Olive Downs

Stage 1 Offset Area Management Plan

Prepared for Pembroke Resources
June 2020

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Stage 1 Offset Area Management Plan

Report Number

B190716 RP#1

Client

Pembroke Resources

Date

22 June 2020

Version

v1 Draft

Prepared by	**Approved by**
	
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1 Introduction

1.1 Background

Pembroke Olive Downs Pty Ltd (Pembroke) are the proponent for the Olive Downs Coking Coal Project (herein referred to as the Project). The Project is a greenfield metallurgical coal mine within the Bowen Basin, located approximately 40 kilometres (km) south-east of Moranbah, Queensland.

The Project comprises four separate components being:

- a rail spur connecting the mine site to the Norwich Park Branch Railway;
- a water pipeline connecting to the Eungella pipeline network;
- an electricity transmission line (ETL); and
- the mine and access road (Figure 1.1).

The coal resource will be mined by conventional open cut mining methods, with product coal to be transported by rail to the Dalrymple Bay Coal Terminal.

The four key Project components were referred to the Commonwealth Department of Agriculture, Water and the Environment (DAWE) via separate referrals, and subsequently determined to be 'controlled actions' requiring assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The four referrals are:

1. Olive Downs Project Water Pipeline (EPBC 2017/7868);
2. Olive Downs Project Electricity Transmission Line (EPBC 2017/7869);
3. Olive Downs Project Rail Spur (EPBC 2017/7870); and
4. Olive Downs Mine Site and Access Road (EPBC 2017/7867).

All referrals were assessed under the bilateral agreement between the Commonwealth and the State of Queensland, via an Environmental Impact Statement (EIS). All four referrals have now received approvals under the EPBC Act, with the last approval being the mine site and access road dated 14 May 2020.

Pembroke have undertaken extensive ecological surveys and impact assessments as part of preparing the EIS for the Project, evaluating the potential for significant impacts to occur to both matters of state and national environmental significance. The total extent of surface disturbance over the life of mine is estimated at 16,300 hectares (ha). Disturbance will occur progressively; therefore, the mine has been broken up into four main delivery stages. Stage 1 includes the first five years of construction and operation of the mine site and access road, plus construction of all ancillary facilities such as the water pipeline, electricity transmission line (ETL) and rail spur.

The EIS identified that significant impacts are likely to occur to matters of national environmental significance (MNES), and environmental offsets will be required for those matters. Pembroke have received approval to deliver the offsets in a staged manner, coinciding with the designated four mine stages. Offsets required for Stage 1 works, including breakdown for each Project component, is summarised in Table 1.1.

The required offsets are proposed to be delivered as direct, land-based offsets and Pembroke have identified the Stage 1 offset area for approval. Pembroke have commissioned detailed ecological surveys across the Stage 1 offset area to confirm the area supports, or has the potential to support, the required MNES and further details on the suitability of the offset are provided in this Offset Area Management Plan (OAMP).

Table 1.1 Stage 1 significant residual impacts to be offset

MNES habitats	Mine site and access road impact - Stage 1 (ha)	Water pipeline impact (ha)	Electricity transmission line impact (ha)	Rail spur impact (ha)	Total Stage 1 Impacts (ha)
Ornamental Snake (*Denisonia maculata*)	1,032	8	10.5	33	**1,083.5**
Australian Painted Snipe (*Rostratula australis)*	16	1	0	6.5	**23.5**
Squatter Pigeon (*Geophaps scripta scripta*)	990.5[1]	21.5[2]	23.5[3]	40.5[4]	**1,076**
Koala (*Phascolarctos cinereus)*	1,110.5	28	22	43.5	**1,204**
Greater Glider (*Petauroides volans*)	978.5	28	20.5	43.5	**1,070.5**

Notes:
1. This includes 855 ha of Squatter Pigeon breeding habitat and 135.50 ha of foraging habitat.
2. This includes 15 ha of Squatter Pigeon breeding habitat and 6.5 ha of foraging habitat.
3. This includes 18.5 ha of Squatter Pigeon breeding habitat and 5 ha of foraging habitat.
4. This includes 40 ha of Squatter Pigeon breeding habitat and 0.5 ha of foraging habitat.

1.2 Purpose and scope

The purpose of this Stage 1 OAMP is to describe the offset area, the performance outcomes to be achieved for each MNES, management actions to be implemented to achieve the set outcomes, risks to achieving those outcomes and appropriate corrective actions, and outline a monitoring and reporting program.

Approval conditions require Pembroke to compensate for the clearance of listed threatened species habitat through provision of environmental offsets that are consistent with the EPBC Act Environmental Offsets Policy (DoSEWPC 2012a). Condition 3 of each approval requires Pembroke to prepare an OAMP while Condition 4 sets out the information required to be contained in the OAMP.

The information that the OAMP needs to include, and where this information is provided is summarised in Table 1.2.

Table 1.2 OAMP requirements and where they are addressed in this report

OAMP requirement	Section of report addressed
a) a description of the offset, including location, size, condition, environmental values present and surrounding land uses;	Section 3
b) baseline data, including results from field validation surveys, and quantifiable ecological data on habitat quality and other supporting evidence that documents the presence of each listed threatened species and the quality of each listed threatened species habitat within the offset area;	Section 3 and Appendix A
c) an assessment of site habitat quality using a method agreed to in writing by the Department;	Section 3.2 and Appendix A

Table 1.2 OAMP requirements and where they are addressed in this report

OAMP requirement	Section of report addressed
d) details of how the offset area will provide connectivity with other habitats and biodiversity corridors and/or will contribute to a larger strategic offset for each listed threatened species;	Section 3.2.1
e) maps and shapefiles to clearly define the location and boundaries of the offset area, accompanied by offset attributes;	Figure 3.1 –Figure 6.1 Shapefiles to be provided separately to DAWE
f) specific offset completion criteria derived from the site habitat quality to demonstrate the improvement in the quality of each listed threatened species habitat in the offset area over the period of effect of this approval;	Table 4.6 and Table 6.3
g) details of the management actions, and timeframes for implementation, to be carried out to meet the offset completion criteria;	Section 4
h) interim milestones that set targets at 5-yearly intervals for progress towards achieving the offset completion criteria;	Table 6.3
i) details of the nature, timing and frequency of monitoring to inform progress against achieving the 5-yearly interim milestones (the frequency of monitoring must be sufficient to track progress towards each set of milestones, and sufficient to determine whether the offset area is likely to achieve those milestones in adequate time to implement all necessary corrective actions);	Section 6
j) proposed timing for the submission of monitoring reports which provide evidence demonstrating whether the interim milestones have been achieved;	Section 6 and Section 7
k) timing for the implementation of corrective actions if monitoring activities indicate the interim milestones will not or have not been achieved;	Section 4, Table 6.2 and Table 6.3
l) a risk analysis and a risk management and mitigation strategy for all risks to the successful implementation of the OAMP and timely achievement of the offset completion criteria, including a rating of all initial and post-mitigation residual risks in accordance with the risk assessment matrix;	Section 5
m) evidence of how the management actions and corrective actions take into account relevant approved conservation advices and are consistent with relevant recovery plans and threat abatement plans; and	Section 4 and Table 4.6
n) details of the legal mechanism for legally securing the offset area, such that legal security remains in force over the offset area for at least the period of effect of this approval.	Section 4.2.9

Additional conditions of approval pertaining to the Stage 1 offsets are addressed in Table 1.3.

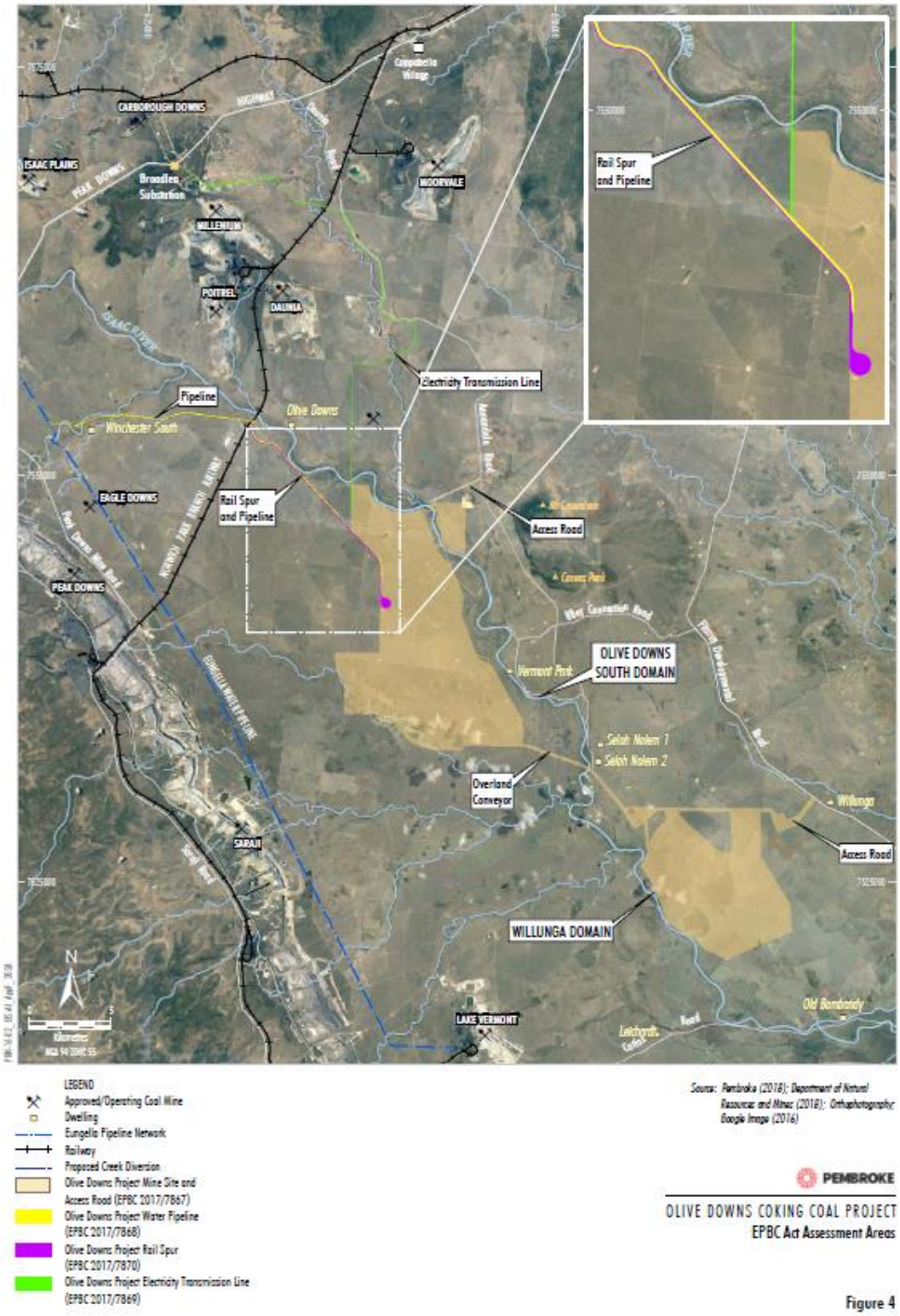
Table 1.3 Offset related conditions of approval for Stage 1 (EPBC 2017/7867)

Condition requirement	Section of report addressed
To compensate for the clearance of habitat for listed threatened species and community for Stage 1 up to the limits as specified in condition 2, the approval holder must provide an environmental offset consistent with the Environmental Offsets Policy.	Table 2.1
The environmental offset to compensate for the clearance of 978.5 ha of Greater Glider (*Petauroides volans*) habitat for Stage 1 must result in a measured increase in Greater Glider (*Petauroides volans*) habitat connectivity in the riparian zones within the Stage 1 environmental offset.	Section 3.3.5, Section 4.2.6 and Table 4.6
The Stage 1 OAMP must include the offset information to compensate for the clearance of listed threatened species and community habitat as provided for in condition 2 in accordance with the principles of the Environmental Offsets Policy.	Table 2.1

Table 1.3 Offset related conditions of approval for Stage 1 (EPBC 2017/7867)

Condition requirement	Section of report addressed
To assess the effectiveness of the management actions in the Stage 1 OAMP to increase Greater Glider (*Petauroides volans*) habitat connectivity in the riparian zones within the Stage 1 environmental offset, the approval holder must engage an independent suitably qualified expert to undertake an assessment every 5 years from the implementation date of the approved Stage 1 OAMP until the approved Stage 1 OAMP offset completion criteria are achieved.	Section 6
The approval holder must ensure each assessment of the effectiveness of the management actions in the Stage 1 OAMP is: a. subject to a peer-review completed within 6 months of the completion of each such assessment; and b. published on its website with the findings of the peer-review within 6 months of the completion of the peer-review and for the duration of this approval.	Section 6

Figure 1.1 Project components



2 Legal framework

Summary of key legislation and policies pertaining to the design and implementation of the Stage 1 offset area is summarised below.

2.1 EPBC Act

Under the EPBC Act approvals for the Project Pembroke are required to offset the significant, residual impacts to MNES. Delivery of the offsets in stages has been approved by DAWE with the Stage 1 OAMP required to be approved by the Minister prior to the Project commencing. For Stages 2 to 4 of the Project, a biodiversity offset would be provided and applicable OAMP approved by the Minister before the commencement of each stage.

The Stage 1 offset area is designed to be consistent with the EPBC Act Environmental Offsets Policy and compensate for residual impacts for the first five years of the Project (referred to as Stage 1). A summary of the residual impacts to MNES required be offset in Stage 1 are summarised in Table 1.1.

The OAMP is required to be prepared by a suitably qualified ecologist and submitted for the written approval of the Minister. The approved OAMP must be implemented.

Applicable conditions of approval associated with the Stage 1 offsets, and where these requirements have been addressed, are summarised in Section 1.2.

2.2 Environmental Offsets Policy

Environmental offsets proposed have been assessed using the framework under the EPBC Act Environmental Offsets Policy (DoSEWPC 2012a) (the Policy). Offset assessment methodologies have applied the criteria within the DoEE *Offset Assessment Guide: Offset Calculator tool*.

The key components of the guide are the Impact Calculator and Offset Calculator (Figure 2.1). Once the inputs have been provided for the Impact Calculator and Offset Calculator, the Offset Assessment Guide provides the results as a percentage of impact offset, where >100% indicates that all of the impact is achieved through a direct offset.

The habitat quality scores on both impact site and offset site have been determined applying the Queensland 'Guide to determining terrestrial habitat quality' (DoES 2017) which is an endorsed method of deriving a habitat quality score for ecological communities and species listed under EPBC Act. BioCondition assessments are the basis for these scores plus consideration of site context and species habitat.

Full details of the EPBC Act offset calculators are provided in Appendix A of this OAMP.

Details on ecological surveys of the proposed offset area including habitat mapping for each MNES species and habitat quality assessments are provided in the 'Olive Downs Coking Coal Project – Additional Information to the Assessment of MNES' prepared by DPM Enviroscienses dated September 2019.

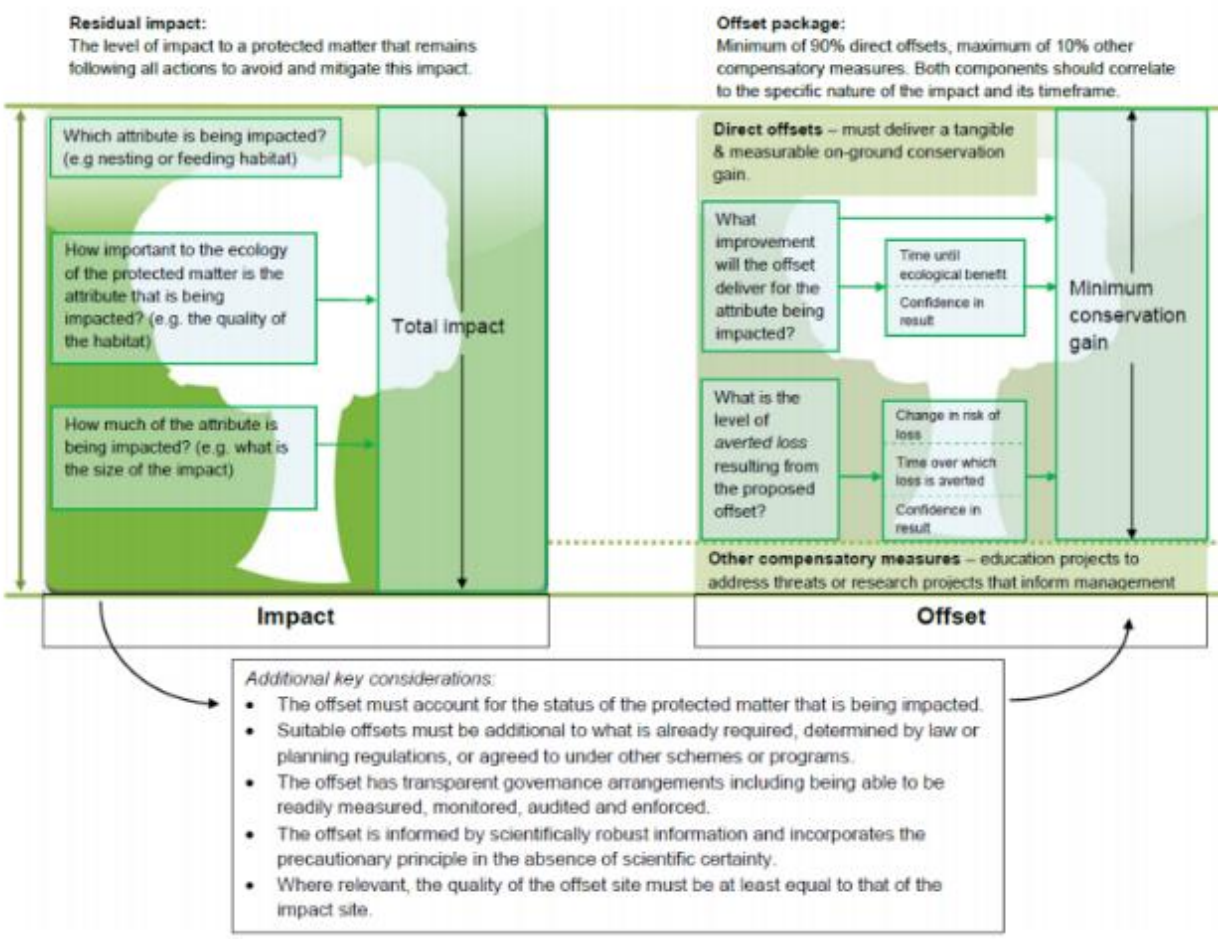


Figure 2.1 Determining suitable offsets under EPBC Act

2.3 Compliance with Environmental Offsets Policy

The key principles that underpin the Environmental Offsets Policy have been addressed in the development of the Stage 1 offset area, management actions proposed, and overarching governance framework as summarised in this OAMP. Key offset principles and how they have been addressed are summarised in Table 2.1.

Table 2.1 Overarching principles to determine offset suitability

Suitable offsets must	Section of report addressed
1. Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environmental law and affected by the proposed action	Section 3 Each impacted MNES in Stage 1 has a direct land-based offset area proposed that currently provides suitable habitat for the species, or will be restored to provide suitable habitat for the species. Offset areas will be legally secured in perpetuity, actively managed to increase their ecological condition and/or habitat extent increased and threats reduced to improve the species viability.

Table 2.1 Overarching principles to determine offset suitability

Suitable offsets must	Section of report addressed
2. be built around direct offsets but may include other compensatory measures	Section 3 Each impacted MNES in Stage 1 has a direct land-based offset area proposed that currently provides suitable habitat for the species, or will be restored and rehabilitated to provide suitable habitat for the species. The direct, land-based offsets for Stage 1 meet 100% of offset policy requirement (see Appendix A). In addition to these direct offsets Pembroke also propose to undertake research and monitoring programs as part of the offset delivery for Stage 1. This includes a supplementary nest box research and monitoring program to determine use by Greater Gliders and most effective nest box design. This is outlined in Section 4.2.6. Koala and Greater Glider surveys will also be completed to gather important information on the use of the offset areas by the species, preferred habitat types and when they start to use regenerating woodlands. Monitoring is outlined in Section 6. Pembroke are also conditioned (Condition 32 of EPBC 2017 /7867) to contribute $100,000 (GST exclusive and indexed in line with CPI for each year to be equal to value of $100,000) from commencement date of Stage 2, each year for 10 years to a program where it will be used for the better protection and long-term conservation of the Koala and Greater Glider in the Bowen Basin. The funded activities must include: • translocation programs to translocate Koala and Greater Glider individuals from project area to reduce individual mortality and its effects on population size; • revegetate, rehabilitate and restore habitat in riparian zones associated with watercourses to create and maintain Koala and Greater Glider habitat connectivity; • surveys to determine Koala and Greater Glider population density and carrying capacity across the Bowen Basin • implement priorities identified in relevant recovery plans, threat abatement plans and/or approved conservation advices, and evaluate their success and cost effectiveness. The above will be implemented as per conditions of approval to supplement the direct offset measures for whole of Project.
3. be in proportion to the level of statutory protection that applies to the protected matter	The land-based offsets proposed have been assessed in accordance with the EPBC Environmental Offsets Policy and Offsets Assessment Guide which takes into account the status of the species.

Table 2.1 Overarching principles to determine offset suitability

Suitable offsets must	Section of report addressed
4. be of a size and scale proportionate to the residual impacts on the protected matter	Section 3, Section 4 and Appendix A The land-based offsets proposed have been assessed in accordance with the EPBC Environmental Offsets Policy and Offsets Assessment Guide. This has included the quantification of starting habitat quality and end habitat quality for each MNES which was input into offsets calculator. This has then identified if the size of offset area is adequate. The total offset areas to be legally secured and actively managed are of a larger size than those impacted and are situated in close proximity to the impacted areas. Offsets will also enhance patch size of habitats and connectivity for impacted species.
5. effectively account for and manage the risks of the offset not succeeding	Section 5 Risks to the offset not succeeding have been identified and assessed. The DAWE risk matrix has been applied and risks have been scored prior to mitigation measures occurring, and post mitigation measures occurring.
6. be additional to what is already required, determined by law or planning regulations or agreed to under schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action, see section 7.6 of offsets policy)	The land-based offsets and supplementary research and funding that are to be delivered by Pembroke provide significant 'additionality' to what is required by law or planning regulation. Currently the proposed offset properties are being grazed and regrowth woodlands can be lawfully cleared. Gilgai areas can continue to be degraded by livestock or ploughed and cropped. A number of weeds and pest animals are also not required to be managed under Qld legislation and therefore would continue to degrade ecological condition of the site. Actively improving condition of remnant vegetation, protecting and managing natural regeneration, undertaking supplementary tree plantings and installing nest boxes are all 'additional' actions to be implemented. Financial contributions to compensatory activities such as threatened species translocation surveys to determine Koala and Greater Glider population density and carrying capacity across the Bowen Basin are also in addition to what is required by law.
7. be efficient, effective, timely, transparent, scientifically robust and reasonable	Section 6 and Section 7 The proposed offsets and governance framework are efficient, effective, timely, scientifically robust and transparent in their design. There will be annual monitoring and reviews of the offset activities and an annual report prepared. More detailed five yearly performance reviews will be undertaken to assess progress towards performance outcomes which include a requirement (Condition 8) to ensure each assessment of the effectiveness of the management actions in the Stage 1 OAMP is: a. subject to a peer-review completed within 6 months of the completion of each such assessment; and b. published on its website with the findings of the peer-review within 6 months of the completion of the peer-review and for the duration of this approval.

Table 2.1 Overarching principles to determine offset suitability

Suitable offsets must	Section of report addressed
8. have transparent governance arrangements including being able to be readily measured monitored, audited and recorded	Section 6 and Section 7 Extensive monitoring and reporting is proposed. Condition 7 of mine approval require some additional auditing as below: To assess the effectiveness of the management actions in the Stage 1 OAMP to increase Greater Glider (*Petauroides volans*) habitat connectivity in the riparian zones within the Stage 1 environmental offset, the approval holder must engage an independent suitably qualified expert to undertake an assessment every 5 years from the implementation date of the approved Stage 1 OAMP until the approved Stage 1 OAMP offset completion criteria are achieved. Condition 8 also requires to ensure each assessment of the effectiveness of the management actions in the Stage 1 OAMP is: a. subject to a peer-review completed within 6 months of the completion of each such assessment; and b. published on its website with the findings of the peer-review within 6 months of the completion of the peer-review and for the duration of this approval.

2.4 Suitably qualified ecologists

It is a requirement that the approval holder submits a Stage 1 OAMP prepared by a 'suitably qualified ecologist' for the written approval of the Minister (Condition 5). A 'suitably qualified ecologist' is defined under EPBC Act approval as "a person who has professional qualifications and at least 3 years of work experience designing and implementing surveys for the listed threatened species and community and their habitat, and can give an authoritative assessment and advice on the presence and habitat requirements of the listed threatened species and community using relevant protocols, standards, methods and/or literature".

Pembroke commissioned EMM Consulting Pty Ltd (EMM) to prepare this OAMP. The authors have qualifications in environmental management, extensive experience in natural resource management, threatened species conservation including designing and implementing surveys for listed species and communities and preparation of management plans. Berlinda Ezzy and Nathan Garvey are also specialists in biodiversity offsets at a State and Commonwealth level and completed numerous environmental offset assessments.

Key authors and their experience are summarised below. Curriculum vitae (CVs) are provided in Appendix B.

i Berlinda Ezzy

Berlinda is an Associate Ecologist with 20 years' professional experience. She has worked for local and state government, as well as the private sector, across a range of environmental disciplines. Berlinda's areas of expertise include environmental planning and approvals, threatened species management, coordinating delivery of field ecology surveys and reporting, impact assessments and biodiversity offsets.

Berlinda has led complex projects as an environmental consultant for over 10 years and successfully managed a large number of ecology, impact assessment and offset projects for resource and infrastructure companies across Queensland and New South Wales. Berlinda led the Koala Conservation Unit and Threatened Species Unit in the Queensland government for a number of years and has a comprehensive understanding of threatened species management and legislative framework under EPBC Act and NC Act.

Berlinda has prepared a number of threatened species management plans and offset management plans over the past 10 years.

ii Chris Beavon

Chris is an Associate Ecologist with 15 years' professional experience throughout Queensland, New South Wales, Northern Territory and Victoria.

Chris has delivered environmental assessments, monitoring and management projects across a range of sectors including energy, mining, renewables, urban development, infrastructure, and natural resource management. His diverse project experience includes terrestrial ecology assessment, environmental impact statements, protected plant surveys, translocation and monitoring of threatened species, biosecurity assessment and management, compliance assessment, and vegetation rehabilitation.

iii Nathan Garvey

Nathan is an experienced ecologist with over 17 years' practice in ecological assessment across eastern Australia. Nathan has delivered projects across a diverse range of sectors including mining, oil and gas, linear infrastructure, renewable energy and residential development. Nathan is practitioner of biodiversity assessment and approvals, including biodiversity assessment for major projects and EPBC Act referrals. He is one of NSW's leading experts in biodiversity offsetting.

Nathan provides an innovative, whole-of-project approach, delivering solutions for our clients and working with teams to ensure high quality outcomes.

Nathan has prepared a large number of biodiversity management plans for offset sites and also threatened species management plans.

iv Patrick Finnerty

Patrick is an ecologist with project experience across a range of sectors including utilities, infrastructure, construction and energy. Patrick has been involved in the successful delivery of numerous projects including ecological impact assessments, ecological monitoring, management plans and offset feasibility studies. Patrick has project managed and has been the technical lead on major biodiversity monitoring projects within NSW and has a wide range of skills including complex survey logistics and planning, data management and report writing along with biodiversity assessments.

3 Biodiversity offset area

3.1 Regional context and location

The Stage 1 offset area, shown in Figure 3.1, is situated directly east of the Olive Downs Coal Project, on eastern side of the Isaac River, and south-east of Moranbah within the Isaac Regional Council area. The offset areas are situated on the Twenty Mile property (Lot 5 SP 113322) and the Iffley property (Lot 11 KL135) (Figure 3.1). Pembroke own these properties on freehold title.

The Stage 1 offset area is located in the Brigalow Belt North bioregion, and the Isaac-Comet Downs sub-region. It is located in the Isaac-Connors River catchment.

The Brigalow Belt North bioregion has a semi-arid to tropical climate with predominantly summer rainfall. Maximum temperatures are typically in the mid 30s in summer, getting up to as high as 45°C , and mid 20s in winter. The nearest Bureau of Meteorology (BoM) weather station to the Project is Moranbah Airport (34035) for rainfall and temperature data. For the region, rainfall is greatest in summer months, with highest mean rainfalls recorded in December, January and February (Plate 3.1). Annual rainfall in the 2 years prior to 2020 totalled 366.2 millimetres (mm) and 324.8 mm, which is marginally lower than the 5 year average of 519.13 mm (Plate 3.2). However, the region has recently experienced good falls of rain in January 2020 (100.2 mm total), February 2020 (76.4 mm total) and March 2020 (53.2 mm total) (BoM 2020). Mean minimum temperature in winter averages around 9°C and mid to low 20s in summer (Plate 3.2).

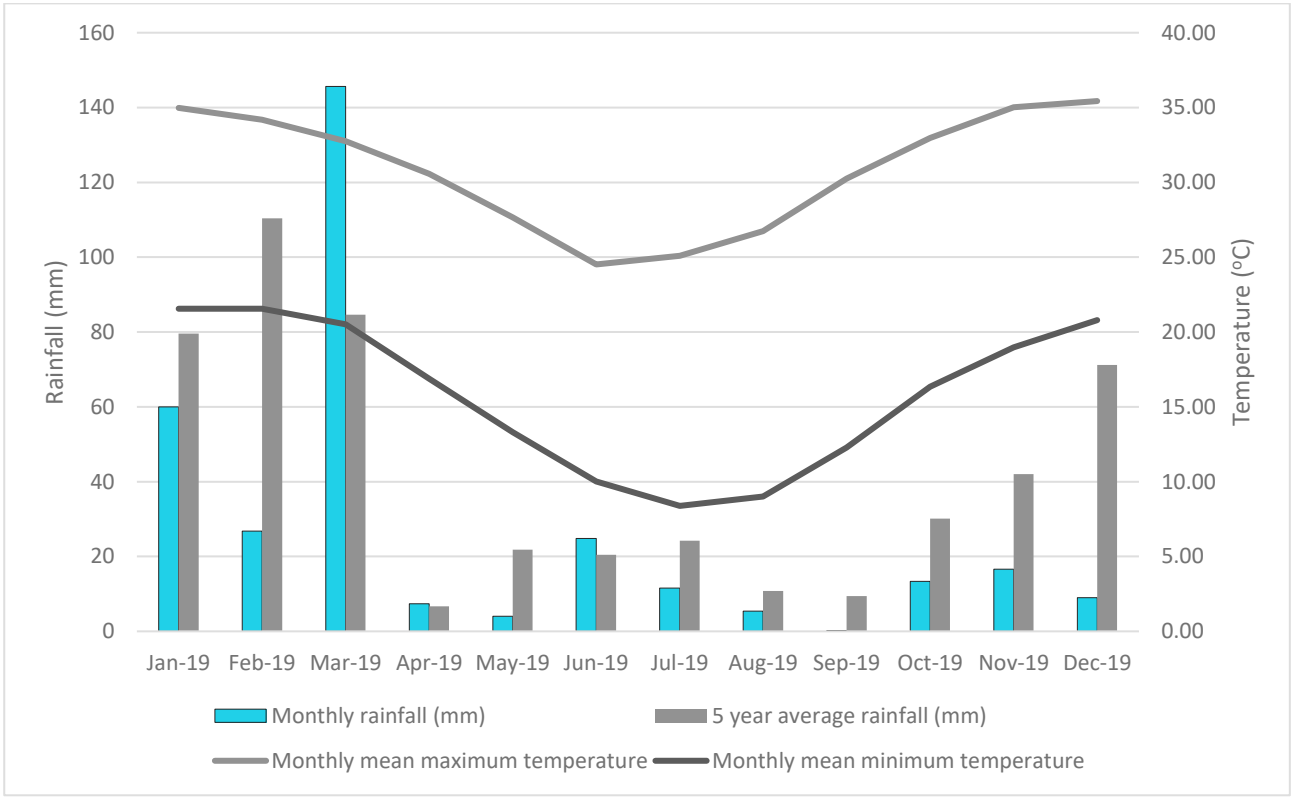


Plate 3.1 Rainfall and temperature at Moranbah, QLD

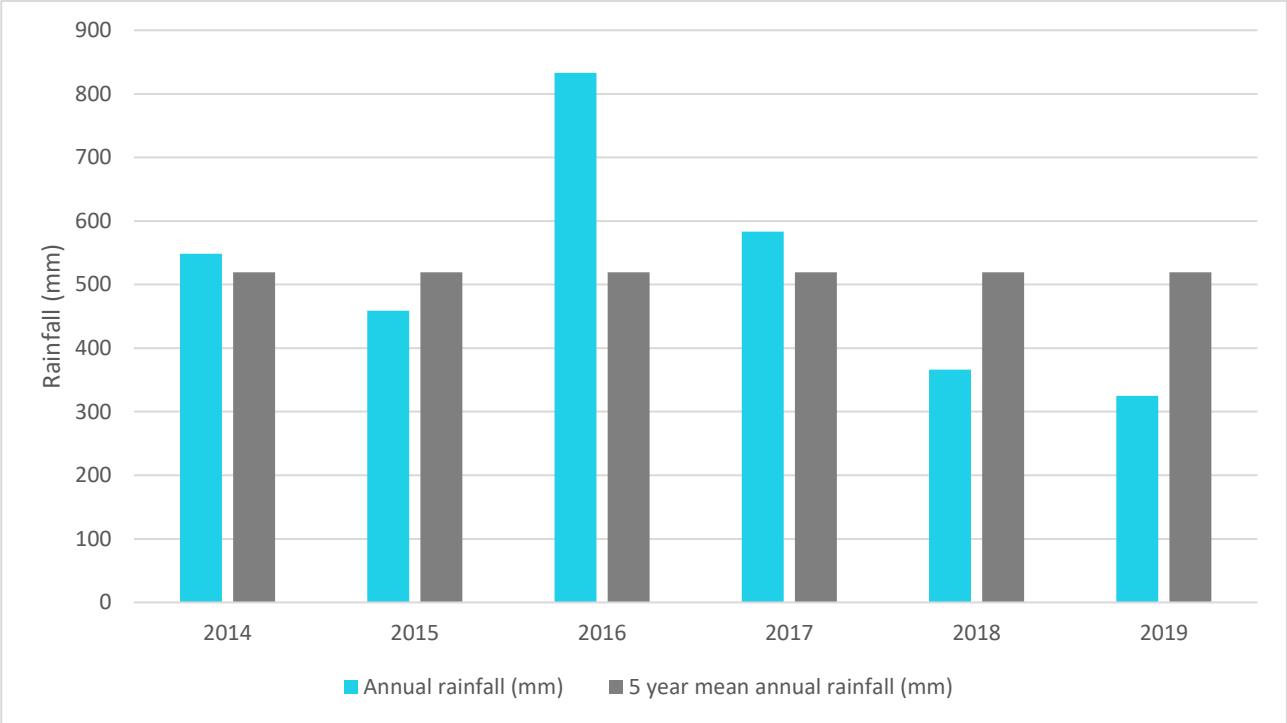


Plate 3.2 Mean Rainfall at Moranbah, QLD

Surrounding land uses are predominantly grazing land and coal mining (Figure 3.2). Mines in the area include Coppabella and Moorvale to the north, Daunia, Caval Ridge and Peak Downs to the west and south-west and Lake Vermont mine to the south. Land directly to north and east is predominantly grazing land, areas supporting remnant vegetation and Dipperu National Park (Scientific) that is situated approximately 20 km north-east of the offset area. The Codrilla Mining Lease is situated to the east but is not developed (Figure 3.2) and there are constraints with development of this area resulting in the mine being unlikely to be developed.

There are no registered interests under the Qld *Land Act 1994* or the Qld *Land Title Act 1994* on the offset properties. There are Mineral Development Lease (MDL), Authority to Prospect (ATP) and Exploration Permits (EPC and EPM) in the region. Those that overlap with the properties in which Stage 1 offset area is proposed are:

- MDL3023 (Peabody – coal) this is excluded from offset area;
- ATP 759 (Arrow Energy – coal seam gas);
- Exploration Permit Mineral (EPM) 26991 (HB Base Metals Pty Ltd);
- EPM 26499 (Kenex Pty Ltd);
- EPC 952 (Fitzroy - coal);
- EPC 649 (Peabody Coppabella P/L);
- ATP1103 (CH4 P/L);
- PCA 152 (CH4 P/L);
- PCA 259 (Arrow Energy P/L);

- ML 70455 (Peabody Coppabella P/L) excluded from offset area running near northern boundary.

3.2 Offset area values

The Stage 1 offset area is a total of 7,992.5 ha. It is comprised of two separate areas as shown in Figure 3.1 and summarised in Table 3.1.

Table 3.1 Olive Downs Stage 1 offset areas

Offset area	Area (ha)
Area 1	5,421.70
Area 2	2,570.80

These areas were selected based on identifying suitable habitats for the target threatened fauna species on land owned by Pembroke, using existing property boundaries and fencelines to help define the extent of offset areas. The habitat areas were informed by on-ground ecological surveys and further information is provided in Section 3 of this OAMP. The offset was also designed to exclude MDL3023. The total offset area required was determined through application of EPBC offset calculators, including an analysis of start and end habitat quality for each species, as provided in Appendix A.

Land within the Stage 1 offset area is presently used for cattle grazing, and small areas show signs of being opportunistically cropped after adequate rainfall. Portions of the land have been cleared through past agricultural practices however there are large tracts of native woody regrowth and remnant vegetation that exist. Field surveys have shown approximately 64% of the Stage 1 offset area comprises cleared agricultural grasslands, with the remainder supporting mapped remnant vegetation and unmapped regrowth (Pembroke 2019).

3.2.1 Connectivity values

Offset area 1 (total 5,421.70 ha in area) is the largest offset area and includes large patches of existing remnant woodlands and regrowth. The remnant woodlands are situated along riparian corridors, in patches between riparian corridors and there are quite large patches of remnant regional ecosystem (RE) 11.5.9 along the eastern boundary. The identified advanced regrowth areas are adjacent to these remnant woodlands supplementing their patch size and connectivity. With active management and time both identified regrowth and cleared areas across the offset will also become ‘remnant’ woodlands increasing the total patch size and connectivity for the site. The second offset area (total 2,570.80 ha in area) includes some existing remnant vegetation including along Scrubby Creek and advanced regrowth. Ground-truthed remnant REs and advanced regrowth are mapped in Figure 3.3.

Connectivity on a broader scale outside of the offset areas is predominantly to the north up into large tracts of remnant vegetation classified of State and Regional biodiversity significance (Figure 3.4). These areas are then connected to a large State significant biodiversity corridor that intersects with Dipperu National Park to the north-east. The offset areas are also an important habitat area between regional significant biodiversity corridors to the east and a state significant corridor to the west associated with the Isaac River (Figure 3.4).

To the south of offset area 2 are other areas of remnant vegetation mapped of state and regional biodiversity significance, and these areas are proposed to be assessed as offsets for future stages of the Olive Downs Project. These areas will be protected under a conservation agreement as part of Stage 2, and will be further rehabilitated thereby increasing connectivity values to the south and connecting to Isaac River.

3.2.2 Summary of vegetation condition types

The offset area has been categorised into three broad vegetation condition types being:

- remnant vegetation;
- regrowth woodlands; and
- cleared agricultural grasslands.

The extent of these vegetation condition types across the offset area is summarised in Table 3.2 and shown in Figure 3.3.

Table 3.2 Vegetation condition types across the offset areas

Vegetation condition type	Area 1 (ha)	Area 2 (ha)	Total (ha)
Remnant vegetation	1,758.3	206.6	1,964.9
Regrowth woodlands	834.2	610.3	1,444.5
Cleared agricultural grasslands	3,663.4	2,364.2	6,027.6

3.2.3 Remnant woodlands

Within the offset area there are tracts of remnant woodlands, including along watercourses and adjacent alluvial flats as well as the eastern boundary of offset area 1. Remnant vegetation also occurs as linear patches within offset area 2. Distribution of REs is illustrated in Figure 3.3.

Remnant woodlands are generally in moderate to good condition, supporting a complex set of vegetation aligned with 10 regional ecosystems (REs):

- RE 11.3.1 Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*) open forest on alluvial plains;
- RE 11.3.2 Poplar Box (*Eucalyptus populnea*) woodland on alluvial plains;
- RE 11.3.25 Forest Red Gum (*Eucalyptus tereticornis*) or River Red Gum (*E. camaldulensis*) woodland fringing drainage lines;
- RE 11.3.27f Palustrine wetland, Coolabah (*Eucalyptus coolabah*) and/or Forest Red Gum (*E. tereticornis*) open woodland to woodland fringing swamps;
- RE 11.4.8 Dawson Gum (*Eucalyptus cambageana*) woodland to open forest with Brigalow (*Acacia harpophylla*) or blackwood (*A. argyrodendron*) on Cainozoic clay plains;
- RE 11.4.9 Brigalow (*Acacia harpophylla*) shrubby woodland with Yellowwood (*Terminalia oblongata*) on Cainozoic clay plains;
- RE 11.5.3 *Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces;RE 11.5.9 *Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces;

- RE 11.5.17 Palustrine swamp with fringing Forest Red Gum (*Eucalyptus tereticornis*) woodland in depressions on Cainozoic sand plains and remnant surfaces;
- RE 11.11.1 *Eucalyptus crebra* +/- *Acacia rhodoxylon* woodland on old sedimentary rocks with varying degrees of metamorphism and folding; and
- RE 11.12.7 *Eucalyptus crebra* woodland with patches of semi-evergreen vine thicket on igneous rocks (boulder-strewn hillsides).

Some patches of RE 11.3.1, RE11.4.8 and RE 11.4.9 align with the Brigalow TEC listed under the EPBC Act, while some patches of RE 11.3.2 may align with the Poplar Box Grassy Woodland on Alluvial Plains TEC listed under the EPBC Act. Remnant woodlands are shown in Photograph 3.1 and Photograph 3.2.

Photograph 3.1 E. populnea woodland (RE11.3.2)

Photograph 3.2 E. tereticornis wetland (RE11.3.27f)

3.2.4 Regrowth woodlands

Regrowth woodlands occur across significant areas of the Stage 1 offset area. The regrowth woodlands occur as regrowth overstorey species interspersed with mature trees. A native shrub layer persists with a moderate diversity of native ground cover/grasses. These areas predominantly support small to medium hollows in larger trees.

Regrowth vegetation occurs as:

- regrowth Poplar Box (*Eucalyptus populnea*) with native shrub species; or
- regrowth eucalypt woodland with regrowth Forest Redgum (*E. tereticornis*), Clarkson's Bloodwood (*Corymbia clarksoniana*) and Moreton Bay Ash (*Corymbia tessellaris*).

Regrowth woodlands are shown in Photograph 3.3 and Photograph 3.4.

Photograph 3.3 Regrowth E. populnea and native shrubs

Photograph 3.4 Regrowth eucalypt woodland

Cleared agricultural grasslands, dominate 64% of the Stage 1 offset areas. These grasslands occur in various conditions states, some of which are dominated by exotic grasses (such as Buffel Grass (*Cenchrus ciliaris*)), while others have been noted as supporting a mix of native and exotic grass species, as well as regenerating native shrub and tree species. Native grasses present include *Eragrostis elongata, Enteropogon ramosus, Panicum effusum, Bothriochloa bladhii, Heteropogon contortus, Themeda triandra, Chrysopogon fallax and Aristida calycina.*

Ecological condition is reduced in areas due to presence of weeds, impacts from grazing and erosion. Scattered weeds occur throughout the site including Parthenium (*Parthenium hysterophorus*), Velvety Tree Pear (*Opuntia tomentosa*), Rubber Vine (*Cryptostegia grandiflora*), Mimosa Bush (*Acacia farnesiana*) and Shrubby Stylo (*Styloanthes scabra*). Cleared agricultural grasslands are shown in Photograph 3.5 and Photograph 3.6.

Photograph 3.5 Open grasslands adjacent to remnant patches

Photograph 3.6 Cleared grasslands currently grazed

3.2.5 Biodiversity values

The Stage 1 offset area supports a number of significant biodiversity values at a Commonwealth and State level. These include:

- Endangered and Of Concern REs;
- Brigalow TEC;
- breeding and foraging habitat for threatened fauna species;
- watercourse vegetation and wetlands; and
- supporting protection and enhancement of habitats and movement corridors for wildlife through remnant and riparian corridors through to other state significant biodiversity corridors to the north and west associated with the Isaac River.

The Stage 1 offset area supports existing habitat for five threatened fauna species listed under the EPBC Act and impacted by the Project, four of which have been observed on site during targeted fauna surveys being:

- Ornamental Snake;
- Squatter Pigeon;
- Koala; and
- Greater Glider.

It is anticipated the Stage 1 offset area also provides habitat for the Australian Painted Snipe. There is suitable habitat present for the species and it has been recorded in the surrounding areas west of the offset along a tributary of Isaac River. The threatened species, and extent of area for each value across the offset, is summarised in Table 3.3.

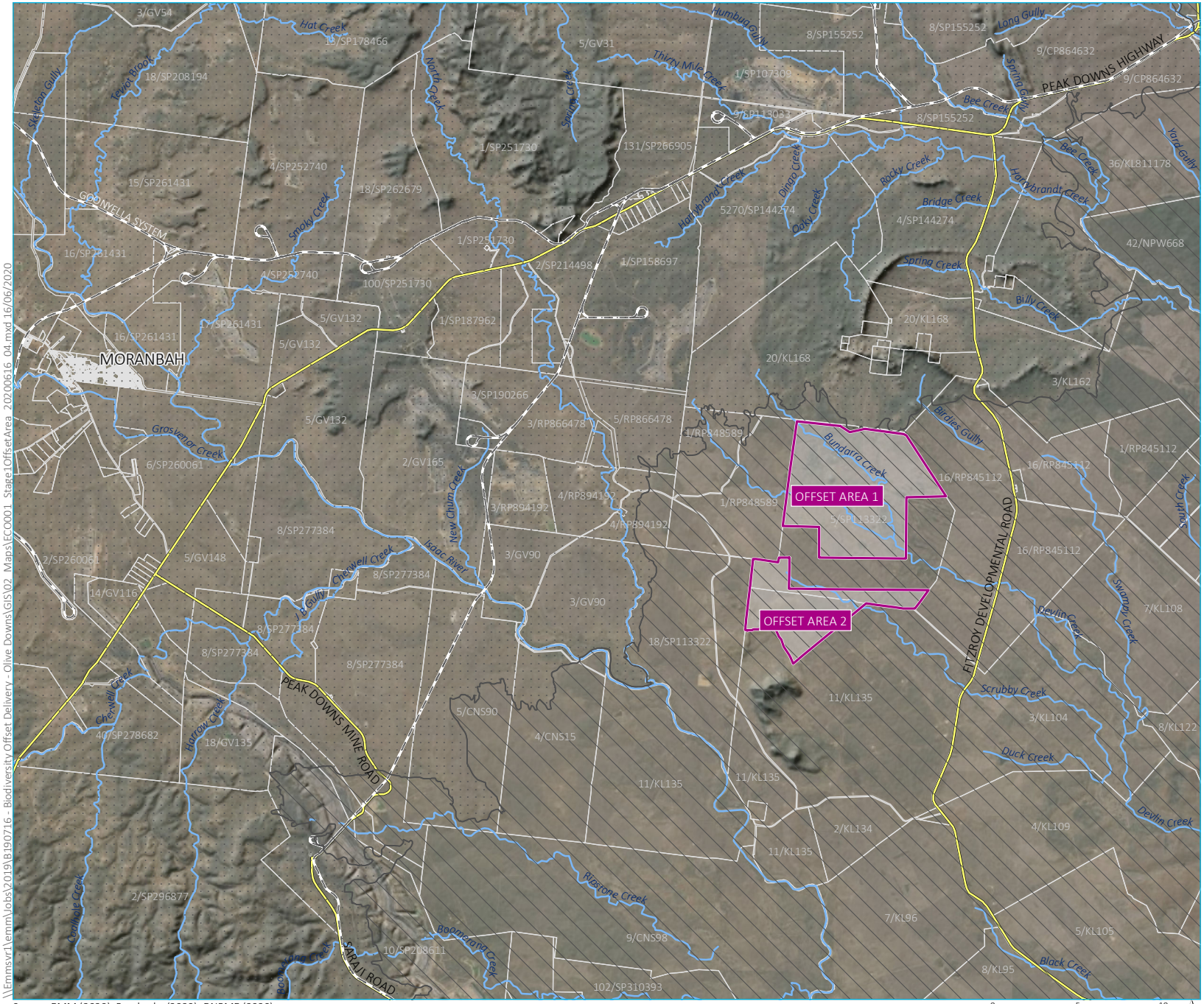
Table 3.3 Stage 1 offset area – MNES values

MNES value	Description	Area 1 (ha)	Area 2 (ha)	Total area (ha)
Ornamental Snake	Known important habitat	997.8	1,009.9	2,007.7
Australian Painted Snipe	Breeding habitat	73.8	0.0	73.8
Squatter Pigeon	Breeding and foraging habitat	1,356.3	220.0	1,576.3
	Potential future habitat	1,779.2	1,043.3	2,822.5
Koala	Known habitat (remnant woodland)	1,516.1	204.5	1,720.6
	Known habitat (regrowth woodland)	860.8	586.7	1,447.5
	Future habitat	1,071.9	550.0	1,621.9

Table 3.3 Stage 1 offset area – MNES values

MNES value	Description	Area 1 (ha)	Area 2 (ha)	Total area (ha)
Greater Glider	Known habitat (remnant woodland including breeding)	1,516.7	204.5	1,721.2
	Known habitat (regrowth woodland)	26.6	0.0	26.6
	Future habitat	2,542.2	1,195.5	3,737.7

The habitat and ecosystem values for each of these species is discussed further below.



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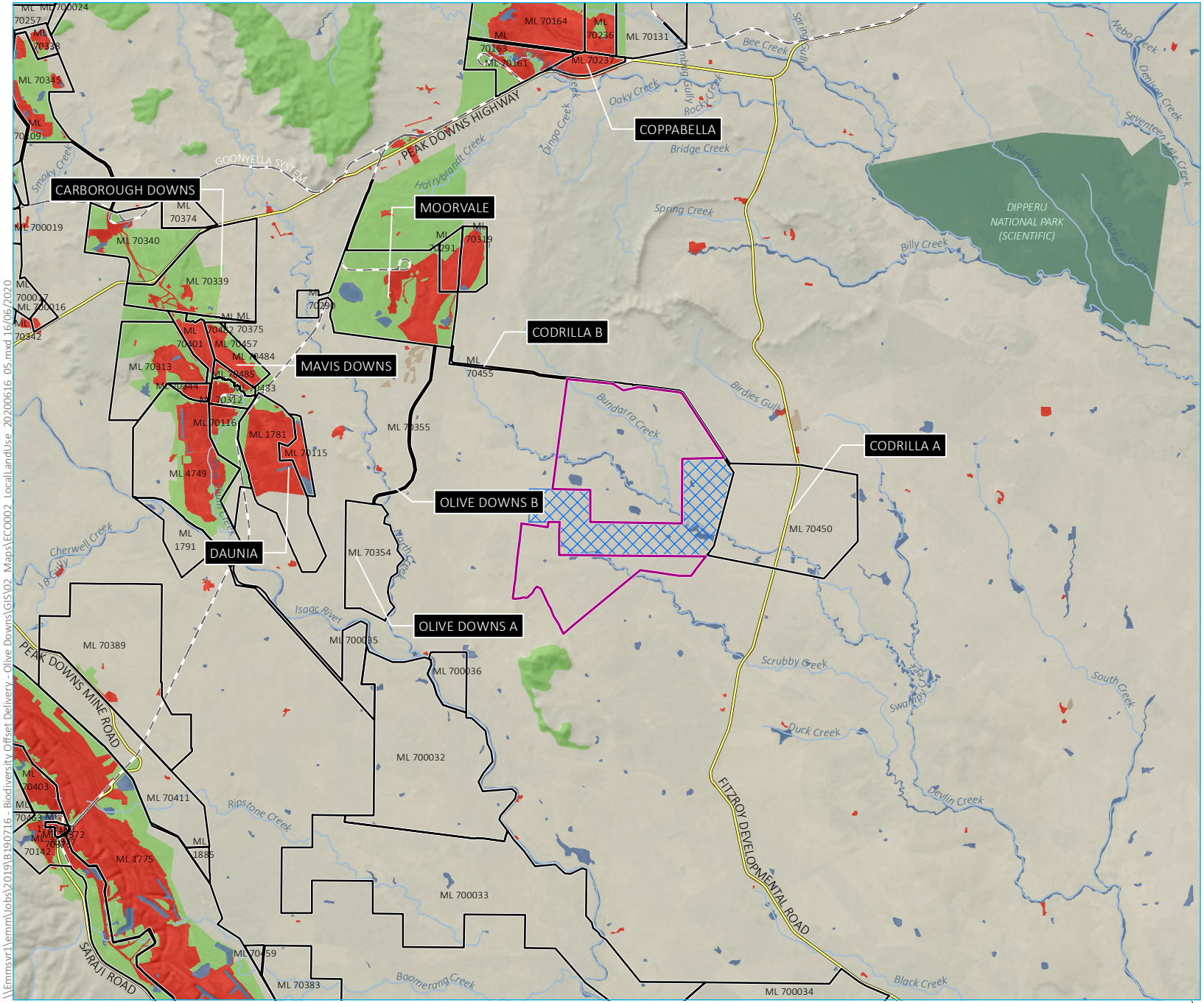
Source: EMM (2020); Pembroke (2020); DNRME (2020)

Stage 1 offset area

Olive Downs
Stage 1 offset area management plan
Figure 3.1

EMM
creating opportunities



KEY

- Stage 1 offset area
- Mining lease
- Mineral Development Licence 3023
- Rail line
- Major road
- Named watercourse
- National park (scientific)

Primary land use mapping (DES, 2017)

- Conservation and Natural Environments
- Production from Relatively Natural Environments
- Production from Dryland Agriculture and Plantations
- Production from Irrigated Agriculture and Plantations
- Intensive Uses
- Water

Source: EMM (2020); Pembroke (2020); DNRME (2020); DES (2019)

0 5 10 km

GDA 1994 MGA Zone 55

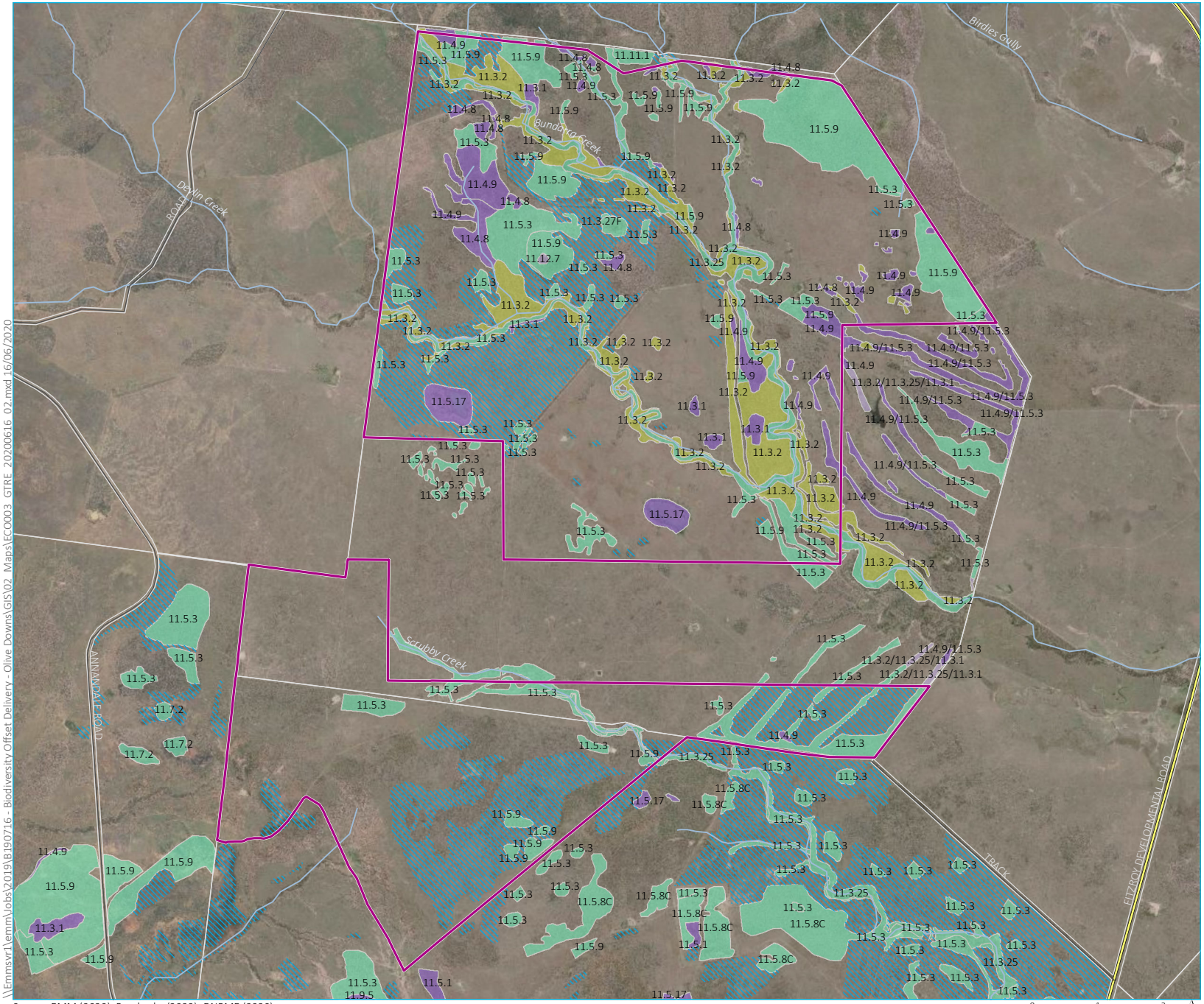
N

\\Emmsvr1\emm\Jobs\2019\B190716 - Biodiversity Offset Delivery - Olive Downs\GIS\02 Maps\EC0002 LocalLandUse 20200616 05.mxd 16/06/2020

Land use mapping

Olive Downs
Stage 1 offset area management plan
Figure 3.2

EMM
creating opportunities



KEY

- Stage 1 offset area
- Major road
- Minor road
- Watercourse/drainage line
- Cadastral boundary

Ground-truthed regional ecosystems

- Remnant endangered - dominant
- Remnant endangered - subdominant
- Remnant of concern - dominant
- Remnant least Concern
- Regrowth

Source: EMM (2020); Pembroke (2020); DNRME (2020)

0 1 2 km

GDA 1994 MGA Zone 55

N

Ground-truthed regional ecosystems

Olive Downs
Stage 1 offset area management plan
Figure 3.3

EMM
creating opportunities

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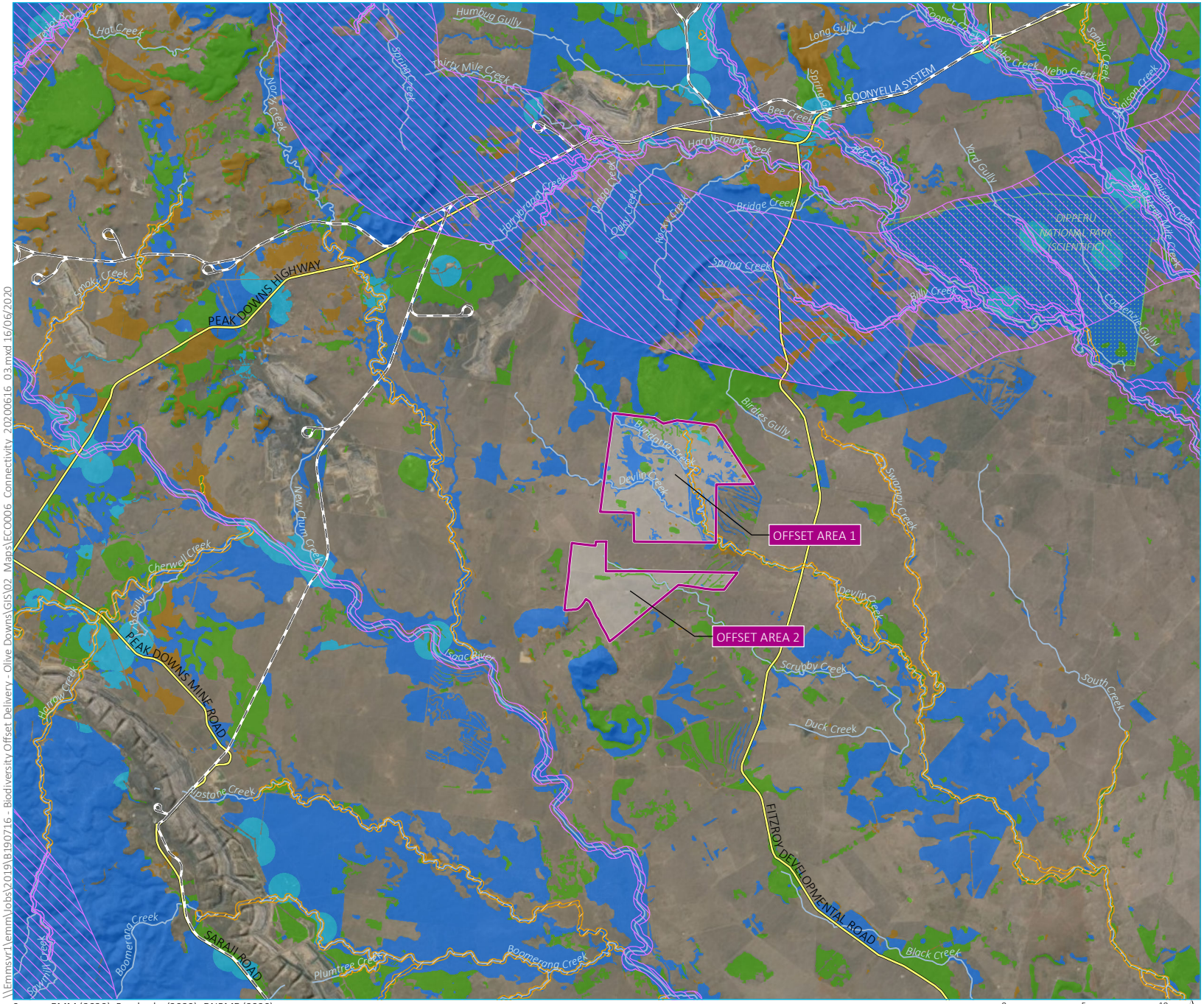

KEY

- Stage 1 offset area
- Rail line
- Major road
- Named watercourse
- National park

Biodiversity corridors

- State
- Regional

Biodiversity significance

- State Habitat for EVNT taxa
- State
- Regional
- Local or Other Values

Connectivity

Olive Downs
Stage 1 offset area management plan
Figure 3.4

EMM creating opportunities

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3.3 Values for MNES

3.3.1 Koala

The Koala has one of the largest distributions of any terrestrial threatened species listed under the EPBC Act. It occupies a variety of vegetation types across this large distribution, can move long distances and is variably affected by a range of threats. Koala habitat is defined by the vegetation community present and the vegetation structure; Koalas do not necessarily have to be present (DoE 2014a). Any forest or woodland containing species that are known Koala food trees, or shrubland with emergent food trees can be considered as 'potential Koala habitat' (DoAWE 2020a). This can include remnant and non-remnant vegetation in natural, agricultural, urban and peri-urban environments. Koala food trees are considered to be those within the genera of *Angophora*, *Corymbia*, *Eucalyptus*, *Lophostemon* and *Melaleuca* (DoAWE 2020a).

Koala surveys comprised terrestrial habitat quality assessments within the Stage 1 offset area conducted by DPM Enviros ciences (DPM Enviros ciences 2018). Assessments were conducted in accordance with the Guide to Determining Terrestrial Habitat Quality Version 1.2 (DoEHP 2017).

Within the Stage 1 offset area, the Koala was recorded on numerous occasions along drainage features and within woodland habitats. Recordings included direct observation and identification of scats and scratches within Eucalypt dry woodlands on inland depositional plains, Eucalypt open forest to woodlands on floodplains, and around wetlands (DPM Enviros ciences 2018) (Figure 3.5).

Within the Stage 1 offset area it was determined that Koala habitat includes all areas of remnant woodland with known Koala food trees or regrowth woodland with emergent Koala food trees. This includes all areas of eucalypt open forests to woodlands on floodplains (i.e. RE 11.3.25), eucalypt dry woodlands on inland depositional plains (ie REs 11.3.2, 11.5.3, 11.5.9, 11.11.1 and 11.12.7), the vegetation surrounding and within the lacustrine and palustrine wetlands (ie REs 11.3.27f and 11.5.17), and regrowth woodland or shrubland which meet the definition provided above.

Koala habitat within the Stage 1 offset area comprises: Remnant Woodlands (1,720.6 ha), shown in Photograph 3.7, Suitable Regrowth Woodlands (1,447.5 ha), shown in Photograph 3.8, and Potential Future Habitat (1,621.9 ha). Refer Figure 3.5.

The 'Potential future habitat' for the Koala (DPM Enviros ciences 2018):

- excludes remnant vegetation (RE);
- includes cleared or regrowth areas (that are not yet Koala habitat) where a combination of ground observations, aerial imagery and State pre-clear mapping suggest that Koala food trees are likely to regenerate or establish with suitable tree plantings;
- excludes areas of cracking clays with gilgai, where Koala food trees are less likely to establish;
- excludes regrowth of RE 11.4.8, where the adopted list of Koala food trees are less likely to grow; and includes existing regrowth RE 11.5.9 as potential future habitat (although some of these areas are currently dominated by regrowth *Corymbia clarksoniana* or Acacia spp., the slower growing *E. crebra* is expected to become more prominent over time.

Starting Koala habitat quality scores are; Remnant Woodland (7 out of 10), Regrowth Woodland (5 out of 10) and Potential Future Habitat (0 out of 10). Koala habitat mapping is shown in Figure 3.5 and offset calculators are provided in Appendix A.

Photograph 3.7 Existing Koala habitat in the offset area

Photograph 3.8 Regrowth Koala habitat in the offset area

3.3.2 Ornamental Snake

Two Ornamental Snakes were recorded during nocturnal spotlighting adjacent and to the north of the Stage 1 offset area. Desktop mapping identified areas of gilgai relief, which are the most accurate reflection of potential habitat for this species.

Within the Stage 1 offset area, it was determined that all areas of remnant Brigalow and mapped gilgai represent potential 'known important habitat' for the Ornamental Snake (Photograph 3.9), as do all wetland REs (11.3.27f and 11.5.17) and REs known to be associated with this species (REs 11.4.8 and 11.4.9, DoSEWPC 2011). In the Stage 1 offset area, the gilgai landform is associated primarily with cleared agricultural grasslands/shrublands. Any habitat that allows connectivity between gilgai depressions is also considered 'important' in accordance with DoSEWPC (2011).

The Stage 1 offset area contains areas of agricultural grassland without gilgai soils between patches of important habitat, similar to that within the Project area. The agricultural grassland without gilgai soils do not form part of the proposed Ornamental Snake offset areas but are captured in part by proposed future habitat offsets for other MNES species. The areas mapped as potential habitat for the Ornamental Snake also contain woody debris (which would provide sheltering habitat for the Ornamental Snake when cracks are not available), are low-lying, and during the

wet season would hold water long enough for frogs to inhabit them, providing a food source for the Ornamental Snake.

There is 2,007.7 ha of known important habitat for the Ornamental Snake in the Stage 1 offset area with a starting habitat quality of 6 out of 10. Ornamental Snake habitat is shown in Figure 3.6 and offset calculator is provided in Appendix A.

Photograph 3.9 Known important Ornamental Snake habitat

3.3.3 Australian Painted Snipe

No Australian Painted Snipe were observed during the field surveys. Records of this species within the broader locality are from waterways or wetlands (including gilgai), with the closest being approximately 5 km north.

Within the Stage 1 offset area, it was determined that all areas of lacustrine and palustrine wetlands (including wetland REs 11.3.27f and 11.5.17) represent potential breeding and foraging habitat for the Australian Painted Snipe, particularly as water levels are expected to change seasonally, with islands or mounds and bare earth exposed. Available habitat in the Stage 1 offset area is shown in Photograph 3.10.

There is approximately 73.8 ha of potential breeding habitat for the Australian Painted Snipe in the Stage 1 offset area with a starting habitat quality score of 6 out of 10. Offset calculator is provided in Appendix A.

Australian Painted Snipe habitat is shown in Figure 3.7.

Photograph 3.10 Potential Australian Painted Snipe breeding and foraging habitat in the offset area

3.3.4 Squatter Pigeon

The Squatter Pigeon was identified in various habitats on two occasions within the Stage 1 offset area and a further four locations within close proximity (Figure 3.8).

The Squatter Pigeon (southern) occurs mainly in grassy woodlands and open forests that are dominated by Eucalypts (DoAWE 2020b). Within the Stage 1 offset area all areas of Eucalypt dry woodlands on inland depositional plains and eucalypt open forests to woodlands on floodplains are considered potential habitat for this species. Potential habitat (stratified into breeding, foraging and dispersal habitat), shown in Photograph 3.11, and potential future habitat, shown in Photograph 3.12, were mapped across the Stage 1 offset area in accordance with the habitat definitions outlined in Table 3.4.

Within the Offset Study Area, REs, 11.5.3 and 11.5.9 provide Squatter Pigeon breeding habitat (where within 1 km of a waterbody) because they contain suitable soils, vegetation structure and composition. In addition, alluvial RE 11.3.2 is also considered suitable for Squatter Pigeon (southern) breeding (where within 1 km of a waterbody) based on site observations of habitat usage in the Project area (including REs 11.3.2 and 11.3.7) and Offset Study Area (including RE 11.3.2, DPM Envirosciences 2018).

Table 3.4 Squatter Pigeon habitat definitions

Habitat type	Maximum distance from nearest waterway	Restricted to	Excludes (overrides the "restricted to" column)	Characteristic Regional Ecosystems (REs) within the Stage 1 offset area
Potential Breeding habitat	1km	Land Zone 5 and selected areas on Land Zone 3 <33% groundcover Patchy native groundlayer*	N/A	11.5.3, 11.5.9, 11.5.17, 11.3.1, 11.3.25 and 11.3.2.
Potential Foraging habitat	3km	Land Zone 5 and selected areas on Land Zone 3 <33% groundcover Patchy native groundlayer*	N/A	11.5.3, 11.5.9, 11.5.17, 11.3.1 and 11.3.2.
Potential Dispersal habitat	N/A	Any grassy-woodland/woodland/forest linking potential breeding and foraging habitat.	Cleared land >100 m across.	Unknown
Future Potential habitat	N/A	Land Zone 5 and 3. Cleared and regrowth areas	Potential Dispersal, Breeding or Foraging habitat Wetlands	Regrowth vegetation on Land Zones 3 and 5.

* either: patchy, native, perennial tussock grasses, or mixed-native perennial tussock grasses and low shrubs/forbs.

The Stage 1 offset area contains 1,576.5 ha of potential habitat and 2,822.5 ha of future potential habitat for the Squatter Pigeon. In the Stage 1 offset area, potential habitat comprises:

- breeding habitat (1,465.8 ha); and
- foraging habitat (110.5 ha).

By comparison, Future Potential Habitat is not further categorised into breeding, foraging or dispersal habitat, as its potential use to the Squatter Pigeon depends upon which management actions are applied and their success. However, in time with management these areas are likely to provide a mix of breeding, foraging and dispersal habitat.

Squatter Pigeon habitat mapping is shown in Figure 3.8 and offset calculators are provided in Appendix A.

Photograph 3.11 Existing Squatter Pigeon habitat in the offset area

Photograph 3.12 Potential future Squatter Pigeon habitat

3.3.5 Greater Glider

The Greater Glider was recorded on four occasions within the Stage 1 offset area along drainage features and within wetland habitats, within Eucalypt dry woodlands on inland depositional plains and Eucalypt open forest to woodlands on floodplains (Figure 3.9).

Within the Stage 1 offset area it was determined that 'Known habitat' for the Greater Glider includes remnant and regrowth forest or woodland which contain suitable hollow bearing trees. This includes:

- all areas of remnant Eucalypt open forests to woodlands on floodplains (ie RE 11.3.25);
- Eucalypt dry woodlands on inland depositional plains (ie REs 11.3.2, 11.5.3, 11.5.9, 11.11.1 and 11.12.7);
- vegetation surrounding and within the lacustrine and palustrine wetlands (ie REs 11.3.27f and 11.5.17);
- acacia woodland dominated/co-dominated by *E. cambageana* (ie RE 11.4.8);
- patches of eucalypt regrowth field-verified as containing hollow-bearing trees (primarily stags). These habitat types contain Greater Glider food trees (*Eucalyptus* spp.), which are less likely to be found or not in high

abundance (as suggested in the Conservation Advice) within other habitat types (that are cleared or Acacia communities) in the Stage 1 offset area.

By protecting and actively managing these remnant and regrowth woodlands that contain hollow bearing trees it will ensure risks from hot bushfires will be reduced, connectivity for Greater Gliders is enhanced through further development of the canopy cover (particularly along the riparian corridors), and with time additional large tree hollows will develop providing more denning opportunities.

'Potential future habitat' for the Greater Glider within the Stage 1 offset area:

- includes cleared or regrowth areas (that are not yet Greater Glider habitat) where a combination of ground observations, aerial imagery and State pre-clear mapping suggest that Eucalypts are likely to regenerate or establish with suitable tree plantings;

- includes areas mapped as 'existing MNES regrowth habitat' for the Koala but not the Greater Glider (as hollows are yet to form); and

- excludes areas of cracking clays with gilgai, where hollow-bearing trees are less likely to form.

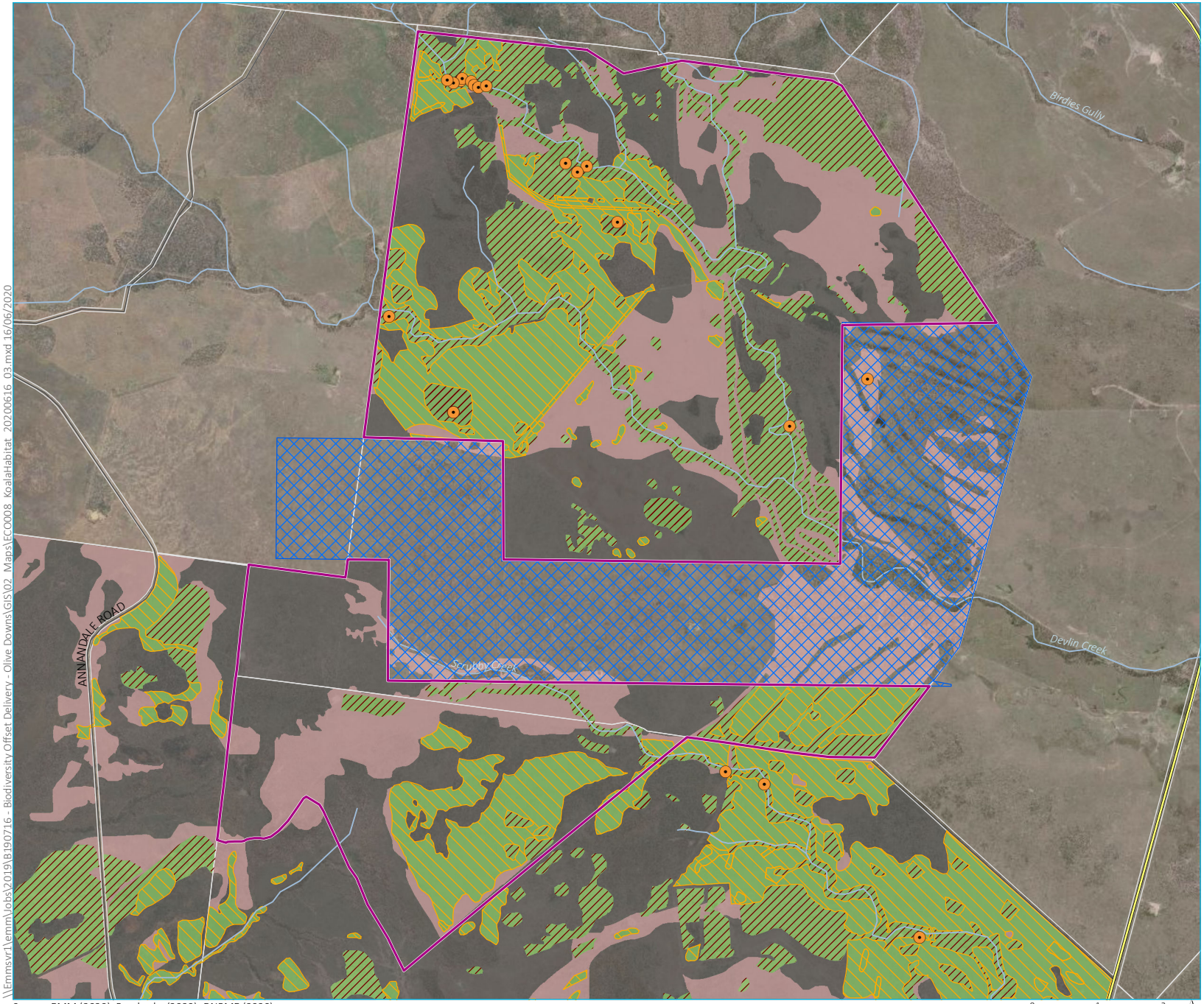
These areas would provide suitable habitat characteristics (hollows) over time with the implementation of appropriate management measures proposed to be implemented by under this OAMP. These naturally regenerating areas will be actively managed so that over time they will provide additional foraging resources for gliders, these areas are situated adjacent to remnant areas so will increase patch size of Greater Glider habitats making them more resilient to edge effects and will also improve connectivity between patches for gliders.

There is approximately 1,721.21 ha of remnant Eucalypt woodland with suitable hollow bearing trees for the Greater Glider that provides known habitat. These areas have a starting habitat quality score of 7 out of 10. There is a separate 26.56 ha of Eucalypt woodland regrowth with suitable hollow bearing trees for the Greater Glider that provides known habitat. These areas have a starting habitat quality score of 4 out of 10. There is a further 3737.69 ha of future potential habitat in the Stage 1 offset area. These areas have a current habitat quality score of 0 out of 10. Offset calculators are provided in Appendix A.

Greater Glider habitat mapping is shown in Figure 3.9.

Photograph 3.13 Known Greater Glider habitat in the offset area

Photograph 3.14 Potential future Greater Glider habitat in the offset area



KEY

- Koala record
- Koala habitat (breeding or foraging)
- Koala potential future habitat
- Regrowth eucalypt woodland which does contain forest or woodland with known Koala food trees or shrubland with emergent food trees
- Eucalypt woodland which does contain Koala food trees or shrubland with emergent food trees
- Not suitable habitat
- Stage 1 offset area

Existing environment

- Major road
- Minor road
- Named watercourse
- Cadastral boundary
- Mineral Development Licence 3023

\\Emmsvr1\emm\Jobs\2019\B190716 - Biodiversity Offset Delivery - Olive Downs\GIS\02 Maps\ECO008 KoalaHabitat 20200616 03.mxd 16/06/2020

Source: EMM (2020); Pembroke (2020); DNRME (2020)

0 1 2 km

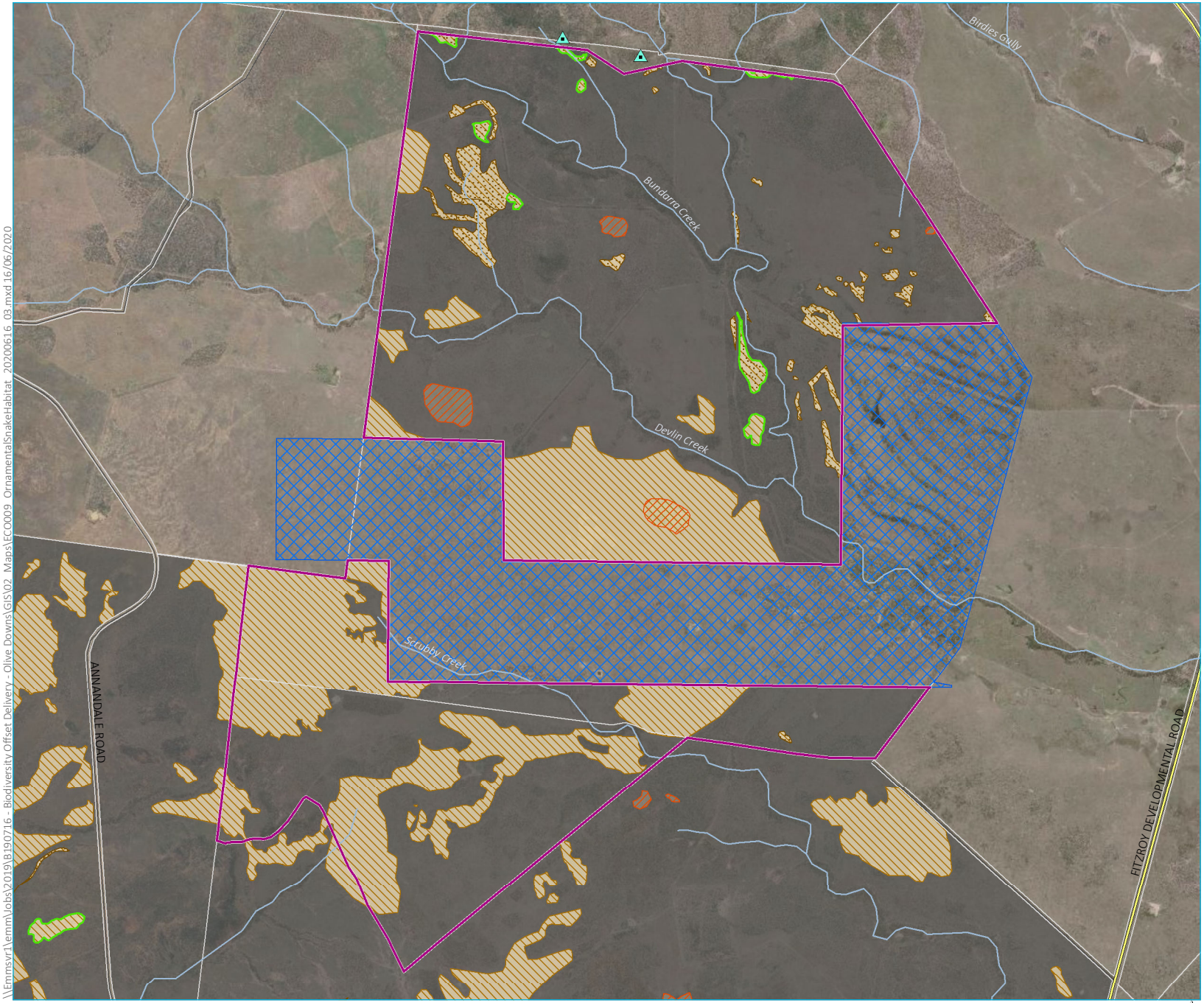
GDA 1994 MGA Zone 55

N

Koala habitat mapping

Olive Downs
Stage 1 offset area management plan
Figure 3.5

EMM
creating opportunities



KEY

- Ornamental Snake record
- Known important habitat (including suitable and dispersal habitat)
- Regional ecosystems associated with the Ornamental Snake (RE 11.4.8, 11.4.9, 11.11.1)
- Palustrine and Lacustrine wetlands (potential frog habitat)
- Gilgai Soils (DPM Enviroscienses, 2019)
- Not suitable habitat
- Brigalow TEC
- Stage 1 offset area

Existing environment

- Minor road
- Major road
- Watercourse/drainage line
- Cadastral boundary
- Mineral Development Licence 3023

\\Emmsvr1\emm\Jobs\2019\B190716 - Biodiversity Offset Delivery - Olive Downs\GIS\02 Maps\ECO009 OrnamentalSnakeHabitat 20200616 03.mxd 16/06/2020

Source: EMM (2020); Pembroke (2020); DNRME (2020)

0 1 2 km

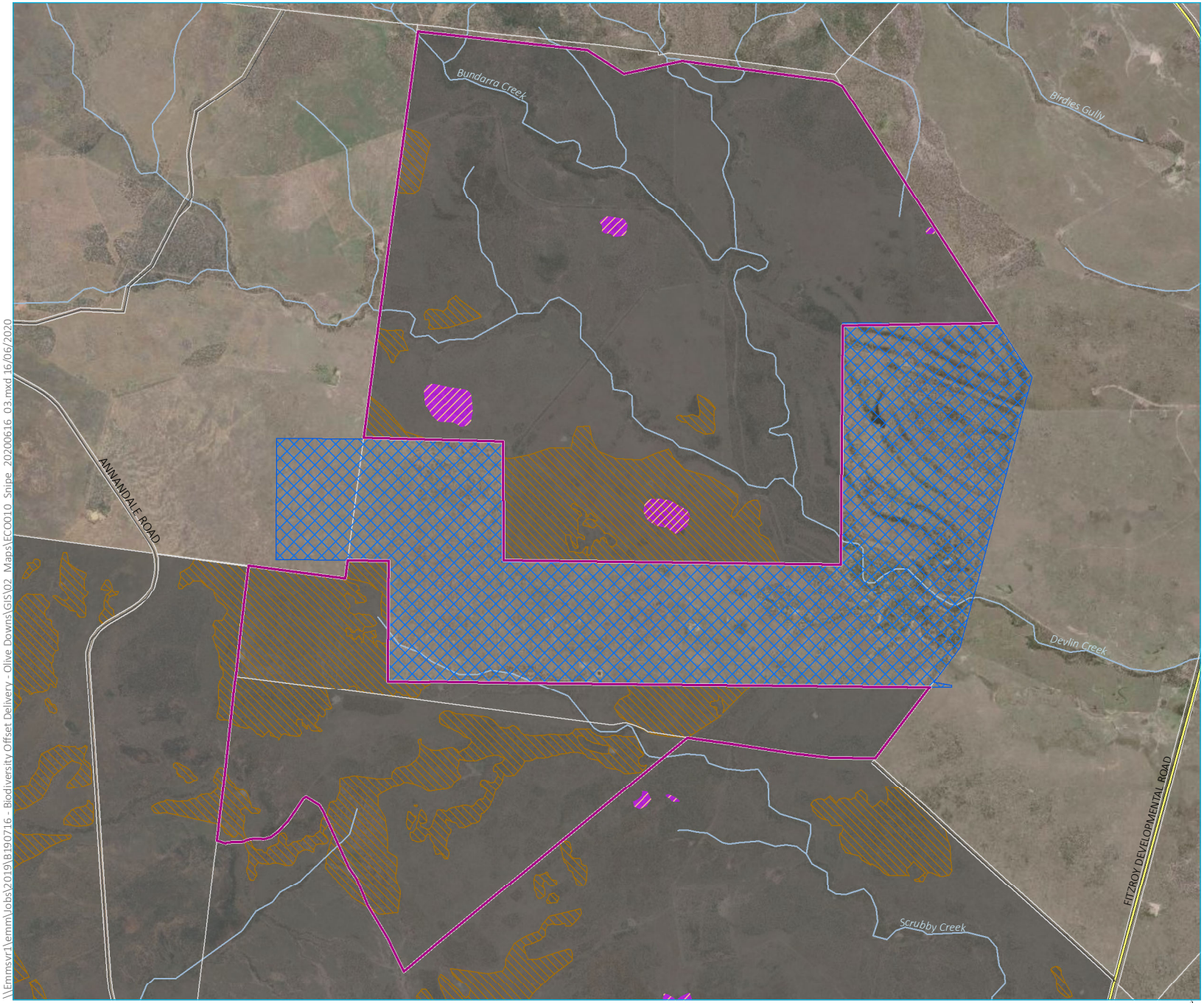
GDA 1994 MGA Zone 55

N

Ornamental Snake habitat mapping

Olive Downs
Stage 1 offset area management plan
Figure 3.6

EMM
creating opportunities



KEY

- Australian Painted Snipe habitat (potential breeding and foraging)
- Palustrine and Lacustrine wetlands with suitable habitat features for breeding
- Gilgai Soils (DPM Enviroscienses, 2019)
- Not suitable habitat
- Stage 1 offset area

Existing environment

- Major road
- Minor road
- Watercourse/drainage line
- Cadastral boundary
- Mineral Development Licence 3023

\\Emmsvr1\emm\Jobs\2019\B190716 - Biodiversity Offset Delivery - Olive Downs\GIS\02 Maps\ECO010 Snipe 20200616 03.mxd 16/06/2020

Source: EMM (2020); Pembroke (2020); DNRME (2020)

0 1 2 km

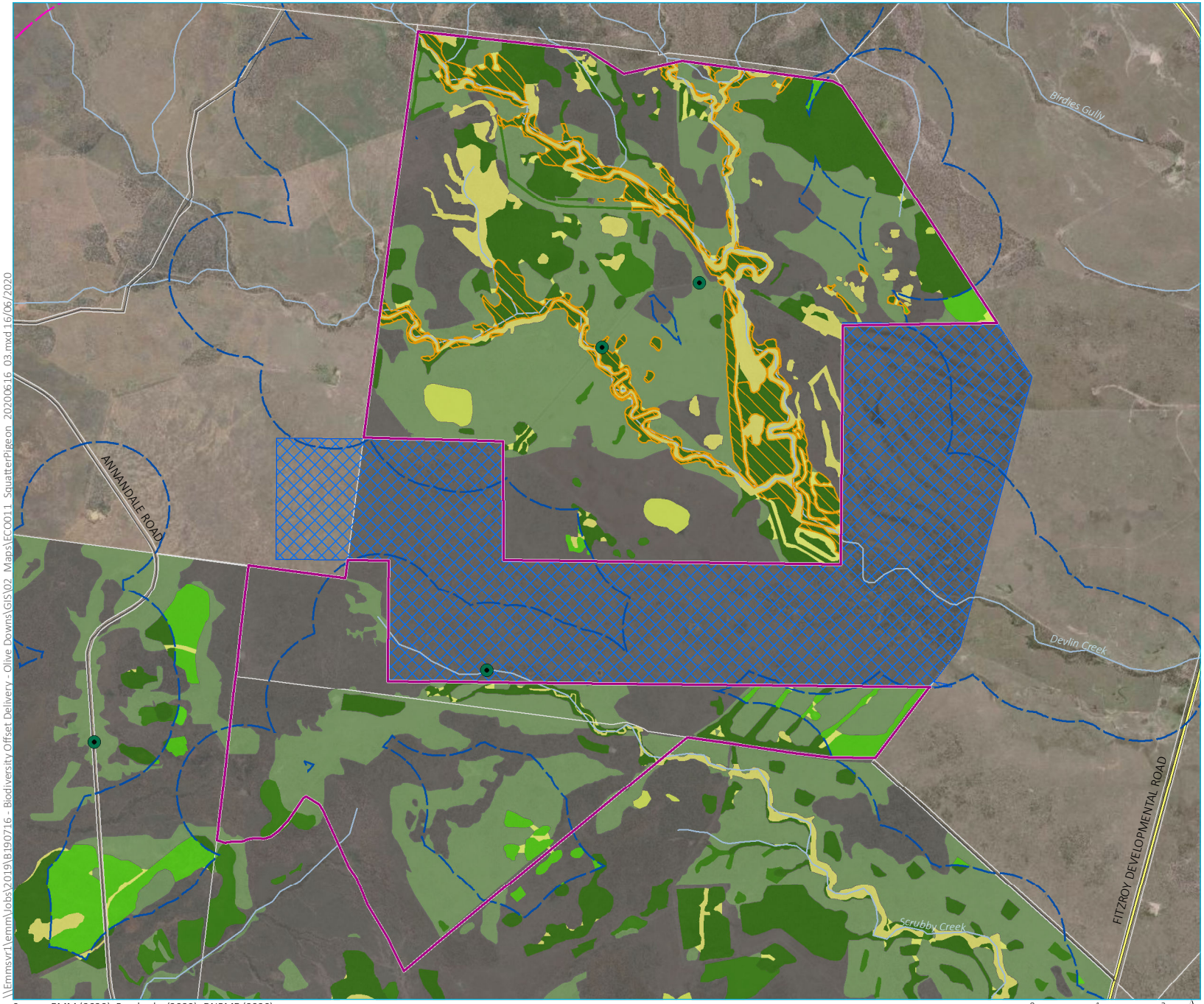
GDA 1994 MGA Zone 55

N

Australian Painted Snipe habitat mapping

Olive Downs
Stage 1 offset area management plan
Figure 3.7

EMM
creating opportunities



KEY

- Squatter Pigeon record
- Potential breeding habitat
- Potential foraging habitat
- Potential dispersal habitat
- Future potential habitat
- Regional Ecosystem 11.3.2 and 11.3.7
- Not suitable habitat
- 1 km boundary from seasonal waterbody/watercourse
- 3 km boundary from seasonal waterbody/watercourse
- Stage 1 offset area

Existing environment

- Major road
- Minor road
- Watercourse/drainage line
- Cadastral boundary
- Mineral Development Licence 3023

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Source: EMM (2020); Pembroke (2020); DNRME (2020)

0 1 2 km

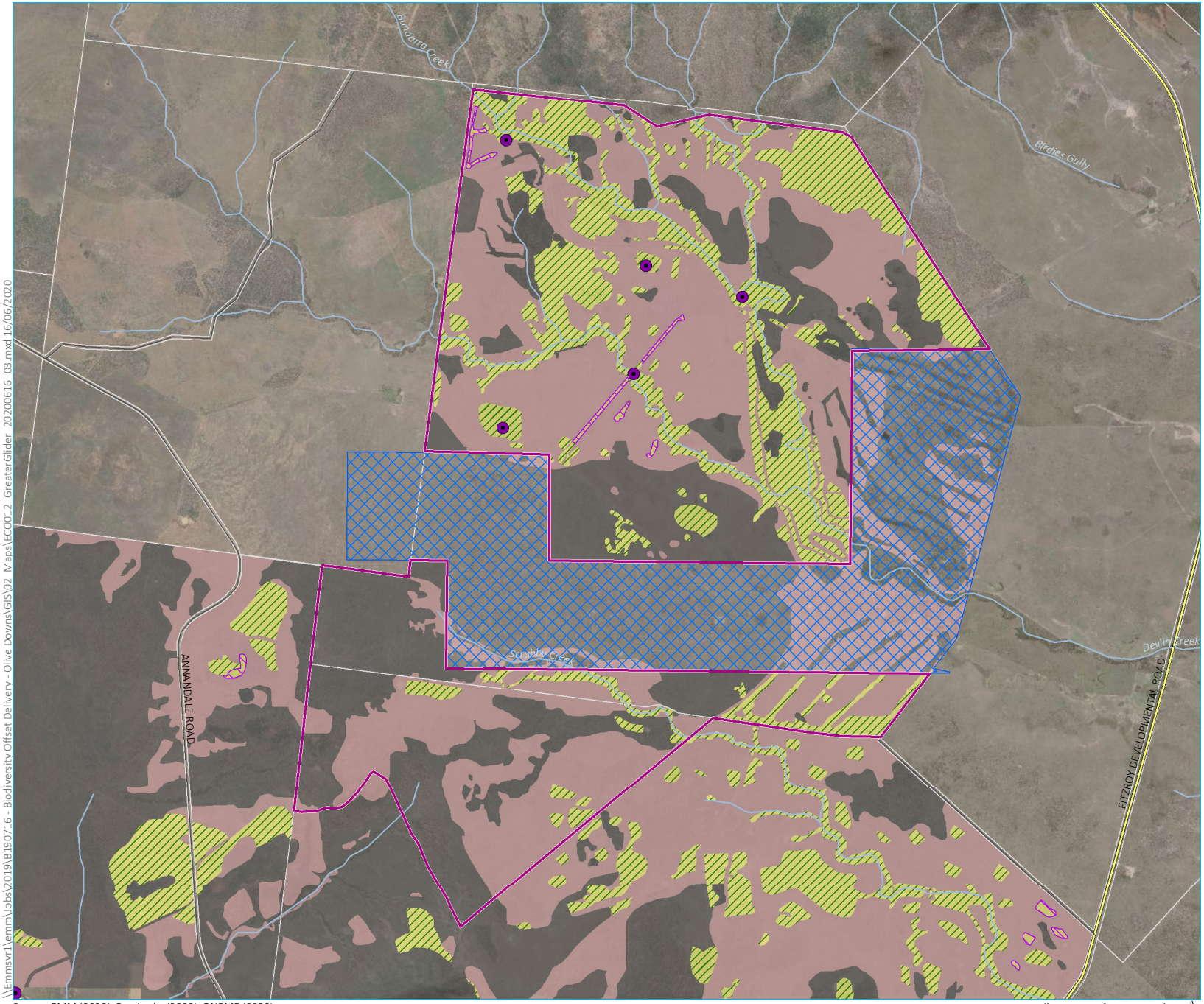
GDA 1994 MGA Zone 55

N

Squatter Pigeon habitat mapping

Olive Downs
Stage 1 offset area management plan
Figure 3.8

EMM
creating opportunities



\\Emmsvr1\emm\jobs\2019\B190716 - Biodiversity Offset Delivery - Olive Downs\GIS\02 Maps\ECO012 GreaterGlider 20200616 03.mxd 16/06/2020

Source: EMM (2020); Pembroke (2020); DNRME (2020)

Greater Glider habitat mapping

Olive Downs
Stage 1 offset area management plan
Figure 3.9

EMM
creating opportunities

4 Management actions

4.1 Overall approach to management of Stage 1 offset area

This section describes the overarching management actions and measures necessary to meet the final habitat quality scores for each MNES and offset completion criteria for the Stage 1 offset area over a 20-year period (Section 6.3). Interim milestones set at 5-yearly intervals will assess the management plans ability to achieve these performance outcomes in the longer term. Should any of the interim milestones not be achieved at the set time, the management plan will be reviewed, effectiveness of management evaluated and corrective actions agreed and implemented to ensure the offset area is tracking towards completion.

Section 4.2 outlines management measures required across the entire Stage 1 offset area that will result in improvements in habitat quality for all MNES, reduce key threatening processes, and ensure the overarching management objectives will be achieved. Species specific management objectives, demonstrating how the management actions and corrective actions take into account relevant approved listing advices, conservation advices and are consistent with relevant recovery plans and threat abatement plans, are outlined in Section 4.2.8.

The key threatening processes that need to be managed across the entire offset are:

- spread and introduction of weeds, pest animal species and pathogens;
- land clearing and habitat fragmentation; and
- inappropriate grazing and fire regimes.

The overarching management actions for the offset that will address the above threatening processes and support the increase in habitat quality and extent of vegetation communities across the site are summarised in Section 4.2.

4.2 Proposed management measures

The general management measures to be employed across the Stage 1 offset areas have been developed to address key threats, management measures and priority actions identified in the various conservation and listing advice for the threatened species. Table 4.1 summarises how each of the proposed general management measures will benefit the threatened species within the Stage 1 offset area, and the applicable conservation advice statements for each MNES species.

Table 4.1 General management measures and how they address key threats, management measures and priority actions for each species

Species	Regeneration of native vegetation communities	Weed control	Biomass control and grazing management	Pest fauna management	Fire management	Fencing
Ornamental Snake	Yes – long term regeneration increases coarse woody debris[2]	Yes – invasive weeds are identified as a key threat[2]	Yes - grazing has potential to degrade wetland/gilgai areas through pugging and compaction of soil cracks	Yes – impacts to wetland habitat from feral pigs is considered a threat[2] along with predation by feral species[1]	Yes – inappropriate fire regimes can result in loss of coarse woody debris	Yes – ensure livestock are kept out of wetland/gilgai areas post rain events.
Australian Painted Snipe	Yes – loss of wetland habitat is identified as a key threat to the species[3,4,5] and the species will benefit from regeneration of wetland habitats	Yes – replacement of native vegetation by invasive weeds is identified as a threat[3,4,5], and control of weeds is identified as a priority action[5]	No	Yes – predation by Foxes and feral Cats is identified as a key threat[4,5]	Yes – altered fire regimes are identified as a threat to this species, with development of a fire management strategy a priority action[3,4,5]	Yes – ensure livestock are kept out of wetland/gilgai areas post rain events
Koala	Yes – habitat loss is identified as a key threat to this species[6,7,8], with regeneration resulting in increased availability of habitat long term	No	No	Yes – predation, particularly by Dogs, is identified as a threat[6]	Yes – fire can be a significant threat to the Koala, with significant loss of habitat during recent bushfires across eastern Australia	No
Squatter Pigeon	Yes – vegetation clearing is identified as a threat to the species[9,10] with regeneration increasing areas of suitable habitat	Yes – invasion by weed species that do not provide natural food plants, particularly Buffel Grass, is identified as a threat to the species[9,10]	Yes – the species does not inhabit areas with dense grass cover[9] and requires bare ground for foraging and bathing[10]	Yes – overgrazing by feral herbivores such as the Rabbit, or predation by feral Cats and Foxes is identified as a threat[9,10]	Yes – inappropriate fire regimes are identified as a threat to this species[9] and may exacerbate other threats[10]	No
Greater Glider	Yes – habitat loss is identified as a catastrophic threat to this species[11]	No	No	No	Yes – too intense or frequent fires are identified as a severe threat to this species[11]	Yes – barbed wire fences are identified as a minor threat to the species[11]

Notes:
1. DoE 2014b - Approved Conservation Advice for Denisonia maculata.
2. DoAWE 2020c - *Denisonia maculata* Species Profile and Threats Database.
3. DoSEWPC 2013 - Approved Conservation Advice for *Rostratula australis* (Australian painted snipe)
4. TSSC 2013 - Commonwealth Listing Advice on *Rostratula australis* (Australian Painted Snipe).
5. DoAWE 2020d - *Rostratula australis* Species Profile and Threats Database

6. DoSEWPC 2012b - Approved Conservation Advice for *Phascolarctos cinereus* (combined populations in Queensland, New South Wales and the Australian Capital Territory).
7. TSSC 2012 - Listing advice for *Phascolarctos cinereus* (Koala)
8. DoAWE 2020a - *Phascolarctos cinereus* (combined populations of Qld, NSW and the ACT) Species Profile and Threats Database
9. TSSC 2015 - Conservation Advice *Geophaps scripta scripta* squatter pigeon (southern).
10. DoAWE 2020b - *Geophaps scripta scripta* Species Profile and Threats Database.
11. TSSC 2016 - Conservation Advice *Petauroides volans* greater glider.

Further details of each management measure are provided below.

4.2.1 Regeneration works

Loss of habitat is identified as a key threatening process in the conservation and listing advice for all species to be managed within the Stage 1 offset area (Table 4.1). Regeneration works will provide long-term benefits for these species through improvements in existing habitat in remnant woodlands and expansion of habitat in regrowth woodlands and cleared agricultural grasslands.

The land within the Stage 1 offset area is considered to have moderate to high resilience despite the past disturbance, as evidenced by natural regrowth of native trees and understorey species occurring. Therefore, the primary method for regenerating non-remnant areas within the Stage 1 offset area will be through actively managing natural regeneration and reducing threatening processes that inhibit this process (eg weeds, feral animals, grazing livestock and soil condition).

Active revegetation (seeding/planting) will be a contingency measure in the event that natural regeneration is not readily occurring after at least three successive annual monitoring events. At least three years is required to allow natural regeneration to occur based on existing seed stock, for weed control and grazing management to encourage further growth over this time and soil conditions to be improved. Managing natural regeneration is more effective in re-establishing native woodland communities particularly across larger areas.

If deemed required, active revegetation works will largely focus on cleared agricultural grasslands not showing signs of tree recruitment. Active revegetation will be undertaken using locally endemic tree species reflective of the RE for that area, brush mulching or seeding from local seed sources, as outlined below:

- During annual monitoring mapping of cleared agricultural grasslands would be undertaken to identify areas that are not naturally regenerating. Surveys will include identification of the underlying cause of a lack of natural regeneration (eg distance from remnant areas, soil conditions, etc.) so these can be considered and addressed.
- Preparation works will be undertaken including soil preparation, weed and biomass control.
- Revegetation may include direct seeding and/or tubestock plantings. Overstorey species will be planted which are consistent with applicable RE that would occur in that area and which are key feed species for Koala and/or Greater Glider.
- Trees will be planted at a density consistent with the applicable RE benchmarks. This will be an average of 300 trees per hectare and will be protected with tree guards. Supplementary watering will be undertaken during and after planting.
- All regeneration works will be undertaken by a qualified bush regenerator.
- Monitoring of revegetation works will be undertaken for a minimum of 5 years, with any mortality observed replaced on an annual basis to maintain tree density.

Active revegetation may be required where extensive weed management is undertaken (such as in area of extensive Buffel Grass control) to ensure other weed species do not establish. This will be determined during monitoring works. If required, active revegetation will be undertaken in accordance with the process outlined above, with additional planting of understorey and groundcover species endemic to the probable RE at a rate of 500 plants per hectare.

If required, active revegetation works surrounding wetlands may also be undertaken to provide benefits for the Australian Painted Snipe. This would include removal of key weed species (see Section 4.2.2) followed by supplementary planting of key wetland species.

Corrective actions to be implemented where natural regeneration success is low will include:

- assessments of fencing structures to ensure there is no unauthorised access by stock or large numbers of native herbivores (ie eastern grey kangaroo) browsing on saplings;
- implement increased controls of pest flora and fauna species, increasing intensity of weed management where weeds are confirmed as key cause for lack of regeneration;
- implement active revegetation techniques such as tubestock planting and direct seeding post appropriate soil preparation procedures including ripping and auguring; and
- assess soil health and suitability for successful regeneration.

4.2.2 Weed control

Invasive weeds are identified as a key threat to the Ornamental Snake, Australian Painted Snipe and Squatter Pigeon (see Table 4.1). Weed invasion is likely to lead to loss of habitat for the Ornamental Snake (DoAWE 2020c, DoE 2014b) and Squatter Pigeon (DoAWE 2020b, TSSC 2015), with invasion by Buffel Grass identified as a key threat for these species. Invasion of weeds is likely to result in replacement of endemic wetland vegetation providing habitat for the Australian Painted Snipe (DoAWE 2020d, TSSC 2013) with management of weeds identified as a priority action in the conservation advice (DoSEWPC 2013).

Management of weeds will be a key management action to address ongoing loss and degradation of habitat for these species within the Stage 1 offset area.

Surveys identified five Weeds of National Significance (WONS) and six which are listed under Qld's *Biosecurity Act 2014* (BS Act) as Category 3 restricted invasive plants. Category 3 plants must not be given away, sold, or released into the environment. The BS Act requires everyone to take all reasonable and practical steps to minimise the risks associated with invasive plants under their control. Ten additional environmental weeds have been observed and are proposed to be actively managed due to their potential to degrade habitats and ecological condition of offset area.

Table 4.2 provides a summary of the weed species present in the in the Stage 1 offset area, the proposed control method and control period and intensity. For most species a minimum of one control event per year is required, and will continue for the 20 years. For other species at least two control events will be undertaken due to follow up weed control being required. It is expected that primary weed control would be undertaken in years 1 to 5, with secondary control in years 6 to 10 and follow up control in years 11 to 20.

Year 1 it is proposed a comprehensive baseline weed survey will be completed. This will confirm; weed species present, their distribution and percentage cover across the offset area. Large infestations will be mapped and permanent photo monitoring points established. Management outcomes will then be prescribed in greater detail for each species for each 5-year interval as to the reduction in cover being sought across the offset, including removal or reduction of certain large infestations as mapped. A more detailed weed management action plan will

then be prepared for each 12-month period to achieve these objectives that will be implemented by suitably qualified persons. Weed mapping will be a key part of this baseline survey and will form an appendix to this OAMP.

Corrective actions to be implemented if weed cover is not being reduced, or new species are detected will include:

- alter weed management strategy to target problematic species and/or outbreaks;
- increase frequency of weed management events; and
- change weed control methods and evaluate if they are more effective in managing the particular weed species.

Table 4.2 Weed management

Species details	Presence on site	Control method (s)	Control period	Management outcomes	Threat to biodiversity
Bellyache Bush *Jatropha gossypiifolia* QLD Biosecurity Act: Cat 3 National Status: WONS	Scatted small populations, mainly on water courses.	*General controls* Mechanical control: For small infestations mechanical control will be used. As bellyache bush is shallow rooted, grubbing the plant by hand is effective. Grazing management: Pasture management to maintain ground cover post treatment significantly reduces seedlings survival through competition. Fire: If deemed suitable fire may be used to control larger infestations. Fire wouldn't be suitable along watercourses, but more if there is a larger infestation in an open grassland or open woodland. This would only occur as part of an approved fuel reduction burn. *Chemical control* Many herbicides are currently or about to be registered for bellyache bush. Below are just two examples of registered chemicals. In native pastures, apply Mtsulfuron-methyl 600g/kg, at a rate of 10 g/100 L + penetrant. Thoroughly wet plants and apply when actively growing.	Annually. September to April* At least one control event per year. * As Bellyache bush flowers throughout the year when moisture is adequate control can also occur at these times. The proposed months are designed to maximise weed-control efficiency across the entire Stage 1 offset area.	No new weed infestations. Key focus is to reduce infestations along watercourses. Reduction in weed cover across offset area.	Dense infestations can occur on river flats and other areas of good loamy soil. It can take over these riparian areas reducing biodiversity values and prohibiting fauna use of the area. Fruits of bellyache bush are poisonous to humans and animals.
Brazilian Nightshade *Solanum seaforthianum* QLD Biosecurity Act: N/A National Status: N/A	Scattered throughout all areas.	*Chemical control* Cut and dab method followed by the Foliar spray method. Apply herbicide immediately to a stump that has been cut to within 15 cm of the ground. Cut-stump method. Spray herbicide to cover all leaves and stems, and ensure the area is not disturbed for 24 hours to allow herbicide uptake. *Mechanical control* For larger infestations mechanical control can be used including slashing. This will only be conducted where it won't impact on native vegetation communities.	Annually. September to April. At least one control event per year.	No new weed infestations. Reduction in weed cover across offset area.	Species is classified as an environmental weed as it can take over bushland and riparian areas. Fruit and leaves are toxic to humans.

Table 4.2 Weed management

Species details	Presence on site	Control method (s)	Control period	Management outcomes	Threat to biodiversity
Buffel Grass *Cenchrus ciliaris* QLD Biosecurity Act: N/A National Status: N/A	Dominates many clearings.	*Strategy* Buffel Grass is a pervasive species that is drought tolerant and grows quickly after summer rainfall. Buffel Grass has proved useful for pasture and soil retention in a wide range of environments due to its drought tolerance, high biomass, deep roots, rapid response to summer rains, relative palatability and resistance to overgrazing. However, it can outcompete native grasses and trees regenerating and increase fuel loads substantially therefore increasing risk of hot fires occurring. Therefore, the approach will be to target the reduction of Buffel Grass where it occurs in forested areas or where it is outcompeting regeneration of native grasses and trees. *Smaller outbreaks in forested areas* For small outbreaks physical removal or herbicide, or combined treatment will be undertaken. Follow-up treatment is essential. *Larger outbreaks in forested areas or regenerating areas* For mixed native-buffel pasture: manage grazing and fire to maintain diversity, eg allow native plants to recruit seedlings and set seed in good seasons. Don't graze these areas while native plants are seeding. For cleared/improved pasture: manage seed production and minimise spread into adjacent areas, remove seedlings from outside planted area. Prevent fires spreading from pastures. Apply herbicide after heavy rain to impact both mature plants and seedlings. Plants must be activity growing. Plants may be flowering but must not be seeding. Herbicide should be applied to as much of the green leaf as possible. This is best achieved through spot spraying. Repeated treatment is often required. Slashing of old foliage followed by spraying after effective rainfall can be very effective. It may be desirable to leave slashed material on the ground to protect the soil from erosive rainfall. Follow up with further spraying or grubbing of surviving plants and seedlings when actively growing. Slashing will only be done if native saplings are not impacted.	Two events per year. This is due to follow up treatment being required. Control most effective after summer rains when in growth phase.	Reduction in Buffel Grass extent in remnant bushland. Fuel loads are managed to specified levels to reduce risk of hot bushfires occurring.	Buffel Grass has spread well beyond planted areas and can dominate the ground layer in many native plant communities. It reduces native plant diversity and can affect vegetation structure by changing fire regimes. It has potential to outcompete regeneration of native grasses and trees and increase risk of hot bushfires.

Table 4.2 Weed management

Species details	Presence on site	Control method (s)	Control period	Management outcomes	Threat to biodiversity
Castor Oil Plant *Ricinus communis* QLD Bio Act: N/A National Status: N/A	Along watercourse and wetland areas. Scattered to dense infestations.	*Manual control* Individual plants or small infestations may be removed by cut stump and foliar spray. *Chemical controls* Fluroxypyr 333 g/L (eg Starane Advanced) applied at a rate of 30 mL/10 L water. This requires PVMA permit PER11463; the permit expires 30/06/2023. Method: Foliar spray (backpack). Read permit and label carefully. Fluroxypyr is suitable for native and exotic areas (DoAF 2020a).	Annually. September to April. At least one control event per year.	No new weed infestations. Key focus is to reduce infestations on watercourses. Reduction in weed cover across offset area.	It is regarded as an environmental weed due to its ability to dominate understorey of bushland areas. In particular along watercourses.
Green Panic *Megathyrsus maximus* QLD Biosecurity Act: N/A National Status: N/A	Dominates many clearings.	*Strategy* Green Panic (or Guinea Grass) is a pervasive grass species that that can dominate understorey in bushland areas and riparian vegetation. Therefore, the approach will be to target the reduction of green panic where it occurs in forested areas or where it is outcompeting regeneration of native grasses and trees. *Grazing* Grazing is an effective method to manage green panic as it is a palatable species. *Chemical controls* There are no products specifically registered for the control of guinea grass in Queensland. However, a permit held by the Department of Agriculture and Fisheries allows people generally to use some herbicide products to control guinea grass as an environmental weed in various situations. Understand permit PER11463 before using these herbicides. Use either: • Glyphosate 360 g/L at 360 g/L water (either foliar spray, or cut and dab), or • Fluazifop 212 g/L, at a rate of 2–4 L per ha. Spray young vegetative growth with 3–6 leaves per shoot when growing actively. Use up to 4 L per ha for well-established infestations or where greater control is required in one season.	Annually. September to April. At least one control event per year.	Reduction in Green Panic extent in remnant bushland and riparian vegetation.	Regarded as an environmental weed. It is common and widespread in bushland and riparian vegetation in the tropical, sub-tropical, warmer temperate and semi-arid regions of Australia.

Table 4.2 Weed management

Species details	Presence on site	Control method (s)	Control period	Management outcomes	Threat to biodiversity
Harrisia Cactus *Harrisia martini* QLD Biosecurity Act: Cat 3 National Status: N/A	Scattered, observed along fence lines.	Control of this plant is difficult as it has a deep underground tuberous root system and use of a combination of physical, biologic and herbicide controls is recommended. *Manual control* Dig out plants completely and burn. Ensure all tubers are removed and destroyed. Spot spray with registered herbicide. *Biological control* Biological control includes two introduced insects: • a stem-boring longicorn beetle (*Alcidion cereicola*) • a mealybug (*Hypogeococcus festerianus*). Stem-boring beetle only attacks older woody stems. In Collinsville area, large beetle colonies developed and contributed to collapse of dense areas of cactus. Populations of *Alcidion cereicola* have declined with reduction in cactus in recent years. More successful biological control agent is mealybug *Hypogeococcus festerianus*, which is now present in most areas infested with harrisia cactus. Mealybug is considered more effective in more northern areas of central Queensland. *Herbicide* Triclopyr as tea 200 g/L + Picloram as tipa 100 g/L (eg Slasher) or Triclopyr as tea 200 g/L + Picloram as tipa 100 g/L + Aminopyralid 25 g/L (eg Tordon RegrowthMaster) (eg Tordon DSH®).	Annually. September–March (Herbicide). September–December (Biological).	No new weed infestations. Reduction in weed cover across offset area.	Highly invasive species. Produces large quantities of seed that is highly viable and easily spread by birds and other animals. Any broken-off portions of the plant will take root and grow.

Table 4.2 Weed management

Species details	Presence on site	Control method (s)	Control period	Management outcomes	Threat to biodiversity
Lantana *Lantana camara* QLD Biosecurity Act: Cat 3 National Status: WONS	Scattered throughout all areas, some dense infestations.	*Manual control* For single-stemmed lantana, basal bark spraying and cut-stump methods give good results at any time of year (but best when the plant is actively growing). For large Lantana infestations, treatment with herbicides by foliar spraying is usually not economically feasible. However, fire and slashing/cutting, can reduce dense infestations, making follow-up spot treatments with chemicals more economically viable. Lantana seed banks remain viable for at least four years, so follow-up control to kill seedlings before they mature is vital to ensure initial management efforts to control the parent bush are not wasted. *Herbicide control* On multi-stemmed varieties, best results by carefully applying herbicide to each stem. When treating actively growing plants less than 2-m tall, spray foliage overall to the point of run-off. Splatter gun techniques are effective and particularly useful in hard-to-access areas. This is best done in autumn, when sap-flows draw the poison down into the root stock, but before night temperatures get too cold.	Annually Manual removal any time of year. March–May for herbicide control.	No new weed infestations. Reduction in weed cover across offset area.	It forms dense thickets that smother and kill native vegetation and are impenetrable to animals, people and vehicles. Research indicates more than 1400 native species are negatively affected by lantana invasion, including many endangered and threatened species. As lantana is a woody shrub that has thin, combustible canes, its presence can also create hotter bushfires, altering native vegetation communities and pastures.
Mimosa Bush *Acacia farnesiana* QLD Bio Act: N/A National Status: N/A	Scattered individuals.	*Chemical controls* Basal bark spray: For stems up to 15 cm diameter, carefully spray completely around base of plant to a height of 30 cm above ground level. Thoroughly spray into all crevices. Larger trees may be controlled by spraying to a greater height, up to 100 cm above ground level. The best time for treatment is during autumn when plants are actively growing, and soil moisture is good. Cut and dab treatment: At any time of year, cut stems off horizontally as close to the ground as possible. Immediately (within 15 seconds) swab cut surface with herbicide mixture.	Annually March–May for basal bark spray treatment. Any time of year for cut and dab treatment.	No new weed infestations. Reduction in weed cover across offset area	Mimosa Bush is an environmental weed. Seeds sprout readily and plants grow rapidly. Mimosa bush does well in dry localities and on loamy or sandy soils, forming thickets along watercourses.

Table 4.2 Weed management

Species details	Presence on site	Control method (s)	Control period	Management outcomes	Threat to biodiversity
Noogoora Burr *Xanthium orientalis* QLD Bio Act: N/A National Status: N/A	Along watercourse and wetland areas. Scattered to dense infestations.	*Biological control* Some level of control has been achieved with biological control agents including stem-boring and stem-galling insects, and a rust fungus (Puccinia xanthii). This form of control has been more effective in tropical areas where temperatures and moisture conditions are favourable. *Mechanical control* Cultivation or hand pulling isolated plants is effective if performed before flowering or burr formation. *Chemical control* Few chemicals approved for use in native vegetation. Therefore, use chemical control as a last resort. Spraying with 2,4-D or MCPA before flowering will give favourable results. As plants mature, higher rates are necessary (DoAF 2020b).	Annually Any time of year for manual control. If chemical control to be done before flowering.	No new weed infestations. Key focus is to reduce infestations along watercourses and in wetlands.	Species is an environmental weed. It can be found along river and creek flats, on roadsides and in pasture land. Noogoora burr spreads by seed in burrs. Burrs are spread by attaching to animals, clothing and bags. Burrs can also float on water.
Parthenium *Parthenium hysterophorus* QLD Bio Act: Cat 3 National Status: WONS	Observed throughout all areas, some scattered patches and dense infestations	*Management through grazing* Grazing management is the most useful method of controlling large-scale parthenium infestations. Objective is to maintain high levels of grass crown cover, which will limit parthenium colonisation. *General controls* No manual method because of the health hazard from allergic reactions and the danger of mature seeds dropping and increasing the infestation area. *Chemical control* Spot spray with registered herbicide early before plants can set seed. Keep a close watch on treated areas for at least 2 years. Preferred method for smaller infestations. Treat small and/or isolated infestations immediately. Herbicide control will involve a knockdown herbicide to kill plants that are present and a residual herbicide to control future germinations. Repeated spraying may be required even within a single growing season to prevent further seed production.	Two events per year. This is due to follow up treatment being required. Spray before seeding occurs.	No new weed infestations. Key focus is to reduce species cover in remnant woodlands. Reduction in weed cover across offset area. Groundcover maintained to reduce spread.	Parthenium can colonise brigalow, gidgee and softwood scrub soils. It will take over pastures with sparse ground cover. Parthenium is also a health problem as contact with the plant or the pollen can cause serious allergic reactions such as dermatitis and hay fever.

Table 4.2 Weed management

Species details	Presence on site	Control method (s)	Control period	Management outcomes	Threat to biodiversity
		Extensive infestations will require herbicide treatment in conjunction with pasture management. Timing of spraying is critical so that parthenium is removed when plants are small and before seeding has occurred.			
Phasey Bean, Siratro *Macroptilium lathyroides* QLD Bio Act: N/A National Status: N/A	Throughout all areas, dense infestations in some wetland areas.	*Manual control* Phasey Bean can be hand pulled, chipped or mowed. Removing the whole crown by grubbing is the most effective manual/mechanical control method. Tangled growth may need to be cleared using a brush cutter. Cannot tolerate grazing. Manual removal suited to small infestations. *Chemical control* Two herbicides are currently registered for the control of Phasey Bean in non-crop situations in Queensland: 2,4-D amin and Glufosinate. Glufosinate ammonium is non-selective and needs to be used with care. Use the foliar spray method. Use chemical control as a last resort (DoAF 2020c).	Annually. Manual control any time of year.	No new weed infestations. Reduction in weed cover across offset area. Key focus is to reduce infestations in wetland areas.	An environmental weed. Can dominate groundcover of open woodland and riparian areas.
Purple Top Grass *Chloris inflata* QLD Bio Act: N/A National Status: N/A	Dominates many clearings.	Otherwise known as Rhodes Grass. *Mechanical control* Slashing or mowing. This would only be appropriate where it is in large infestations in cleared areas where native vegetation won't be impacted. *Chemical control* Foliar spray with herbicide – water mixture.	Annually. Any time of year.	No new weed infestations. Reduction in weed cover across offset area.	Environmental weed. Aggressive invader of degraded land and coastal sites, spreading from roadsides and pastures into natural habitats, where it out-competes native species.
Red Natal Grass *Melinis repens* QLD Bio Act: N/A National Status: N/A	Dominates many clearings.	*Chemical control* Foliar spray with herbicide – water mixture, or Complete removal via weed lifting (should have their major root structures lifted out entirely to prevent re-shooting). All plant material should be hung up as leaving plants on the ground can lead to them re-shooting.	Annually.	No new weed infestations. Reduction in weed cover across offset area.	Environmental weed.

Table 4.2 Weed management

Species details	Presence on site	Control method (s)	Control period	Management outcomes	Threat to biodiversity
Rhodes Grass *Chloris gayana* QLD Bio Act: N/A National Status: N/A	Dominates many clearings.	*Chemical control* Foliar spray with Glyphosate – water (1L per 100 L of water) mixture. *Manual control* Complete removal via weed lifting (should have their major root structures lifted out entirely to prevent re-shooting). All plant material should be hung up as leaving plants on the ground can lead to them re-shooting.	Annually.	No new weed infestations. Reduction in weed cover across offset area.	Environmental weed. It was recently listed among the top 50 invasive plants in south-eastern Queensland, where it spreads from roadsides and pastures to invade native bushland and rainforest margins. Its tolerance of a wide range of conditions and its ability to rapidly reproduce, combined with its capacity to smother native ground cover species and form almost pure stands, has led to its developing reputation as an invasive species.

Table 4.2 Weed management

Species details	Presence on site	Control method (s)	Control period	Management outcomes	Threat to biodiversity
Rubber Vine *Cryptostegia grandiflora* QLD Bio Act: Cat 3 National Status: WONS	Likely scattered along water courses.	Effective control of rubber vine can be achieved by a number of methods, alone or in combination depending on the situation and the severity of infestation. All areas treated must be periodically checked and any regrowth treated or the initial treatment efforts will be wasted. Any isolated plants located should be treated promptly. *Chemical control* Basal bark treatment - For single stem plants, thoroughly spray around the base of the plant to a height of 20−100 cm above ground level, spraying higher on larger plants. Cut stump treatment - This is the most successful method, but also the most labour intensive. The following should be followed carefully: Cut stems off horizontally as close to ground as possible and immediately swab or spray cut surface and stem with herbicide mixture. *Mechanical control* Scattered or medium-density infestations: Where possible, repeated slashing close to ground level is recommended. Slashing will only occur where native vegetation won't be impacted.	Two events per year. This is due to follow up treatment being required. Optimal when plant is actively growing in summer months.	No new weed infestations. Reduction in weed cover across offset area. Key focus is to reduce infestations along watercourses.	Rubber Vine generally invades waterways first, where the seeds germinate in moist silt layers after rain. The plant smothers riparian vegetation and forms dense, sometimes impenetrable, thickets. Prevents movement of animals within riparian corridors.
Velvety Tree Pear *Opuntia tomentosa* QLD Bio Act: Cat 3 National Status: WONS	Scattered throughout all areas.	*Chemical control* Spot spray with registered herbicide. *Biological control* Includes eight insects and the mite in Queensland. These species are: • Stem-boring moths: Cactoblastis cactorum; • Cochineal scale insects: Dactylopius ceylonicus, D. opuntiae, D. confuses and D. austrinus; • Cell-sucking bugs: Chelinidea tabulate; • Stem-boring moths: Tucumania tapiacola; • Stem-boring beetles: Archlagocheirus funestus; • Prickly pear red spider mites: Tetranychus opuntiae; and • Catoblastis spp. and Dactylopius spp. provide the most success.	Annually September−April	No new weed infestations. Reduction in weed cover across offset area.	Dense infestations compete with native vegetation, limiting the growth of small shrubs and groundcover species. The plant's sharp spines or barbs can cause injury to stock and native animals.

4.2.3 Weed and fuel/biomass load management through grazing, slashing and fire

Weeds and/or increased biomass are identified as key threats for the Australian Painted Snipe, Squatter Pigeon and Ornamental Snake (see Table 4.1), resulting in loss and degradation of habitat, loss of feed plants and loss of bare ground important to foraging (Squatter Pigeon). Undertaking weed and biomass control is a key action to be undertaken to provide benefits for these threatened species.

Weed and fuel/biomass load will be managed through a combination of crash grazing, slashing and/or hazard reduction burns and cool burns (see Section 4.2.4) where relevant.

Land within the Stage 1 offset area is currently used predominately for cattle grazing, with small areas showing some evidence of opportunistic cropping. Quite large areas have been historically cleared through past agricultural practices (DPM Envirosciences 2018); however, some tracts of remnant vegetation remain and significant regrowth is occurring across the site.

Weed and fuel/biomass load management will differ between the types of habitat available across the Stage 1 offset area. Management strategies have been developed based on the following habitat types:

- riparian areas along major watercourses - including existing remnant riparian vegetation and regenerating riparian vegetation;
- gilgai landforms including gilgai in cleared agricultural grasslands/shrublands as they provide habitat for Ornamental Snake;
- other remnant woodland areas;
- regrowth woodland areas; and
- future habitat for threatened species – consisting of cleared agricultural grasslands which will be restored for future habitat and may include active seeding/supplementary plantings.

Table 4.3 outlines the weed and fuel/biomass load management strategies to be implemented across each of these habitat types, including background information to inform the strategy, what strategy will be undertaken and triggers for grazing.

Table 4.3 Weed and fuel/biomass load management strategies

Grazing management area	Background information	Management strategy	Trigger for control
Riparian areas along watercourses	Riparian areas are considered sensitive habitats. Trees, shrubs and grasses are all important for the stability, productivity and filtration capacity of riparian and wetland areas. The grass layer slows the flow of water, reducing erosion and increasing infiltration as well as filtering soil and nutrients from the run-off. Trees and shrubs along a stream and within wetlands help cycle nutrients, provide shade and habitat, reinforce the banks by holding soil together and also dry out the soil helping to prevent soils from becoming saturated and slumping. The riparian areas in the Stage 1 offset area support critical habitat for Greater Glider, Koalas and other fauna species as well as provide important connectivity corridors. The objective is to improve the habitat quality of these riparian areas which includes allowing regeneration of native grasses, shrubs and trees. Control methods need to consider the sensitivity of these environments. For example, livestock have the potential to cause stream bank erosion (particularly where there is a lack of vegetation) and stir up sediments and cause pugging within the waterway which can then, in turn, reduce water quality.	*Grazing is excluded* To ensure creek banks are not degraded, existing riparian vegetation is retained and natural regeneration along riparian areas can occur, it is proposed grazing is excluded from these areas. Major watercourses and adjacent riparian areas (at least 50 m either side of any major water source) will be fenced off. Off-stream watering points will be installed to ensure cattle have adequate access to water. As riparian environments are susceptible to erosion, control utilising fire would also be avoided. *Slashing* Where control of fuel load/biomass is required, slashing would be preferred over grazing. Slashing will need to ensure no native tree saplings are harmed.	For biomass control: • Restricted to areas with biomass cover of exotic species of >50%. • Slashing to be undertaken using manual brush cutters to a height of no less than 20 cm. • Slashing to occur immediately prior to flowering and seeding period of key weed species to reduce seed set.
Gilgai landforms	Gilgai (otherwise referred to as melon holes) are known habitat for the threatened Ornamental Snake. These gilgai occur on deep cracking clay soils. In dry periods Ornamental Snake live down the soil cracks and are less susceptible to grazing impacts. However, after rain the clay soils swell, and gilgai fill up with water. When grazing occurs at this time, they can degrade the gilgai by compacting the ground and causing pugging, compromising soil structure. Habitat degradation through overgrazing by stock is identified as a threat to the Ornamental Snake (DoAWE 2020c).	*Grazing is excluded at certain times of year* During set times of year (wet season) or following significant rainfall (>50 mm in 7 days), grazing will be excluded in these gilgai areas to ensure gilgai habitats are protected. At other times grazing will be used to control biomass and/or weeds in line with the grazing strategy outlined below for remnant woodland, regrowth woodland and cleared agricultural grasslands.	Following significant rainfall (>50 mm in 7 days), grazing will be excluded in these gilgai areas to ensure gilgai habitats are protected. Where grazing is permitted in these areas for biomass control refer to triggers set out below based on type of vegetation.

Table 4.3 Weed and fuel/biomass load management strategies

Grazing management area	Background information	Management strategy	Trigger for control
Remnant woodland	Remnant woodlands within the Stage 1 offset area provide significant high-quality habitat for threatened species across ten REs. These areas are generally in good condition. Weed cover ranges from minimal (5%) to high (90%). These areas provide existing, high quality habitat for all threatened species (dependent on predominant RE and/or overstorey species and/or groundcover). Grazing can provide a useful tool for managing weed loads and/or biomass in certain areas. Any grazing strategy will need to consider the underlying weed and biomass cover and species composition of these areas. Fire will be of limited utility for weed control, except where recommended for particular weed species. Fire may be an important measure for fuel load/biomass control.	*Grazing permitted to reduce biomass* Crash grazing will be used to maintain native vegetation and grassy open woodland ecosystems. Crash grazing will be undertaken at specific times of year for short periods to control weed cover or control excessive grass biomass in above average growth seasons. Grazing will be undertaken at a time of year immediately prior to flowering of key weed species to reduce seed set, or as required to control biomass. Grazing should be excluded from any areas with low levels of weed cover (<50%) or low biomass (<70%). *Cool mosaic burns to reduce biomass* Fire will be implemented to control fuel load/biomass in line with recommendations in Section 4.2.4.	For weed control: • Restricted to areas with weed cover of >50% or areas with high threat weed (WONS or Bio Act listed). • Grazing timed to occur immediately prior to flowering and seeding period of key weed species to reduce seed set. • Grazing undertaken for very short periods (time will be depending on paddock size, generally days). • Grazing removed once reduction in seed heads has occurred. For biomass control: • Restricted to areas with biomass cover of >70%. • Grazing undertaken within a grazing window, avoiding key growth period for native species. • Groundcover maintained at a minimum of 70%. • Sward heights of dominant grasses maintained at following minimum sward height: – Short grasses (<0.6 m): maintained at 5 cm bulk sward height. – Medium grasses (0.6 m to 1.2 m): maintained at 10 cm bulk sward height. – Large grasses (>1.2 m): maintained at 20 cm bulk sward height. • Fire may be used to manage biomass, in line with recommendations in Section 4.2.4.

Table 4.3 Weed and fuel/biomass load management strategies

Grazing management area	Background information	Management strategy	Trigger for control
Regrowth woodland	Regrowth woodlands occur across significant areas of the Stage 1 offset area. These areas are showing significant signs of natural regeneration of the overstorey, and support significant areas of native shrub layer with a moderate diversity of native ground cover/grasses. These areas currently provide suitable habitat for a number of threatened species, including the Ornamental Snake and Squatter Pigeon. They also provide existing and future potential habitat of the Koala and Greater Glider, subject to maturing of overstorey species. Grazing can provide a useful tool for managing weed loads and/or biomass in certain areas. However, regrowth areas are incredibly susceptible to impacts from grazing, with livestock capable of trampling young vegetation. Fire will be of limited utility for weed control, except where recommended for particular weed species. Fire may be an important measure for fuel load/biomass control.	*Grazing excluded from young saplings/planted tubestock* Areas of existing naturally regenerating native vegetation (ie naturally occurring areas of saplings or 'suckers') should be fenced off and grazing excluded. Grazing may not occur in these areas until the saplings are of a size to withstand grazing and browsing from stock (approximately 2−3 years). After such time, crash grazing will be used to maintain native vegetation and grassy ecosystems. Crash grazing will be undertaken at specific times of year for short periods to control weed cover or control excessive grass biomass in above average growth seasons. Grazing will be undertaken at a time of year immediately prior to flowering of key weed species to reduce seed set, or as required to control biomass. Grazing should be excluded from any areas with low levels of weed cover (<50%) or low biomass (<70%). *Cool mosaic burns to reduce biomass* Fire will be implemented to control fuel load/biomass in line with recommendations in Section 4.2.4.	Exclude all grazing in naturally regenerating areas until saplings are capable of withstanding impacts from livestock (approximately 2−3 years). For weed control: • Restricted to areas with weed cover of >50% or areas with high threat weed (WONS or Bio Act listed). • Grazing timed to occur immediately prior to flowering and seeding period of key weed species to reduce seed set. • Grazing undertaken for very short periods (time will be depending on paddock size, generally days). • Grazing removed once reduction in seed heads has occurred. For biomass control: • Restricted to areas with biomass cover of >70%. • Grazing undertaken within a grazing window, avoiding key growth period for native species. • Groundcover maintained at a minimum of 70%. • Sward heights of dominant grasses maintained at following minimum sward height: – Short grasses (<0.6 m): maintained at 5 cm bulk sward height. – Medium grasses (0.6 m to 1.2 m): maintained at 10 cm bulk sward height. – Large grasses (>1.2 m): maintained at 20 cm bulk sward height. • Fire may be used to manage biomass, in line with recommendations in Section 4.2.4.

Table 4.3 Weed and fuel/biomass load management strategies

Grazing management area	Background information	Management strategy	Trigger for control
Cleared agricultural grasslands	Cleared agricultural grasslands are the predominant vegetation type across the Stage 1 offset area, representing 60% of the total area. These areas occur in various condition states, with some dominated by weeds (90% cover) while other shown a strong cover of native grasses. These areas have potential to provide significant areas of future potential habitat for all threatened species, subject to suitable management. Grazing will provide a key tool for managing weed loads and/or biomass in these areas to allow regeneration to occur. However, grazing will need to consider state of regeneration along with underlying weed and biomass cover and species composition of these areas. Fire will be of limited utility for weed control, except where recommended for particular weed species. Fire may be an important measure for fuel load/biomass control.	*Grazing permitted to reduce biomass* Crash grazing will be used to maintain native vegetation and grassy ecosystems. Crash grazing will be undertaken at specific times of year for short periods to control weed cover or control excessive grass biomass in above average growth seasons. Grazing will be undertaken at a time of year immediately prior to flowering of key weed species to reduce seed set, or as required to control biomass. Grazing should be excluded from any areas with low levels of weed cover (<50%) or low biomass (<70%). Once evidence of natural regeneration is occurring, the grazing management strategy for regrowth woodlands outlined above should be applied. *Cool mosaic burns to reduce biomass* Fire will be implemented to control fuel load/biomass in line with recommendations in Section 4.2.4.	For weed control: • Restricted to areas with weed cover of >50% or areas with high threat weed (WONS or Bio Act listed). • Grazing timed to occur immediately prior to flowering and seeding period of key weed species to reduce seed set. • Grazing undertaken for very short periods (time will be depending on paddock size, generally days). • Grazing removed once reduction in seed heads has occurred. For biomass control: • Restricted to areas with biomass cover of >70%. • Grazing undertaken within a grazing window, avoiding key growth period for native species. • Groundcover maintained at a minimum of 70%. • Sward heights of dominant grasses maintained at following minimum sward height: – Short grasses (<0.6 m): maintained at 5 cm bulk sward height. – Medium grasses (0.6 m to 1.2 m): maintained at 10 cm bulk sward height. – Large grasses (>1.2 m): maintained at 20 cm bulk sward height. • Fire may be used to manage biomass, in line with recommendations in Section 4.2.4. • Once regeneration is evident, exclude all grazing in naturally regenerating areas until saplings are capable of withstanding impacts from livestock (approximately 2-3 years).

Table 4.3 outlines strategies for management of weed and fuel/biomass load that are reliant on triggers related to weed and biomass cover. For example, the trigger point to implement biomass control will be when biomass exceeds 70% ground cover (ie less than 30% bare ground). The trigger point will be measured using the following quadrat sampling method for ground cover and herbage mass (Lang & McDonald 2005) by the grazier/appointed biodiversity auditor:

- Using a wooden or metal square (quadrat) of at least 0.5 m x 0.5 m internal dimensions, undertake the following steps.
- Walk at random path within each area to be assessed and throw the quadrat a short distance.
- For each throw look only at the area within the quadrat and assess and record the following:
    A. the percentage of total cover (living and dead);
    B. the percentage cover of live native plants;
    C. the percentage cover of live non-native plants; and
    D. measure height of pasture cover using Meat and Livestock Australia Pasture Ruler to estimate herbage mass.
- Take at least 10 random samples for each assessment area (the number of samples will be increased by 1 for each additional 5 ha for areas greater than 50 ha).
- Calculate the percentage of the assessment area covered by vegetation (living or dead): Sum of A / Number of samples.
- Calculate the percentage of the living vegetation that is live native ground coved by: (Sum of B x 100) / (Sum of B + Sum of C).
- Calculate average mass by: Sum of D / Number of samples.

This quadrat data will be provided for the commencement, and at the completion of grazing in the annual reports along with the following information:

- livestock movement including dates of entry and removal from the grazing area;
- a map of the grazed offset area;
- number of livestock, type and condition;
- quantity of supplement (if any);
- any livestock health or other management issues; and
- daily rainfall data.

Quadrat sampling method should occur monthly to determine trigger levels, and then once a week when grazing is occurring.

4.2.4 Fire management

Management of bushfire regimes in the Stage 1 offset area (and surrounds on adjacent land owned by Pembroke) would reduce the likelihood of threatened species mortality because of uncontrolled bushfire and prevent hot bushfires as they are a threat to foraging and breeding habitat. Fire management will also be used as a method to control biomass of native and invasive species, and may be used as a part of an integrated management approach for key weed species (eg Buffel Grass).

Bushfire preventative measures would include:

- Educating employees and contractors on general fire awareness and response procedures.
- Creation and maintenance of fire tracks (fire breaks) for fire control.
- Ground fuel loads will be monitored and, where required, reduced through crash grazing to prevent thick grass biomass from accumulating over time (see Section 4.2.3). Reducing the fuel load will minimise the impact of uncontrolled fires (eg from lightning strike).
- When necessary, fuel management (eg hazard reduction burns prior to the dry season) will be undertaken in consultation with the Qld Rural Fire Service.
- Local fire wardens will be consulted, and fire permits will be obtained prior to hazard reduction burns.
- Controlled burning at appropriate intervals to promote regeneration and germination of native vegetation communities and species may be undertaken.

The creation of key fire tracks will occur in the first 12 months of the biodiversity offset commencing and will be maintained each year thereafter. Other essential fire tracks may be added in following years if required. Hazard reduction burns prior to the dry season will be undertaken in those years where deemed necessary and conditions are appropriate.

Pembroke will undertake visual inspections of fire tracks and will ensure they are maintained. Pembroke will visually inspect and monitor ground fuel loads, will liaise on potential strategic rotational grazing and will reassess fuel loads after such grazing has occurred. The overall objective to prevent uncontrolled fires in particular hot fires occurring.

Corrective actions to be implemented for fire management will include:

- review effectiveness of fuel load management and monitoring techniques. Thresholds may need to be reduced if fuel loads get too high; and
- if controlled burning is implemented review effectiveness of that cool burn and monitor any changes post event. Ensure any learnings are adopted for next round.

4.2.5 Pest fauna management

Pest species represent key threats to a number of threatened species to be managed within the Stage 1 offset area. Feral pigs result in degradation of gilgai habitat for the Ornamental Snake (DoAWE 2020c), while feral herbivores such as the Rabbit result in degradation of habitat for the Squatter Pigeon (TSSC 2015). Predation by species such as Foxes, feral Cats and wild Dogs is considered a key threat to the Ornamental Snake (DoE 2014b), Australian Painted Snipe (TSSC 2013, DoAWE 2020d), Koala (DoSEWPC 2012b) and Squatter Pigeon (TSSC 2015, DoAWE 2020b).

Feral Cats, Foxes, wild Dogs, Rabbits and Pigs are the main pest vertebrate species found on the Stage 1 offset area that have the potential to damage or destroy native flora and fauna or their habitat. This damage is usually transient and isolated rather than widespread.

The complete eradiation of fauna pest species within the Stage 1 offset area is considered unfeasible, due to the cost of erecting and maintaining a pest-proof fence around the entire area or significant effort could be expended to eradicate pests in the offset, but they are likely to re-enter from adjoining properties. Therefore, the objective will be to reduce pest fauna populations which will in turn reduce threats on MNES species and their habitats.

Control of pest fauna within the Stage 1 offset area will be undertaken via several methods that are:

- species specific (wherever possible);
- cause no or little damage to the natural environment;
- are humane; and
- meet relevant Work, Health, Safety and Environment regulatory requirements.

Corrective actions to be implemented for pest fauna management where monitoring results are indicating an increase in numbers or increased habitat degradation will include:

- increase frequency of pest control events;
- change pest control methods where possible and in consultation with experienced professionals;
- look to adopt pest control across a broader area if it is likely pest animals are breeding in adjacent areas;
- look to install pest fauna exclusion fencing in ecologically sensitive areas (eg gilgais if feral pigs are causing significant damage).

Pest fauna specific control methods, timing, monitoring and corrective actions are outlined in Table 4.4. All pest fauna management would be undertaken by suitably qualified and experienced contractors.

Table 4.4 Pest fauna management

Pest species	Control method	Frequency and timing
Feral Cats	The control of feral Cat numbers within the Stage 1 offset area will be achieved though several methods, including: • Trapping - cage traps or soft-jaw foothold traps, focusing on territorial markers. Attractants, such as Tuna oil, may be used to attract feral Cats. • Shooting - night shooting programs over the Stage 1 offset area. • Baiting - Curiosity® and more recently the History bait uses an acid-soluble encapsulated pellet known as the 'hard shell delivery vehicle' (HSDV) (Johnston et al. 2011). Baiting would be undertaken throughout the Stage 1 offset area in conjunction with other programs as a part of an integrated control program. May not be as effective if there is a lot of prey around. All feral cat control will comply with the *Code of practice for the humane control of feral cats* (Sharp & Saunders 2010). Feral Cat control will be undertaken across all habitat types within the Stage 1 offset area.	Feral Cat control will be undertaken on an annual basis in late autumn, prior to breeding occurring. Control using shooting will be undertaken over a minimum of five days and nights. Baiting will be undertaken for a month, with baits laid out and collected to determine take.
Wild Dogs	The control of wild Dog numbers within the Stage 1 offset area will be achieved though several methods, including: • Trapping - rubber-jawed leg-hold trapping will be undertaken in conjunction with other programs as a part of an integrated control program. • Shooting - day-time and night-time shooting will be used for opportunistic control where appropriate. • Poisoning – 1080 targeted baiting programs will be undertaken throughout the Stage 1 offset area as the primary method for control of wild Dogs. Wild Dog control will be undertaken across all habitat types within the Stage 1 offset area.	Wild Dog control will be undertaken on an annual basis in late autumn, prior to breeding occurring. Control using trapping or shooting will be undertaken over a minimum of five days and nights. Baiting with 1080 will be undertaken for a month, with baits laid out and collected to determine take.
Foxes	The control of Fox numbers within the Stage 1 offset area will be achieved though several methods, including: • Trapping - rubber-jawed leg-hold trapping and/or snare trapping will be undertaken in conjunction with other programs as a part of an integrated control program. • Shooting - day-time and night-time shooting will be used for opportunistic control where appropriate. • Poisoning – 1080 targeted baiting programs will be undertaken throughout the Stage 1 offset area as the primary method for control of Foxes. Fox control will be undertaken across all habitat types within the Stage 1 offset area.	Fox control will be undertaken on an annual basis in late autumn, immediately prior to breeding occurring. Control using trapping or shooting will be undertaken over a minimum of five days and nights. Baiting with 1080 will be undertaken for a month, with baits laid out and collected to determine take.

Table 4.4 Pest fauna management

Pest species	Control method	Frequency and timing
Feral Pigs	The control of feral Pig numbers within the Stage 1 offset area will be achieved though several methods, including: • Poisoning - 1080 targeted baiting programs will be undertaken throughout the Stage 1 offset area as the primary control method. Pre-feeding is an important step in success of this control measure. To maximise effectiveness, feral Pigs must be free fed with non-poisoned bait for several days before laying poisoned baits. Pig-specific feeding stations (eg Hoghopper) will help reduce access to bait by non-target species. • Shooting - day-time and night-time shooting will be used for opportunistic control where appropriate, eg isolated males, in conjunction with other programs. Feral Pig control will be undertaken across the Stage 1 offset area with a focus on wetland areas and gilgai habitats where feral Pigs are most likely to be active.	Feral Pig control will be undertaken on an annual basis in conjunction with other control programs. Pre-feeding before annual baiting efforts will be carried out by the land holder/Pembroke for a minimum of three days prior. Control via shooting will be opportunistic and done in conjunction with other control programs.
Rabbits	An integrated control approach, combining different control methods with land management practices will be undertaken for Rabbits. Control methods to be implemented include: • Harbour destruction - where there is abundant surface harbour, high proportion of rabbits may live above ground rather than in underground warrens. Rabbits can make homes in windrows, dense shrubs (eg blackberries, lantana) and old machinery. To eliminate above-ground breeding areas any windrows, large weedy shrubs and foreign objects such as machinery will be removed from the Stage 1 offset area. • Warren ripping - as many rabbits as possible should be chased inside warren by Dogs before ripping starts. A tractor should be used with tyned (sharp-pronged) implement, one tyne or many, that rips through warren and collapses it. All warrens within 1km of permanent water should be ripped. • Poisoning - targeted baiting programs using 1080 or Pindone will be undertaken throughout the Stage 1 offset area. Pre-feeding can increase bait uptake and prove more effective and will be undertaken at least three times over a one-week period prior to baiting. • Trapping – trapping undertaken via cage and barrel traps can be labour intensive but may be used to ‘mop up’ after other control methods have been enforced. • Shooting - day-time and night-time shooting will be used to ‘mop up’ after other control methods have been enforced.	Harbour destruction will be undertaken in the first year of the implementation of this OAMP and largely as a one-off program. Warren ripping will be undertaken by the land holder and/or Pembroke on an as needs basis when warrens are identified. Trapping and shooting will be undertaken opportunistically to mop up following harbour destruction and/or warren ripping. Poisoning will be undertaken on an annual basis in conjunction with other control programs. Poisoning should occur when green pick is low to ensure uptake and when Rabbits are not breeding.

4.2.6 Nest box research program (Greater Glider)

The offset areas for Greater Glider which are classified as 'potential future habitat' it is recognised will not result in the creation of additional trees with natural forming hollows within a 20-year timeframe. Hollow formation is dependent on a tree's history, its species and location. Generally, small hollows with narrow entrances suitable for small animals such as the brush-tailed phascogale (*Phascogale tapoatafa*) and the eastern pygmy-possum (*Cercartetus nanus*), take about 100 years to form. Hollows of a medium size and suitable for animals such as parrots will take around 200 years to form, and the larger and deeper hollows occupied by glossy black cockatoos (*Calyptorhynchus lathami*) and other larger animals such as Australian masked owls (*Tyto novaehollandiae*) can take a longer (NPWS 1999).

The regenerating woodlands in Stage 1 offset area would be on a trajectory towards creating hollows in the future as the offset land will be secured in perpetuity and continue to mature beyond 20 years of this OAMP. In recognition of this, a supplementary nest box program is proposed that will supplement denning and breeding habitat for the Greater Glider as hollows are forming and research will be undertaken to evaluate the success of these nest boxes for the species. It will take approximately five to eight years for tree plantings within the 'potential future habitat' to reach a size to support Greater Glider nest boxes and to provide potential breeding habitat. Therefore, in the first five years some supplementary nest boxes in existing habitat that is low in suitable sized hollows could be implemented.

Measures to offset the loss of hollow- bearing trees due to development are largely focused on installing nest boxes, with successful delivery based on the number of boxes installed rather than the number of threatened species that use and successfully breed in them. To date, little research has examined the effectiveness of nest boxes as an offset conservation tool (Threatened Species Recovery Hub 2018). A case study is the Qld Glider Network (QGN) installed 18 nest boxes in a bushland reserve north of Brisbane in December 2017 to learn more about Greater Glider nest box use. The project design included two nest boxes per tree (5 m and 10 m installation heights) on nine trees, including regular monitoring. Greater Gliders were observed in nest boxes installed at 10 m; no evidence of occupation by any glider species has been observed in nest boxes at 5 m. Consultation is proposed to occur with QGN to gain information on their nest box design and monitoring program during further development of this program.

Pembroke propose to implement a nest box research programme, for the 26.5 ha of 'woodland regrowth' in the first five years, and 2,843 ha of 'potential future habitat' post five years once replanting tree growth is large enough to support nest boxes.

This research programme will include the installation and monitoring of up to six nest boxes within the 26.56 ha woodland regrowth offset area (one nest box across one Greater Glider home range (approximately 4 ha home range per individual Conservation advice, Threatened Species Scientific Committee (TSSC 2016)). An estimated 300 nest boxes will be trialled across the 3,737.69 ha of 'potential future habitat'. The nest boxes will be installed under the direction of a suitably qualified person. There is also possibility to trial using the naturally formed hollows from the impact site to be placed into the offset site as part of this research and monitoring program.

The Brisbane City Council Conservation Action Statement: Gliders September 2010 (Brisbane City Council 2010) provides suggested dimension for purpose built Greater Glider-specific nest boxes which Pembroke could use as a guide for the design of suitable nest boxes (Table 4.5). Pembroke will also investigate new materials being used to build nest boxes including CYPLAS boxes made from 100% recycled high density polyethylene (HDPE) that have an estimated 30+ year lifespan and termite and rot proof. https://www.hollowloghomes.com/products

Table 4.5 Greater Glider nest box dimensions (BCC 2010)

Species	Inside Measurement (mm)	Depth of box from bottom of entrance hole (mm)	Entrance diameter (mm)
Greater Glider	250 x 250	400	80 Jagged spout entrance

Source: Brisbane City Council Conservation Action Statement: Gliders September 2010

The location in which the nest box will be installed will take into account the following factors:

- the tree on which it is be installed (ie healthy living trees with existing hollows and some without existing hollows);
- the existing tree hollow density of the surrounding area in which they will be installed (ie with a preference for a location with low tree hollow density);
- to provide shelter from rain and, if possible, excessive sun; and
- camouflage from potential predators.

The recommended attachment method for nest boxes is the Habisure system (Frank and Franks 2006) which allows for at least one metre growth in the diameter of the host tree before adjustment is required. Bolting or screwing nest boxes to trees is not recommended due to increased damage to trees and a comparatively short lifespan. This is recommendation of NSW Roads and Maritime who have extensive experience in nest box installation.

In Year 1 a survey will be completed to confirm the location for nest boxes, have the nest boxes produced and/or obtain naturally formed hollows from trees on the impact site, and confirm their installation process. The installation of nest boxes should occur in Year 2 within the 26.56 ha of 'woodland regrowth'. The placement of the nest boxes within the 3737.69 ha of 'potential future habitat' will require at least five years of growth of regrowth trees to ensure these trees are large enough to support nest boxes and to provide potential foraging habitat for the Greater Glider. Therefore nest box installation in 'potential future habitat' will be monitored and is anticipated from Year 6.

Monitoring (by Appropriately Qualified Person(s)) will include quarterly inspections during the first year which will enable occupation timing to be documented. Following the first year, monitoring will occur annually in spring and winter for the next two years, and may then be reduced to biennial monitoring following a review of the monitoring results.

Regular maintenance of the nest boxes will be completed. Regular inspection of the condition of the box and presence of pest animals is essential. Nest box materials can deteriorate over time, and parts such as lids may become damaged. Maintenance may be needed to keep nest boxes in a usable condition. The security of attachment of the nest box should also be checked regularly. Pests, such as Common Myna and feral bee, may need to be controlled if they occupy the nest box. It is recommended that such inspections take place from the outside to avoid disturbing animals that are using the box.

By collecting good quality nest box data we can determine:

- whether the target species is using the box over time, including for breeding;
- occupancy rates, frequency of use, proportion of use by different species, pattern and timing of use;
- whether boxes are only supporting common species or are also used by target threatened species;

- use of the nest boxes by pests (eg European honeybees, Common Myna); and
- suitability of designs, and maintenance needs and cost.

In order to facilitate monitoring of nest boxes all nest boxes should be assigned a unique identification code referencing the nest box zone and number. Aluminium identification tags with the nest box code are to be placed at eye level on the recipient tree. At the time of installation the ecologist is to record the following information:

a) Identification number;

b) Nest box type;

c) GPS location;

d) Tree species;

e) DBH of host tree;

f) Nest box height; and

g) Orientation.

All the above help to inform how effective nest boxes are at contributing to the conservation of a species.

Corrective actions to be implemented for the supplementary nest box program will include:

- increased maintenance of nest box structures if monitoring is finding they are being used by pest species;
- alter design, height and location of nest boxes if monitoring is showing a low success rate of occupancy; and
- increase frequency of monitoring in case Greater Gliders are only using nest boxes at certain months of the year.

4.2.7 Other general management measures

i Fencing design

Fencing is an integral part of land management. Fences delineate legal boundaries and control access, restrict stock movements, and often provide access routes for land managers with tracks along fencelines. However, fences can restrict the movement of native wildlife, and can cause serious injury and deaths. Barbed wire, in particular, is a major hazard for wildlife with more than 75 wildlife species identified in Australia as occasional or regular victims of barbed wire fences, especially nocturnal animals such as bats, gliders and owls. Barbed wire fences are identified as a threat to the Greater Glider (TSSC 2016). Many species fail to see the fence, or cannot clear the height under windy conditions. Most of those rescued are too severely damaged to return to the wild. Most entanglements occur on the top one or two strands of a barbed wire fence.

For existing fences, the top strand of barbed wire will be replaced with plain or borderline (white plastic coated) wire this can significantly reduce the risk of entanglement. Reflectors will also be placed on the top wire to increase detectability at night by wildlife.

For new fencing design parameters can include:

- Design a fence to allow for animals to pass underneath. Leave a minimum of 40 cm between the ground and the bottom wire.

- Choose a plain, high-tensile fencing wire or borderline (white plastic coated) for top strand. If this is tensioned correctly, this fencing material can contain most stock. Put reflective material on top strand so fauna can more easily see this at night.

- Electric fencing can be used with caution. Electric fencing has shown to be effective in keeping cattle out and not injuring wildlife. Remember to keep the hot wire above 40 cm to allow for small animals to pass under with ease. As it is cheaper and quicker to construct it may be useful to be installed around revegetation areas or gilgai where it is for a shorter period and a permanent fence isn't needed.

ii Track establishment and maintenance

A number of access tracks, to enable management fire control, will be established as a part of the Stage 1 offset areas. Largely, these management tracks will use the existing track network. Annual maintenance of access tracks will be undertaken, including grading and erosion control measures, using graders and road base materials where required. Access tracks/fire breaks will be no wider than 3 metres in width.

iii Pathogen management

Phytophthora cinnamomi is a soil fungus that attacks the root (and sometimes stem) systems of plants, destroying the ability of the plant to uptake water and nutrients (DoEE 2018). Dieback caused by the root-rot fungus *Phytophthora cinnamomi* is also listed as a KTP under the EPBC Act.

Currently, no evidence of *Phytophthora cinnamomi* has been recorded on site. Therefore, specific management measures are not required. Washdown bays at the entrances of the Stage 1 offset area will be provided to limit the risk of pathogens spreading onto site. Washdowns of vehicles and machinery will be required each time the site is visited.

If any areas are reasonably suspected to be infected with this pathogen in future (for example, areas of unexplained vegetation death) a targeted sampling, diagnosis and management strategy will be designed to address impacts and further spread.

iv Erosion management

Erosion within the site is limited to the edges of waterways, such as creeks and dams.

Erosion will be further limited through fencing stock out, revegetating waterways, and managing pigs. Where those controls are not adequate to maintain or improve erosion, appropriate erosion-control measures will be implemented, such as sandbags.

4.2.8 Prohibited activities

The following activities are not permitted to occur under this OAMP, unless express written permission is received from Pembroke and DAWE.

- No clearing of native woody vegetation is permitted within the offset area unless it is required for maintaining 3-m wide fencelines and fire breaks. Clearing of large trees will be avoided to greatest extent possible.

- No clearing of hollow-bearing trees will be permitted.

- Existing or future habitat mapped within the offset known important habitat, connecting habitat or adjacent patches of suitable habitat would be cleared, unless essential for management purposes (eg fire breaks).

- The following practices will be prohibited in the Stage 1 offset area:

    a) ploughing;

    b) fertiliser application;

    c) aerial application of pesticide from planes or helicopters;

    d) continuous grazing;

    e) use of livestock feed;

    f) littering or dumping foreign waste;

    g) removal of firewood, native plants or animals;

    h) removal of rocks, sand or gravel;

    i) logging;

    j) hunting;

    k) trapping or shooting (unless approved under this OAMP for controlling pest animals); and

    l) keeping of European beehives and domestic cats and/or dogs.

4.2.9 Securing the offset areas through a legally binding mechanism

The Stage 1 offset area is required to be legally secured in perpetuity.

Pembroke propose the Stage 1 offset area will initially be legally secured through a Voluntary Declaration under the *Vegetation Management Act 1999* (VM Act) within six months of the OAMP being approved by Commonwealth DoAWE. This will protect the vegetation on the title, and require land management is undertaken in accordance with the OAMP. This is legally binding on current and future landowners.

Pembroke then propose to commence discussions with Queensland DES regarding protecting the Stage 1 offset area, and possibly future biodiversity offset stages for Olive Downs, under a Nature Refuge Agreement under *Nature Conservation Act 1992* (NC Act). The Nature Refuges Program is the Queensland Government's primary voluntary conservation covenanting program. Key aspects of the program are:

- each nature refuge is negotiated directly with the landholder through a nature refuge agreement;
- it can apply to a whole property or a portion of the property, depending on the conservation values and the landholder's wishes;
- perpetual, registrable on title and binds successive owners or lessees of the land. A nature refuge is the best way landholders can ensure the good land management practices and conservation works they have initiated will be continued when future generations or new owners take over. So, if a property changes hands, responsibility for the nature refuge rests with the new owners or lessees;
- when a landholder signs a nature refuge agreement they are supported by nature refuge officers located in key locations across the state. These officers support landholders through one-on-one specialist advice on how to best protect the conservation values on their nature refuge; and

- a nature refuge is a Category C Environmentally Sensitive Area under *Environmental Protection Act 1992* and a Matter of State Environmental Significance (MSES) which provides greater protection to the offset.

Nature refuge declarations can take over 12 months to finalise hence the reason to use a Voluntary Declaration to initially secure the offset.

4.3 Threatened fauna management objectives

The management measures outlined above have been informed by key threats, recovery actions and management priorities from each species listing advice, conservation advice, recovery plan and threat abatements plan. Table 4.6 provides a summary of how the proposed management measures address key threats and will provide a positive conservation outcome for these MNES species.

It demonstrates how the proposed Stage 1 offset area will compensate for the clearance of listed threatened species habitat at the Olive Downs Coking Coal project.

Table 4.6 Summary of threatened fauna management objectives

Management objective (addressing key threats)	Management outcome	Management action/s to address key threats
Koala		
Habitat loss, fragmentation and/or degradation	• Overall improvement in Koala habitat quality • Increase in Koala habitat extent through natural regeneration and/or active restoration	Habitat loss is identified as a key threat to the Koala, particularly in the Brigalow Belt Bioregion due to historical land clearing (DoSEWPC 2012b, TSSC 2012, DoAWE 2020a). A total of 4,790 ha of existing and future Koala habitat will be protected and managed within the Stage 1 offset area. Existing grazing practices will be removed from the site, allowing natural regeneration to occur across the site, with active revegetation where natural regeneration does not result. Weed control works and weed and fuel/biomass control will be implemented across the 1,720.6 ha of remnant woodland, resulting in a net improvement in condition through reduction of weeds and control of biomass and ongoing growth and recruitment of Koala feed trees and resting trees. Weed control works and weed and fuel/biomass control will be implemented across the 1,447.5 ha of regrowth woodland, resulting in continued regeneration of these areas and a net increase in availability of Koala habitat. In other regions of Australia (eg Gunndeah in NSW) revegetation work resulted in regional population increases against an overall decline in population numbers across Australia (Lunney et al. 2009). Weed control works, weed and fuel/biomass control and, if required, active revegetation will be implemented across the 1,621.9 ha of potential future habitat resulting in regeneration of these areas and a net increase in availability of Koala habitat. As outlined above, these works have the capacity to result in population increases at a local and regional scale. These measures, combined, address a key threat of habitat loss and will have a positive impact on the local and regional population of the Koala.

Table 4.6 Summary of threatened fauna management objectives

Management objective (addressing key threats)	Management outcome	Management action/s to address key threats
Predation by wild Dogs	• Reduced likelihood of predation by wild Dogs	Predation, particularly by Dogs, is identified as a threat to the Koala and may lead to localised declines (DoSEWPC 2012b, TSSC 2012, DoAWE 2020a). Whilst much of the available data is from urban and peri-urban environments Dogs will predate on Koalas in rural and regional settings and may lead to significant local declines, particularly when coupled with other impacts. Predator control works, focusing on Dogs, Cats and Foxes, will be undertaken across the Stage 1 offset area using a variety of methods (Table 4.4). Predator control works will be undertaken on an annual basis across the Stage 1 offset area. Reductions in predator numbers, particularly wild Dogs, will reduce overall population pressure, providing positive benefits for the local Koala population.
Climate change and drought, leading to increased impacts from fire	• Reduce frequency and intensity of fires within Koala habitat • Increased survival of extreme fire events	Climate change and resultant increased risk of fire is identified as an increasing threat to the Koala, resulting in mortality and range reductions (TSSC 2012). The recent 2019/2020 bushfire season have resulted in significant losses of Koala habitat and the Koala is identified as needing urgent, emergency action to address an increased risk of extinction. This event demonstrates that capacity of increased fire risk to impact this species. Weed and fuel/biomass control will be undertaken across the Stage 1 offset area to reduce fuel loads and risk of high intensity to catastrophic fires. Further, these measures are c-designed to ensure they do not have negative impact on other habitat features such as regeneration. Hazard reduction burns will be undertaken in consultation with the Qld Rural Fire Service to further reduce this risk. These measures will provide an increased level of protection for the Koala within the Stage 1 offset area, reducing the risk of both mortality and habitat loss because of fire. This will provide benefits for local populations as well the regional population through ensuring an available source population should fires have detrimental impact on regional populations.
Ornamental Snake		
Habitat loss and fragmentation	• Overall improvement in existing Ornamental Snake habitat quality • Increase in Ornamental Snake habitat through natural regeneration or active restoration • Increase in available shelter through increases in coarse woody debris	Past and ongoing clearing of habitat for the Ornamental Snake, particularly broad-scale land clearing, has had a significant effect on the species (DoE 2014b, DoAWE 2020c). In turn, this has led to restricted reptile dispersal, isolated populations and genetic fragmentation as well as increased habitat degradation from edge effects (DoSEWPC 2011). A total of 2,007.7 ha of known important habitat for the Ornamental Snake will be protected and managed within the Stage 1 offset area. Existing grazing practices will be removed from the site, removing impacts resulting from grazing (see below). Weed control works and weed and fuel/biomass control will be implemented the Stage 1 offset area resulting in a net improvement in condition through reduction of weeds and control of biomass and ongoing growth and recruitment of trees that will result in long-term increases in coarse woody debris which provides shelter for this species. These measures, combined, address a key threat of habitat loss and will have a long-term benefit for the species.

Table 4.6 Summary of threatened fauna management objectives

Management objective (addressing key threats)	Management outcome	Management action/s to address key threats
Habitat degradation resulting from grazing leading to soil compaction and compromising of soil structure	• Reduce habitat degradation resulting from stock grazing	Grazing by stock has resulted in degradation of habitat for the Ornamental Snake, particularly in sensitive wetland and gilgai habitats (DoE 2014b, DoAWE 2020c). Grazing leads to soil compaction and compromising of soil structures, impacting on key habitats for the Ornamental Snake including cracking clay soils. This, in turn, reduces habitat quality and function leading to reduced resilience of populations to adverse environmental change (DoSEWPC 2011). Grazing will largely be removed from site, with crash grazing (short-term) undertaken to control weeds and fuel load/biomass. Sensitive gilgai habitats will be protected from grazing through the implementation of additional controls during the wet season and following significant rainfall events. These measures are anticipated to result in all impacts to key habitat from grazing being removed from the site, with resultant increases in habitat quality across the Stage 1 offset area.
Destruction of wetland habitat by feral Pigs	• Reduce the likelihood of habitat degradation by feral pigs	Destruction of wetland habitats, including gilgai, by feral Pigs is highlighted as a key threat to the species (DoE 2014b) likely to result in ongoing habitat loss and degradation, as well as mortality. This type of impact is also likely to reduce the suitability of this habitat for key prey species for the Ornamental Snake, further exacerbating impacts. Control of feral Pigs will, will be undertaken across the Stage 1 offset area using a combination of baiting (for broad control) and shooting (for opportunistic control). Feral Pig control will focus on wetland areas and gilgai habitats where feral Pigs are most likely to be active. Ongoing control of feral Pigs will result in reduced degradation of known important habitat, addressing habitat loss and increasing availability of prey items.
Predation by feral species	• Reduce the likelihood of predation by feral cats, European Red Fox and feral pigs	The Ornamental Snake has undergone a decline in abundance in the past few decades due to a number of impacts on the species, one of which is predation by feral species (DoAWE 2020c). Predator control works will be undertaken across the Stage 1 offset area using a variety of methods such as trapping and shooting programs (Table 4.4). Predator control works will be undertaken on an annual basis across the Stage 1 offset area.
Invasion by weeds	• Reduce invasion of weed species (Buffel Grass)	The degradation of habitat by invasive weeds, such as Buffel Grass, is considered a potential contributing factor the decline of the Ornamental Snake (DoAWE 2020c). Weed control will be undertaken across the Stage 1 offset area using a variety of methods (Table 4.3). Methods of removal and control for Buffel Grass include physical removal and/or use of herbicide. Weed control events will be completed at least once a year between October to April.
Australian Painted Snipe		
Predation by feral species	• Reduce the likelihood of predation by feral cats and European Red Fox	Predation, particularly nest predation by feral cats and foxes, is identified as a potential threat to the Australian Painted Snipe (DoSEWPC 2013). However, there is no evidence to suggest predation has caused a decline of the species. Predator control works, focusing on feral cats and foxes, will be undertaken across the Stage 1 offset area using a variety of methods such as trapping and shooting programs (Table 4.4). Predator control works will be undertaken on an annual basis across the Stage 1 offset area.

Table 4.6 Summary of threatened fauna management objectives

Management objective (addressing key threats)	Management outcome	Management action/s to address key threats
Habitat degradation resulting from grazing leading to soil compaction and compromising of soil structure	• Reduce habitat degradation resulting from stock grazing	Grazing and associated trampling by stock and has resulted in degradation of wetland vegetation, nutrient enrichment and disturbance to substrate (DoSEWPC 2013). Grazing will largely be removed from site with crash grazing (short-term) undertaken to control weeds and fuel load/biomass. Riparian vegetation and natural re-generative native vegetation will be protected from grazing using fencing. Planted areas will be fenced off and excluded from grazing within the first 2 to 3 years. These measures are anticipated to result in all impacts to key habitat from grazing being removed from the site, with resultant increases in habitat quality across the Stage 1 offset area. Rotation of livestock will occur during years with sufficient rainfall (dependent on seasonal conditions).
Invasion by weeds	• Reduce invasion of weed species	Wetland vegetation is critical to the survival of the Australian Painted Snipe. The replacement of native wetland vegetation by invasive, noxious weeds could render the species habitats less suitable or unsuitable (DoAWE 2020d). Weed control will be undertaken across the Stage 1 offset area using a variety of methods (Table 4.2).
Greater Glider		
Habitat loss, fragmentation and/or degradation	• Overall improvement in Greater Glider habitat quality • Increase in Greater Glider habitat through natural regeneration and/or revegetation • Increased denning habitat for the Greater Glider • Increased Greater Glider habitat connectivity in riparian areas	Habitat loss and fragmentation is identified as a key threat to the Greater Glider (TSSC 2016). The species is known to occur within tall forests with a diversity of eucalypt species and an abundance of hollow bearing trees (TSSC 2016). A total of 1,721.2 ha of remnant woodland, 26.56 ha of regrowth woodland and 3,737.7 ha of potential future habitat for the Greater Glider will be protected and managed within the Stage 1 offset area. Existing grazing practices will be removed from the site, allowing natural regeneration to occur across the site, with active revegetation where natural regeneration does not result. Weed control works and weed and fuel/biomass control will be implemented across the Stage 1 offset area, resulting in a net improvement in condition through reduction of weeds and control of biomass and ongoing growth and recruitment of Greater Glider feed trees and resting trees. Additionally, supplementary planting of suitable habitat trees will be conducted within future potential habitat areas. Planting and regeneration efforts should commence as early as possible into the offsetting process and be ongoing until a satisfactory amount of re-planting and habitat generation has occurred within the future potential habitat. Maintenance will occur continuously until these areas are self-sustaining. Regenerative habitat will be fenced to protect future Greater Glider habitat from grazing pressures. Installation and monitoring of 6 nest boxes in the woodland regrowth and over time 300 nest boxes within the potential future habitat will provide additional breeding habitat for the Greater Glider. Section 4.2.6 includes further details of the nest box research program. Greater Glider habitat connectivity in riparian areas will be improved by increasing the height and cover of remnant vegetation and regrowth vegetation along riparian corridors. Existing hollow-bearing trees will be retained and new large hollows will develop over time. Non-remnant areas will then start to develop in their regrowth vegetation making these riparian corridors larger and providing improved foraging resources for the species. Supplementary nest boxes will be installed in remnant, regrowth woodlands and over time will be installed into regeneration/revegetated areas. This will provide more denning opportunities for the species and improve their connectivity through these habitats.

Table 4.6 Summary of threatened fauna management objectives

Management objective (addressing key threats)	Management outcome	Management action/s to address key threats
Climate change and drought, leading to increased impacts from fire	• Reduce frequency and intensity of fires within Greater Glider habitat • Increased survival of extreme fire events	The Greater Glider is sensitive to wildlife and is slow to recover following major disturbance (TSSC 2016). High intensity and frequent fires are considered a severe threat to the Greater Glider (TSSC 2016). Weed and fuel/biomass control will be undertaken across the Stage 1 offset area to reduce fuel loads and risk of high intensity to catastrophic fires. Further, these measures are C-designed to ensure they do not have negative impact on other habitat features such as regeneration. Hazard reduction burns will be undertaken in consultation with the Qld Rural Fire Service to further reduce this risk. These measures will provide an increased level of protection for the Greater Glider within the Stage 1 offset area, reducing the risk of both mortality and habitat loss because of fire. This will provide benefits for local populations as well the regional population through ensuring an available source population should fires have detrimental impact on regional populations.
Squatter Pigeon		
Habitat and resource loss	• Reduce competition of food source by rabbits • Improve Squatter Pigeon habitat extent and connectivity	Overgrazing of habitat and competition of food sources by feral herbivores such as rabbits is a threat to the Squatter Pigeon (TSSC 2015). Pest fauna management controls for rabbits will be undertaken across the Stage 1 offset area using a variety of methods such as warren ripping, harbour destruction, baiting, trapping and shooting. Warren ripping and harbour destruction should be completed monthly. Trapping, baiting and shooting programs will occur annually. Reduction in feral herbivores, particularly rabbits, will reduce pressures from competition of food source, providing positive benefits for the local Squatter Pigeon population.
Habitat degradation resulting from grazing leading to soil compaction and compromising of soil structure	• Reduce habitat degradation resulting from stock grazing	The degradation of Squatter Pigeon habitat by overgrazing by stock has contributed to the decline of the species (DoAWE 2020b). Within Queensland much of the species original habitat has been replaced with improved pasture for cattle-grazing (TSSC 2015). However, grazing by sheep is identified as more destructive to the species (TSSC 2015). Grazing will largely be removed from site with crash grazing (short-term) undertaken to control weeds and fuel load/biomass. Riparian vegetation, existing and future habitat will be protected from grazing using fencing. Planted areas will be fenced off and excluded from grazing within the first 2 to 3 years. These measures are anticipated to result in all impacts to key habitat from grazing being removed from the site, with resultant increases in habitat quality across the Stage 1 offset area. Rotation of livestock will occur during years with sufficient rainfall (dependent on seasonal conditions).
Invasion by weeds	• Reduce invasion of weed species (Buffel Grass)	The degradation of habitat by invasive weeds, such as Buffel Grass, is one of the main threats to the Squatter Pigeon (DoAWE 2020b). Weed control will be undertaken across the Stage 1 offset area using a variety of methods (Table 4.3). Methods of removal and control for Buffel Grass include physical removal and/or use of herbicide. Weed control events will be completed at least once a year between October to April.
Predation by feral cats and the European Red Fox	• Reduce likelihood of predation by feral cats and the European Red Fox	Predation, particularly by feral cats and foxes, is identified as having the greatest impact upon the Squatter Pigeon (southern) population (DoAWE 2020b). Predator control works, focusing on feral cats and foxes, will be undertaken across the Stage 1 offset area using a variety of methods such as trapping and shooting programs (Table 4.4). Predator control works will be undertaken on an annual basis across the Stage 1 offset area.

Table 4.6 Summary of threatened fauna management objectives

Management objective (addressing key threats)	Management outcome	Management action/s to address key threats
Climate change and drought, leading to increased impacts from fire	• Reduce frequency and intensity of fires within Squatter Pigeon habitat • Increased survival of extreme fire events	It is suggested that drought and bushfires may exacerbate the impacts of other threatening processes and contribute to the decline of the species (DoAWE 2020b). Weed and fuel/biomass control will be undertaken across the Stage 1 offset area to reduce fuel loads and risk of high intensity to catastrophic fires. Further, these measures are C-designed to ensure they do not have negative impact on other habitat features such as regeneration. Hazard reduction burns will be undertaken in consultation with the Qld Rural Fire Service to further reduce this risk. These measures will provide an increased level of protection for the Squatter Pigeon within the Stage 1 offset area, reducing the risk of both mortality and habitat loss because of fire. This will provide benefits for local populations as well the regional population through ensuring an available source population should fires have detrimental impact on regional populations.

5 Risk assessment

This section of the OAMP performs a risk analysis and a risk management and mitigation strategy for the successful implementation of the OAMP and timely achievement of the offset management outcomes. It includes a rating of all initial and post-mitigation residual risks in accordance with the risk assessment matrix provided by DAWE.

The key risks have been assessed using qualitative likelihood (Table 5.1) and qualitative consequence ratings (Table 5.2) with the interaction of likelihood and consequence determining the overall resultant risk. The risk assessment matrix is presented as Table 5.3.

Table 5.1 Qualitative measure of likelihood[1]

Score	Definition / rationale
Highly Likely	Is expected to occur in most circumstances
Likely	Will probably occur during the life of the project
Possible	Might occur during the life of the project
Unlikely	Could occur but considered unlikely or doubtful
Rare	May occur in exceptional circumstances

Notes: 1. how likely is it that this event/circumstances will occur after management activities are implemented

Table 5.2 Qualitative measure of consequence

Score	Definition / rationale
Minor	Minor incident of environmental damage that can be reversed (eg short-term delays to achieving plan objectives, implementing low-cost, well-characterised corrective actions)
Moderate	Isolated but substantial instances of environmental damage that could be reversed with intensive efforts (eg short-term delays to achieving plan objectives, implementing well-characterised, high-cost/effort corrective actions)
High	Substantial instances of environmental damage that could be reversed with intensive efforts (eg medium-long term delays to achieving objectives, implementing uncertain, high-cost/effort corrective actions)
Major	Major loss of environmental amenity and real danger of continuing (eg plan objectives are unlikely to be achieved, with significant legislative, technical, ecological and/or administrative barriers to attainment that have no evidenced mitigation strategies)
Severe	Severe widespread loss of environmental amenity and irrecoverable environmental damage (eg plan objectives are unable to be achieved, with no evidenced mitigation strategies)

Table 5.3 Risk assessment matrix

Risk Assessment		Consequence				
		Minor (C1)	Moderate (C2)	High (C3)	Major (C4)	Severe(C5)
Likelihood	Highly likely (L5)	Medium	High	High	Severe	Severe
	Likely (L4)	Low	Medium	High	High	Severe
	Possible (L3)	Low	Medium	Medium	High	Severe
	Unlikely (L2)	Low	Low	Medium	High	High
	Rare (L1)	Low	Low	Low	Medium	High

Table 5.4 outlines the key identified risks which will influence the ability of the offset to achieve the conservation outcomes set at the end of the OAMP, and effectiveness of identified management actions achieving the set management objectives. It outlines feasible mitigation measures to reduce the overall risk and failure of the offset.

The ratings assume that the risks are untreated i.e. have not been addressed by specific risk mitigation measures other than routine design and operational practice. The residual risk resulting from corrective actions applied to each risk event is then applied.

Table 5.4 Risk Assessment

Risk	Description	Inherent Risk (Likelihood / Consequence)	Mitigation measures	Timing	Residual risk (Likelihood/ Consequence)
Impacts to offset from conflicting land uses					
Impacts to the offset from resource tenements and/or future development.	The offset is proposed on land that is freehold tenure, owned by Pembroke, and not encumbered by easements or other interests under Qld Land Act. The Stage 1 offset area is not constrained by any mining leases. There is an area directly to the south of the offset area which has an approved mining tenement. An adjacent property in east has a mining lease granted. Pembroke and resource holders will have agreements in place to ensure future development activities do not impact on offset values.	**High** (L3/C4)	Legally secure Stage 1 offset area through declaration as a reserve under NC Act declaration or legally binding covenant. This will remain on the title binding future owners and constrain future development occurring. Should Pembroke sell the offset land once performance outcomes are achieved the offset protection mechanism is still legally binding and they need to comply with the accompanying conservation agreement. If future mining or development is proposed over the offset area the proponent would need to offset the offset. They would also need to submit a referral under EPBC Act for impacts to MNES. Fencing the offset boundary will occur to ensure the offset land is clearly delineated from the mining tenement and there is no unauthorised access.	The Stage 1 offset area will be legally secured on title within 6 months of project commencing.	**Medium** (L1/C4)
Impacts to the offset from unauthorised access	Unauthorised access and activities have potential to degrade the ecological values of the offset. These activities could include: • 4WD access - degrade wetlands and gilgais, erode tracks particularly after rain, introduce weed species and/or spread weeds. • Shooting/hunting. • Timber harvesting. • Release of cattle/horses for grazing. • Dumping of rubbish. • Poaching of wildlife.	**Medium** (L3/C2)	Property will be appropriately fenced, and gates installed and locked. Only the landholder and approved contractors will be granted access. Property regularly monitored and patrolled looking for unauthorised access. If access restrictions are not successful, implementation of camera monitoring to identify perpetrators.	Installation of boundary fencing and locked gates in first two years of offset management commencing. Regular monitoring during life of offset. Notification to police and DAWE if suspected/substantiated unlawful access.	**Low** (L2/C2)

Table 5.4 Risk Assessment

Risk	Description	Inherent Risk (Likelihood / Consequence)	Mitigation measures	Timing	Residual risk (Likelihood/ Consequence)
Expanding available habitat and increasing Habitat Quality					
Woodland regeneration and habitat quality scores are not achieved in timeframes set.	Natural regeneration is proposed to be actively managed to increase extent of remnant woodland and habitats across the offset site. Natural regeneration is preferred method due to the size of areas containing regrowth and non-remnant areas. Other management actions are also proposed to improve habitat quality including weed management, fire management and pest animal control.	**High** (L4/C3)	If natural regeneration is not showing to be progressing to set targets additional intervention will be undertaken. This may include further ripping and seeding, supplementary planting of tubestock, reducing and/or excluding grazing and increasing weed control efforts.	Managing natural regeneration and other habitat quality management measures such as weed control will be the focus in the first five years. Additional intervention may then be undertaken from Year 4 such as ripping and seeding and supplementary plantings. Monitoring of the progress of the offset and habitat quality benchmarks will occur annually. Where objectives are not being met corrective actions will be applied.	**Medium** (L3/C2)
Micro habitat features for target MNES species do not develop appropriately during OAMP life	Coarse woody debris (CWD) is insufficient relative to RE benchmarks to provide micro-habitat for Ornamental Snake. Squatter Pigeon require adequate foraging resources and native grass species diversity. Australian Painted Snipe require wetlands and gilgai for foraging and breeding. Greater Gliders require tree hollows for breeding.	**High** (L4/C3)	If CWD is not developing based on set benchmarks investigate introducing CWD into Ornamental Snake habitats salvaged from impact site. If native grass species are not regenerating investigate increasing weed control as weeds may be outcompeting native grasses and reducing or removing grazing. Cool burns may also encourage native grass regeneration. Deployment of supplementary nest boxes for Greater Glider is going to be undertaken. This recognises the fact some habitats will take a long time to develop naturally forming hollows. Trials of using salvaged tree hollows from impact site will be undertaken and	Monitoring will occur annually to evaluate effectiveness of management actions, and track progress of habitat quality objectives. Corrective actions and adaptive management will be applied over the life of the offset.	**Medium** (L3/C2)

Table 5.4 Risk Assessment

Risk	Description	Inherent Risk (Likelihood / Consequence)	Mitigation measures	Timing	Residual risk (Likelihood/ Consequence)
			monitoring to determine if Greater Gliders are using nest boxes. Undertake feral pig management to reduce impacts on wetland and gilgai areas. Do not allow grazing in wetland and gilgai areas after rain events when compaction is likely to occur.		
Wetland and riparian habitat regeneration fails	Wetlands and riparian areas are important habitats for the target MNES species (eg Painted Snipe and Ornamental Snake utilise wetlands, gilgais and Koalas and Greater Gliders key habitats are found along watercourses). Increased activity by site personnel, unauthorised access, stock access or feral animals (pigs) can supress natural regeneration and erode creek banks.	**Medium** (L3/C2)	Measures to reduce/eliminate access and impacts to these areas will include: • Contractor management plans restricting access of contractors to certain areas. • Keeping vehicles to designated access tracks. • Stock being fenced out of riparian areas with off-stream watering points. • Restrictions on unauthorised access (4WD and hunting). • Pest animals (active reduction in feral pig numbers).	Monitoring will occur annually to evaluate effectiveness of management actions, and track progress of habitat quality objectives. Corrective actions and adaptive management will be applied over the life of the offset.	**Low** (L3/C2)
Weed management					
Introduction, establishment and spread of weeds as a result of access to OAMP. Weed populations do not reduce or increase.	Weeds carried on vehicles, plant, machinery and equipment may be introduced/further spread and subsequently colonise disturbed ground, leading to increased risk of competition with regenerating native plants / increased biomass resulting in heightened bushfire risk. Weeds may outcompete regenerating native grasses and tree species. Weeds can reduce fauna movement through the offset area.	**High** (L4/C3)	Baseline weed survey will occur in Year 1 across Stage 1 offset area. The survey will clearly document weed species present, distribution and any larger infestations. Weed control will be undertaken as a minimum annually. The following actions will also reduce risks associated with weeds and increase effectiveness of management: • Access only to authorised personnel.	Monitoring will occur annually to evaluate effectiveness of management actions, and track progress of weed populations and reduction in distribution. Corrective actions and adaptive management will be applied over the life of the offset.	**Medium** (L3/C2)

Table 5.4 Risk Assessment

Risk	Description	Inherent Risk (Likelihood / Consequence)	Mitigation measures	Timing	Residual risk (Likelihood/ Consequence)
			• Mapping infestations and areas of exclusions (weed baseline). • Weed treatment schedule addressing method of control, pesticides, location and timing of treatments. • Develop hygiene control program including vehicle washdown – machinery to arrive and depart from site in a clean condition (general biosecurity obligation), free from seed or mud. • Any introduced mulch, soil or plants are to be weed free and disease free. • Weed control to be implemented by suitably qualified and appropriately permitted pest control personnel. • Ongoing monitoring conducted for weed species and location. If weed populations are not decreasing or new weed species have been introduced a review of measures will be undertaken. Different control methods will be trialled and weed control effort may need to be increased.		
Biomass control					
Biomass increases, thus increasing likelihood of hot fires occurring. Hot fires can remove habitat features such as CWD, tree hollows and kill native vegetation. Too frequent fires can also	Biomass (i.e fuel load) is proposed to be managed through a combination of control methods such as: • Grazing • Cool burns • Weed control	**High** (L4/C3)	Biomass will be regularly monitored throughout the year. Once it reaches set levels grazing will be permitted to keep fuel loads to manageable levels. In areas where grazing isn't appropriate cool burns or manual slashing can be used to reduce fuel load.	Monitoring will occur throughout the year to identify when grazing can and can't occur based on biomass levels. A formal annual monitoring program will also be completed to evaluate effectiveness of management	**Low** (L2/C2)

Table 5.4 Risk Assessment

Risk	Description	Inherent Risk (Likelihood / Consequence)	Mitigation measures	Timing	Residual risk (Likelihood/ Consequence)
reduce CWD, reduce regeneration of saplings and increase certain weed species.			Fire breaks will also be put in place and maintained to reduce likelihood of hot fires occurring and improve access around offset for fire management activities.	actions, and track progress of weed populations and reduction in distribution. Corrective actions and adaptive management will be applied over the life of the offset.	
Loss of Squatter Pigeon habitat due to too dense ground cover, and exotic grasses and weeds outcompeting native grass regeneration.	Utility pf potential breeding and foraging habitat for Squatter Pigeon decreases when ground cover exceeds >33% and requires bare ground for foraging and dust bathing. Weed establishment/expansion in potential habitats, especially by Green Cestrum and Buffel Grass are significant threats. Encroachment by woody native species is also an issue and the species may benefit from the presence of light grazing by livestock.	**Medium** (LC/C3)	Implement biomass control activities including grazing. Implement the Squatter Pigeon monitoring plan to track habitat quality improvements are being achieved including increase in native grass species diversity. Weed control will be undertaken to reduce competition with native grass species recruitment.	Monitoring will occur throughout the year to identify when grazing can and can't occur based on biomass levels. A formal annual monitoring program will also be completed to evaluate effectiveness of management actions, and track progress of weed populations and reduction in distribution. Corrective actions and adaptive management will be applied over the life of the offset.	**Low** (L2/C2)
Pest animal management					
Uncontrolled or increasing feral pig activity which degrades Ornamental Snake and Australian Painted Snipe habitats.	Impacts to wetland habitat from feral pigs is considered a threat to wetland and habitat values for Ornamental Snake and Australian Painted Snipe.	**Medium** LC/C3)	Feral pig control to be undertaken annually to reduce feral pig numbers and ecological impacts. Measures must consider humane measures to destroy pigs, and in the case of poisoned baits, consider poisoning of target animal. If monitoring is showing feral pig populations are not decreasing, or wetland impacts are increasing, feral pig control will be increased. Feral pig control in adjacent properties may also need to be undertaken.	A formal annual monitoring program will also be completed to evaluate effectiveness of management actions, and track reduction in feral pig populations. Corrective actions and adaptive management will be applied over the life of the offset.	**Low** (L2/C2)

Table 5.4 Risk Assessment

Risk	Description	Inherent Risk (Likelihood / Consequence)	Mitigation measures	Timing	Residual risk (Likelihood/ Consequence)
Uncontrolled feral animal activity	Feral predators (eg cats, foxes and wild dogs) pose a serious threat to native fauna (including MNES species). Uncontrolled these fauna pose a serious threat to native animal establishment and survival in rehabilitating and existing natural habitat of the OAMP. For example, feral cats predate on Squatter Pigeon and wild dogs on Koalas.	**Medium** LC/C3)	Feral animal control to be undertaken annually to reduce feral animal numbers and impacts on MNES. Measures must consider humane measures of destruction, and in the case of poisoned baits, consider poisoning of target animals. Pest management efforts if shown not to be effective other corrective actions will be implemented such as changing control methods, increasing efforts and broadening areas of control.	A formal annual monitoring program will be completed to evaluate effectiveness of management actions, and track reduction in feral animal populations. Corrective actions and adaptive management will be applied over the life of the offset.	**Low** (L2/C2)
Fire management					
Increasing intensity, duration or frequency of fires. Hot fires can remove habitat features such as CWD, tree hollows and kill native vegetation. Too frequent fires can also reduce CWD, reduce regeneration of saplings and increase certain weed species.	Excessive/uncontrolled establishment of exotic weeds (eg Green Cestrum and Buffel Grass) create fire risks through increased fuel loads. These often result in fires of greater intensity and duration and impact upon natural regenerative processes affecting structural and floristic change to habitats. A drying climate can also stimulate greater frequency (and intensity) of fire.	**Severe** (L5/C4)	Fire management activities will be undertaken on an annual basis. This will include establishment of fire breaks and fuel load reduction. Fire management will look to: • Reduce fuel loads primarily through grazing, weed control and cool burns. • Mosaic burn patterns will take into account the vegetation community type, maturity and developmental stage of the regenerating areas. • Appropriate burn times including cool burns to influence a variety of ecological responses by conducting a variety prescribed burn responses that do not favour any one species.	Fire breaks and fuel loads will be regularly monitored throughout the year. A formal annual monitoring program will be completed to evaluate effectiveness of management actions, including reducing risk of hot bushfires occurring. Corrective actions and adaptive management will be applied over the life of the offset.	**Moderate** (L3/C3)

Table 5.4 Risk Assessment

Risk	Description	Inherent Risk (Likelihood / Consequence)	Mitigation measures	Timing	Residual risk (Likelihood/ Consequence)
Fencing					
Death or injury of native animals due to barbed wire fencing.	Some existing fencing has barbed wire on the top strand for livestock control. Barbed wire poses a significant threat to native fauna especially bats, owls, birds and gliders (ie greater gliders in this instance). Such animals become entangled, usually on top wires in the case of gliders, and are serious injured and perish. Ground fauna can be injured when fleeing predators or other threats. Such as wallabies trying to cross the fence.	**Medium** LC/C3)	• Existing barbed wire fencing will be replaced with a high tensile wire. The top strand will also have reflectors added. • New fencing will have the top three strands as high tensile wire. Reflectors on top strand. New fencing will be designed to allow fauna to safely move underneath leaving a gap of 40cm between ground and bottom wire. • Electric fencing can be used with caution. Electric fencing has shown to be effective in keeping cattle out and not injuring wildlife. Remember to keep the hot wire above 40 cm to allow for small animals to pass under with ease. As it is cheaper and quicker to construct it may be useful to be installed around revegetation areas or gilgai where it is for a shorter period and a permanent fence isn't needed.	Barbed wire will be replaced in the first year of offset commencing. Fences will be regularly monitored throughout the year to ensure they are not damaged and keeping livestock out of certain areas.	**Low** (L4/C1)

6 Monitoring program

6.1 Monitoring program objectives

Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced. The monitoring program is designed to support operational decision-making, in particular to:

- inform and report 'early-control', ie to demonstrate that management actions are effective in achieving interim performance targets, and therefore in time completion criteria; and
- Support an 'early warning' function, ie to inform timely decisions on corrective actions to ensure performance and completion criteria are achieved/maintained.

The Monitoring Program will:

- confirm all prescribed management actions have been completed in timeframes set for that 12 month period;
- identify trends and areas for improvement through early control and early warning functions;
- assess effectiveness of environmental controls implemented;
- where necessary, identify modifications required to the monitoring program and methods;
- assess vegetation community growth, health and extent;
- assess habitat quality for each MNES including interim performance outcomes are being achieved;
- determine that the final habitat quality is on track to being achieved;
- assess presence, abundance and habitat utilisation by target MNES species; and
- confirm performance objectives have been met at end of management period.

BioConditon assessments will also be undertaken in the early stages of the monitoring program at both new and previously established sites. This is to ensure baseline data is sufficient to inform ongoing offset management strategies and measure temporal changes in habitat quality from the onset of the monitoring program. This will also ensure habitat quality levels are measured and required gains are achieved over the course of the program.

Established and additional BioCondition sites are summarised below in Table 6.2 according to vegetation community and offset value. BioCondition sites are illustrated in Figure 6.1.

Table 6.1 BioCondition assessment sites

Regional Ecosystem	Offset Area 1		Offset Area 2		Totals		Associated MNES species habitat
	Existing sites	Additional sites	Existing sites	Additional sites	BioCondition sites	Area (ha)	

11.3.2	2	3	RE not present	RE not present	**5**	**497.7**	Koala, Greater Glider, Squatter Pigeon
11.3.25	3	0	0	1	**4**	**223.0**	Koala, Greater Glider, Squatter Pigeon
11.3.27f	1	0	RE not present	RE not present	**1**	**10.0**	All MNES species
11.4.8	0	2	RE not present	RE not present	**2**	**70.2**	Ornamental Snake, Squatter Pigeon
11.4.9	2	2	0	1	**5**	**151.2**	Ornamental Snake, Squatter Pigeon
11.5.17	3	0	RE not present	RE not present	**3**	**63.9**	All MNES species
11.5.3	0	1	0	3	**4**	**446.5**	Koala, Greater Glider, Ornamental Snake, Squatter Pigeon
11.5.9	0	4	0	4	**8**	**469.7**	Koala, Greater Glider, Squatter Pigeon
11.12.7	0	1	RE not present	RE not present	**1**	**2.0**	Koala, Greater Glider, Squatter Pigeon
Non-remnant/regrowth	7	2	0	9	**18**	**7,472.1**	All MNES species

6.2 Monitoring methods

The specific monitoring methods and frequency to address the Monitoring Program objectives in Section 6.1 are summarised in Table 6.2.

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
Offset Administration			
Confirm all prescribed management actions have been completed in timeframes set for that 12 month period	All set management actions in each 12 month period will be evaluated to confirm they have been completed. These are outlined in further detail below including: • Weed management • Fire management • Fence and access track maintenance • Fuel load and grazing management	A suitably qualified person will be engaged by Pembroke Resources to inspect the offset area and confirm work has been completed. The appointed person will consult with applicable parties engaged to do the work and seek evidence tasks were completed in accordance with the approved OAMP. This may be Pembroke employees, grazing manager or suitably qualified contractors. A report will be prepared summarising the audit completed and findings. Report will be issued to Pembroke.	Audit will occur annually (estimated around April). Report will be finalised at least one month prior to the Annual Report being due on 30 June.
Assess effectiveness of environmental controls implemented	Post each monitoring event the results will be evaluated and measured against the specific management outcomes for that particular matter, and habitat quality objectives set out in Table 6.3.	A range of monitoring methods will be implemented. These are outlined below in Table 6.2.	Effectiveness of management actions and any corrective actions put in place will be assessed annually. This will be as part of the Annual Report process described in Section 7.
		The approval holder must ensure each assessment of the effectiveness of the management actions in the Stage 1 OAMP is: a. subject to a peer-review completed within 6 months of the completion of each such assessment; and b. published on its website with the findings of the peer-review within 6 months of the completion of the peer-review and for the duration of this approval.	Every five years
Timing of corrective actions and evaluation of effectiveness		The below monitoring actions will be implemented to confirm if the management actions are effective.	Implement corrective actions within three months of identifying a corrective action is required.

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
Identify modifications required to the monitoring program and methods		Pembroke will undertake a review of the monitoring program. The review will consider: • Are the monitoring methods effective and providing the information required? • Are the monitoring frequencies suitable? • Is the monitoring program efficient or are there improvements that could be made? • What changes may be justified and why?	At the end of the first 5 years (and every 5 years post that) a review of the monitoring program will occur. A report summarising key findings and any recommendations for refinement will be prepared. The report will also be submitted to DAWE for review. If changes are proposed and agreed the OAMP will be updated and new revision approved.

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
Ecosystem Health			
Weeds	Weed species present. Weed species abundance. Weed species distribution.	Undertake weed baseline survey across offset area. Document weed species present, locations observed, and larger infestations. Map results. Establish permanent weed monitoring transects at large infestations to document weed populations and reduction in cover. Establish permanent photo monitoring points at large weed infestations.	Weed baseline survey will occur in Year 1. Weed monitoring surveys will then occur annually Year 2–Year 10. Weed monitoring will then occur every 2 years from Year 11–Year 20.
Feral animals	Feral animal species present. Feral animal abundance. Feral animal distribution.	Undertake feral animal baseline survey across offset area. The survey will be to confirm presence of feral animal species, their abundance, distribution and document evidence of impacts. Establish baited camera trap locations and assessment sites to determine their presence eg wetland and gilgai areas for feral pigs. The same camera trap locations will be repeated each monitoring event to gauge presence of feral animal species and any change in numbers. Minimum of 20 cameras would be deployed. The baited camera traps will be set up across the offset area in particular key habitats. Camera traps will be left out for four weeks. Spotlighting looking for presence of feral animals will also be undertaken. This will coincide with spotlighting being undertaken for Ornamental Snake and Koalas.	Feral animal baseline survey will occur in Year 1. Feral animal surveys will occur annually between Years 2–Year 5. Then every 2 years from Years 6−20.
Fire	Fire track maintenance. Fuel loads. Fire regimes.	Survey all fire tracks and confirm they are adequately being maintained. Monitor fuel loads and seasonal conditions. Fuel reduction burns may be used if required. If a cool fuel reduction burn is applied monitoring post the event will be undertaken to evaluate no damage to native trees, habitat values occurred.	Survey fire tracks annually. Monitor fuel load and fire conditions quarterly. Low intensity fires may be permitted at intervals recommended by a qualified ecologist over the life of the offset. Cool burns will need to take into account reducing impacts to regrowth/replanted vegetation, fallen woody debris, fauna species, etc.

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
Grazing	Fuel loads. Fence maintenance. Evaluate stock numbers, timing of grazing and impact on fuel load.	Monitor fuel loads via biomass method using quadrats and assessing groundcover and grass height. This is to be completed by the grazing manager. Survey fences and confirm they are adequately being maintained. Assess grazed areas for effectiveness in managing fuel load and that no degradation to environmental values is occurring. Checklist to be filled out by grazing manager that will include: • Weather conditions • Grazing intensity and stock rotation • Fuel load levels at commencement of grazing and completion of grazing and duration including photos • General property maintenance activities such as fencing, access track maintenance	Quadrat sampling method should occur monthly to determine trigger levels, and then once a week when grazing is occurring. Survey fences and access tracks every year. Assess grazed areas and evaluate effectiveness of rotational grazing every year. Checklist to be completed quarterly by grazing manager.

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
Habitat Quality			
Track changes in habitat quality scores for each MNES. Confirm they are on track to achieve interim milestones and final milestone. Refer Table 6.3 for further detail on MNES Habitat Quality Scores.	Complete Habitat Quality Assessments. This will include measuring: • Canopy species • Canopy height • Canopy cover • Number of large trees • Groundcover species • Total tree species richness • Grass species richness • Weed species and cover • Litter cover • Coarse woody debris • Recruitment of woody perennial species • Photo points • Patch size • Connectivity • Hollow bearing trees and size of hollows (to be added to all BioCondition)	Baseline BioCondition transects will be established in Year 1 across the offset areas. Thirty BioCondition transects have been established to date, and 22 additional ones will be established in all offset areas. This will ensure adequate representation of vegetation communities and habitat types. Refer Figure 6.1. In Year 3 BioCondition transects will be re-assessed and habitat quality scores prepared for each MNES species. An analysis of changes will be undertaken including those elements tracking well, and any that haven't improved or worsened. Results will be assessed against interim habitat quality scores set out in Table 6.2 for each MNES species. The BioCondition transects and habitat quality scores will be repeated every second year (eg Year 5, 7, 9, 11, etc) to assist to track progress against habitat quality objectives, and identify if corrective actions need to be taken. Permanent photo point monitoring will occur at each BioCondition site.	Year 1 will be finalising all baseline BioCondition transects. BioCondition assessments and habitat quality scoring will then occur in the following years to ensure regular progress is evaluated, and to coincide with the 5 yearly milestones. Years 3, 5, 7, 10, 12, 15, 17 and 20.

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
Target MNES species presence, abundance and habitat utilisation			
Ornamental Snake	Condition of gilgai (through BioCondition assessment, weed surveys and feral animal surveys).	Habitat assessments to evaluate gilgai ecological condition. Considering presence of cracking clays, grass cover, woody debris, weeds, etc. Baseline BioCondition transects will be established in Year 1 across the offset areas. Thirty BioCondition transects have been established to date, and additional 22 will be established in all offset areas. This will ensure adequate representation of vegetation communities and habitat types. Refer Figure 6.1. In Year 3 BioCondition transects will be re-assessed and habitat quality scores prepared for each MNES species. An analysis of changes will be undertaken including those elements tracking well, and any that haven't improved or worsened. Results will be assessed against interim habitat quality scores set out in Table 6.3 for each MNES species. Photo monitoring points in gilgai. Assess presence of feral pigs in gilgai, and evaluate any negative impacts being caused.	Year 1 will be finalising all baseline BioCondition transects. BioCondition assessments and habitat quality scoring will then occur in the following years to ensure regular progress is evaluated, and to coincide with the 5 yearly milestones. Years 3, 5, 7, 10, 12, 15, 17 and 20. Feral animal baseline survey will occur in Year 1. Feral animal surveys will occur annually between Years 2–Year 5. Then every 2 years from Years 6−20.

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
	Species presence and abundance	Spotlighting in warmer months is the most effective survey method to identify the species. Spotlighting will be completed by suitably qualified ecologist/s. Spotlighting will be completed across representative areas of the Ornamental Snake habitats to confirm presence of Ornamental Snake. Spotlighting will target gilgai, wetlands, riparian habitats. Those areas where species has historically been recorded will be resurveyed (refer Figure 3.6). Permanent transects will be established across the habitat areas. These will be surveyed at each survey period to support an estimate of population numbers, and how these are changing over time. Each spotlighting survey will be at least 5 consecutive nights for a team of three ecologists, being a minimum of 120 hours.	The first targeted surveys for Ornamental Snake is proposed to occur in Year 2 between late September through to late March when weather conditions are warm, not too dry and maximum temperatures are greater than 25°C on most survey days (Brigalow Belt Reptile Guideline). This is to allow BioCondition transects to be established in Year 1 and suitable locations for Ornamental Snake spotlighting and transects can be assessed. The targeted Ornamental Snake surveys will then be completed every second year being Years 4, 6, 8 and 10. Then targeted Ornamental Snake surveys would be undertaken in Years 13, 16 and 19 as habitat areas will be more established and less change is occurring.
	Habitat utilisation and dispersal	Based on spotlighting survey results an evaluation of habitats they species are found in will be undertaken and their location. This is to gain a greater understanding of the habitats they are occurring in including remnant, regrowth and non-remnant, condition and any other relevant factors such as climatic conditions. What are habitat factors and climatic conditions determining their presence. It will also support an understanding of the species distribution across the offset area.	As part of above surveys.

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
Koalas	Condition of Koala habitats (through BioCondition assessment, weed surveys)	Baseline BioCondition transects will be established in Year 1 across the offset areas. Thirty BioCondition transects have been established to date, and additional 22 will be established in all offset areas. This will ensure adequate representation of vegetation communities and habitat types. Refer Figure 6.1. In Year 3 BioCondition transects will be re-assessed and habitat quality scores prepared for each MNES species. An analysis of changes will be undertaken including those elements tracking well, and any that haven't improved or worsened. Results will be assessed against interim habitat quality scores set out in Table 6.3 for each MNES species. Photo monitoring points in Koala habitats including representation of remnant, advanced regrowth and cleared areas. Weed surveys will be conducted to determine weed species present, abundance and distribution.	Year 1 will be finalising all baseline BioCondition transects. BioCondition assessments and habitat quality scoring will then occur in the following years to ensure regular progress is evaluated, and to coincide with the 5 yearly milestones. Years 3, 5, 7, 10, 12, 15, 17 and 20. Weed baseline survey will occur in Year 1. Weed monitoring surveys will then occur annually Year 2–Year 10. Weed monitoring will then occur every 2 years from Year 11–Year 20.
	Species presence and abundance	Complete Koala surveys to determine the presence of the species within the offset area. Koala surveys will include: • SAT surveys (permanent transects are chosen and replicated) • Indirect survey methods such as looking for scratches and scats (particularly focused along riparian corridors) • Spotlighting (sampling all habitat types) • Call playback (done during spotlighting) • Koala detection dogs (will look to trial this survey method to confirm presence of individuals)	The first targeted survey for Koalas is proposed to occur in Year 2 between August and January when koala activity is at a peak. This is to allow BioCondition transects to be established in Year 1 and suitable Koala habitat survey locations to be evaluated. The targeted Koala surveys will then be completed every 2 years being Years 4, 6, 8 and 10. Koala monitoring surveys will occur between August and January.

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
	Population numbers and health	Where koalas are detected on site assessments of individual health will be carried out. This will include size, estimated age, sex, colouring, any young present, health such as any signs of chlamydia. Results of koala surveys will be used to help determine population numbers and changes over time on the offset site and their dispersal across the offset.	Then targeted Koala surveys would be undertaken in Years 13, 16 and 19. Feral animal baseline survey will occur in Year 1. Feral animal surveys will occur annually between Years 2–Year 5. Then every 2 years from Years 6−20.
	Habitat utilisation and dispersal	When koalas are detected, their location and trees they are present in will be recorded. This will help to assess habitat utilisation and dispersal across the offset site.	
	Evidence of predation	During koala surveys any deceased koalas will be noted. Signs of dog attack will be looked for. Feral animal surveys will also note any wild dogs observed. Feral animal monitoring will occur through deployment of baited camera traps to determine their presence, eg wetland and gilgai areas for feral pigs. The same camera trap locations will be repeated each monitoring event to gauge presence of feral animal species and any change in numbers. Minimum of 20 cameras would be deployed. The baited camera traps will be set up across the offset area in particular key habitats. Camera traps will be left out for four weeks. Spotlighting looking for presence of feral animals will also be undertaken.	

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
Squatter Pigeon	Condition of Squatter Pigeon habitat including foraging resources	Baseline BioCondition transects will be established in Year 1 across the offset areas. Thirty BioCondition transects have been established to date, and additional 22 will be established in all offset areas. This will ensure adequate representation of vegetation communities and habitat types. In Year 3 BioCondition transects will be re-assessed and habitat quality scores prepared for each MNES species. An analysis of changes will be undertaken including those elements tracking well, and any that haven't improved or worsened. Results will be assessed against interim habitat quality scores set out in Table 6.3 for each MNES species. Photo monitoring points in Squatter Pigeon habitat. Weed surveys will be conducted to determine weed species presence, abundance and distribution.	Year 1 will be finalising all baseline BioCondition transects. BioCondition assessments and habitat quality scoring will then occur in the following years to ensure regular progress is evaluated, and to coincide with the 5 yearly milestones. Years 3, 5, 7, 10, 12, 15, 17 and 20. Feral animal baseline survey will occur in Year 1. Feral animal surveys will occur annually between Years 2–Year 5. Then every 2 years from Years 6−20.
	Species presence and abundance	Complete targeted surveys to determine the presence of the species within the offset area. Squatter Pigeon surveys will include: • Diurnal bird surveys between sunrise and 9 am and between 3:30 pm and sunset over minimum of four days • Camera traps (set up near waterbodies and left out for minimum of 4 weeks) • Driving surveys along dirt tracks	The first targeted surveys for Squatter Pigeon is proposed to occur in Year 2 between May to October when the species is most actively foraging for grass seed. Squatter Pigeon targeted surveys will occur annually between Years 2 and 5. Followed by every two years for the following 5 years. Then Year 10, 15 and 20.
	Habitat utilisation and dispersal	Based on targeted survey results an evaluation of habitats they species are found in will be undertaken and their location. This is to gain a greater understanding of the habitats they are occurring in including remnant, regrowth and non-remnant, condition and any other relevant factors such as proximity to water, land zone and other climatic conditions. What are habitat factors and climatic conditions determining their presence? It will also support an understanding of the species distribution across the offset area.	

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
Australian Painted Snipe	Condition of Australian Painted Snipe habitats (through BioCondition assessment, weed surveys)	Baseline BioCondition transects will be established in Year 1 across the offset areas. Thirty BioCondition transects have been established to date, and additional 22 will be established in all offset areas. This will ensure adequate representation of vegetation communities and habitat types. Refer Figure 6.1. In Year 3 BioCondition transects will be re-assessed and habitat quality scores prepared for each MNES species. An analysis of changes will be undertaken including those elements tracking well, and any that haven't improved or worsened. Results will be assessed against interim habitat quality scores set out in Table 6.3 for each MNES species. Photo monitoring points in Australian Painted Snipe habitats including representation of remnant, advanced regrowth and cleared areas. Weed surveys will be conducted to determine weed species present, abundance and distribution.	Year 1 will be finalising all baseline BioCondition transects. BioCondition assessments and habitat quality scoring will then occur in the following years to ensure regular progress is evaluated, and to coincide with the 5 yearly milestones. Years 3, 5, 7, 10, 12, 15, 17 and 20. Weed baseline survey will occur in Year 1. Weed monitoring surveys will then occur annually Year 2–Year 10. Weed monitoring will then occur every 2 years from Year 11–Year 20.
	Species presence and abundance	Targeted surveys for the Australian Painted Snipe will be undertaken to confirm presence of the species within the offset area and population numbers. Targeted surveys will be undertaken by suitably qualified ecologist/s. Surveys will include daytime searches in preferred habitats flushing species out from shrubs/long grasses etc. Spotlighting is also effective in detecting the species. Spotlighting will be completed across representative areas of the Australian Painted Snipe habitats to confirm presence of the species. The same wetland areas will be surveyed each monitoring survey period to support an estimate of population numbers, and how these are changing over time. The daytime searches are proposed over two days and spotlighting survey will be at least 5 consecutive nights for a team of three ecologists, being a minimum of 120 spotlight hours.	Targeted surveys will occur over warmer months between October to March. Surveys will be timed where possible to occur after rainfall event as species requires shallow wetlands, dams with water, etc for foraging.

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
	Habitat preferences and seasonal use of area	Based on targeted survey results an evaluation of habitats they species are found in will be undertaken and their location. This is to gain a greater understanding of the habitats they are occurring in including remnant, regrowth and non-remnant, condition and any other relevant factors such as climatic conditions. What are habitat factors and climatic conditions determining their presence? It will also support an understanding of the species distribution across the offset area.	Targeted surveys will occur over warmer months between October to March. Surveys will be timed where possible to occur after rainfall event as species requires shallow wetlands, dams with water, etc for foraging.
Greater Glider	Condition of Greater Glider habitats (through BioCondition assessment, weed surveys).	Baseline BioCondition transects will be established in Year 1 across the offset areas. Thirty BioCondition transects have been established to date, and additional 22 will be established in all offset areas. This will ensure adequate representation of vegetation communities and habitat types. Refer Figure 6.1. In Year 3 BioCondition transects will be re-assessed and habitat quality scores prepared for each MNES species. An analysis of changes will be undertaken including those elements tracking well, and any that haven't improved or worsened. Results will be assessed against interim habitat quality scores set out in Table 6.3 for each MNES species. Photo monitoring points in Greater Glider habitats including representation of remnant, advanced regrowth and cleared areas. Weed surveys will be conducted to determine weed species present, abundance and distribution.	Year 1 will be finalising all baseline BioCondition transects. BioCondition assessments and habitat quality scoring will then occur in the following years to ensure regular progress is evaluated, and to coincide with the 5 yearly milestones. Years 3, 5, 7, 10, 12, 15, 17 and 20. Weed baseline survey will occur in Year 1. Weed monitoring surveys will then occur annually Year 2–Year 10. Weed monitoring will then occur every 2 years from Year 11–Year 20.

Table 6.2 Monitoring for threatened species and offset effectiveness

Monitoring activity	Variables monitored	Monitoring Method	Frequency
	Greater Glider connectivity	To assess the effectiveness of the management actions in the Stage 1 OAMP to increase Greater Glider *(Petauroides volans)* habitat connectivity in the riparian zones within the Stage 1 environmental offset, the approval holder must engage an independent suitably qualified expert to undertake an assessment every 5 years from the implementation date of the approved Stage 1 OAMP until the approved Stage 1 OAMP offset completion criteria are achieved.	Every 5 years from the implementation date of the approved Stage 1 OAMP until the approved Stage 1 OAMP offset completion criteria are achieved.
	Species presence and abundance	Complete targeted surveys to determine the presence of the species within the offset area. Greater Glider surveys will be primarily focused on spotlighting as this is the most effective survey technique. All habitat types will be surveyed, in particular riparian communities that support hollows. Locations where the species have been previously recorded will be surveyed as shown in Figure 3.9. Each spotlighting survey will be at least 5 consecutive nights for a team of three ecologists, being a minimum of 120 hours.	The first targeted surveys for Greater Glider is proposed to occur in Year 2. This is to allow BioCondition transects to be established in Year 1 and suitable Greater Glider habitat survey locations to be evaluated. The targeted Greater Glider surveys will then be completed every 2 years being Years 4, 6, 8 and 10. Then targeted Greater Glider surveys would be undertaken in Years 13, 16 and 19.
	Habitat utilisation and dispersal	When Greater Gliders are detected their location and trees in which they are present within will be recorded. This will help to assess habitat utilisation and dispersal across the offset site.	
	Breeding success	Refer to Section 4.2.6 for nest box monitoring program. Cameras to be used to determine if Greater Gliders are using nest boxes, or if other species are competing for nest boxes.	Nest box monitoring will be undertaken annually in spring.

6.3 Completion criteria and interim milestones

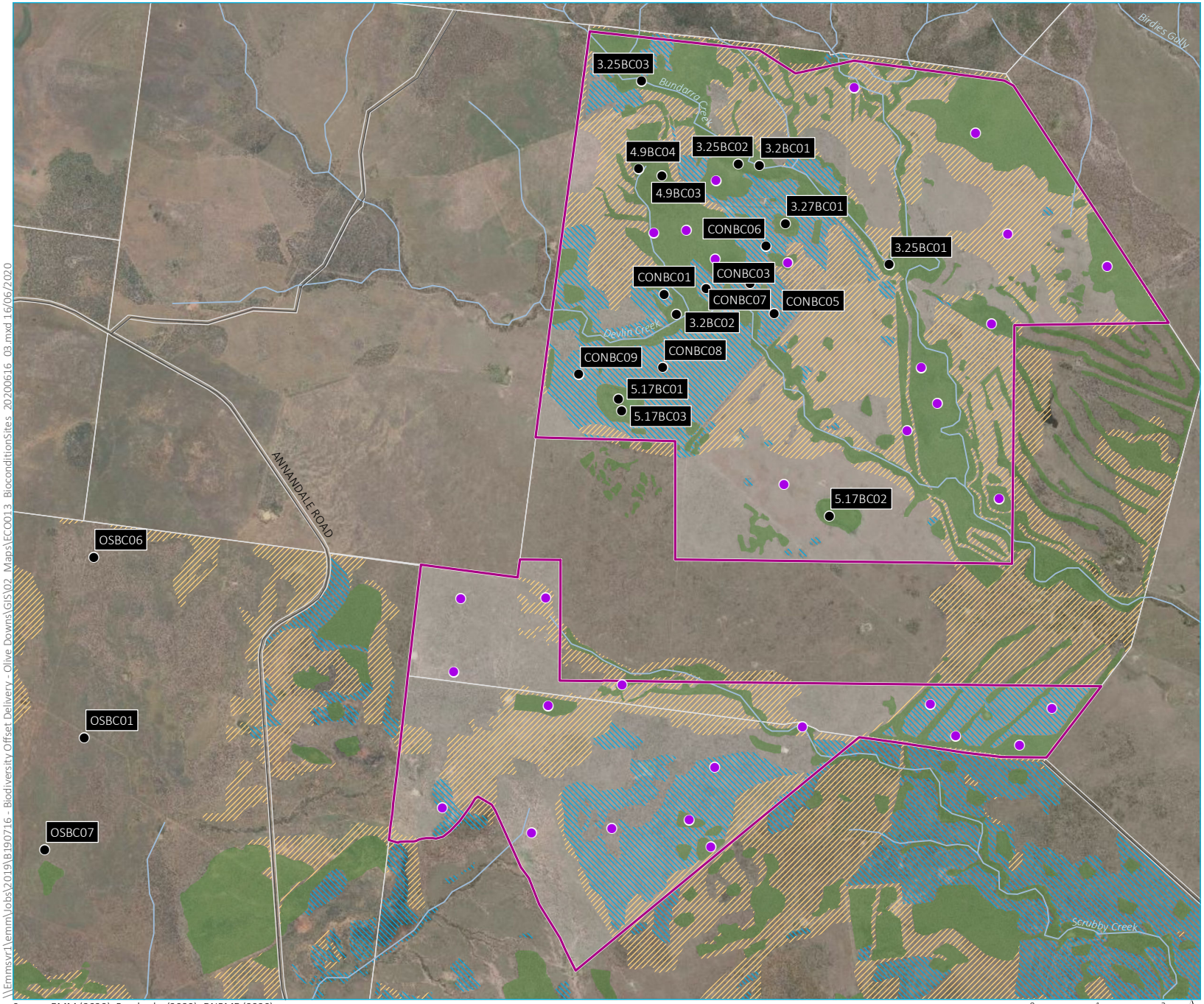
The following is a summary of the habitat quality score increases for each MNES species that are sought to be achieved over the course of the 20 year management timeframe. It includes interim milestones every five years. Interim scores and measurements are also identified (applying BioCondition methods) to demonstrate where gains can be achieved, how progress will be tracked to ensure final habitat quality scores are achieved.

Table 6.3 Habitat quality milestones

Species	Habitat quality	Habitat quality scores				
		0 years (starting score)	5 years	10 years	15 years	20 years (final score)
Koala	Remnant woodland	7	7 • Reduce weed cover to a score of 5/10 • Reduce the potential of threats to a score of 10/15 • Improve quality of foraging to a score of 6/10	7 • Reduce weed cover to a score of 6/10 • Improve habitat connectivity to a score of 3/5	7 • Reduce weed cover to a score of 7/10 • Reduce the potential of threats to a score of 11/15 • Improve quality of foraging to a score of 7/10	8
	Regrowth woodland	5	5 • Reduce weed cover to a score of 3/10 • Improve habitat connectivity to a score of 1/5 • Reduce the potential of threats to a score of 6/15	6	6 • Reduce weed cover to a score of 4/10 • Improve habitat connectivity to a score of 2/5 • Reduce the potential of threats to a score of 8/15	7
	Future habitat	0	1	3	4	5
Squatter Pigeon	Existing habitat	7	7 • Reduce weed cover to a score of 5/10	7 • Improve habitat connectivity to a score of 3/5 • Improve native perennial grass cover to a score of 4/5	7 • Reduce weed cover to a score of 6/10 • Improve habitat connectivity to a score of 4/5	8
	Future habitat	0	1	2	3	4

Table 6.3 Habitat quality milestones

Species	Habitat quality	Habitat quality scores				
		0 years (starting score)	5 years	10 years	15 years	20 years (final score)
Greater Glider	Remnant woodland	7	7 • Reduce weed cover to a score of 5/10 • Reduce the potential of threats to a score of 8/15	7 • Reduce weed cover to a score of 6/10 • Reduce the potential of threats to a score of 9/15 • Improve patch size to a score of 8/10	7 • Reduce weed cover to a score of 7/10 • Reduce the potential of threats to a score of 10/15	8
	Regrowth woodland	4	5	5 • Reduce weed cover to a score of 3/10	6	7
	Future habitat	0	1	2	2 • Reduce weed cover to a score of 1/10 • Improve patch size to a score of 2/10 • Improve connectivity to a score of 2/5	3
Ornamental Snake	Known important habitat	6	6 • Reduce weed cover to a score of 6/10 • Improve native perennial grass cover to a score of 5/5	7	7 • Reduce weed cover to a score of 7/10 • Improve quality of shelter to a score of 8/10	8
Australian Painted Snipe	Potential breeding habitat	6	6 • Improve native perennial grass cover to a score of 5/5 • Reduce the potential of threats to a score of 8/15 • Improve shrub layer cover to a score of 1/5	7	7 • Improve quality of foraging to a score of 8/10 • Reduce the potential of threats to a score of 9/15 • Improve shrub layer cover to a score of 2/5	8



Source: EMM (2020); Pembroke (2020); DNRME (2020)

Biocondition sites

Olive Downs
Stage 1 offset area management plan
Figure 6.1

EMM
creating opportunities

7 Reporting

7.1 Reporting

Environmental offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced. To support transparent governance arrangements, and demonstrate compliance with the OAMP, regular compliance reporting is proposed to occur.

An Annual Report will be prepared and submitted to DoAWE for their information.

The Annual Report is proposed to be submitted by 30 June each year. This date is to allow for the main monitoring periods in late Summer – early Autumn each year to be completed, and adequate time for report preparation to occur.

The Annual Report will be prepared by suitably qualified personnel with experience in offset management and threatened species, and will be signed off by Pembroke.

The Annual Report will include:

- description of all management actions that have been completed in that 12 month period;
- description of the monitoring activities that were completed and results;
- evaluation of progress against the proposed management outcomes;
- habitat quality scores for each MNES species and how they are tracking against relevant interim 5-yearly goal;
- identification of any constraints to monitoring and management actions over that timeframe (eg high rainfall event therefore inability to access some areas due to flooding, etc);
- how any risks or threats have impacted on the area (eg drought period therefore lack of growth);
- photos from photo monitoring points;
- identification of any risks or potential threats to the offset and offset values that have become apparent and how they will be addressed;
- any learnings in that period from implementing the OAMP and monitoring; and
- any changes to the OAMP that may be proposed and justification.

7.2 Data management

Pembroke will ensure that all data collected as part of the OAMP implementation is managed and stored appropriately. A data management framework will be established to ensure proper data quality assurance, storage and protection occurs.

Key features of the data management will be:

- spatial data collection proformas for use in the field to ensure robust data is collected, and in a consistent manner;

- establishment of a geodatabase for management of spatial data;
- standardised data collection methods by qualified personnel, particularly for monitoring so that it is completed consistently each year to enable comparison of results;
- quality assurance review process by suitably qualified persons;
- version control of data and reports; and
- appropriately stored information for future use and reference.

7.3 Audits

In addition to any audit required under EPBC conditions of approval, self-auditing will be undertaken over the life of the offset to verify OAMP implementation is occurring, and progress towards the management outcomes sought to be achieved. Pembroke will commission this self-auditing to occur as part of the ongoing monitoring program as detailed in Section 6 and every five years as part of a more formal review of the success of management actions and effectiveness of the OAMP.

Systems for recording management action implementation and performance will be auditable, and include details of who, what, where and how implementation and performance were identified and/or assessed. This will include Pembroke keeping records of information such as:

- contractors expense claims for chemicals and materials for actions such as weed management, fence maintenance, establishing and maintaining fire breaks;
- engagement of contractors to complete particular tasks such as feral animal control, tree planting and associated invoices;
- engagement of contractors to undertake ecological monitoring and associated reports; and
- any internal staff conducting an internal audit and inspection of the offset site and key findings.

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Appendix A

EPBC Act offset calculators

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	squatter pigeon
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Spigeon	**Area**	1076	Hectares	
			Quality	**8**	Scale 0-10	
			Total quantum of impact	860.80	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	860.80	Adjusted hectares	1476.5	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	1476.5	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%								
									Future area without offset (adjusted hectares)	1476.5	**Future area with offset (adjusted hectares)**	1476.5	0.00	90%	0.00	0.00	383.04	44.50%	No	
					Time until ecological benefit	20	**Start quality (scale of 0-10)**	**7**	**Future quality without offset (scale of 0-10)**	**5**	**Future quality with offset (scale of 0-10)**	**8**	3.00	90%	2.70	2.59				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	860.8	383.04	44.50%	**No**	$0.00	#DIV/0!	#DIV/0!
Area of community	0				$0.00		$0.00
					$0.00	**#DIV/0!**	**#DIV/0!**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	squatter pigeon
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Spigeon	**Area**	1076	Hectares	
			Quality	**8**	Scale 0-10	
			Total quantum of impact	860.80	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	860.80	Adjusted hectares	2822.51	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	2822.51	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%								
									Future area without offset (adjusted hectares)	2822.5	**Future area with offset (adjusted hectares)**	2822.5	0.00	70%	0.00	0.00	759.34	88.21%	No	
					Time until ecological benefit	20	**Start quality (scale of 0-10)**	**0**	**Future quality without offset (scale of 0-10)**	**0**	**Future quality with offset (scale of 0-10)**	**4**	4.00	70%	2.80	2.69				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	860.8	759.34	88.21%	**No**	$0.00	#DIV/0!	#DIV/0!
Area of community	0				$0.00		$0.00
					$0.00	**#DIV/0!**	**#DIV/0!**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	AP snipe
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	**1.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	AP Snipe	**Area**	23.5	Hectares	
			Quality	**7**	Scale 0-10	
			Total quantum of impact	16.45	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	16.45	Adjusted hectares	73.83	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	73.83	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%								
									Future area without offset (adjusted hectares)	73.8	**Future area with offset (adjusted hectares)**	73.8	0.00	80%	0.00	0.00	16.69	101.48%	Yes	
					Time until ecological benefit	5	**Start quality (scale of 0-10)**	**6**	**Future quality without offset (scale of 0-10)**	**5**	**Future quality with offset (scale of 0-10)**	**8**	3.00	80%	2.40	2.26				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	16.45	16.69	101.48%	**Yes**	$0.00	N/A	$0.00
Area of community	0				$0.00		$0.00
					$0.00	**$0.00**	**$0.00**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	osnake
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	osnake	**Area**	1083	Hectares	
			Quality	**5**	Scale 0-10	
			Total quantum of impact	541.50	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	541.50	Adjusted hectares	2033.3	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	2033.3	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%								
									Future area without offset (adjusted hectares)	2033.3	**Future area with offset (adjusted hectares)**	2033.3	0.00	80%	0.00	0.00	625.17	115.45%	Yes	
					Time until ecological benefit	20	**Start quality (scale of 0-10)**	**6**	**Future quality without offset (scale of 0-10)**	**4**	**Future quality with offset (scale of 0-10)**	**8**	4.00	80%	3.20	3.07				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	541.5	625.17	115.45%	**Yes**	$0.00	N/A	$0.00
Area of community	0				$0.00		$0.00
					$0.00	**$0.00**	**$0.00**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Gglider
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Gglider	**Area**	1071	Hectares	
			Quality	**7**	Scale 0-10	
			Total quantum of impact	749.35	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	749.35	Adjusted hectares	1721.21	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	1721.21	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%								
									Future area without offset (adjusted hectares)	1721.2	**Future area with offset (adjusted hectares)**	1721.2	0.00	90%	0.00	0.00	148.84	19.86%	No	
					Time until ecological benefit	20	**Start quality (scale of 0-10)**	**7**	**Future quality without offset (scale of 0-10)**	**7**	**Future quality with offset (scale of 0-10)**	**8**	1.00	90%	0.90	0.86				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	749.35	148.84	19.86%	**No**	$0.00	#DIV/0!	#DIV/0!
Area of community	0				$0.00		$0.00
					$0.00	**#DIV/0!**	**#DIV/0!**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Gglider
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Gglider	**Area**	1071	Hectares	
			Quality	**7**	Scale 0-10	
			Total quantum of impact	749.35	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	749.35	Adjusted hectares	26.5	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	26.5	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%								
									Future area without offset (adjusted hectares)	26.5	**Future area with offset (adjusted hectares)**	26.5	0.00	85%	0.00	0.00	6.49	0.87%	No	
					Time until ecological benefit	20	**Start quality (scale of 0-10)**	**4**	**Future quality without offset (scale of 0-10)**	**4**	**Future quality with offset (scale of 0-10)**	**7**	3.00	85%	2.55	2.45				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	749.35	6.49	0.87%	**No**	$0.00	#DIV/0!	#DIV/0!
Area of community	0				$0.00		$0.00
					$0.00	**#DIV/0!**	**#DIV/0!**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	gglider
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	Spigeon	**Area**	1071	Hectares	
			Quality	**7**	Scale 0-10	
			Total quantum of impact	749.35	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	749.35	Adjusted hectares	3737.69	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	3737.69	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%								
									Future area without offset (adjusted hectares)	3737.7	**Future area with offset (adjusted hectares)**	3737.7	0.00	70%	0.00	0.00	754.17	100.64%	Yes	
					Time until ecological benefit	20	**Start quality (scale of 0-10)**	**0**	**Future quality without offset (scale of 0-10)**	**0**	**Future quality with offset (scale of 0-10)**	**3**	3.00	70%	2.10	2.02				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	749.35	754.17	100.64%	**Yes**	$0.00	N/A	$0.00
Area of community	0				$0.00		$0.00
					$0.00	**$0.00**	**$0.00**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	koala
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	koala	**Area**	1204	Hectares	
			Quality	**7**	Scale 0-10	
			Total quantum of impact	842.80	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	842.80	Adjusted hectares	1720.67	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	1720.67	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%	0.00	90%	0.00	0.00	148.79	17.65%	No		
									Future area without offset (adjusted hectares)	1720.7	**Future area with offset (adjusted hectares)**	1720.7								
					Time until ecological benefit	20	**Start quality (scale of 0-10)**	**7**	**Future quality without offset (scale of 0-10)**	**7**	**Future quality with offset (scale of 0-10)**	**8**	1.00	90%	0.90	0.86				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	842.8	148.79	17.65%	**No**	$0.00	#DIV/0!	#DIV/0!
Area of community	0				$0.00		$0.00
					$0.00	**#DIV/0!**	**#DIV/0!**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	koala
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	koala	**Area**	1204	Hectares	
			Quality	**7**	Scale 0-10	
			Total quantum of impact	842.80	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	842.80	Adjusted hectares	1447.43	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	1447.43	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%	0.00	85%	0.00	0.00	236.42	28.05%	No		
									Future area without offset (adjusted hectares)	1447.4	**Future area with offset (adjusted hectares)**	1447.4								
					Time until ecological benefit	20	**Start quality (scale of 0-10)**	**5**	**Future quality without offset (scale of 0-10)**	**5**	**Future quality with offset (scale of 0-10)**	**7**	2.00	85%	1.70	1.63				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	842.8	236.42	28.05%	**No**	$0.00	#DIV/0!	#DIV/0!
Area of community	0				$0.00		$0.00
					$0.00	**#DIV/0!**	**#DIV/0!**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

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Matter of National Environmental Significance	
Name	koala
EPBC Act status	Vulnerable
Annual probability of extinction Based on IUCN category definitions	**0.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		**Area**			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	koala	**Area**	1204	Hectares	
			Quality	**7**	Scale 0-10	
			Total quantum of impact	842.80	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				**Risk-related time horizon (max. 20 years)**		**Start area (hectares)**		**Risk of loss (%) without offset**		**Risk of loss (%) with offset**									
									Future area without offset (adjusted hectares)	0.0	**Future area with offset (adjusted hectares)**	0.0								
					Time until ecological benefit		**Start quality (scale of 0-10)**		**Future quality without offset (scale of 0-10)**		**Future quality with offset (scale of 0-10)**									
Threatened species habitat																				
Area of habitat	Yes	842.80	Adjusted hectares	1621.91	**Time over which loss is averted (max. 20 years)**	20	**Start area (hectares)**	1621.91	**Risk of loss (%) without offset**	0%	**Risk of loss (%) with offset**	0%								
									Future area without offset (adjusted hectares)	1621.9	**Future area with offset (adjusted hectares)**	1621.9	0.00	70%	0.00	0.00	545.43	64.72%	No	
					Time until ecological benefit	20	**Start quality (scale of 0-10)**	**0**	**Future quality without offset (scale of 0-10)**	**0**	**Future quality with offset (scale of 0-10)**	**5**	5.00	70%	3.50	3.36				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Summary

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	842.8	545.43	64.72%	**No**	$0.00	#DIV/0!	#DIV/0!
Area of community	0				$0.00		$0.00
					$0.00	**#DIV/0!**	**#DIV/0!**

Appendix B

Personnel CVs

Nathan Garvey

Associate Director - Ecology | Divisional Leader Ecology, Heritage and Spatial Solutions

Curriculum vitae

Nathan is an experienced ecologist with over 17 years' practice in ecological assessment across eastern Australia. Nathan has delivered projects across a diverse range of sectors including mining, oil and gas, linear infrastructure, renewable energy and residential development. Nathan is practitioner of biodiversity assessment and approvals, including biodiversity assessment for major projects and EPBC Act referrals. He is one of NSW's leading experts in biodiversity offsetting.

Nathan provides an innovative, whole-of-project approach, delivering solutions for our clients and working with teams to ensure high quality outcomes.

Qualifications

- Bachelor of Science, University of NSW, 2001
- Graduate Diploma (Biological Science), University of NSW, 2003
- Certified Environmental Practitioner (CEnvP)
- Biodiversity Assessment Method (BAM) Accredited Assessor
- Ecological Consultants Association of NSW – member since 2010
- Environment Institute of Australia and New Zealand (EIANZ) – Member since 2007

Career

- EMM Consulting, 2017–present
- Senior Consultant Ecologist and Resource Group Manager, Biosis, 2010–2017
- Consultant Zoologist, Biosis, 2009–2010
- Zoologist, Biosis, 2009–2009
- Technical Assistant, Biosis, 2007–2009
- Project Manager and Ecologist, Cumberland Ecology, 2003–2007
- Research Assistant, University of New South Wales, 2001–2003

Representative experience

Biodiversity assessments

- Snowy 2.0, biodiversity assessment and EPBC referral, Kosciuszko National Park NSW (Snowy Hydro Ltd)
- McPhillamys Gold Project, biodiversity assessment, Blayney (Regis Resources)
- New England Solar Farm, biodiversity assessment, Uralla (UPC Renewables)
- Mugga Quarry, biodiversity assessment and EPBC referral, Symonston (Boral)
- Gulgong Solar Project, biodiversity assessment, Gulgong (Vena Energy)
- Wagga Wagga Solar Project, biodiversity assessment, Gulgong (Vena Energy)

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- Orange Grove Solar Farm, biodiversity assessment, Orange Grove (Overland Sun Farming)
- Quorn Park solar project, biodiversity assessment, Parkes (Renewable Energy Consultancy)
- Blueys Estate Planning Proposal, biodiversity assessment, Blueys Beach (City Plan Services)
- Wee Waa Solar Farm, biodiversity assessment, Wee Waa (Overland Sun Farming)
- Junee Solar Farm Grid Connection Biodiversity Assessment, Junee (Geolyse and Terrain Solar)
- Coffs Harbour Bypass, biodiversity assessment and EPBC referral, NSW (Aurecon and NSW Roads and Maritime Services)
- Goonumbla Solar Farm, biodiversity assessment, Goonumbla (Geolyse and Renewable Energy Developments)
- Gunnedah, Limondale, Hay and Hillston Solar Farms, biodiversity assessments, NSW (Overland Sun Farming)
- Walgett Solar Farm, biodiversity assessment and biodiversity management plan, Walgett (Geolyse and Epuron)
- Amended Rocky Hill Coal Project, biodiversity assessment, targeted fauna surveys and EPBC referral, Gloucester (RW Corkery & Co and Gloucester Resources Limited)
- Yarraman Abattoir and Feedlot, biodiversity impact assessment, Yarraman (KMH Environmental)
- Brandy Hill Quarry Expansion, biodiversity impact assessment, Brandy Hill (Hanson Construction Materials)
- Underground Expansion Project, biodiversity assessment and EIS for the EPBC referral, Wollongong (Hansen Bailey and Wollongong Coal)
- Nyngan Inground Storage, biodiversity assessment, Nyngan (NSW Public Works)
- Crest Road Albion Park, flora and fauna assessment, Albion Park (MMJ Wollongong and Spinitu)
- Princes Highway Upgrade, Foxground and Berry Bypass, biodiversity assessment, Foxground (AECOM and Roads and Maritime Services)
- Princes Highway Upgrade, Berry Bypass, biodiversity assessment, Berry (AECOM and Roads and Maritime Services)
- AGL Camden North Gas Project, flora and fauna assessment, Camden (AGL Upstream Investments)
- Dundas Tablelands Wind Farm, detailed flora and fauna assessment, Casterton (Origin Energy)
- Underground Expansion Project, biodiversity offset strategy, Russell Vale (Wollongong Coal)

Biodiversity offsets

- Snowy 2.0 Exploratory Works, biodiversity offset framework and strategy (Snowy Hydro Ltd)
- Gunlake Quarry, BioBanking agreement, Marulan (Gunlake Quarries)
- 33 – 35 Warradale Road, Silverdale: credit sourcing and retirement, Silverdale (SitePlus and TRN Group)
- Western Sydney Priority Growth Areas, biodiversity advice (Office of Environment and Heritage)
- Wilton Gardens and Wilton East, biodiversity offset advice and strategy, Wilton (Country Garden Australia)
- Albion Park Rail Bypass project, offset site advice, Albion Park (Shellharbour City Council)
- BioBanking Assessor services, various location in NSW (NSW Office of Environment and Heritage)
- Redgum Ridge Western Precinct, biodiversity certification, Figtree (Clifford Developments)
- Redgum Ridge Western Precinct, BioBanking Agreement, Figtree (Clifford Developments)
- 89 Port Stephens Drive Taylors Beach, BioBanking Agreement and BioBanking Statement, Taylors Beach (Port Stephens Council)
- Lots 4 and 6 DP 243079 Wilton, BioBanking Agreement, Wilton (Weaving Family Trust)
- 33 – 35 Warradale Road, Silverdale, BioBanking Statement, Silverdale (SitePlus and TRN Group)
- 33 – 35 Warradale Road, Silverdale, BioBanking Agreement, Silverdale (SitePlus and TRN Group)
- NorthConnex, biodiversity offset strategy, Sydney NSW (Lend Lease Bouyeres Joint Venture)
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Peer review and expert witness services

- Gunlake Quarry: modification to cent in Land and Environment, Marulan (Gunlake Quarries)
- IRT Culburra Beach Development Application: biodiversity assessment peer review, Culburra Beach (Illawarra Retirement Trust)
- Blueys Estate Biodiversity Assessment: peer review, Blueys Beach (City Plan Services)
- Expert review of the Addendum to NSW Biodiversity Offset Policy for Major Projects: Upland swamps impacted by longwall mining subsidence (NSW Minerals Council).
- Tarrone Gas-fired Power Station, expert witness statement, Tarrone (URS Corporation)
- Ballarat Koala Habitat Assessment, expert witness testimony to the Victorian Civil and Administrative Tribunal, Vic (VCAT)

Ecological monitoring and management plans

- Dunmore Hard Rock Quarry, flora and fauna management plan, Dunmore (Boral)
- Beryl Solar Farm, biodiversity management plan, Beryl (Geolyse and Downer)
- Mona Vale Road, biodiversity monitoring plan and implementation, Sydney NSW (Roads and Maritime Services)
- Walgett Solar Farm, biodiversity management plan, Walgett (Geolyse and Epuron)
- Balickera Tunnel, targeted microbat surveys, Balickera (GHD and Hunter Water)
- Additional Crossing of the Clarence River at Grafton, flora and fauna management plan, NSW (Fulton Hogan)
- Dendrobium Mine, biodiversity management plans and monitoring (Illawarra Coal)
- Longwall 6 and 7, biodiversity and upland swamp management plans, Russell Vale (Wollongong Coal)
- NRE No. 1 Colliery Dam 6 Green and Golden Bell Frog monitoring program, Russell Vale (Wollongong Coal)
- Appin Area 9, biodiversity management plan, Appin (Illawarra Coal)
- Shell Port Kembla, Green and Golden Bell Frog management plan, Port Kembla NSW (URS Australia)
- Penshurst Wind Farm, targeted surveys for the Brolga and Southern Bent-wing Bat, Penshurst (RES Australia)
- Holcim Colac Quarry, Coorangamite Water Skink translocation plan, Colac (Holcim Australia)
- Victorian Desalination Plant, targeted surveys for the Growling Grass Frog, Wonthagi (GHD)

Publications and presentations

- BAM – where does fauna fit into the requirements of the new Biodiversity Conservation Act? Presented to the *Ecological Consultants Association of NSW annual conference*, 2017.
- The Biodiversity Conservation Act 2016: a new framework for biodiversity assessment in NSW and how you can be prepared, presented to EMM breakfast seminar, Sydney, 2017.
- An assessment of changes in the extent and distribution of upland swamps in relation to longwall mining, report to Wollongong Coal, 2015.
- The assessment and offsetting of indirect impacts, presented at *Biodiversity Offsetting for Mining, Infrastructure and Urban Development Conference*, Sydney, 2015.
- Coastal upland swamps and longwall mining, presented to *the Australian Institute of Mining and Metallurgy*, Wollongong, 2014.
- Garvey, N, Ben-Ami, D, Ramp, D & Croft, D 2010, Survival behaviour of swamp wallabies during prescribed burning and wildfire, *Wildlife Research* 37(1), pp. 1–12.

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Berlinda Ezzy

Ecology Team Lead & Associate Ecologist

Curriculum vitae

Berlinda is an Associate Ecologist with 20 years of professional experience. She has worked for local and state government, as well as the private sector, across a range of environmental disciplines. Berlinda's areas of expertise include environmental planning and approvals, threatened species management, coordinating delivery of field ecology surveys and reporting, impact assessments and biodiversity offsets.

Berlinda has led complex projects as an environmental consultant for over 10 years and successfully managed a large number of ecology, impact assessment and offset projects for resource and infrastructure companies across Queensland and New South Wales.

Berlinda is also engaged and consulted with by government agencies on biodiversity offsets due to her long standing experience in this area.

Qualifications

- Bachelor of Applied Science (Honours) Natural Systems and Wildlife Management, University of Queensland, 1998

Career

- Ecology Team Lead, EMM Consulting, 2018–present
- Senior Project Manager and Ecology and Offsets Lead, Amec Foster Wheeler Australia, 2011–2018
- Senior Manager, Environmental Offsets, Ecofund Queensland, 2009–2011
- Manager of Wildlife, Queensland Parks and Wildlife Service, 2008–2009
- Team Leader (Koala Conservation), Senior Planner (Marine and Coastal Planning), Senior Biodiversity Planning Officer, Environmental Protection Agency (now Department of Environment and Science), 2005–2008
- Senior Environmental Planning Officer, Logan City Council, 1999–2004
- Conservation Officer (Moreton Bay Marine Park), Queensland Parks and Wildlife Service, 1998

Representative experience

Infrastructure

- Inland Rail (Qld Geotech Program) preparation of EPBC Act referral, protected plant surveys, Protected Plant Reports, Clearing application under NC Act, Environmental Management Plan, Approvals Strategy and Species Management Program, Qld (ARTC)
- Inland Rail (Qld sections) biodiversity offset assessments, preparation of Qld Biodiversity Offset Strategy, identification of potential offset sites, preparations for meeting with Department of Environment and Energy (ARTC)
- Inland Rail (Qld sections) managing pre-clearance ecology surveys and associated reporting for proposed disturbance sites along corridor to support Geotech program (ARTC)
- Woolgoolga to Ballina Pacific Highway Upgrade, Threatened Species Mg't Plans

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- Moomba to Wilton Pipeline, ecology and cultural heritage surveys and due diligence assessments of proposed maintenance areas, Western Qld, NSW and South Australia (APA)
- Wiggins Island Coal Terminal, environmental offset assessments, identification of offset sites, ecology surveys of shortlisted offset property, landholder consultation, preparation of offset management plan (Aurizon)

Oil and Gas

- Spring Gully Gas Project, Significant Impact Assessments, environmental offset analysis and advice, Env Offset Strategy, Central Qld (Origin Energy)
- Bowen Gas Project, EPBC Act referral, identification of environmental offset properties, ecology surveys of offset properties, landholder engagement and preparation of offset management plans, Central Qld (Arrow Energy)
- Australia Pacific LNG, Threatened Species Management Plans, Central Qld (Origin Energy)

Mining

- Olive Downs Mine, biodiversity offset assessments, engaging with government regulators, ecology surveys of offset site, preparing offset management plan
- Blackwater Mine, coordination of baseline surveys including terrestrial and aquatic ecology, threatened species habitat mapping, groundwater and noise for proposed future expansion, central Qld (BMA)
- Blackwater Mine, ecology surveys including habitat mapping and significant impact assessments for proposed seismic investigations (BMA)
- Bauxite Hills Mine Project, coordination of seasonal terrestrial and aquatic surveys and impact assessments, Cape York (Metro Mining)
- Bauxite Hills Mine Project, preparation of Environmental Offset Strategy (addressing State and Federal requirements), Cape York (Metro Mining)
- Bauxite Hills Mine Project, monitoring surveys for receiving environment monitoring program, Qld (Metro Mining)
- Kevin's Corner Coal Mine, coordination of terrestrial ecology surveys, impact assessments, preparation of environmental offset strategy, EPBC Act referral, Galilee Basin (Hancock Galilee)
- Mount Isa Mines, Biodiversity studies including vegetation community surveys, fauna surveys and condition assessments, Mount Isa (Mount Isa Mines)
- Moorlands Coal Project, environmental offset strategy, central Qld (Cuesta Coal)
- Walton Coal Mine, Environmental Offset Strategy, central Qld (Aquila Resources).

Auditing

- Audit of application of Koala state planning regulatory provisions and offsets, South East Qld (Moreton Bay Regional Council)
- Audit of solar farm approvals and requirement for EPBC Act referral, Gympie (AMP Power)

Renewable Energy

- Baseline terrestrial ecology surveys including regional ecosystem surveys and mapping, threatened flora surveys, threatened fauna surveys, bird utilisation surveys and habitat mapping for two wind farms, Qld (Epuron)

Government

- Provision of strategic advice and analysis on review of current environmental offset framework in Queensland including specific advice regarding pros and cons of mitigation banking, Qld (Department of Environment and Science)

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Chris Beavon

Associate Ecologist

Curriculum vitae

Chris is an Associate Ecologist with 15 years' professional experience throughout Queensland, New South Wales, Northern Territory and Victoria.

Chris has delivered environmental assessments, monitoring and management projects across a range of sectors including energy, mining, renewables, urban development, infrastructure, and natural resource management. His diverse project experience includes terrestrial ecology assessment, environmental impact statements, protected plant surveys, translocation and monitoring of threatened species, biosecurity assessment and management, compliance assessment, and vegetation rehabilitation.

Qualifications

- Bachelor of Science, University of Queensland, 2010
- BioCondition v2.2 Application, Assessment and Scoring, Oberonia Botanical Services, 2016
- Regional Ecosystem Training, Oberonia Botanical Services, 2016
- Certificate IV in Small Business Management, Sarina Russo, 2014
- Conservation and Land Management, Certificate I & II (in progress), Hortus Australia, 2004

Career

- EMM Consulting, 2019–present
- Director/Senior Ecologist, E2M Consulting, 2014–2019
- Director/Senior Ecologist, Terrestrial Ecology Co, 2013
- Senior Ecologist, AMEC Environment & Infrastructure, 2011–2012
- Ecologist, Mining and Engineering Technical Services, 2010–2011
- Ecologist/Senior Bush Regenerator, Ecosure, 2007–2010
- Senior Bush Regenerator, Bushcare Services, 2005–2007
- Bush Regenerator/Nursery Hand, Barung Landcare, 2003–2005

Representative experience

Ecological monitoring and management

- Australia Pacific LNG Pipeline Network, rehabilitation photo-monitoring assessment program, biosecurity monitoring/mapping, and reporting, (Origin Energy)
- KABAN Green Power Hub Wind Farm Project, vegetation management plans, fauna management plans, and bird and bat management plans, Ravenshoe Qld, (Neoen Australia)
- Directlink and Murraylink Electricity Transmission lines, review of biosecurity management plans and operational environmental management plans, gap analysis, and facilitation of team specific workshops, Mullumbimby and Berri NSW (APA Group)

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- Berwyndale Wallumbilla Pipeline, review of biosecurity management plans and operational environmental management plans, gap analysis, and facilitation of team specific workshops, Berwyndale to Wallumbilla Qld (APA Group)
- Carpentaria Gas Pipeline, review of biosecurity management plans and operational environmental management plans, gap analysis, and facilitation of team specific workshops, Ballera and Mount Isa Qld (APA Group)
- Reedy Creek Wallumbilla Pipeline, review of biosecurity management plans and operational environmental management plans, gap analysis, and facilitation of team specific workshops, Reedy Creek and Wallumbilla Qld (APA Group)Roma Brisbane Pipeline, review of biosecurity management plans and operational environmental management plans, gap analysis, and facilitation of team specific workshops, Wallumbilla gas hub, near Roma, to Brisbane Qld (APA Group)South West Queensland Pipeline, review of biosecurity management plans and operational environmental management plans, gap analysis, and facilitation of team specific workshops, Wallumbilla in South East Queensland to Moomba NSW (APA Group)
- 'Wipe Out Weeds' Biosecurity Surveys, biosecurity survey of various reserves managed by Brisbane City Council, in accordance with the State legislation and local council weed and pest management plan, Brisbane (Brisbane City Council)

Ecological impact assessments

- Australia Pacific LNG, detailed ecological assessment, watercourse determinations and threatened species searches, Surat Basin Qld (Origin Energy)
- Rodds Bay Solar Farm, ecological survey, identify fauna habitat values and potential advanced offset areas, Bororen Qld (Renew Estate)
- Targinnie Solar Farm, preliminary environmental constraints assessment, Yarwun Qld (Renew Estate)
- Carmichael Coal Mine, pre-clearance surveys including biocondition assessment, animal breeding places, threatened species assessment and vegetation ground-truthing, Galilee Basin Qld (Adani Australia)
- QCLNG Pipeline, pre-clearance environmental surveys, Surat Basin Qld (Queensland Gas Company)
- Kevin's Corner Coal Mine Project, off lease rail and road survey report, survey and assessment for Black-throated Finch supplementary MNES report, Galilee Basin Qld (GVK/Hancock Coal)

Biodiversity assessments

- Snowy Hydro 2.0, Adit closure and microbat monitoring, targeted Booroolong frog (*Litoria booroolongensis*), arboreal fauna trapping and targeted bird surveys, Kosciuszko National Park NSW (Snowy Hydro Limited)
- KABAN Green Power Hub Wind Farm Project, protected plants surveys and association documentation for preliminary geotechnical works, Ravenshoe Qld (Neoen Australia)
- Inland Rail geotechnical Investigations, protected plant surveys, protected plants reporting, Toowoomba Qld (Australian Rail Track Corporation)
- Roma to Brisbane Pipeline Toowoomba replacement section, ecological assessment and protected plants surveys with associated documentation for clearing permits, Toowoomba Qld (APA Group)
- Carmichael Coal Mine, targeted Black-throated Finch (southern sub-species) (*Poephila cincta cincta*) monitoring surveys and habitat assessment, Galilee Basin Qld (Adani Australia)
- Alcan Gove, bauxite mine pre-clearance surveys, management and monitoring of protected species translocation program, Gove NT (Rio Tinto)
- South Galilee Coal Project, vegetation verification, detailed flora and fauna assessments, preparation of terrestrial ecology flora and fauna chapters for EIS, Alpha Qld (AMCI Pty Ltd)
- M1/M3 Merge Project, vegetation survey and mapping, koala habitat and offset assessment, fauna and flora survey, Eight Mile Plains to Rochedale Qld (Jacobs)
- Boondooma Dam, ecological assessment and targeted flora surveys, South Burnett Region Qld (Fulton Hogan)
- Wiggins Island Balloon Loop, design monitoring and evaluation, fish surveys, and surface water quality sampling, Gladstone Qld (Aurizon)
- Environmental vegetation community's assessment, detailed assessment of Environmental Vegetation Communities (utilising Victoria's Habitat Hectare Assessment technique), threatened flora surveys, data entry and analysis, throughout Victoria (Department of Sustainability and Environment Victoria)

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Patrick Finnerty

Ecologist

Curriculum vitae

Patrick is an ecologist and environmental management professional with project experience across a range of sectors including utilities, infrastructure, construction and energy. Patrick has been involved in the successful delivery of a range of projects including ecological impact assessments, ecological monitoring and management plans.

Patrick has also undertaken academic and field research for various environmental and ecological projects in New South Wales, Western Australia and South Africa.

Qualifications

- Bachelor of Science (Advanced) (Hons I) and University Medal, University of Sydney, 2017
- HLTAID003 Provide First Aid Certificate – S512/4032
- White Card – Work Safety in the Construction Industry, 2018

Career

- EMM Consulting, 2018–present
- Casual employment with Benbow Engineering and Environmental Consulting, 2018
- Casual employment with Western Australia Department of Parks and Wildlife, 2017
- Graduate Field Ecological Scientist (Casual), SMEC Consulting, 2017
- Casual employment with the NSW Office of Environment and Heritage, 2017

Representative experience

Ecological impact assessment and due diligence

- Snowy 2.0, field investigations including soil surveys, vegetation mapping and targeted species survey for environmental impact statements, Kosciuszko National Park NSW (Snowy Hydro Limited)
- Gunlake Quarry Biodiversity and Conservation Agreement, vegetation assessment of potential offset areas, NSW (Gunlake Quarries)
- Beryl Solar Farm Biodiversity Assessment Report, Beryl NSW (Downer Group)
- New England Solar Farm, targeted fauna and flora surveys and vegetation assessments, Uralla (UPC)

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Ecological monitoring and management plans

- Mona Vale Rd Upgrade Biodiversity Monitoring, targeted surveys for Giant Burrowing Frog, Red-crowned Toadlet and Eastern Pygmy Possum, Terrey Hills to Ingleside, NSW (Roads and Maritime Services)

Relevant environmental expierience

- Western Australia Department of Parks and Wildlife: conducted a number of invasive species environmental and pest control projects in Kununurra.
- NSW Office of Environment and Heritage: conducted a number of native mammal environmental and ecological research projects.
- Worked as part of a collaborative research team that conducted a four month investigation into the environmental impact of African elephants in Hazyview, Kruger National Park, South Africa.

Publications

- Finnerty P B, Shine R & Brown G P 2018, The costs of parasite infection: Effects of removing lungworms on performance, growth and survival of free-ranging cane toads, *Functional Ecology* 32(2), pp. 402–415.
- Finnerty P B, Shilton C M, Shine R & Brown G P 2018, Using experimental de-worming to measure the immunological and pathological impacts of lungworm infection in cane toads, *International Journal for Parasitology: Parasites and Wildlife* 6(3), pp. 310–319.
- Finnerty P B, Shine R & Brown G P 2019, Survival of the feces: Does a nematode lungworm adaptively manipulate the behaviour of its cane toad host? *Ecology and Evolution 8* (9), pp. 1–13.
- Finnerty P B, Stutz R S, Price C J, Banks P B & McArthur C 2017, Leaf odour cues enable non-random foraging by mammalian herbivores, *Journal of Animal Ecology* 86(6), pp. 1317–1328.

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