Schedule 3, Condition 37 of the Development Consent SSD-6764. Upon resolution of the performance and completion criteria, in accordance with Condition 65 of the Development Consent SSD-6764, the BMP will be comprehensively updated as required to reflect the new criteria.
	All actions, monitoring data and performance outcomes are documented and reported	Document all actions, monitoring data and performance outcomes	
Management of Biodiversity Offsets 1-5	Manage Biodiversity Offset Areas 1-5 and facilitate their transfer to the National Parks Estate.	Demolition and removal of any houses and/or buildings that are not required by the NPWS. Undertake a survey of the Biodiversity Offset Area boundaries that do not follow existing cadastral boundaries (and any necessary lot subdivision with the assistance of the Mid-Western Regional Council).	This process has commenced and WCPL are schedule to complete within the timeframes as nominated by the SSD-6764.
Early establishment of Regent Honeyeater habitat in available areas	Establish Regent Honeyeater habitat within existing mine rehabilitation areas where rehabilitation to date has focussed on the establishment of productive pasture for grazing.	Undertake monitoring of Rehabilitation Areas and determine initial success of non-native species control and re-seeding works. Continue to implement the control of non-native species and re-seeding of select existing rehabilitation areas to a combination of suitable native plant species (e.g. key canopy species of recognised BVTs).	In 2017, a burn and herbicide trial in August 2017 was undertake in a section of the rehabilitation area to determine if existing woodland areas could be converted to nominated BVTs. In 2018 investigations into existing rehabilitation conversion into BVT s (as soon as they are confirmed). BVT performance and completion criteria relevant to the rehabilitation areas are still being developed in accordance with Schedule 3, Condition 37 of the Development Consent SSD-
Rehabilitation of the Mine site to recognised habitat and ecosystem values	Establish recognised BVTs and Regent Honeyeater habitat in the Rehabilitation Areas.	Commence implementation of rehabilitation strategy to develop BVT and Regent Honeyeater habitat.	

BMP 3 Year Schedule: Assessment of Actions

Management Strategy	Objectives	2018	Assessment of Actions
			6764. Upon resolution of the performance and completion criteria, in accordance with Condition 65 of the Development Consent SSD-6764, the BMP will be comprehensively updated as required to reflect the new criteria
Propagation of *Ozothamnus tesselatus*	Successfully propagate *Ozothamnus tesselatus* in suitable Mine site rehabilitation areas.	Undertake trial plantings of *Ozothamnus tesselatus* within potentially suitable rehabilitation areas.	Collection of seeds for *Ozothamnus tessalatus* was undertaken in 2018. The focus of 2019 will be propagation trials and viability trials and collection will continue in 2019.
Revegetation works along Cumbo and Wilpinjong Creeks	Establish revegetation on sections of Cumbo and Wilpinjong Creeks in WCPL and Peabody ownership.	Continue to implement the works program with remedial measures as required.	Weed management activities occurred in 2018 refer to Weed Spray Mat in Appendix 5. Stock was excluded from portions of the creek in 2017. Activities along sections of Wilpinjong Creek included weed spraying and excluding stock in 2018.