







#### **Declaration of accuracy**

In making this declaration, I am aware that sections 490 and 491 of the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) make it an offence in certain circumstances to knowingly provide false or misleading information or documents. The offence is punishable on conviction by imprisonment or a fine, or both. I declare that all the information and documentation supporting this compliance report is true and correct in every particular. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed

Full name (please print)

Position (please print)

Jacques Labuschagne

Director

Organisation (please print including ABN/ACN if applicable)

CMOC Mining Service Pty Ltd ACN: 165 717 895

Date

31/05/2019



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#### 1. INTRODUCTION

CMOC Northparkes (Northparkes) is a copper and gold mine, majority owned and operated by CMOC with Sumitomo Metal Mining and Sumitomo Corporation as minority owners.

Located 27 kilometers North West of Parkes, Northparkes has been operating since 1993. Northparkes was the first mine in Australia to use the highly efficient block cave mining method, beginning in 1997.

In 2006, Northparkes completed construction of a second block cave section, and in 2015, it completed installation of a highly automated equipment control system. It also operates a sub-level cave mining section, an ore processing plant, a tailings management facility, transport, logistics and asset management services. Northparkes products are transported by road train and rail to Port Kembla where they are shipped principally to Japan and China.

Northparkes is also a proud agricultural producer of canola and wheat, with 8,684 ha of its 10,314 ha holdings in Central West operating for commercial cropping.

#### 1.1 Project background

The Northparkes Mine Step Change Project (the Project) was approved with conditions under section 130 (1) and 133 of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999) on 13<sup>th</sup> February 2014 (EPBC 2013/6788). Key elements of the Project included:

- continued underground block cave mining in two existing ore bodies;
- the development of an additional underground block cave mine, under one of the existing open cut pits;
- additional campaign open cut mining in existing mine leases;
- augmenting approved Tailings Storage facilities (TSFs);
- moving the existing access road;
- construction of the new TFS (Rosedale) in Figure 1; and
- extending the life of the mine by seven years to 2032.

In early 2015, construction commenced on the Rosedale Tailing Storage Facility Project (the Rosedale Project) (Figure 2), which included:

- extending the approved TSF 2;
- construction of the new Rosedale TSF;
- construction of a new main access road (known as Northparkes Way) as well as upgrades to existing roads;
- construction of a new access control for site; and
- stockpiles associated with construction of the TSF.

On 25 February 2016, Northparkes received a variation to Project Approval EPBC 2013/6788 (the approval) following correspondence between Northparkes and the Department of the Environment. This variation included the deletion of conditions 4, 6 and 7 attached to the approval dated 13 February 2014 and substituted with updated conditions 4 and 6 as specified in the variation to conditions document dated 25 February 2016. These variation have been outlined in Table 2.



#### 1.2 Purpose of this report

This report has been produced to address compliance with Condition 12, EPBC 2013/6788 stating that:

Within 3 months of every 12 month anniversary of the commencement of the action, the person taking the action must publish a report on their website addressing compliance with each of the conditions of this approval (Table 1), including implementation of any plans as specified in the conditions.

As the commencement of the action occurred on 13 March 2015, this report has been prepared for the period 13 March 2018 to 13 March 2019, and will be published on Northparkes web page by 12 June annually.

Refer to the sections below and the associated appendices for information on the compliance activities undertaken to satisfy the conditions outlined in EPBC 2013/6788.



Figure 1 Indicative Location of Northparkes Mines Step Change Project Features



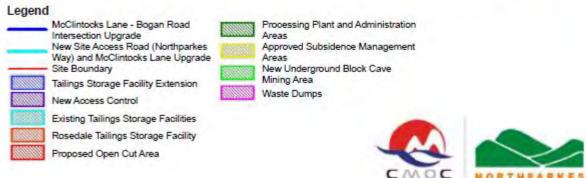
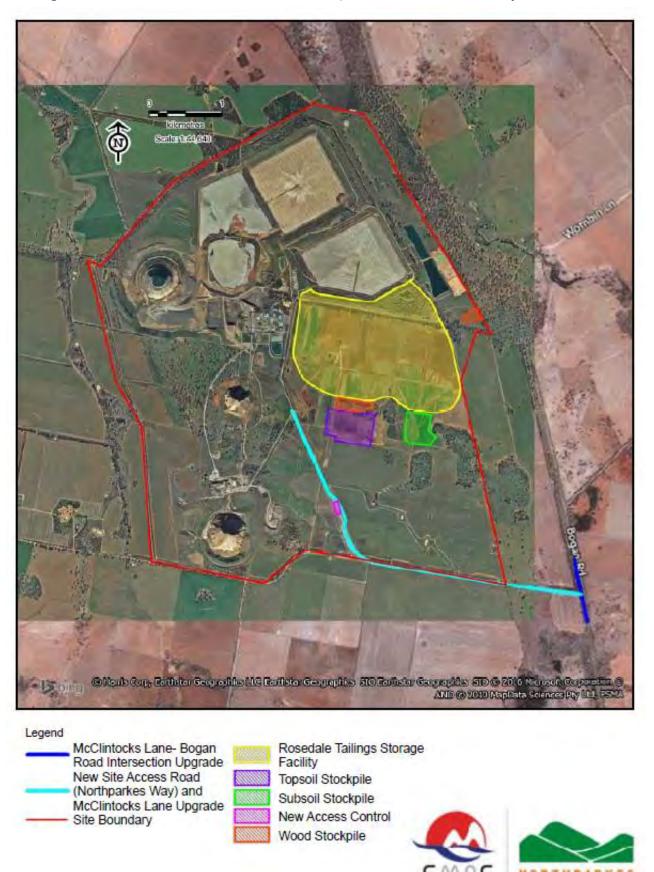




Figure 2 Indicative Disturbance Areas for Northparkes Mines Rosedale Project





# 2. CONDITIONS ATTACHED TO THE PROJECT APPROVAL UNDER THE EPBC ACT (EPBC 2013/6788)

The tables below outline the approval conditions in EPBC 2013/6788 and the associated compliance activities undertaken to fulfil these conditions.



Table 1 Avoidance and mitigation of impacts on site

	Table 1 Avoidance and mitigation of impacts on site			
	Condition	Description of Actions Undertaken	Supporting documentation	Compliance
1.	The person taking the action must not clear more than 46 hectares of Grey Box ( <i>Eucalyptus macrocarpa</i> ) grassy woodlands and derived native grasslands of south eastern Australia (GBGW) as part of the action.	No vegetation characterised as being a part of the mapped GBGW was cleared during the reporting period. The total amount of GBGW cleared as part of the project remains under 46 hectares total.	Not applicable	Compliant
2.	The person taking the action must avoid clearing native vegetation in the Project area, so as to maintain the vegetation specified in Section 2.2 (a) of the Preliminary Documentation and ensure that these areas of native vegetation persist on site.	During the reporting period, a small area had been cleared as part of the E31N Project and is reported in the Pre-clearance and Clearing Supervision Report – E31N Project. Vegetation in this area was previously mapped as part of the Bimble Box-White Cypress Pine Woodland and Exotic Grassland vegetation communities. All clearing undertaken as part of the E31N Project has been contained to the area approved within EPBC 2013/6788.	Appendix A Pre-clearance and Clearance Supervision Report – E31N Project	Compliant
3.	To reduce direct and indirect impacts to matters of national environmentation 2.2 (b) of the Preliminary Documentation.	ental significance, the person taking the action must implement th	ne mitigation measures set out in and	as specified in
	From Section 2.2 (b) of the Preliminary Documentation Table 2.1 – Pre-clearing surveys	Pre-clearance surveys were conducted prior to all disturbance activities to identify critical habitat of threatened species known, or that are potentially occurring, within the clearing area.  Clearing supervision was conducted for E31N Project, which forms part of the area approved by EPBC 2013/6788. This was the only project requiring pre-clearance surveys during the reporting period.	Appendix A Pre-clearance and Clearance Supervision Report – E31N Project	Compliant
	From Section 2.2 (b) of the Preliminary Documentation Table 2.2 - Habitat Augmentation Works	Nest box inspections have been carried out annually since installation in 2017 to assess use by target species, structural integrity and general condition of the box.  During the reporting period, the nest box assessment found the majority to be in perfect or good condition. Replacement and repair of nest boxes is undertaken as required.  Northparkes will continue to provide threatened species compensatory habitat, relative to that disturbed by the Project.	Appendix E Nest Box Inspection – May 2018	Compliant
	From Section 2.2 (b) of the Preliminary Documentation Table 2.3 – Clearing Supervision	Clearing supervision was undertaken for all potentially critical habitat marked during preclearance surveys, with the aim of minimising the impact to threatened species or ecological communities.	Appendix A Pre-clearance and Clearance Supervision Report – E31N Project	Compliant



Condition	Description of Actions Undertaken	Supporting documentation	Compliance
	10 trees were identified as potential critical habitat during the E31N pre-clearance survey, however following clearance supervision, none of these trees were determined to have any nests or suitable hollows for superb parrot nesting.  No fauna with the exception of common bird species were observed traversing through the area during clearing works.  No fauna were recorded to be injured or disturbed during the clearing works.		
From Section 2.2 (b) of the Preliminary Documentation Table 2.4 - Vegetation and Habitat Enhancement Monitoring and Maintenance	Vegetation and habitat enhancement monitoring and maintenance activities, as outlined in the Preliminary documentation and Northparkes Flora and Fauna Management Plan, was undertaken at the Kokoda Offset Site during the reporting period.  Qualitative assessments of the natural regeneration across site were also recorded during the biannual inspections at the Kokoda property. It was noted that natural regeneration had progressed since the previous biannual inspections with regeneration 0.5 – 3 m high in some locations.	Appendix B 2018 Kokoda Biodiversity Offset Area Ecological Monitoring Report Appendix D 2018 Biannual Inspection Report for the Kokoda Biodiversity Offset Site Appendix E Nest Box Inspection – May 2018	Compliant
From Section 2.2 (b) of the Preliminary Documentation Table 2.5 - Weed Management	Weed management is undertaken on an as needed basis across Northparkes holdings in accordance with the Flora and Fauna Management Plan.  Blackberry populations at the Kokoda Offset site had significantly reduced as a result of programmed spraying during the current and previous reporting periods.  Weed monitoring is undertaken during biannual inspections, identifying Tree of Heaven at a single isolated location during the reporting period. A weed control program has been actioned for 2019 to eradicate the tree of heaven population and any other opportunistic weeds observed.	Appendix D 2018 Biannual Inspection Report for the Kokoda Biodiversity Offset Site	Compliant
From Section 2.2 (b) of the Preliminary Documentation Table 2.6 – Feral Animal Management	Feral animal control is undertaken on an as needs basis across Northparkes holdings in accordance with the Flora and Fauna Management Plan. Northparkes also implements feral animal management in conjunction with our near neighbours (e.g. fox baiting programs).	Appendix D 2018 Biannual Inspection Report for the Kokoda Biodiversity Offset Site	Compliant



Condition	Description of Actions Undertaken	Supporting documentation	Compliance
	During the reporting period, strategic feral rabbit control was undertaken at the Kokoda Offset Site. In consultation with the Local Land Services (LLS), Northparkes implemented a baiting program to limit the spread and colonisation of feral rabbits. Following the execution of the baiting program, a reduction in rabbit population has been evident.  Continual feral animal monitoring will be undertaken at the Kokoda Offset Site during biannual inspections and opportunistic site visits.		
From Section 2.2 (b) of the Preliminary Documentation Table 2.7 - Rehabilitation Management	Rehabilitation works are to be undertaken as soon as practical following disturbance in accordance with Northparkes site disturbance procedures. Rehabilitation works are also outlined in the Northparkes Mine Operations Plan.	Not applicable	Compliant
From Section 2.2 (b) of the Preliminary Documentation Table 2.8 - Biodiversity Monitoring and Reporting	A range of ongoing ecological monitoring is undertaken within Northparkes holding, both within the mining leases and at the offset sites. Biodiversity monitoring continued at the Kokoda Biodiversity Offset Site during the reporting period. This included Landscape Function Analysis (LFA) surveys, flora quadrats, winter and spring targeted bird surveys and biannual inspections.  Bird surveys during the reporting period observed 10 threatened species and one migratory species listed under the Biodiversity Conservation (BC) Act 1999. Notably, large flocks of Little Lorikeet were recorded for the first time in the offset area since the baseline surveys in 2014.	Appendix B 2018 Kokoda Biodiversity Offset Area Ecological Monitoring Report Appendix D 2018 Biannual Inspection Report for the Kokoda Biodiversity Offset Site Appendix C 2018 Bird Surveys (Winter and Spring)	Compliant
From Section 2.2 (b) of the Preliminary Documentation Table 2.9 – Threatened Species Adaptive Management	Acknowledged, if an unexpected occurrence of a threatened species was recorded within the Northparkes Site, adaptive management to mitigate impacts to the species would be implemented in accordance with the Northparkes Flora and Fauna Management Plan.  However, no new threatened species other than those assessed through the impact assessment process were recorded during pre-clearance and clearing supervision surveys.	Appendix A Pre-clearance and Clearance Supervision Report – E31N Project	Compliant



Table 2 Offsetting of residual impacts

	Table 2 Offsetting of residual impacts  Condition	Description of Actions Undertaken	Supporting decumentation	Compliance
		Description of Actions Undertaken	Supporting documentation	Compliance
4.	CONDITION VARIATION AS OF 25 FEBRUARY 2016  To compensate for the loss of 46 hectares of GBGW and the related and additional loss of habitat for other matters of national environmental significance ( <i>Polytelis swainsonii; Lathmus discolour; Anthochaera phrygia</i> ) the person taking the action must secure the offset lands as identified as the 'Kokoda Offset Site' in Section 2.3 of the Preliminary Documentation. These offset lands must be protected by a legal instrument under relevant legislation on the title within 12 months of the date of this variation [25 February 2016).	Northparkes purchased the Kokoda Offset Site in early 2014.  Northparkes had commenced the process to obtain the Voluntary Conservation Agreement (VCA) for Kokoda. The VCA was not executed by 30 June 2015 as per the approval due to additional biometric monitoring being requested by the Office of Environment and Heritage (OEH).  A variation was granted to extend this time out till 25 September 2017.  Kokoda Offset VCA was submitted in 2017 and signed by the OEH Chief Executive in February of 2018. Registration of the agreement by the Biodiversity Conservation Trust (BCT) has been executed, with the return of documents to Northparkes.	Appendix H OEH Kokoda Conservation Agreement Acceptance Appendix I Registration of Kokoda Biodiversity Offset Conservation Agreement	Not Applicable
5.	The instrument referred to in Condition 4 must:	As per condition 4	Appendix H OEH Kokoda	Compliant
(a)	Provide for the legal protection of the land for the duration of the impact;		Conservation Agreement Acceptance	
(b)	Prevent any conflicting future development activities, including mining and mineral extraction;		Appendix I Registration of Kokoda Biodiversity Offset	
(c)	Ensure the active management of the land (in accordance with		Conservation Agreement	
	Condition 9).			
6.	CONDITION VARIATION AS OF 25 FEBRUARY 2016  The person taking the action must provide evidence to the Department of their compliance with Condition 4, along with offset attributes, shapefiles and textual description and maps to clearly define the location and boundaries of the offset sites, within 1 month of the offset lands being protected under condition 4.	As per condition 4. In 2018, Northparkes submitted offset attributes, textual descriptions and maps that clearly define the location and boundaries of the offset site following receipt of confirmed registration of the VCA from BCT.  In May 2019, Northparkes sent a copy of the Shapefiles to DoEE.	Appendix H OEH Kokoda Conservation Agreement Acceptance Appendix I Registration of Kokoda Biodiversity Offset Conservation Agreement	Non-compliant  Corrective Action: N/A
7.	THIS CONDITION HAS BEEN DELETED AS OF 25 FEBRUARY 2016	No action required	No documentation required	
8.	The area of land contained within the offset lands that are secured must include appropriate areas of the offset lands (consistent with the Department's EPBC Act offsets policy) for each of the matters of national environmental significance that are impacted by the action, as per Section 2.4.2 and Appendix 6 of the Preliminary Documentation.	The Kokoda Offset Site was purchased as an offset site as it contains areas of threatened ecological communities and suitable habitat for the threatened species that were potentially impacted by the Project.	Appendix F Vegetation Community Mapping – Proposed Kokoda Offset Site	Compliant



	Condition	Description of Actions Undertaken	Supporting documentation	Compliance
9.	The offset lands ('Kokoda Offset Site') identified in Condition 4 must be managed to improve and maintain the condition of the offset lands to the satisfaction of the Department and achieve the conservation objectives of the affected lands, including:	The Kokoda Biodiversity Offset Management Plan was approved by the Department of Environment on 5 December 2016.  Biannual inspections are conducted to assess fence integrity,	Appendix B 2018 Kokoda Biodiversity Offset Area Ecological Monitoring Report Appendix D 2018 Biannual	Compliant
(a)	Development of a suitable management plan for the offset land which specifies conservation objectives and how they are to be achieved. The conservation objectives must be clearly set out, measureable and consistent with the conservation management intent described in Section 2.3 of the Preliminary Documentation;	track access, weed infestations and a qualitative assessment on regeneration. The information from the inspections during the reporting period are contained in Appendix D Sections 1.1 and 2.1. All stock has been removed from the Offset Area and the perimeter fence replacement program continued in 2018.	Inspection Report for the Kokoda Biodiversity Offset Site Appendix G Biodiversity Offset Management Plan	
(b)	Implementation of all management actions and conservation measures	The VCA was executed in 2018. Northparkes will implement the management measures documented within it, subject to		
(C)	Active management of derived native grassland areas (GBGW) to allow regeneration and full recovery of these areas of GBGW ecological community over time;	favourable conditions.  Ecological monitoring has been conducted as per the Biodiversity Offset Management Plan and results recorded in		
(d) (e)	Allocation of appropriate funding to achieve the conservation objectives;  Regular monitoring against conservation objectives and adaptive	Appendix B. Performance against primary completion indicators are provided in this report (based on ESG3 MOP Guidelines).		
	management as appropriate to achieve the conservation objectives			



Table 3 Reporting and auditing

	Table 3 Reporting and auditing							
	Condition	Action	Supporting documentation	Compliance				
10.	All survey data collected for the project, which relates to the identification and/ or conservation of matters of national environment significance, must be collected and recorded so as to conform to a reasonable standard such that it can be readily used by a third party or to data standards notified from time to time by the Department. When requested by the Department, the proponent must provide to the Department all species and ecological survey data and related survey information from ecological surveys undertaken for matters of national environmental significance. The survey data must be provided within 30 business days of the request, or in a timeframe agreed to by the Department in writing. The Department may use the survey data for various purposes, which relate to the promotion of environmental protection and biodiversity conservation.	Acknowledged, strict data management protocols have been used for the project. All ecological data collected as part of the project has been recorded using standard templates in the field, which have been scanned and then have been entered into excel spreadsheets. Additionally, all ecological data entry for the project has been undertaken by trained members of the Environment Team, to manage the consistency of data being entered and reduce the possibility of human error. Data will be provided to the Department on request. All documents produced for the project have been managed in accordance with the Northparkes Procedure for Document Control.	Not applicable	Compliant				
11.	Within 14 days after the commencement of the action, the person taking the action must advise the Department in writing of the actual date of commencement of the action.	Completed in 2015.	Not applicable	Compliant				
12.	Within three months of every 12 month anniversary of the commencement of the action, the person taking the action must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any plans as specified in the conditions. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the Department at the same time as the compliance report is published. The person taking the action must also notify any non-compliance with this approval to the Department in writing within two business days of becoming aware of the non-compliance.	The current report has been prepared to comply with condition 12 by addressing compliance with each condition in EPBC 2013/6788 individually.  A copy of the report will be made accessible on the Northparkes website. http://www.northparkes.com/	Not applicable	Compliant				
13.	Upon the direction of the Minister, the person taking the action must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor must be approved by the Minister prior to the commencement of the audit. Audit criteria must be agreed to by the Minister and the audit report must address the criteria to the satisfaction of the Minister.	Acknowledged. This condition will be fulfilled if requested by the Minister.	Not applicable	Compliant				



#### Table 4 Revisions

	Condition	Action	Supporting documentation	Compliance	
14.	If the person taking the action wishes to carry out any activity otherwise than in accordance with the plans, as specified in the conditions, the person taking the action must submit to the Department for the Minister's written approval a revised version of that plan. The varied activity shall not commence until the Minister has approved the revised plan in writing. The Minister will not approve a revised plan, unless the revised plan would result in an equivalent or improved environmental outcome. Of the Minister approves the revised plan that plan must be implemented in place of the plan originally approved.	Acknowledged. Actions relating to the project have been undertaken in accordance to Northparkes Management Plans. Additionally, any project changes would be managed in accordance with the Northparkes Procedure for Management of Change (MOC). This MOC procedure ensures changes in site activities are identified and if appropriate, proper requests sent for approval of revised plans.	Not applicable	Compliant	
15.	If the Minister believes that it is necessary or convenient for the better protection of listed threatened species and communities or listed migratory species to do so, the Minister may request that the person taking the action make specified revision to the relevant management plan specified in the conditions and submit the revised plan for the Minister's written approval. The person taking the action must comply with any such request. The revised approval plan must be implemented. Unless the Minister has approved the revised plan then the person taking the action must continue to implement the originally approved plan, as specified in the conditions.	Acknowledged. At the time of writing, the Minister has not made any requests that Northparkes make specific revisions to management plans relevant to EPBC 2013/6788.	Not applicable	Compliant	
16.	If, at any time after 5 years from the date of this approval, the person taking the action has not substantially commenced the action, the person taking the action must not substantially commence the action without the written agreement of the Minister.	The action as approved under EPBC 2013/6788 commenced in early 2015.	Not applicable	Compliant	



Table 5 Publication of plans

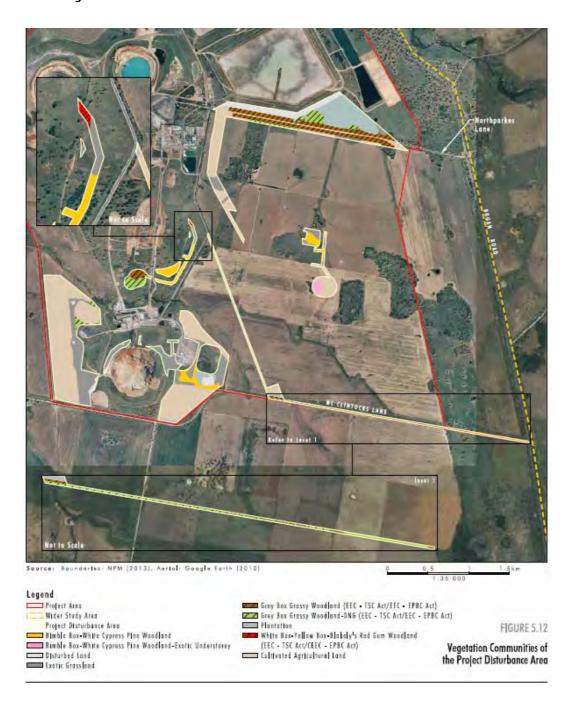
	Condition	Action	Supporting documentation	Compliance
17.	The person taking the action must maintain accurate records substantiating all activities and outcomes associated with or relevant to the above conditions of approval, including measures taken to implement the management plans required by this approval, and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the Department's website. The results of audit may also be publicised through general media.	Acknowledged. Accurate records have been kept for the activities undertaken to comply with EPBC 2013/6788. Also, all documents produced for the project have been managed in accordance with the Northparkes Procedure for Document Control.	Not applicable.	Compliant



December 2018

# Pre-clearanceand Clearing Supervision Report

E31N Project





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#### 1. INTRODUCTION

Northparkes Mines (Northparkes) is a copper – gold mine located approximately 27 kilometres north north-west of Parkes in central west New South Wales (NSW). It is a joint venture between China Molybdenum Co. Ltd (CMOC) (80%) and the Sumitomo Group (20%), with CMOC as managers of the mine. Northparkes produces ore from the mine at a rate of approximately 6 million tonnes per annum.

Northparkes consists of underground operations accessing several copper sulphide porphyry ore bodies. In addition, Northparkes farms the bulk of its 6,115 ha landholding including much of the 2,456 ha of land within its three existing mining leases.

#### 1.1 Project background

The Northparkes Mines Step Change Project (the Project) was approved with conditions under the Environmental Planning and Assessment Act 1979 (NSW) (PA11\_0060) and the Environment Protection and Biodiversity Act 1999 (EPBC 2013/6788) in 2014. Key elements of the Project included:

- continued underground block cave mining in two existing ore bodies;
- the development of an additional underground block cave mine, under one of the existing open cut pits;
- additional campaign open cut mining in existing mine leases;
- augmenting approved Tailings Storage Facilities (TSFs);
- moving the existing access road;
- construction of the new Rosedale TSF (Rosedale); and
- extending the life of the mine by seven years to 2032.

In early 2015, construction commenced on the Rosedale project, which included:

- extending the approved TSF 2;
- construction of the new Rosedale TSF;
- construction of a new main access road (known as Northparkes Way) as well as upgrades to existing roads including the Bogan Road and McClintocks Lane intersection;
- construction of a new access control for site; and
- stockpiles associated with construction of the TSF.

The current report only details pre-clearance and clearing supervision undertaken for the E31N Project (Figure 1).



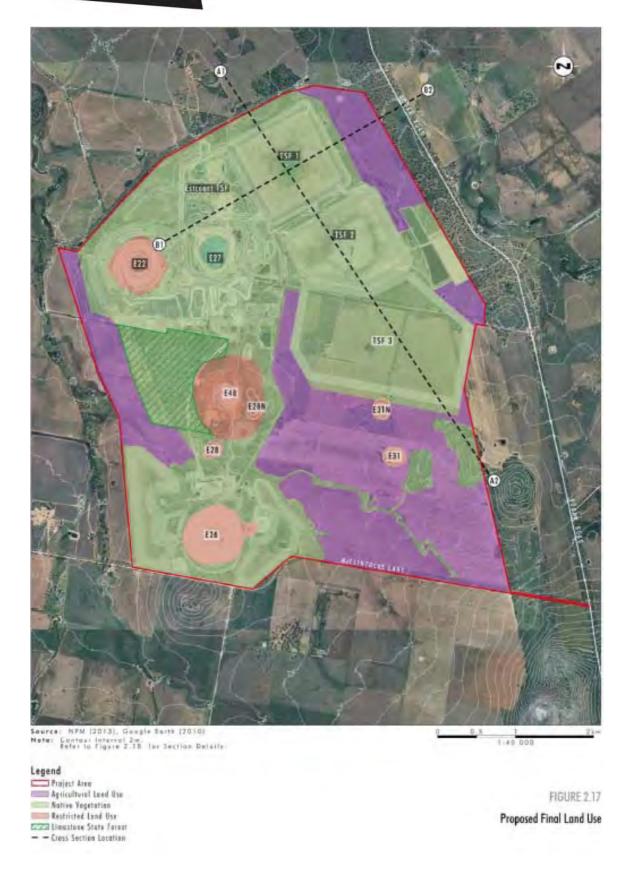


Figure 1: Indicative disturbance area for Northparkes E31N Project



#### 1.2 Scope and purpose

The purpose of the current report is to provide supplementary information to the Northparkes Pre-clearance and Clearing Supervision Reports for Rosedale. For more information on pre-clearance and clearing supervision, methodologies and previous ecological studies undertaken for the Rosedale Project, including compliance requirements, refer to these reports.

The E31N Project is located south of the Rosedale Tailings Storage Facility. Vegetation in this area is previously disturbed and includes isolated mature trees, a ground cover layer that is dominated by weed species and small areas of immature regrowth, which were absent of habitat features. Ten mature eucalyptus trees were removed for the E31N Project and these eucalypts will be the focus of this report.

#### 1.3 Survey schedule and team

Pre-clearance and clearing supervision surveys were undertaken on 6 December 2018 by Michael Thomas (Environmental Advisor) and Donna Shaw (Environmental Officer). Michael and Donna were supported during clearing supervision by the E31N Project Supervisor, who communicated with the heavy machine operators. A WIRES representative and qualified venomous snake handler was present and on call for the duration of clearing supervision in case their services were required.

#### 2. SITE CONTEXT

The dominant land use in the region is agriculture, with major industries including production of wool, cattle and wheat. The largest area of remnant woodland and forest vegetation in the landscape surrounding Northparkes is Goobang National Park, located approximately 30 km to the east of Northparkes. This national park comprises native vegetation and offers a wide range of habitats. While Northparkes occurs in predominately flat farmland, Goobang National Park is dominated by hilly ridgelines that extends from Manildra in the south to west of Tomingley, approximately 62 kilometres to the north. Several state forests containing woodland vegetation occur in the landscape surrounding Northparkes.

#### METHODOLOGY

Methodologies used for the preclearance and clearing supervision for the E31N Project were consistent with those used during the Rosedale Project in 2015.

For construction of the E31N Project, 10 mature trees, with potential habitat features, were removed. Due to the limited number of potential habitat features associated with the works, all mature trees removed as part of the project were GPS marked and supervised by a suitably qualified person during tree felling.

Once the mature trees were felled using the Northparkes method for felling trees with potential significant habitat features (Appendix A), they were assessed for significant habitat features. Where hollows were presents, they were assessed against the superb parrot hollow criteria (



Appendix B). Hollows that fulfilled the criteria of the assessment, will be replaced at a one to one ratio with nest boxes suitable for superb parrots.

#### 4. RESULTS AND DISCUSSION

Table 1 outlines the features of the mature trees removed, as recorded during the potentially significant habitat feature assessment.



Table 2 outlines the results of the tree hollow assessment undertaken following tree felling. None of the trees were recorded to have hollows suitable for superb parrot nesting. Additionally, three stick nests were recorded during the assessment, however, these were recorded to be inactive.

No fauna, with the exception of common bird species traversing through the area, were observed during tree felling. No fauna were recorded to be injured or disturbed during the tree felling process.



Table 1: Potentially significant habitat feature assessment

ID#	Species	Easting	Northing	DBH	Height	Number of Potential features	Photo
E31N01	Eucalyptus populnea (bimble box)	0600101	6356388	45	20	1	N/A
E31N02	Eucalyptus populnea (bimble box)	0600096	6356386	35	15	1	N/A
E31N03	Eucalyptus populnea (bimble box)	0600104	6356409	50	20	3	N/A
E31N04	Eucalyptus populnea (bimble box)	0600114	6356414	35	20	1	N/A
E31N05	Eucalyptus populnea (bimble box)	0600119	6356412	100	20	1	N/A
E31N06	Eucalyptus populnea (bimble box)	0600141	6356401	45	20	2	N/A
E31N07	Eucalyptus populnea (bimble box)	0600118	6356302	45	15	1	N/A
E31N08	Eucalyptus populnea (bimble box)	0600207	6356245	30	15	1	N/A
E31N09	Eucalyptus populnea (bimble box)	0600195	6356246	30	10	1	N/A
E31N10	Eucalyptus populnea (bimble box)	0600239	6356276	30	10	1	N/A



Table 2: Tree hollow assessment results

	Number			Superb Parr	ot hollow criteria		
ID#	Number of hollows	Size of hollow	Eucalypt with DBH >30 cm	Hollow entrance >5 m high	Hollow size >10 cm diameter	Hollow depth >30 cm	Hollow suitable for superb parrot?
E31N01	1	10	Yes	Yes	Yes	No	No
E31N02	1	<10	Yes	No	No	No	No
E31N03	<10 Yes >10 Yes			No Yes Yes	No Yes Yes	No No No	No No No
E31N04	Nest	-	-	-	-	-	-
E31N05	1	>10	Yes	Yes	Yes	No	No
E31N06	1 + Nest	>10	Yes -	Yes -	Yes -	No -	No -
E31N07	Nest	-	-	-	-	-	-
E31N08			Yes	No	No	No	
E31N09	1	<10	Yes	No	No	No	No
E31N10	1	<10	Yes	No	No	No	No



#### 5. REFERENCES

Department of the Environment (DoE) (2016). Polytelis swainsonii in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 11 March 2016.

Baker-Gabb, D. 2011. National Recovery Plan for the Superb Parrot Polytelis swainsonii. Department of Sustainability and Environment, Melbourne. Available from: http://www.environment.gov.au/system/files/resources/4d6611e8-0965-48f1-940d-1c32ec0e2b88/files/polytelis-swainsonii-recovery-plan.pdf.



#### Appendix A: Method for felling trees with potential significant habitat features

Method for felling trees with potential significant habitat features

- All felling of trees with significant habitat features requires supervision by the Northparkes Environment Advisor, with a WIRES representative either present or on stand-by during clearing works.
- All trees assessed to have potential significant habitat features have been marked in the field with pink spray paint.
- Prior to the heavy machinery approaching the marked tree, a brief visual inspection of the tree will be undertaken by Northparkes Environment Advisor.
- All staff on foot will vacate into an area that is (1) safe from heavy vehicle interactions and; (2) where positive communications with the heavy vehicle operator is possible.
- Once visual inspection is complete and no immediate ecological issues are identified, the heavy machinery will approach the marked tree and shake the tree for a minimum of thirty seconds.
- The heavy machinery will wait a minimum of 30 seconds to allow fauna to leave tree. If it is evident that fauna have not left tree, this process (shake then wait) should be repeated.
- Once the Northparkes Environment Advisor has signalled that the tree is ready to be felled, the heavy machinery operator is to lower the marked tree as gently as possible.
- The heavy machinery operator is to park up and signal that it is safe for the Northparkes staff on foot to inspect the tree. The Environment Advisor will inspect the felled tree for any fauna.
- Capture of displaced fauna by suitably qualified persons:
  - o If any injured fauna are discovered, a WIRES representative or veterinary will be contacted for consultation.
  - o Felled trees will be rolled so that the number of hollows blocked against the ground are minimized.
- All felled trees to remain in place overnight to allow any unidentified fauna to escape.
- Heavy machinery is to move onto next marked tree.

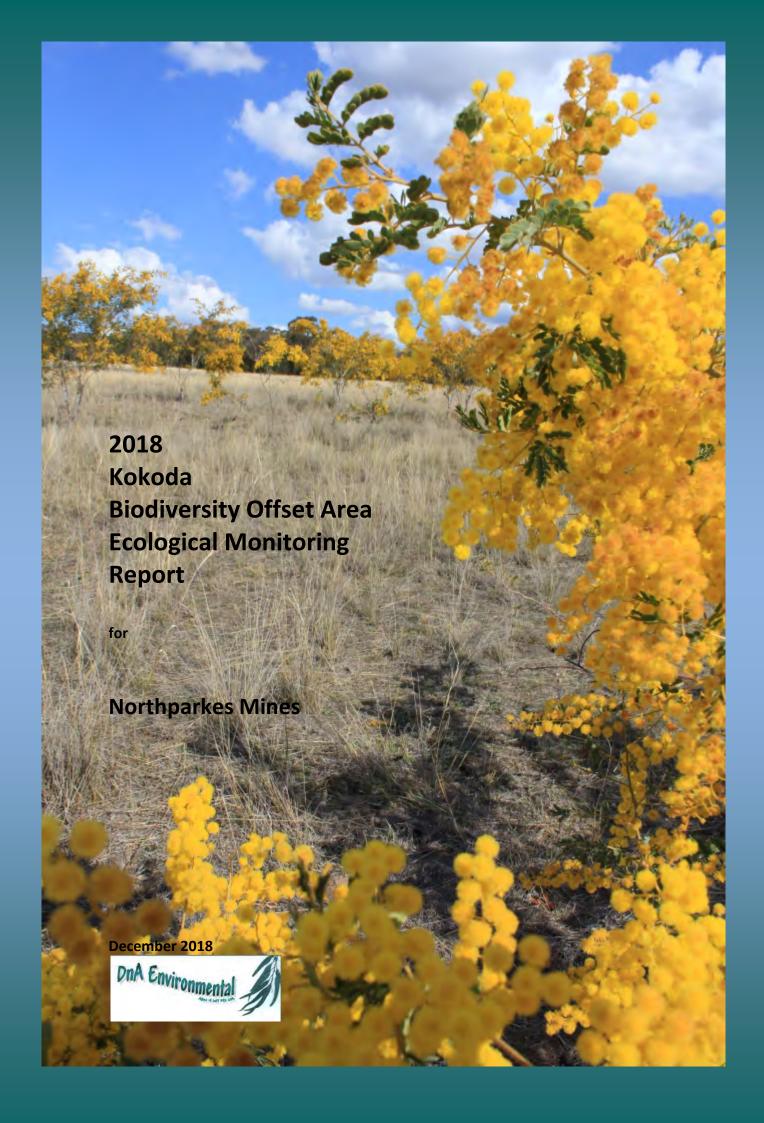


#### Appendix B: Superb parrot tree hollow assessment criteria

Criteria was developed to assess if tree hollows were suitable for superb parrots was based on nesting information from the National Recovery Plan for the Superb Parrot (Polytelis swainsonii) (Baker-Gabb, 2011) and Birdlife Australia's Nest Boxes- Technical Information guide (BirdLife Australia, 2014). Criteria was developed as a yes/ no answer and included four criteria assess if a hollow was suitable for superb parrot nesting. These included:

- Hollow was present in a eucalypt species with a diameter at breast height (DBH) of greater than 30 cm;
- Hollow entrance was greater than 5 m high;
- Hollow size was greater than 10 cm in diameter; and
- Hollow depth was greater than 30 cm.

If yes was answered to all of the four criteria, the hollow was classified as a suitable hollow for superb parrot nesting.



#### Disclaimer

This is a report of work carried out by DnA Environmental, under contract and on behalf of China Molybdenum Co. Ltd (CMOC) Pty Ltd as agent severally for and on behalf of the Northparkes Joint Venture and has been prepared according to the brief provided by the client. The information contained herein is complete and correct to the best of my knowledge. The representations, statements, opinions and advice, expressed or implied in this report are produced in good faith but on the basis that DnA Environmental are not liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any or all of the content.

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PhD, BAppSc (Hons) MEIANZ

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#### Cover photo

Natural regeneration of *Acacia spectabilis* (Mudgee Wattle) had matured and was extensively flowering this year.

#### **Executive summary**

The 2018 Kokoda Offset Area (KOA) ecological monitoring report was prepared by DnA Environmental on behalf of Northparkes Mines (NPM) as part of the Biodiversity Offset Strategy and associated Biodiversity Offset Management Plan (BOMP). The (BOMP) provides a framework for the implementation of ecological management actions, regeneration strategies, controls and monitoring programs for the Kokoda Offset Site.

This ecological monitoring report describes the monitoring methodology and presents the results of the monitoring program first established in 2015. The primary objective of the monitoring program is to compare the progress of natural regeneration and revegetation areas by comparing a range of ecological performance targets or completion criteria against less disturbed areas of remnant woodland (reference sites) that are representative of the desired woodland community as described in the BOMP.

The Kokoda Offset Site is 350 hectares and is located in the Mandagery locality of the Central West Slopes of NSW, approximately 52 kilometres south-east of the Northparkes mine. Historically the property has been partially cleared and grazed by sheep and cattle, however will now remain free from domestic livestock grazing. Vegetation surveys undertaken by Umwelt in 2014 indicated the property is comprised of ten different vegetation communities consisting of derived grasslands and a variety of different woodland communities which vary according to soil type, topography and historical land practices.

The Umwelt surveys indicated there are approximately 96 ha of *Eucalyptus microcarpa* (Grey Box) Derived Native Grasslands (DNG) Endangered Ecological Community (EEC). As part of the BOMP these DNG areas will be regenerated to their original *E. microcarpa* Grassy woodland community. The remaining 15 ha area of grasslands are thought to have been dominated by *Eucalyptus dwyeri* (Dwyer's Red Gum) – *E. microcarpa* (Grey Box) – *E. sideroxylon* (Mugga Ironbark) – *Callitris endlicheri* (Black Cypress Pine) community, and these will also be regenerated to the original woodland structure. There is also a very small area (2.2 ha) of *E. albens* (White Box) Grassy Woodland EEC. All areas of remnant woodland within the Kokoda Offset Area will be managed to improve wildlife habitat and biodiversity outcomes.

In 2014 Umwelt implemented the first ecological surveys and established 16, 20 x 20m monitoring sites across the range of vegetation communities and management zones at the KOA. The results of these surveys are provided in Umwelt (2014b). In 2015, DnA Environmental was engaged to review the monitoring program and establish a comprehensive range of ecological data which will fulfil the monitoring and reporting requirements of the BOMP. The monitoring program aimed to establish clearly defined, repeatable and consistent methodologies for monitoring changes in various aspects of ecosystem function, succession and long-term sustainability. Part of this process includes:

- Selecting a range of woodland reference sites that would be suitable benchmarks for the regenerating /revegetated woodland communities;
- Obtaining a range of completion performance indicators from these woodland reference sites;
- Comparing the progress and ecosystem function of the regenerating/revegetation areas;
- Identify positive recovery trends or indications of ecosystem failure; and
- Provide recommendations to improve the monitoring program and revegetation process.

In 2015, 17, 20 x 20m permanent monitoring sites were established across the range of vegetation communities which included:

- Three Grey Box Grassy woodland reference sites (GBWood1 GBWood3);
- Five DNG sites which will be revegetated back to Grey Box Grassy woodland (GBReveg1 GBReveg5):
- Three Dwyer's Red Gum (DRG) Grey Box Mugga Ironbark Black Cypress woodland reference

- sites (DWood1 DWood3);
- Three DNG which will be revegetated back to the Dwyer's Red Gum Grey Box Mugga Ironbark Black Cypress woodland community (DReveg1 – DReveg3);
- One White Box Grassy Woodland EEC, CEEC (WBWood1);
- One Grey Box Ironbark woodland (IronWood1); and
- One Dwyer's Red Gum Grey Box Mugga Ironbark Black Cypress Pine Forest which was mapped as low quality woodland (DWoodLQ).

The monitoring methodology adopted at Kokoda is consistent with that used in the NPM rehabilitation monitoring program (DnA Environmental 2010 – 2014a; 2018a) and the Estcourt Offset Area ecological monitoring program (DnA Environmental 2010b – 2014; 2018b). The monitoring programs are compliant and consistent with a range of approval conditions, specifically the Biodiversity Offset Strategy and associated Biodiversity Offset Management Plan (BOMP) and ESG3 MOP guidelines. The monitoring methodology includes a combination of Landscape Function Analyses, accredited soil analyses and various measurements of ecosystem diversity and habitat values adapted from the Biometric Manual 3.1.

At Kokoda, a range of Key Performance Indicators (KPI's) were quantified by ecological data obtained from replicated reference sites which were representative of the Grey Box Woodland EEC and Dwyer's Red Gum woodland. All performance indicators are quantified by range values measured from these reference sites which form *upper* and *lower* KPI targets. The same ecological performance indicators are also measured in the regeneration/revegetation sites and these should equal or exceed these values, or at least demonstrate an increasing trend.

These Key Performance Indicators have been further separated into "Primary performance indicators" and "Secondary performance indicators". Primary performance indicators are those chosen as completion criteria targets, and have been identified as those that will satisfy requirements identified within the BOMP. The range values of each ecological performance indicator are adapted annually to reflect seasonal conditions and disturbance events. The results of the monitoring program have been broken down into the relevant rehabilitation phases as described in the ESG3 MOP guidelines and include:

- Landform establishment and stability;
- Growth medium development;
- Ecosystem and landuse establishment; and
- Ecosystem and landuse sustainability.

The annual vegetation monitoring has been undertaken in spring and this year was undertaken during 24<sup>th</sup> - 26<sup>th</sup> September.

#### Summary of results

The average annual rainfall at Parkes Airport is 608 mm, however there have been extreme seasonal conditions with below average rainfall being recorded in 2015 and 2017, while in 2016, widespread flooding was experienced around Parkes with a total annual rainfall of 833 mm being recorded. In 2017, very low rainfall activity occurred except in March where 195 mm of rainfall was recorded. Rainfall remained well below the expected monthly averages for most of the year, with a total of 562 mm being recorded for the year. Extremely dry conditions extended into 2018 and these included the key growing seasons in autumn and spring where very limited rainfall fell. Up until November this year only 300 mm was received, compared to an expected average of 553 mm.

The Grey Box and Dwyer's Red Gum (DRG) woodland reference sites were typically characterised by having a mature tree canopy and a well developed decomposing leaf litter layer and a sparse cover of native perennial forbs and grasses. The White Box, Ironbark and low quality Dwyer's Red Gum woodland sites were similar in structure, however low shrubs were more common in the Ironbark woodland. The Grey Box and DRG derived grassland revegetation sites presently exist as degraded native grasslands but they typically had good ground cover comprised of a combination of annual and perennial plants and cryptogams.

This year, drought conditions and heavy grazing has resulted in a reduction in the stability, infiltration and nutrient recycling capacity of all sites. Heavy grazing and disturbance by animals has tended to reduce the integrity of the ground covers and litter layers where the soils have become more susceptible to erosion. Most sites continued to maintain high functional patch areas however a decline in patch area was recorded in DReveg2 and DWood3.

There continued to be an absence of trees and mature shrubs (>5cm dbh) in the derived grassland areas, however some regenerating eucalypt seedlings were recorded in low densities in some sites. There was also natural regeneration of a variety of species scattered throughout the native pasture areas, including small pockets of *Acacia spectabilis* (Mudgee Wattle; see front cover). In some areas however, significant regeneration of *E. dwyeri* had occurred with stems densities estimated to be ~18, 700 stems per hectare. In the DRG reference sites (DWood3) up to 29,450 *Callitris endlicheri* seedlings per hectare were recorded.

Since 2017 floristic diversity has continued to decline, however most revegetation sites had a higher floristic diversity than their respective reference sites. There was significant reduction in exotic annual species this year, however numerous grassland sites continued to have a higher diversity of exotic species compared to the reference sites. Despite the decline in diversity and abundance in exotic species, most grassland sites continued to be dominated by exotic species and were weedler than desired.

The results of the soil analyses indicate that the soils associated with the Grey Box and DRG woodlands and derived native grasslands are naturally moderately to very strongly acidic and low in organic matter, phosphorous and nitrate. They tended to have a low cation exchange capacity and are non saline and non sodic. There were high levels of iron in many sites including the various woodland reference sites, suggesting these are typical of the local area.

## Performance of the revegetation monitoring sites against "proposed" Primary Completion Performance Indicators

The table below indicates the performance of the woodland revegetation monitoring sites against a selection of proposed Primary Completion Performance Indicators in 2018. The selection of criteria has been presented in order of rehabilitation phases according to the ESG3 MOP guidelines. The range values of the ecological performance targets are amended annually. Revegetation sites meeting or exceeding the range values of their representative target community type have been identified with a coloured box and have therefore been deemed to meet these primary completion performance targets this year. Hashed coloured boxes associated with soil condition indicate they may be outside of the reference target ranges, but within acceptable agricultural limits.

Performance of the Grey Box, White Box, Ironbark and Dwyer's Red Gum woodland revegetation sites against primary completion performance indicators in 2018.

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement	DReveg1	DReveg2	DReveg3	DWoodLQ	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	WBWood1	IronWood1
Performance	e indicators are o	quantified by the range of val reference sites	lues obtained fro	m replicated	2018	2018	2018	20185	2018	2018	2018	2018	2018	2018	2018
Phase 2: Landform establishment and stability	Landform slope, gradient	Landform suitable for final landuse and generally compatible with surrounding topography	Slope	< Degrees (18°)	4	3	4	3	5	4	3	4	3	3	4
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	No.	0	0	0	0	0	0	0	0	0	0	0
Phase 3: Growth medium development	Soil chemical, physical properties	Soil properties are suitable for the establishment and maintenance of selected	рН	pH (5.6 - 7.3)	5.6	5.7	5.2	5.3	6.6	5.3	6.1	6.0	6.1	6.2	5.1
	and amelioration	vegetation species	Organic Matter	% (>4.5)	3.2	3.5	2.2	3.2	2.7	5.2	3.4	2.3	1.8	3.1	3.6
			Phosphorous	ppm (50)	9.2	7.9	9.2	5.2	6.6	9.2	7.2	7.9	6.2	7.9	7.2
Phase 4: Ecosystem & Landuse Establishment	Function pe	performing as it was designed to do  LFA Lands	LFA Stability	%	74.1	68.4	66.5	65.2	71.1	68.5	73.1	69.0	74.4	61.0	66.3
			LFA Landscape organisation	%	100	86	100	99	100	100	100	100	100	100	100
	Vegetation diversity	diversity of species comparable to that of the local remnant vegetation Dive	Diversity of	species/area	2	2	1	3	1	0	0	0	0	3	6
			shrubs and juvenile trees	% population	100	100	100	100	100	0	0	0	0	100	100
			Exotic species richness	<no. area<="" td=""><td>7</td><td>0</td><td>12</td><td>0</td><td>13</td><td>6</td><td>11</td><td>12</td><td>13</td><td>0</td><td>0</td></no.>	7	0	12	0	13	6	11	12	13	0	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement	DReveg1	DReveg2	DReveg3	DWoodLQ	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	WBWood1	IronWood1
	Vegetation density	Vegetation contains a density of species comparable to that of the local remnant vegetation	Density of shrubs and juvenile trees	No./area	11	2	1	11	1	0	0	0	0	5	139
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to that of the local remnant vegetation	Trees	No./area	1	0	1	2	1	0	0	0	0	3	4
			Shrubs	No./area	1	2	0	2	0	0	0	0	0	2	3
			Herbs	No./area	15	3	23	8	15	14	15	13	19	14	7
Phase 5: Ecosystem & Landuse Sustainability	Landscape Function Analysis (LFA): Landform function and ecological performance	Landform is ecologically functional and performing as it was designed to do	LFA Infiltration	%	45.7	38.4	41.5	54.5	44.3	37.6	46.5	43.3	47	50.6	52.5
			LFA Nutrient recycling	%	42.7	40.9	36.2	53.7	44.1	36.2	44.6	39	45.5	49.8	49.8
	Protective ground cover	Ground layer contains protective ground cover and habitat structure comparable with the local remnant vegetation	Perennial plant cover (< 0.5m)	%	3.5	3.5	3.5	2.5	9.5	6.5	20.5	5.5	6	4.5	2.5
			Total Ground Cover	%	98	87.5	91.5	95	100	94	97.5	99	99	99.5	94
	Native ground cover abundance	Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	%	64.3	100	50	100	46.6	75	47.2	51.9	49.1	100	100
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	No./area	1	2	1	11	1	0	0	0	0	4	99

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Unit of measurement	DReveg1	DReveg2	DReveg3	DWoodLQ	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	WBWood1	IronWood1
			shrubs and juvenile trees 1.5 - 2m in height	No./area	4	0	0	0	0	0	0	0	0	0	1
	structure	The vegetation is developing in structure and complexity comparable to that of the local remnant vegetation	Foliage cover 0.5 - 2 m	% cover	0	0	0	0	0	0	0	0	0	0	1
			Foliage cover >6m	% cover	0	0	0	26	0	0	0	0	0	53	46
	Tree diversity	Vegetation contains a diversity of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree diversity	%	100	0	0	100	0	0	0	0	0	100	100
	Tree density	Vegetation contains a density of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree density	No./area	1	0	0	9	0	0	0	0	0	8	40
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Live trees	% population	100	0	0	100	0	0	0	0	0	100	72.5
			Healthy trees	% population	100	0	0	0.0	0	0	0	0	0	12.5	2.5
			Flowers/fruit: Trees	% population	0	0	0	66.7	0	0	0	0	0	50	22.5

### Conclusion

The extreme seasonal conditions experienced over the past few years combined with simultaneous changes in total grazing pressure has had a significant impact on the composition and diversity of the vegetation at Kokoda, with these being reflected in the range of ecological monitoring data.

The derived grassland revegetation sites presently did not meet many completion targets related to diversity and density of tree and shrub species as presently there is limited regeneration occurring within the selected grassland monitoring sites. Most of the derived grassland sites also contained a high dominance of exotic annual species and were weedier than the reference sites. Other primary ecological attributes which fell short of meeting completion performance targets tended to be associated with the lack of mature tree and shrub populations and limited structural complexity of the sites.

The proposed revegetation activities within the derived grassland areas as described in the BOMP aim to increase biodiversity and habitat values through the removal of livestock grazing to allow natural regeneration, supplemented with direct seeding and tubestock planting. These activities are likely to result in the cleared grassland areas developing into woodland communities and therefore meeting most ecological performance indicators in the medium to longer term. It must be noted that the reference sites at Kokoda are typically degraded and of low quality which subsequently have provided low benchmarks for some performance targets. In the Grey Box woodlands in particular, there was limited abundance and diversity of the grassy understorey and there were limited shrubs. Subsequently the revegetation activities proposed should include a range of species known to occur within these communities and not just restricted to those occurring within the existing reference sites.

Where possible revegetation practices should follow "Best Practice Revegetation Guidelines" such as Sydes *et al* Greening Australia (2003). It is good practice to establish a mosaic of shrub thickets, open woodland and grassy clearings to increase heterogeneity and patchiness of revegetation areas. The patchiness will be critical in the long-term sustainability of the woodlands, whilst promoting and maintaining biodiversity and varying habitats for woodland wildlife.

While floristic diversity targets were often met, the revegetation sites tended to be dominated by exotic annual species, which are likely to decline in the medium to longer-term as perennial plants including trees and shrubs become more abundant. Strategic grazing is likely to be a critical management strategy which will be required to maintain biodiversity, encourage tree and shrub regeneration and to reduce fuel loads as part of the integrated and adaptive management strategy for the Kokoda Offset Area in the longer-term. This process has however been affected by drought conditions and heavy grazing by pests. Presently, extensive disturbance and herbivory by macropods and goats has become an important management issue. A control program may need to be implemented with advice from the Local Land Services with the most beneficial outcomes being obtained by a cooperative approach with neighbouring landholders. Exclusion fencing in strategic locations may also be required in order to achieve successful revegetation outcomes.

In 2015 and 2016 several species of orchids were observed at various locations around the property. As part of the management of the Kokoda property, the location of these populations should be considered when undertaking revegetation, weed control and strategic grazing, particularly as most orchids are only identifiable during a limited time period. As a result of the dry conditions experienced throughout most of 2017 and 2018, none of these populations were observed to be flowering, thus emphasising the need to map their known locations.

Other potential management issues may be related to high density *E. dwyeri* and/or *Callitris endlicheri* regeneration which was observed to be occurring within and adjacent to woodland areas where mature trees

were present. The increase in competition from high density stands is likely to suppress the herbaceous understorey as they become more established, thereby adversely affecting floristic and biodiversity targets in the medium to longer term. Dense tree cover may also encourage herbivores which may increase predation and disturbance. Strategic grazing may reduce the density of existing seedlings and regulate the degree of regeneration through manipulation of the herbaceous understorey and germination niches, in more favourable seasonal conditions.

Safe and easy access should always be maintained around main access tracks and boundary fences to facilitate monitoring, property maintenance and bushfire management. Regular inspections should be undertaken with slashing and/or strategic grazing management implemented on a needs basis. Several areas of boundary fence also require maintenance to ensure neighbouring livestock cannot freely access the property.

There were little other management issues that have not already been addressed in the BOMP.

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# 1 2018 Kokoda Offset Area Ecological Monitoring Report

### 1.1 Introduction

The 2018 Kokoda Offset Area (KOA) ecological monitoring report is a result of work carried out by DnA Environmental on behalf of Northparkes Mines (NPM) as part of the Biodiversity Offset Strategy. A Biodiversity Offset Management Plan (BOMP) has been prepared to guide the ongoing management of the Kokoda Offset Area for biodiversity conservation and enhancement purposes (Umwelt 2014a). The BOMP was prepared in accordance with the NSW Project Approval requirements (PA11\_0060) and Commonwealth Project Approval (EPBC 2013/6788) requirements issued for the NPM Step Change Project and provides a framework for the implementation of ecological management actions, regeneration strategies, controls and monitoring programs for the Kokoda Offset Site.

This ecological monitoring report describes the ecological monitoring methodology and presents the results of the annual ecological monitoring program first established in 2015. The primary objective of the annual monitoring program is to compare the progress of natural regeneration and/or active revegetation areas by comparing a selection of ecological targets or completion criteria against less disturbed areas of remnant vegetation (reference sites) that are representative of the desired vegetation assemblage as described in the BOMP.

### 2 Kokoda Offset Area

### 2.1 Landuse

The Kokoda Offset Site is located in the Mandagery locality of the Central West Slopes of NSW, approximately 52 kilometres south-east of the Northparkes mine. The property is 350 hectare in size and is comprised of native grasslands to the north of the property with regrowth eucalypt woodland on the steeper slopes and ridges in the southern part of the property. Historically the property has been grazed by sheep and cattle but the property will remain free from domestic livestock grazing (Umwelt 2014).

## 2.2 Vegetation communities

Vegetation surveys undertaken by Umwelt (2014b) indicate there are ten different vegetation communities consisting of derived grasslands and a variety of different woodlands communities which vary according to soil type, topography and historical land practices (Table 2-1). The remaining 2.5ha is associated with farm infrastructure including farm dams and access tracks.

The Umwelt surveys indicated there are approximately 96 ha of Derived Native Grasslands (DNG) once thought to have been *Eucalyptus microcarpa* (Grey Box) Grassy Woodland which conform to the TSC Act listed *Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions* EEC and the EPBC Act listed *Grey Box (Grassy Woodlands and Derived Native Grasslands of South-eastern Australia* EEC. As part of the BOMP these DNG areas will be regenerated to their original Grey Box Grassy woodland community (Umwelt 2014).

The remaining 15 ha area of DNG are thought to have been dominated by *Eucalyptus dwyeri* (Dwyer's Red Gum) – *E. microcarpa* (Grey Box) – *E. sideroxylon* (Mugga Ironbark) – *Callitris endlicheri* (Black Cypress Pine) community, and these will also be regenerated to the original woodland structure as part of the BOMP (Umwelt 2014).

There is a very small area (2.2 ha) of *E. albens* (White Box) Grassy Woodland which conforms to the TSC Act listed *E. albens* (White Box) – *E. melliodora* (Yellow Box) – *E. blakelyi* (Blakely's Red Gum) Woodland EEC and the EPBC Act listed *E. albens* (White Box) – *E. melliodora* (Yellow Box) – *E. blakelyi* (Blakely's Red Gum) Grassy Woodland and Derived Native Grassland CEEC. All areas of remnant woodland within the Kokoda Offset Area will be managed to improve wildlife habitat and biodiversity outcomes (Umwelt 2014). The distribution of the various vegetation communities as mapped by Umwelt (2014) is provided in Figure 2-1.

Table 2-1. Vegetation communities occurring at the Kokoda Offset Area (Umwelt 2014b).

Vegetation Community	TSC Act	EPBC Act	Vegetation within Kokoda Offset Site (ha)
	Status	Status	
Grey Box Grassy Woodland	EEC	EEC	13
Grey Box Grassy DNG	EEC	EEC	96
White Box Grassy Woodland	EEC	CEEC	2.2
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest			150
Rocky Rise Shrubby Woodland			26
Grey Box – Ironbark Woodland			25

Vegetation Community	TSC Act	EPBC Act	Vegetation within Kokoda Offset Site (ha)
	Status	Status	
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine DNG			15
Dwyer's Red Gum Creek line Woodland			9.4
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Woodland Low Quality			8.6
Mugga Ironbark Woodland			1.9
Farm Tracks and Dams – Disturbed Land			2.5
Total			350

## 2.3 Threatened Species

### 2.3.1 Flora

No threatened flora species were recorded by Umwelt (2014) in the Kokoda Offset Area.

### 2.3.2 Fauna

Twelve threatened fauna species were recorded in the Kokoda Offset Site by Umwelt (2014b) and are listed in Table 2-2. The grey-crowned babbler, brown treecreeper and the superb parrot were the most commonly recorded threatened fauna species across the Kokoda Offset Area (Umwelt 2014b). The grey-crowned babbler and the brown treecreeper are both sedentary birds and will utilise the site across all seasons whereas the superb parrot is a seasonally nomadic species which will largely utilise the Kokoda Offset Site for foraging during spring and summer. Given the array of varied habitats within the site, there is a high potential that other threatened fauna species may occur within the Kokoda Offset Area.

Table 2-2. Threatened fauna species recorded at Kokoda (Umwelt 2014b)

Common Name	Scientific Name	Status		No. of Individuals/	
		TSC Act	EPBC Act	Locations	
Glossy black-cockatoo	Calyptorhynchus lathami	V		2/1	
Superb parrot	Polytelis swainsonii	V	V	162/23	
Little lorikeet	Glossopsitta pusilla	V		25/2	
Brown treecreeper (eastern subspecies)	Climacteris picumnus victoriae	V		18/10	
Speckled warbler	Chthonicola saggitatus	V		13/9	
Hooded robin (south-eastern form)	Melanodryas cucullata cucullata	V		1/1	
Grey-crowned babbler (eastern subspecies)	Pomatostomus temporalis temporalis	V		95/20	
Varied sittella	Daphoenositta chrysoptera	V		2/2	
Diamond firetail	Stagonopleura guttata	V		8/3	
Eastern bentwing-bat	Miniopterus schreibersii oceanensis	V		-/2	
Little pied bat	Chalinolobus picatus	V		-/2	
Yellow-bellied sheath tail-bat	Saccolaimus flaviventris	V		-/2	

# 2.4 Management zones

The KOA has been further delineated according to the condition of the vegetation and their recovery potential. A conceptual plan of the different management areas according to potential regenerative capacity and active revegetation management requirements is given in Figure 2-2 (Umwelt 2014a). Management zones 1 to 5 are DNG communities that occur on the lower slopes in the northern section of the property. These areas will each receive varying levels of management. The long term goal for each of these zones, including zone 6, is to return them to their former woodland community structure (Table 2-3).

Table 2-3. Management Zones at the Kokoda Offset Area. (Umwelt 2014a).

Management Zone	Vegetation Type	Objective	Total Area (ha)
1	Grey Box Grassy Woodland – DNG – Active Revegetation	Restore to woodland	36.3
2	Grey Box Grassy Woodland – DNG – Potential Regeneration	Restore to woodland	21.3
3	Grey Box Grassy Woodland – DNG – Natural Regeneration	Restore to woodland	38.4
4	Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine DNG Active Regeneration	Restore to woodland	1
5	Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine DNG Natural Regeneration	Restore to woodland	13.8
6	Disturbed – Potential Regeneration	Restore to woodland	1.3
7	All Remnant Woodland and Forest	Conserve and maintain	238
		Total	350

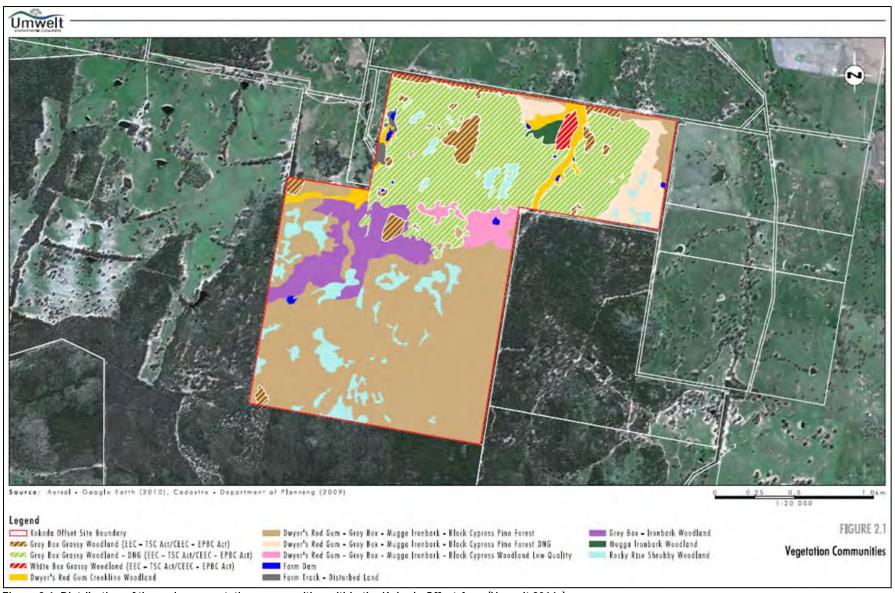


Figure 2-1. Distribution of the various vegetation communities within the Kokoda Offset Area (Umwelt 2014a)

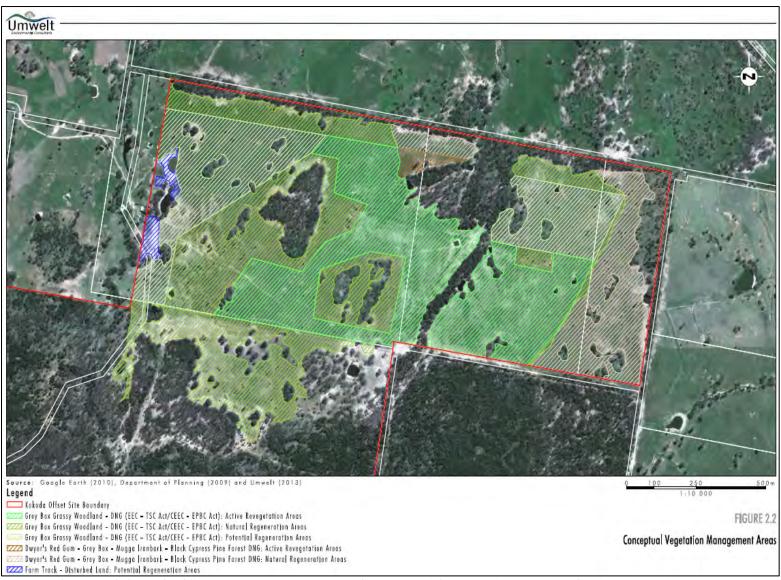


Figure 2-2. Conceptual plan of the different management areas according to potential regenerative capacity and active revegetation management requirements (Umwelt 2014a).

## 2.5 Biodiversity Management targets

There are a range of biodiversity management targets which will be required to be met as part of the approval conditions. These have been determined by Umwelt (2104a) as short, medium and long-term targets with these being provided below. Specific performance indicators and completion criteria will be used to track the recovery of the woodlands and effectiveness of the proposed management strategies as described in the BOMP.

### 2.5.1 Short-term objectives

The short term (3 year) biodiversity management targets for the management of the Kokoda Offset Site are to:

- establish signage throughout the Kokoda Offset Site;
- remove stock-grazing activities from the Kokoda Offset Site;
- establish a monitoring program to assess the success of ongoing management and improvement strategies, in particular focusing on the regeneration potential of Grey Box Grassy Woodland DNG areas; and
- commence establishment of Grey Box Grassy Woodland in areas of DNG through assisted natural regeneration principles;
  - include a range of flora species from each vegetation strata represented in the target community (such as trees, shrubs, and ground cover forbs and grasses), even if only as seedlings/juvenile plants initially, as determined through monitoring of selected reference sites in the target community within the Kokoda Offset Site;
  - contain a flora species assemblage trending towards the target communities (i.e. Grey Box Grassy Woodland EEC or Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest) as determined through monitoring of selected reference sites in the target community within the Kokoda Offset Site;
  - support no more than 20 per cent foliage cover of perennial weed species (as a total of all strata, based on monitoring plot data); and
  - support no more than 20 per cent bare ground as part of the ground layer.
- effectively manage weed and pest species;
- implement weed monitoring at 6, 12, 18 and 24 months to assess if weed species are out competing native species once grazing pressure has been removed. Adaptive management practices will be adopted to control weed species as necessary;
- from year 2 onwards, initiate active revegetation methods to establish Grey Box Grassy Woodland in areas of low recovery potential DNG as deemed required through the results of monitoring in years 1 and 2;
- manage the remnant woodland areas to maintain similar or increasing flora and fauna species diversity;
- establish an appropriate long-term conservation mechanism; and
- demonstrate that accurate records are being maintained substantiating all activities and monitoring associated with the BOMP.

### 2.5.2 Medium-term objectives

The preliminary medium term (6, 10 and 15 years) biodiversity management targets for the Kokoda Offset Site are to:

- effectively monitor, control and reduce weed and pest species populations;
- monitor and document collective trend towards an increase in native flora and fauna species diversity;
- monitor and document DNG areas trending toward woodland communities, containing natives species commensurate with those of the target woodland communities

### 2.5.3 Long-term objectives

The preliminary long term (i.e. 20 years) biodiversity management targets for the Kokoda Offset Site are to:

- effectively control and reduce weed and pest species populations;
- increase the overall native flora and fauna species diversity compared to conditions during baseline assessments;
- improve the habitat values of the remnant woodland communities in the Kokoda Offset Site compared to conditions during baseline assessments;
- successfully establish an additional 96 hectares of Grey Box Grassy Woodland EEC in areas of existing DNG and demonstrate that the regenerated communities are representative of local reference sites in remnant Grey Box Grassy Woodland EEC.
- regenerate/revegetate management areas contain a minimum of 50 per cent of the native flora species diversity recorded from reference sites in the target community within the Kokoda Offset Site;
- regenerate/revegetate management areas support a vegetation structure that is similar to that recorded for reference sites in the target community within the Kokoda Offset Site;
- demonstrate that second generation trees are present within regeneration/revegetation areas;
- identify that more than 75 per cent of trees are healthy and growing as indicated by long term monitoring;
- ensure that weed species do not dominate any vegetation stratum (i.e. weed species comprise less than 10 per cent of any vegetation stratum);
- ongoing monitoring of soil stability, including implementation of erosion and sediment controls to management significant erosions concerns, as required; and
- regenerate/revegetate areas linked to existing woodland remnants to establish vegetation corridors within the broader landscape and manage excessive edge effects.

## 2.6 Ecological Monitoring Program

The Kokoda Offset Area will be subject to an ongoing monitoring program to measure the success of management and restoration strategies in meeting the approval conditions, management targets and performance indicators in a timely manner. The monitoring program will incorporate annual systematic monitoring as well as biannual (twice yearly) inspections as indicated in the BOMP (Umwelt 2014a). Primary monitoring objectives as indicated in the BOMP (Umwelt 2014a) include;

- identify any potential loss of biodiversity values over the entire Kokoda Offset Site;
- document the ecological characteristics of remnant woodland vegetation to establish a baseline for developing accurate closure criteria for the regeneration of DNG;
- assess the recovery of DNG areas;
- assess and map the presence of threats such as significant populations of pest fauna species or weed infestations; and
- identify the need for additional or corrective management measures to achieve the performance indicators and completion criteria.

# 2.7 Ecological monitoring timing and schedules

It has been proposed that the ecological monitoring will be annual for the first five years, then every three years for the following 15 years (Umwelt 2014a).

The first ecological monitoring surveys were completed in Winter and Spring 2014 (Umwelt 2014b). Where possible subsequent monitoring events should occur in the same season and preferentially ecological

monitoring surveys should be undertaken in spring or autumn as there tends to be a lower diversity of species detectable in the more extreme weather conditions of winter and summer seasons (except where specific seasons are required for targeted bird surveys).

# 3 Ecological monitoring methodology

It has been proposed in the BOMP that the monitoring program should incorporate techniques that:

- are relatively simple to measure, can be replicated with limited subjectivity, and are reproducible;
- adopt the SMART principles (specific, measurable, achievable, realistic and timely);
- are targeted towards recording information that provides a good indication of the status of the biodiversity values of the Kokoda Offset Site;
- allow for floristic composition and structure to be monitored over time using basic statistical analysis;
- allow for comparison to reference (control) sites; and
- are cost effective.

## 3.1 2014 surveys

In 2014 Umwelt implemented the first ecological surveys and established 16, 20 x 20m monitoring sites across the range of vegetation communities and management zones at the KOA. The results of these surveys are provided in Umwelt (2014b).

## 3.2 2015 vegetation assessments

### 3.2.1 Conceptual approach

In 2015, DnA Environmental was engaged to review the monitoring program and establish a comprehensive range of ecological data which will fulfil the monitoring and reporting requirements of the BOMP.

The monitoring programs aim to establish clearly defined, repeatable and consistent methodologies for monitoring changes in various aspects of ecosystem function, succession and long-term sustainability. Part of this process includes:

- Establishing a range of relevant reference sites to compare and track the progress and inherent ecosystem function of rehabilitation areas;
- Selecting a range of suitable reference sites that reflect the desired final land use, biodiversity targets, historical disturbances and local community expectations; and
- Undertaking a monitoring program that provides simple but informative and reliable information that indicates positive recovery trends or rapid detection of rehabilitation failure.

At Kokoda, a range of Key Performance Indicators (KPI's) were quantified by data obtained from replicated reference sites which were representative of the Grey Box Woodland EEC and Dwyer's Red Gum woodland. All ecological performance indicators are quantified by range values measured from these reference sites which form both *upper* and *lower* KPI targets. The same ecological performance indicators are also measured in the revegetation/rehabilitation sites and these should equal or exceed these values, or at least demonstrate an increasing trend.

These Key Performance Indicators have been further separated into "Primary performance indicators" and "Secondary performance indicators". Primary performance indicators are those chosen as essential completion criteria targets, and have been identified as those that will satisfy requirements identified within the BOMP. The range values of each ecological performance indicator are adapted annually to reflect seasonal conditions and disturbance events. Secondary performance indicators are those that would be desirable to achieve but do not necessarily have a direct affect on consent conditions or meeting biodiversity targets.

The monitoring methodology adopted at Kokoda is consistent with that used in the NPM rehabilitation monitoring program (DnA Environmental 2010 – 2014a; 2018a) and the Estcourt Offset Area ecological monitoring program (DnA Environmental 2010 – 2014a; 2019b). The annual vegetation monitoring will aim to be undertaken during spring where possible and this year was undertaken from the 24 - 26th September.

# 4 Vegetation monitoring methodology

The methodology includes a combination of Landscape Function Analyses (CSIRO Tongway & Hindley 1996), accredited soil analyses and various measurements of ecosystem diversity and habitat values using an adaptation of methodologies derived from the Biometric Manual 3.1 (DECCW 2011) and these have been described in more detail below.

## 4.1 Landscape Function Analyses

The LFA is a methodology used to assess key indicators of ecosystem function including landscape organisation and soil surface condition as measure of how well the landscape retains and uses vital resources. It was developed by CSIRO scientists Tongway and Hindley (Tongway 1994, Tongway and Hindley 1995, 1996, 2003, 2004). The indicators used quantify the utilisation of the vital landscape resources of water, topsoil, organic matter and perennial vegetation in space and time. Additional information and data spreadsheets are freely available on the internet.

The LFA methodology collects data at two "nested" spatial scales.

- 1. At coarse scale, **landscape organisation** is characterised. Patches and interpatches, indicators of resource regulation, are mapped at the 0.5 to 100 m scale from a gradient-oriented transect (making sense of landscape heterogeneity); and
- 2. At fine scale, **soil surface assessment** (soil "quality") examines the status of surface processes at about the 1-m scale, with rapidly assessed indicators on the patches and interpatches identified at coarse scale.

At each scale, parameters are calculated that reflect several aspects of landscape function. In the first stage, we identify and record the patches and interpatches along a line oriented directly down slope. Sometimes there are several different types of each patch/interpatch which provides a measure of heterogeneity or "landscape organisation".

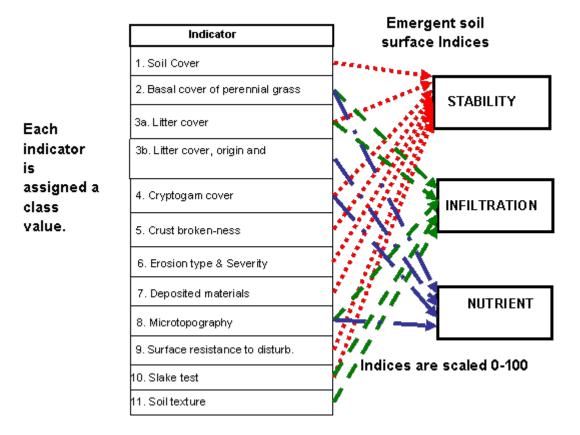
In the second stage, called "soil surface condition" (SSC) assessment, it is possible to assess and monitor soil quality using simple indicators including:

- Rain splash protection;
- Perennial vegetation cover;
- Litter:
  - Percent litter cover:
  - o Origin of the litter;
  - Extent of decomposition;
- Cryptogam cover;
- Crust Brokenness;
- Soil Erosion Type and Severity;
- Deposited Materials;
- Soil Surface Roughness;
- Surface Nature (resistance to disturbance);
- Slake Test; and
- Soil Surface Texture.

These 11 features are compiled and calculated into three indices of soil quality:

- 1. **Stability** (that is, resistance to accelerated erosion),
- 2. Infiltration (the rate soil absorbs water) and

3. **Nutrient Cycling** (the way plant litter and roots decompose and become available for use by other plants).



## 4.2 Soil analyses

Soil samples are undertaken using standard soil sampling techniques within the monitoring quadrat. At least 12 samples are taken at each site and bulked together. Soil samples are sent to Southern Cross University at their National Association of Testing Authorities (NATA) accredited laboratory for analysis. Soil analysis consist of assessing the parameters, pH, Electrical Conductivity (EC), available calcium (Ca), magnesium (Mg), potassium (K), nitrate nitrogen (N), sulphur (S), organic matter (OM), exchangeable Sodium (Na), Ca, Mg, K, hydrogen (H), cation exchange capacity, available and extractable phosphorus (P), micronutrients zinc (Zn), manganese (Mn), Iron (Fe), copper (Cu), boron (B), silicon (Si), aluminium (Al), molybdenum (Mo), Cobalt (Co) and selenium (Se) and total carbon.

A report with analysis and desirable levels recommended in the agricultural industry is provided by the laboratory. Exchangeable Sodium Percentages were calculated as a measure of sodicity or dispersion.

# 4.3 Monitoring structural diversity, floristic and other biodiversity attributes

In addition to LFA, assessments of various biodiversity components must also be made to monitor changes in particular plants and groups of plants through the various successional phases and to document and/or identify critical changes or management actions required.

Some simple and rapid procedures for making these assessments were developed by CSIRO scientists (Gibbons 2002, Gibbons et al 2008). They were developed for assessing habitat quality across a range of

vegetation types in the southern NSW Murray-Darling Basin which formed the basis of the Biometric Model used in the Property Vegetation Planning Process (DECCW 2011). Some adaptations have been made to reduce monitoring effort where possible, and to incorporate aspects of newly formed revegetation sites or sites in the early stages of recovery. For example some habitat features such as the detailed measuring and assessment of decomposition of the logs and branches has been omitted, whilst the understorey assessment included planted tubestock, direct seeding as well as natural recruitment and naturally occurring shrubs.

The rapid ecological assessment provides quantitative data that measures changes in:

- Floristic diversity including species area curves and growth forms;
- Ground cover diversity and abundance;
- Vegetation structure and habitat characteristics (including ground cover, cryptogams, logs, rocks, litter, projected foliage cover at various height increments);
- Understorey density and growth (including established shrubs, direct seeding and tubestock plantings and tree regeneration);
- Overstorey characteristics including tree density, health and survival; and
- Other habitat attributes such as the presence of hollows, mistletoe and the production of buds, flowers and fruit.

### 4.3.1 The permanent monitoring quadrats

The permanent monitoring quadrats are a standard 20 x 20m. The 20m LFA transect must face down slope and this same transect has also been used as the vegetation transect, in most cases. In all but one site (DWood1) the left side of the monitoring plot forms both the LFA and vegetation transect with the remaining plot occurring to the right.

Four marker pegs were used to mark out the permanent transect position (using Umwelt marker posts where possible) and these are situated at each corner of the 20 x 20m square plot. GPS readings are taken to ensure quadrats can be relocated over time. Permanent photo-points are also established at various marker pegs of the quadrat to record changes in these attributes over time.

### 4.3.2 Amendments

Since 2017, comprehensive soil sampling and analyses for heavy metals were not undertaken as previous soil results indicated that all sites did not have a heavy metal contaminants, other than high iron levels which were typical of the local area as demonstrated in the various woodland reference sites.

Rather, a "Basic agricultural soil analyses" was undertaken and included analyses of the following parameters: Soil pH and EC (1:5 water); Available (Calcium, Magnesium, Potassium, Ammonium, Nitrate, Phosphate, Sulfur); Exchangeable (Sodium, Potassium, Calcium, Magnesium, Hydrogen, Aluminium, Cation Exchange Capacity); Bray I and II Phosphorus; Colwell Phosphorus; Available Micronutrients (Zinc, Manganese, Iron, Copper, Boron, Silicon); Total Carbon (TC), Total Nitrogen (TN), Organic Matter, TC/TN Ratio; Basic Colour, Basic Texture.

## 4.3.3 Changes to completion targets

On review of the proposed completion targets in 2017, a few changes were considered and these were:

• Inclusion of Landform slope as a primary completion criteria;

- Inclusion of Phosphorous (P) as a primary completion criteria;
- Omission of Nitrate (N) as a primary completion criteria; and
- Inclusion of Tree and mature shrubs (>5cm dbh) density as a primary completion criteria.

These changes have been reflected in the relevant KPI tables throughout the document since 2017.

# 5 Ecological monitoring sites

A preliminary evaluation of the location of the sites established by Umwelt in 2014 via digital mapping suggested that not all main vegetation communities occurring and mapped at Kokoda by Umwelt were represented. In addition, there appeared to be more sites in the cleared DNGs than necessary to fulfil minimum quadrat numbers according to DEC guidelines (2012). Subsequently sites established by Umwelt in 2014 were retained where possible, however in some cases the sites were not required, were not in suitable condition for use as a reference site or new sites were established in unrepresented vegetation communities.

In 2015, 17 permanent monitoring sites were established which included three Grey Box Grassy woodland reference sites and five DNG sites which will be regenerated back to Grey Box Grassy woodland (Table 5-1). There were three Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress woodland reference sites and three DNG which will be regenerated back to the Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress woodland community.

There were also one site established in each of represented examples of White Box Grassy Woodland CEEC, Grey Box – Ironbark woodland and Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest which was mapped as low quality woodland. The remaining two vegetation communities were rather patchy and/or narrow linear corridors and made an overall relatively minor contribution in terms of overall biodiversity significance or influence on biodiversity targets that would not already be reflected within the existing range of monitoring sites.

Table 5-1. The numbers of permanent monitoring sites established in each of the vegetation communities as compared to

those mapped by Umwelt and their 2014 surveys.

Community type (as per Umwelt 2014)	Size (ha)	Site description	No sites established by Umwelt 2014	No. sites established by DnA 2015
Grey Box Grassy woodland DNG (EEC)	96	Probable active rehabilitation area	6	5
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine DNG	15	Probable active rehabilitation area	4	3
Grey Box Grassy woodland EEC	13	reference site	3	3
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest	150	reference site	3	3
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest	8.6	Low quality	0	1
White Box Grassy Woodland CEEC	2.2	CEEC	0	1
Grey Box – Ironbark woodland	25	Non EEC	0	1
Dwyer's Red Gum creek-line woodland	9.4	Non EEC – narrow linear	0	0
Rocky Rise Shrubby woodland	26	Non EEC – Numerous small pockets	0	0
Total No. monitoring Sites			16	17

# 6 Monitoring site descriptions and locations

GPS co-ordinates (GDA94), aspects and slopes of the ecological monitoring sites first established at Kokoda in 2015 are provided in Table 6-1. The map showing the locations of the monitoring sites is shown in Figure 6-1.

Table 6-1. GPS co-ordinates, aspects and slopes of the offset monitoring sites (GDA94).

Site Reference	LFA/Veg	LFA/Veg	Slope (°)	Bearing (°)	Right bottom	Right top
	transect Start	transect Finish	•		marker peg	marker peg
GBReveg1	55635984	55635965	5	270 W	55635991	55635971
-	6318463	6318468			6318478	6318484
GBReveg2	55636009	55635990	4	269 W	55636017	55635996
-	6317740	6317742			6317758	6317761
GBReveg3	55636556	55636575	3	53 NE	55636563	55636582
	6318096	6318102			6318075	6318083
GBReveg4	55636934	55636912	4	270 W	55636939	55636919
	6318008	6318012			6318026	6318031
GBReveg5	55637056	55637041	3	303 NW	55637070	55637057
	6318287	6318301			6318307	6318314
WBWood1	55636830	55636817	3	325 NW	55636845	55636836
	6318372	6318388			6318378	6318396
IronWood1	55635137	55635133	4	337 NW	55635156	55635147
	6317458	6317479			6317464	6317481
GBWood1	55636102	55636087	2	273 W	55636111	55636097
	6318312	6318322			6318331	6318337
GBWood2	55635682	55635668	3	318 NW	55635696	55635685
	6317695	6317708			6317700	6317714
GBWood3	55635075	55635090	1	90 E	55635071	55635086
	6318036	6318037			6318019	6318075
DReveg1	55636561	55636576	4	98 E	55636551	55636571
	6318557	6318552			6318539	6318533
DReveg2	55636612	55636632	3	90 E	55636610	55636631
	6318473	6318469			6318453	6318447
DReveg3	55637301	55637319	4	93 E	55637296	55637316
	6318051	6318049			6318031	6318029
DWoodLQ	55636185	55636200	3	82 E	55636179	55636198
	6317769	6317769			6317749	6317751
*DWood1	*55635679	*55635661	4	290 NW	*55635668	*55635652
	6316724	6316733			6316707	6316715
DWood2	55636043	55636059	3	95 E	55636035	55636050
	6316811	6316804			6316793	6316788
DWood3	55636166	55636176	3	27 NE	55636175	55636186
	6317342	6317357			6317329	6317344

\*NB: Transect along right edge, site flips to the left

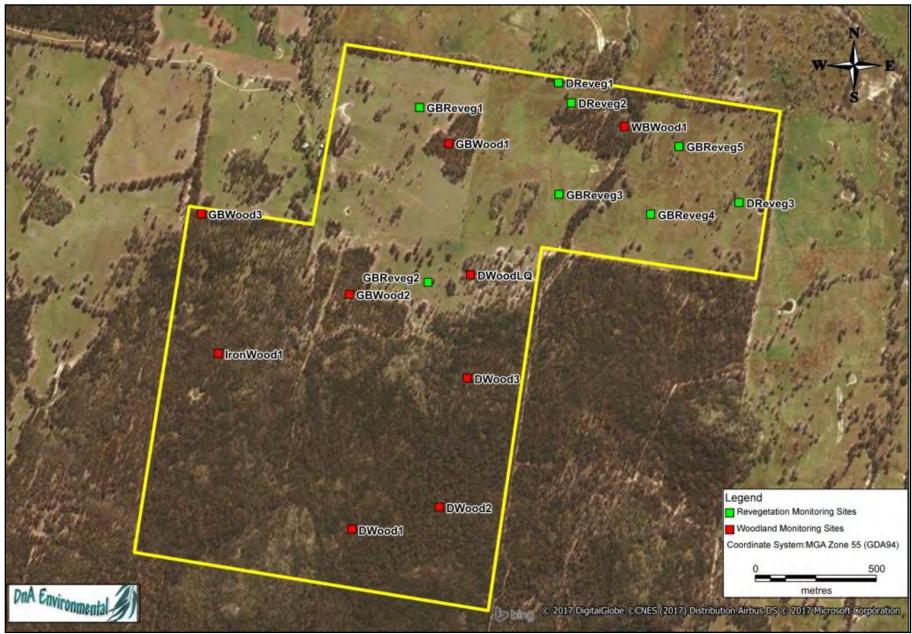


Figure 6-1. Map showing the location of the ecological monitoring sites at Kokoda.

### 7 Rainfall

The average annual rainfall at Parkes Airport is 608mm (BoM 2018), however there have been extreme seasonal conditions with below average rainfall being recorded in 2015 and 2017. This was followed by widespread flooding in 2016 with a total annual rainfall of 833mm being recorded (Figure 7-1).

Despite these extremes in annual rainfall activity, the monthly averages indicate there has also been high seasonal variability and erratic rainfall activity over the past few years (Figure 7-2). 2015 was a dry rainfall year with limited rainfall occurring February and March 2015. Above average rainfall was then experienced in April, July and August which stimulated a flush of annual plant growth during the 2015 Kokoda monitoring period.

April 2016, marked the beginning of a long period of above average monthly rainfall, with record breaking rains falling from April through to October causing widespread flooding. In this nine month period, 605 mm was recorded, with expected averages also being recorded in November and December. In 2017, very low rainfall activity occurred and except in March where 195mm of rainfall was recorded. Rainfall remained well below the expected monthly averages for most of the year, with a total of 562 mm being recorded for the year.

Extremely dry conditions extended in 2018 and these included the key growing seasons in autumn and spring where very limited rainfall fell. Up until November this year, only 300 mm was received compared to the expected average of 553 mm for the first 11 months of the year.

The extreme seasonal conditions experienced over the past few years combined with simultaneous changes in total grazing pressure has had a significant impact on the composition and diversity of the vegetation at Kokoda, with these being reflected in the range of ecological monitoring data.

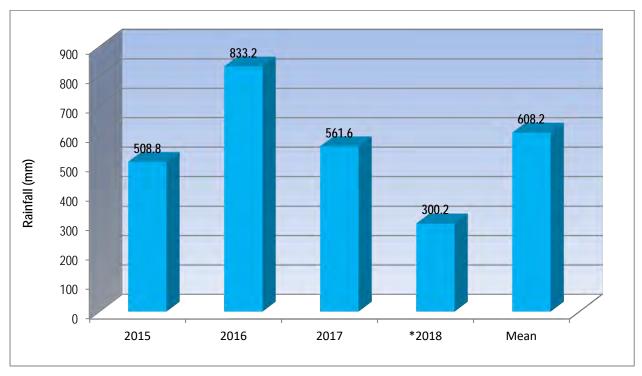


Figure 7-1. Total annual rainfall recorded at Parkes January 2015 to November 2018 compared to the long term averages recorded at Parkes Airport (BoM 2018).

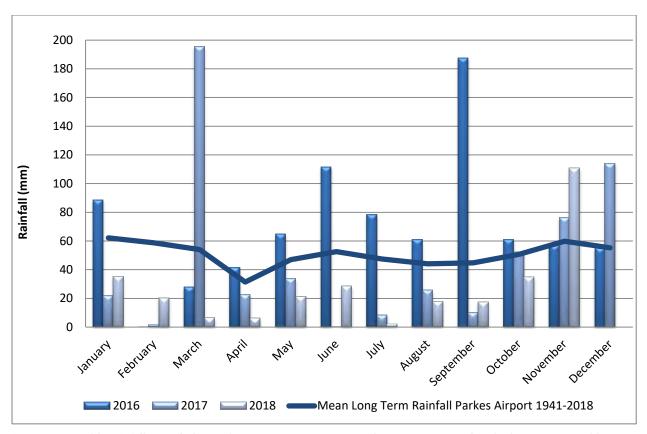


Figure 7-2. Monthly rainfall recorded at Parkes January 2015 to November 2018 compared to the long term monthly averages recorded at Parkes Airport (BoM 2018).

# 8 Results Grey Box Woodland monitoring sites

This section provides the results of the monitoring within the Grey Box monitoring sites and demonstrates ecological trends and performance of the revegetation sites against a selection of ecological performance indicators. This section has also included the White Box grassy woodland and Grey Box Ironbark woodland.

## 8.1 Photo-points

General descriptions of the Grey Box Grassy Woodland monitoring sites established at Kokoda in 2015 including photographs taken along the vegetation transect are provided in Table 8-1.

Table 8-1. General site descriptions and permanent photo-points of the Grey Box woodland monitoring sites at Kokoda.

2015 2016 2017 2018

GBReveg1: Degraded native pasture dominated by the exotic annuals *Trifolium angustifolium* (Narrow-leaf Clover) and *Vulpia muralis* (Rats-tail Fescue). The site was however relatively diverse and maintained relatively good ground cover. The natives *Bothriochloa macra* Red-leg Grass and *Rytidosperma spp* (Wallaby Grass) were also very common. In 2018, the pastures were heavily grazed causing the deterioration of the litter and cryptogam layers and species diversity was low.









GBReveg2: Degraded native pasture dominated by the exotic annuals Aira cupaniana (Silvery Hairgrass) and Vulpia muralis (Rats-tail Fescue) with large patches of Parentucellia latifolia (Red Bartsia). In 2018, the need was beautiful to the little and expression of the little and expression diversity was law.

the pastures were heavily grazed causing the deterioration of the litter and cryptogam layers and species diversity was low.







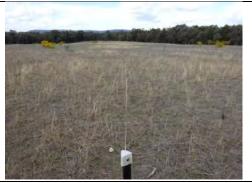


GBReveg3: Native pasture dominated by *Bothriochloa macra* and the exotic annuals *Aira cupaniana*, *Hypochaeris glabra* (Smooth Catsear) with patches of *Vulpia muralis*. In 2018, the pastures were heavily grazed causing the deterioration of the litter and cryptogam layers and species diversity was low.

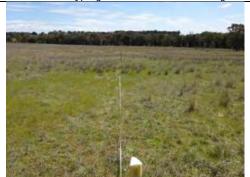


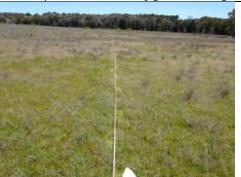






**GBReveg4:** Degraded native pasture dominated by *Bothriochloa macra*, but the exotic annuals *Vulpia muralis* (Rats-tail Fescue), *Hypochaeris glabra* (Smooth Catsear) and *Aira cupaniana* were also abundant. Mosses and cryptogam were scattered throughout. In 2018, the pastures were heavily grazed causing the deterioration of the litter and cryptogam layers and species diversity was low.









**GBReveg5**: Degraded native pasture dominated by *Bothriochloa macra*, but the exotic annuals *Vulpia muralis* (Rats-tail Fescue), *Hypochaeris glabra* (Smooth Catsear) and *Aira cupaniana* were also abundant. In 2018, the pastures were heavily grazed causing the deterioration of the litter and cryptogam layers and species diversity was low.









**WBWood1**: High quality open regrowth woodland dominated by E. albens (White Box) with some scattered mature E. blakelyi (Blakely's Red Gum) and Callitris endlicheri. In 2015, Several species of ground orchids were found. In 2018 there continued to be deep litter layer however species diversity was low.

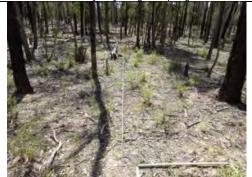








**IronWood1:** Moderate density regrowth woodland dominated by *E. sideroxylon* (Mugga Ironbark) with scattered *E. microcarpa*, *E. albens*, *E. dwyeri* and *Callitris endlicheri*. There were scattered mature trees and a moderate density of younger saplings. There were scattered individuals of *Brachyloma daphnoides* (Daphne Heath). In 2018 there continued to be deep litter layer however species diversity was low.









**GBWood1**: Very degraded regrowth woodland dominated by *E. microcarpa* with some scattered *Callitris endlicheri*. There were some large old regrowth trees, pockets of older regrowth but there was no young regeneration and there were no shrubs. There were some dead stags and fallen branches. In 2018, there continued to be deep litter layer however species diversity was low.









**GBWood2**: Degraded regrowth woodland dominated by E. microcarpa with some scattered E. sideroxylon. There was a moderate density of regrowth trees and some limited but recent recruitment of volunteer shrubs. There were some dead stags and fallen braches were common across the site. There was a high cover of dead leaf litter with a sparse cover of native ground cover species. In 2018, numerous shrubs had died however there continued to be litter layer however species diversity was low.









GBWood3: Degraded regrowth woodland dominated by E. microcarpa with some scattered E. sideroxylon. There was a moderate density of regrowth trees and some limited but recent recruitment of volunteer shrubs. There were no dead stags but some fallen braches occurred across the site. There was a high cover of dead leaf litter with a sparse cover of native ground cover species. In 2018, there continued to be deep litter layer however species diversity was low.









## 8.2 Landscape Function Analyses

## 8.2.1 Landscape Organisation

A patch is an area within an ecosystem where resources such as soil and litter tend to accumulate, while areas where resources are mobilised and transported away are referred to as interpatches. Landscape Organisation Indices (LOI) are calculated by the length of the patches divided by the length of the transect to provide an index or percent of the transect which is occupied by functional patch areas (Tongway and Hindley 2004).

The three Grey Box woodland reference sites were characterised by having a mature tree canopy and a well developed decomposing leaf litter layer and a sparse cover of native perennial forbs and grasses. Despite the dry conditions and heavy grazing pressure the woodland reference sites maintained high functional patch area and a Landscape Organisation ranging from 97 - 100%.

While the Grey Box revegetation sites presently existed as degraded grassland and were structurally different to the woodland reference sites, they typically had good ground cover comprised of a combination of annual and perennial plants and cryptogams. This year, there was limited live ground cover and often the integrity of the litter layer had declined, however all sites maintained high functional patch areas and continued to score LO's of 100% (Figure 8-1).

The White Box and Ironbark woodland sites were also characterised with having a mature tree canopy and a well developed leaf litter layer. In the White Box woodland, native grass and forb cover was low, while in the Ironbark woodland there continued to be scattered low shrubs and both sites also continued to have high functional patch areas and LO's of 100%.

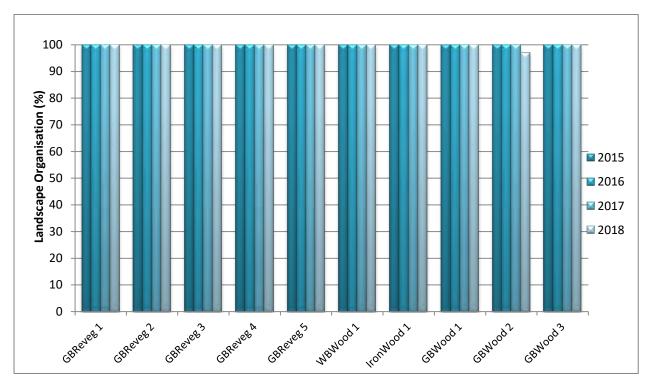


Figure 8-1. Landscape Organisation Indices recorded in the Grey Box woodland monitoring sites.

### 8.2.2 Soil surface assessments

### 8.2.2.1 Stability

LFA stability indices in the Grey Box woodland reference sites slightly improved in GBWood3 and no change was recorded in GBWood2, however a marginal decline was recorded in GBWood1 and this year they provided a stability range of 63.5 – 70.1. The stability of the reference sites were being provided by the perennial tree cover, moderately deep litter layers and sandy clay loam soils which were very stable. This year there was a further reduction in live plant cover in the understorey and there continued to be a lot of litter mobilised and deposited across these sites. The White Box and Ironbark woodlands were similar in structure to the reference sites. This year the stability indices had declined in WBWood1 and IronWood1, with indices of 61.0 and 66.3 respectively. While IronWood1 had an ecological stability that was similar to the Grey Box woodland reference sites, stability was slightly too low in WBWood1 this year (Figure 8-2).

In the Grey Box revegetation sites the stability continued to decline in three sites including GBReveg1, GBReveg2 and GBReveg4 but they continued to more stable than the Grey Box reference sites. While there was a reduction in live ground cover and loss of integrity of the litter and cryptogam layers in some sites, there was limited erosion or deposition occurring in the sites. There was a marginal increase in stability in GBReveg3 and GBReveg5 and with indices of 73.1 and 74.4 respectively, continued to be more ecological stable than the reference sites.

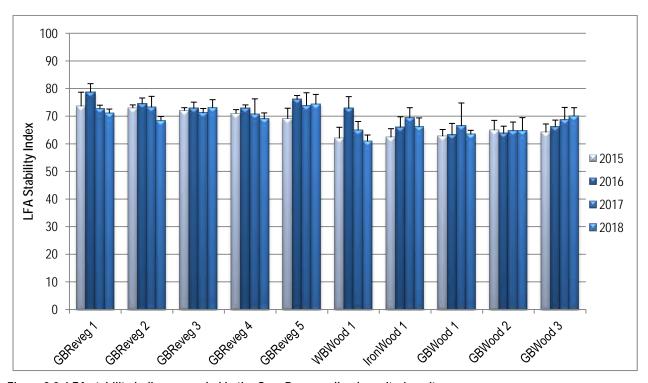


Figure 8-2. LFA stability indices recorded in the Grey Box woodland monitoring sites.

### 8.2.2.2 Infiltration

The infiltration capacity of the Grey Box, White Box and Ironbark woodland sites continued to be similar to each other with the Grey Box woodland reference sites providing a slightly lower target range of 50.6 – 55.7 this year. (Figure 8-3). There continued to be a well developed and decomposing litter layer that had often formed a rich spongy humus layer, however this year there was a loss of integrity of the litter layers and increased usage by wildlife has tended to result in increase surface crusting, thus reducing infiltration capacity. Similar changes

were recorded in the White Box and Iron Bark woodlands and this year had an infiltration capacity which was comparable to the Grey Box woodlands.

In comparison to the reference sites the revegetation sites tended to have an undeveloped litter layer and a hard surface crust which reduces the infiltration capacity of moisture to enter the soil profile. Infiltration capacity was slightly lower or had remained unchanged and this year had infiltration indices that ranged from a low of 37.6 (GBReveg2) to a high of 47.0 (GBReveg5).

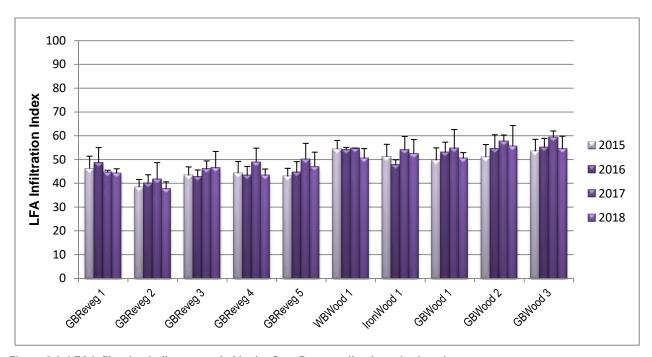


Figure 8-3. LFA infiltration indices recorded in the Grey Box woodland monitoring sites.

### 8.2.2.3 Nutrient recycling

The nutrient recycling capacity is influenced by the degree of perennial plant cover and accumulation and decomposition of the litter layers, which is in turn influenced by the degree of soil compaction and soil surface crusting. This year there was a further reduction in perennial plant cover and there was a loss of integrity of the litter layer, therefore the nutrient recycling capacity had decreased to provide a range of 47.8 – 51.5 (Figure 8-4). There was also a decline in the White Box and Iron Bark woodlands which both had indices of 49.8 this year with this nutrient recycling capacity being similar to the reference sites.

In the Grey Box revegetation sites, there were limited to no perennial trees or shrubs and the litter and humus layers were presently less developed but cryptogams were usually abundant. Heavy grazing has however caused a deterioration of grassy understorey and subsequently nutrient recycling indices also declined in all of the revegetation pasture areas. Nutrient recycling indices ranged from a low of 36.2 (GBReveg2) to a high of 45.5 (GBReveg5).

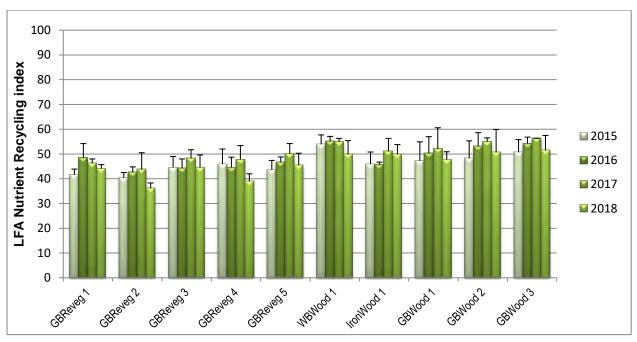


Figure 8-4. LFA nutrient recycling indices recorded in the Grey Box woodland monitoring sites

### 8.2.3 Most functional sites

The sum of the LFA stability, infiltration and nutrient recycling components provide an indication of the most functional to least functional monitoring sites recorded this year and is provided in Figure 8-5. The maximum score possible is 300 with the woodland reference sites GBWood3 continuing to be the most ecologically functional site with a total score of 176, followed by GBWood2 with 171, followed closely by Ironwood1 with a sum of scores of 169. These sites contained high patch area, a mature tree canopy and well developed grassy ground cover layer, with high levels of decomposing litter and had very spongy and stable soils.

Despite the lack of perennial overstorey there was relatively high functionality in GBReveg5 and GBReveg3 and with a sum of scores of 167 and 164 respectively were more functional than the woodland sites GBWood1 (162) and WBWood1 (161). The derived native grassland revegetation areas, GBReveg1 scored 160, GBReveg4 scored 151 while the least functional community continued to be GBReveg2 which scored 142.

Examples of the various combinations of ground covers which are critical to overall ecosystem function have been provided in Table 8-2.

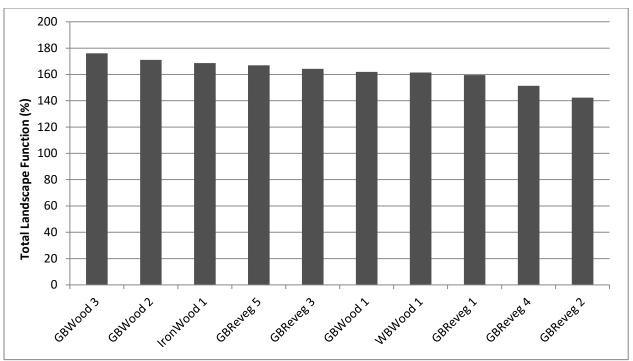
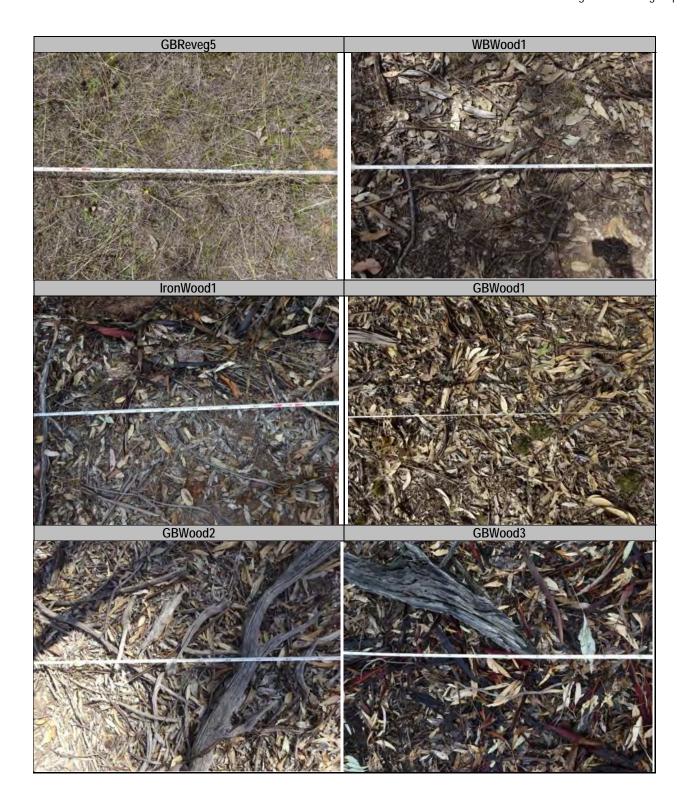


Figure 8-5. Sum of the LFA stability, infiltration and nutrient recycling components indicating the most functional to least functional monitoring site recorded in 2018.

Table 8-2. Examples of the different ground covers in the Kokoda Grey Box monitoring sites in 2018.





### 8.3 Trees and mature shrubs

## 8.3.1 Population density

Mature trees and shrubs with a stem diameter >5cm dbh were recorded in the three Grey Box woodland reference sites as well as the White Box and Ironbark woodland sites. In Ironwood1 another individual had died during the past year. The resultant population densities recorded in the Grey Box reference sites were 8 - 23, equating to a density of 200 – 575 stems per hectare (Figure 8-6). There continued to be eight individuals in the

White Box site and there were 29 in the Ironbark woodland. No trees or mature shrubs were yet present in the derived native grassland sites.

### 8.3.2 Diameter at breast height

The average dbh recorded in the Grey Box reference sites ranged from 17 – 34cm with the minimum dbh being 6cm and the maximum dbh 57cm (Table 8-3). The relatively small trunk diameters indicate the trees are relatively young and indicative of their regrowth status. In the White Box woodland the average dbh was 30 cm with the maximum dbh of 39cm, while in the Ironbark woodland the average dbh was 17 with a maximum of 50 cm.

### 8.3.3 Condition

The trees and mature shrubs in the Grey Box woodland monitoring sites were typically in medium health but all sites contained individuals in a state of advanced dieback. In GBWood3 and Ironwood1 there were also some (dead) stags. There continued to be an absence of mistletoe and this year only GBWood1 and GBWood3 had some trees bearing reproductive structures such as buds, flowers or fruits. Hollows suitable as nesting sites (>10cm) were noted in GBWood1 and GBWood2.

### 8.3.4 Species composition

The Grey Box reference sites were dominated by *Eucalyptus microcarpa* (Grey Box). A single mature *Acacia implexa* (Hickory) was also recorded in GBWood2, while a single *E. sideroxylon* (Mugga Ironbark) was recorded in GBWood3.

The White Box woodland was dominated by *E. albens* but a *Callitris endlicheri* and *E. blakelyi* were also present. The Ironbark woodland was dominated by *E. sideroxylon* and contained numerous individuals of *E. albens* and *E. dealbata*, and there was one *Callitris endlicheri*.

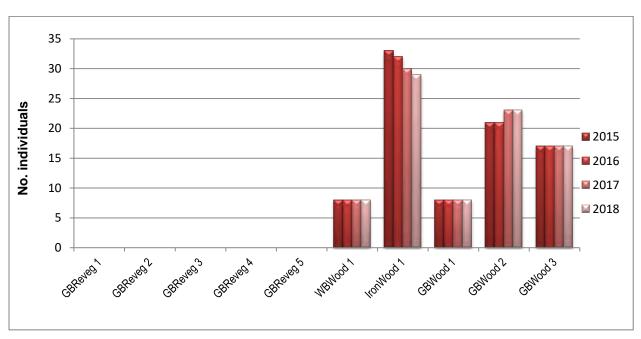


Figure 8-6. Tree and mature shrub densities (>5cm dbh) in the Kokoda Grey Box woodland monitoring sites.

Table 6-3. II	ulik ula	illicici 3 c	ina com	aition oi	the trees		itui e si	ii ubs iii t	ne woodi	anu mon	itoring	31163 1114	2010.	
Site Name	No species	Average dbh (cm)	Max dbh (cm)	Min dbh (cm)	Total trees	No. with multiple limbs	% Live trees	% Healthy	% Medium Health	% Advanced Dieback	% Dead	% Mistletoe	% Flowers / fruit	%. Trees with hollows
GBReveg1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GBReveg2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GBReveg3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GBReveg4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GBReveg5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WBWood1	3	30	39	18	8	4	100	13	63	25	0	0	50	0
IronWood1	4	17	50	6	40	3	73	3	33	38	28	0	23	0
GBWood1	1	34	57	12	8	0	100	0	75	25	0	0	13	50
GBWood2	2	17	30	8	23	4	100	30	43	26	0	0	0	52
GBWood3	2	24	53	6	20	9	85	15	50	20	15	0	50	0

Table 8-3. Trunk diameters and condition of the trees and mature shrubs in the woodland monitoring sites in 2018.

# 8.4 Shrubs and juvenile trees

### 8.4.1 Population density

In the woodland reference sites there were 1 - 21 shrubs and juvenile trees (Figure 8-7), equating to a maximum density of 25 - 525 stems per hectare.

In the White Box woodland some seedlings had died with only five individuals recorded this year as a result of the prolonged dry conditions. In the Ironbark woodland there were 139 individuals. One seedling continued to be recorded in GBReveg1 this year.

# 8.4.2 Height class

In the reference sites most individuals continued to be less than 0.5m in height but there were increasing numbers that were 0.5 - 1.0m tall. In WBWood1 and IronWood1 most were less than 1.5m in height. In IronWood1 a few individuals were > 2.0 m tall (Table 8-4).

# 8.4.3 Species diversity

In the woodland reference sites there were 1 - 3 species of shrubs and juvenile trees with the range of species including juvenile *E. microcarpa, Acacia implexa* (Hickory), *A. paradoxa* (Kangaroo Thorn), *A. spectabilis* (Mudgee Wattle), *Cassinia laevis* (Cough Bush) and/or Brachyloma daphnoides (Daphne Heath).

In the White Box woodland there were three *A. decora* (Western Golden Wattle) and one each of *Acacia implexa* and *Callitris endlicheri* (Black Cypress Pine). In the Ironbark woodland, the shrubby understorey was much more diverse and continued to be dominated by *Brachyloma daphnoides* with numerous *Callitris endlicheri* seedlings. There were also occasional juvenile of *Cassinia laevis*, *Acacia implexa*, *E. dealbata* and *E albens*. This year no *Callitris glaucophylla* seedlings were found in GBReveg1, but there was one *Cassinia laevis* seedling.

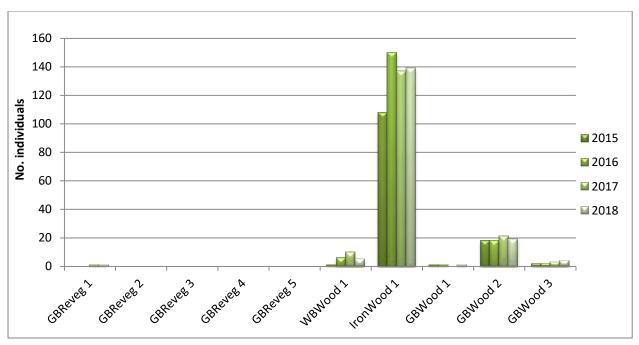


Figure 8-7. Total shrubs and juvenile trees recorded in the Grey Box monitoring sites.

Table 8-4 Number of individuals represented in each height class across the range of monitoring sites.

Site Name	0-0.5m	0.5-1.0m	1.0-1.5m	1.5-2.0m	>2.0m	Total	No. species	% Endemic
GBReveg1	1	0	0	0	0	1	1	100
GBReveg2	0	0	0	0	0	0	0	0
GBReveg3	0	0	0	0	0	0	0	0
GBReveg4	0	0	0	0	0	0	0	0
GBReveg5	0	0	0	0	0	0	0	0
WBWood1	4	1	0	0	0	5	3	100
IronWood1	99	36	2	1	1	139	6	100
GBWood1	1	0	0	0	0	1	1	100
GBWood2	9	8	2	0	0	19	3	100
GBWood3	2	1	0	0	1	4	3	100

# 8.5 Total ground Cover

Total ground cover, which is a combination of leaf litter, annual plants, cryptogams, rocks, logs and live perennial plants (<0.5m in height) continued to be relatively high in the woodland reference sites though this year it had slightly decreased to provide a target range of 94.0 – 98.0% (Figure 8-8). Despite some minor reductions in ground cover in the some of the remaining sites, all sites had an adequate total ground cover this year and ranged from 94.0 % (GBReveg2, IronWood1) to 100% cover in GBReveg1.

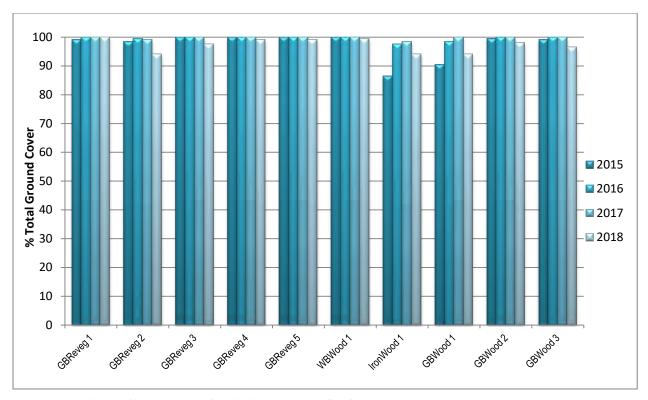


Figure 8-8. Total ground cover recorded in the Grey Box woodland monitoring sites.

### 8.6 Structural composition

The various combinations of the ground covers and structural compositions of the woodland sites are provided in Figure 8-9. In the Grey Box woodland reference sites the most dominant form of ground cover continued to be provided by dead leaf litter which were largely derived from fallen eucalypt leaves and twigs which provided 87.0 - 97.5% of the total ground cover this year. As a result of the dry conditions there was much less perennial ground cover with only 0 - 4% cover provided by perennial ground cover plants. There were no annual plants and there continued to be a small contribution of cover provided by fallen branches (0.5 - 6.5%). Cryptogams and rocks were not important ground cover components.

The White Box woodland was very similar in structure this year and had a slightly higher cover of 4.5% perennial ground cover plants. In the Ironbark woodland, perennial plants provided only 2.5% of the total cover and cryptogams and logs provided 3.5% and 4.0% respectively. This year no annual plants were recorded at either WBWood1 or IronWood1 site this year.

In the derived grassland revegetation sites, annual plant cover had declined in all sites and this year all sites were dominated by dead litter, derived from dead ground cover plants. Annual plants however continued to be recorded in low abundances in all sites with a low cover of 4.5% in GBReveg2 to a high of 24.0% in GBReveg1. Cryptogams were also recorded in high abundance in GBReveg2 which provided 29.5% of the total ground cover, while in GBReveg1 they provided 7.0% cover. Cryptogams were present but in lower abundance in the remaining Reveg sites. Perennial plants provided 5.5 – 20.5 % in GBReveg4 and GBReveg3 respectively, with these exceeding minimum perennial ground cover requirements.

The reference sites were also characterised by having a mature canopy cover which exceeded 6.0m in height with low hanging braches also providing occasional projected cover in the lower height classes. The White Box and Ironbark woodlands had a similar overstorey structure. Presently there is no vertical structure > 0.5m in

height in the derived grassland revegetation areas. Examples of the various structural compositions of the individual sites have been provided in Table 8-5.

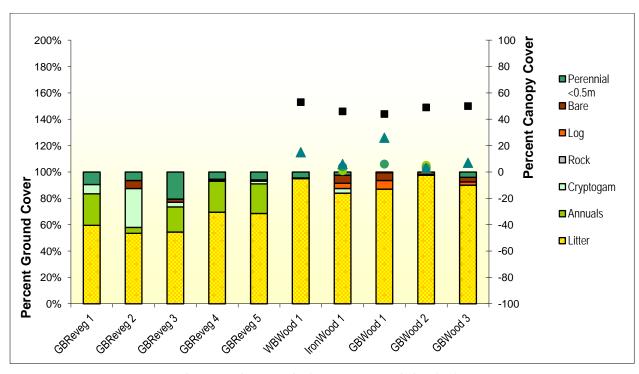


Figure 8-9. Average percent ground cover and projected foliage cover recorded in the Grey Box monitoring sites in 2018.

Table 8-5. Structural compositions of the Grey Box monitoring sites in 2018.

GBReveg1

GBReveg2

GBReveg3

GBReveg3

GBReveg4



# 8.7 Floristic Diversity

Total floristic diversity recorded within the 20 x 20m Grey Box woodland reference sites was highly variable between the sites and in 2016 there was a high diversity of species as a result of the wet seasonal conditions with 36 - 58 species being recorded (Figure 8-10). The dry conditions experienced in 2017 resulted in a significantly lower diversity of species with 10 - 22 species being recorded in the three reference sites. This year prolonged dry conditions resulted in the further decline in species richness across all monitoring sites, where 7 - 15 species were recorded in the Grey Box woodland reference sites.

There were 28 species in the White Box woodland, while in the Ironbark woodland there were a total of 23 species. The grassland revegetation sites were more diverse than the reference sites and this year there were 18 (GBReveg2) – 26 (GBReveg5) different species recorded.

In the woodland reference sites, native species continued to be far more diverse than exotic species with 7 – 15 native species being recorded this year (Figure 8-11) and only one exotic species was recorded in GBWood3. In WBWood1 and IronWood1 native species were also more diverse with 28 and 23 native species respectively and this year no exotic species were found in either site (Figure 8-12).

The derived grassland sites contained a higher diversity of species than the reference sites, however there was also a much higher diversity of exotic species with 6 (GBReveg2) – 13 (GBReveg1, GBReveg5) exotic species. All grassland sites had an acceptable diversity of native species.

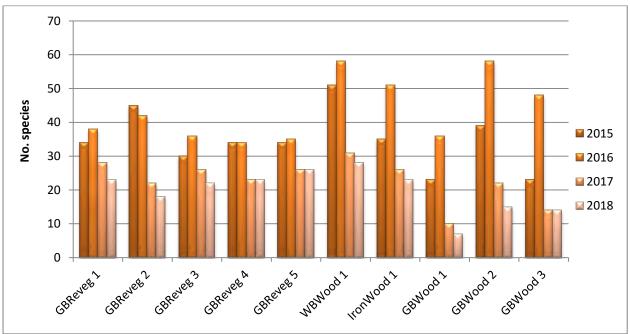


Figure 8-10. Total species diversity recorded in the Grey Box monitoring sites.

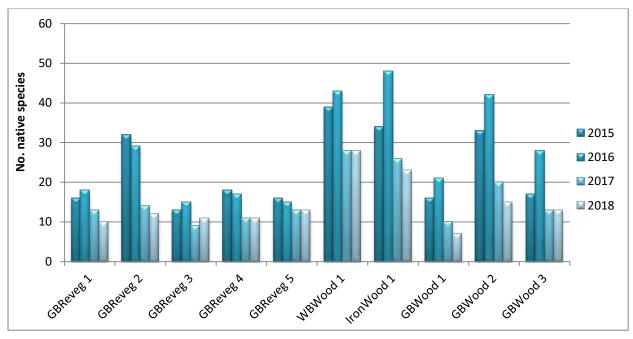


Figure 8-11. Total native species diversity recorded in the Grey Box monitoring sites.

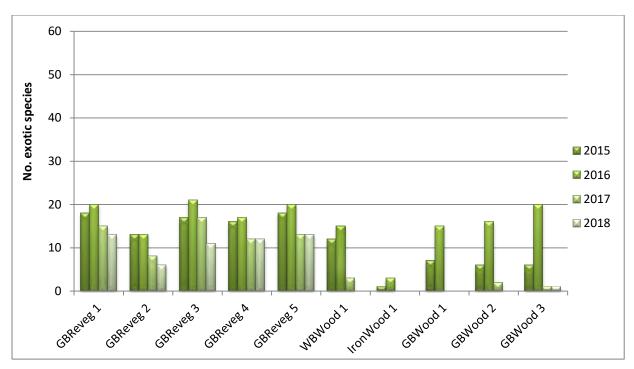


Figure 8-12. Total exotic species recorded in the Grey Box monitoring sites.

### 8.7.1 Percent endemic ground cover

The percent endemic ground cover is an ecological indicator used to provide some measure of the cover abundance of the live native vegetation along the vegetation transect and therefore indicates the level of weediness at the monitoring sites. While it is only estimation the percent cover of endemic ground cover species has been derived by the following equation.

Percent cover endemic species = sum of the five Braun- blanquet scores for native species / (sum of the five Braun- blanquet scores of exotic species + native species) x 100

In 2016 most of the live plant cover in the Grey Box woodland reference sites was provided by native species however due to the increase in exotic annual plant cover, endemic plant cover scores had declined from 2015, and ranged from 82.7 – 85.2% (Figure 8-13). In 2017 and 2018, there was limited live annual plant cover in the woodland reference sites with all plant cover being provided by native ground cover plants. This was also evident in WBWood1 and IronWood1 this year (Figure 8-13).

In the derived grasslands, there has been an increasing trend in native plant abundance in numerous sites however GBReveg2 was the only site dominated by native species, where native plants provided 75% of the live plant cover. In the remaining grassland sites, native plants provided 47 – 52% of the live plant cover and were weedier than desired.

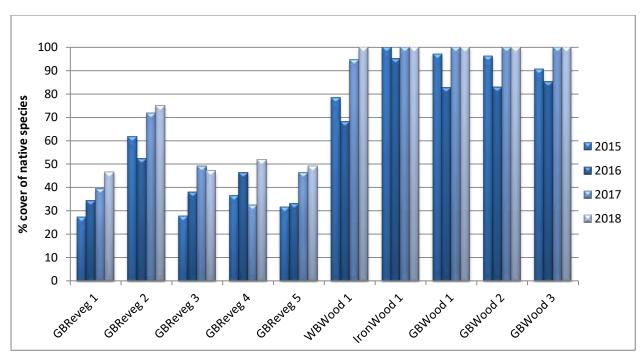


Figure 8-13. Percent endemic ground cover recorded in the Grey Box monitoring sites.

# 8.8 Vegetation composition

The composition of the vegetation as categorised by seven different growth forms is given in Figure 8-14. In the Grey Box woodland reference sites herbs were the most diverse plant group with 3 - 7 different species followed by grasses with 3 - 4 species. There were 1 - 2 tree species, 1 - 3 shrubs and there may have been a sub-shrub. There may also have been one reeds and no fern species were recorded this year.

The White Box and Ironbark woodland were comprised of an adequate representation of the major plant groups. In the grassland revegetation areas there was also an adequate representation of most growth forms except that there were was a low diversity of tree species in all sites except GBReveg1. There also continued to be an absence of shrubs in all grassland sites this year.

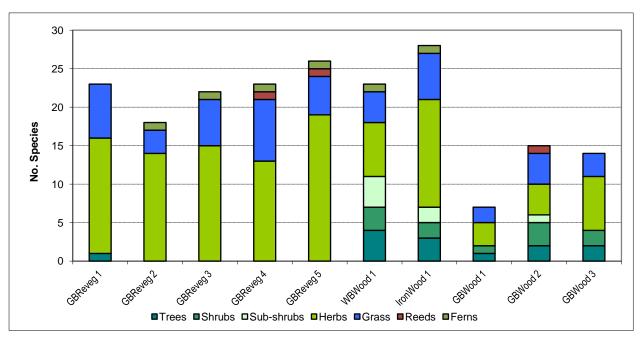


Figure 8-14. Composition of the vegetation recorded in the Grey Box monitoring sites in 2018.

# 8.9 Most common species

The most common species, those that were recorded in at least four of the seven revegetation sites are provided in Table 8-6. This year *Bothriochloa macra* (Red-leg Grass) continued to be recorded in all sites except IronWood1, while *Cheilanthes sieberi* subsp. *sieberi* (Rock Fern) a native fern was also recorded in all sites except GBReveg1. Neither species were recorded in any of the woodland reference sites.

The exotic annuals *Arctotheca calendula* (Capeweed) and *Hypochaeris glabra* (Smooth Catsear) were recorded in five of the revegetation monitoring sites and so were the native perennials *Aristida ramosa* (Threeawn Grass) and *Oxalis perennans* (Yellow Wood-sorrel). Other common species were the natives species *Panicum* sp. and *Triptilodiscus pygmaeus* (Austral Sunray) and there were a variety of other annual exotics.. A comprehensive list of species recorded in all monitoring sites has been included in Appendix 1.

Table 8-6. The most common species recorded in the Grey Box monitoring sites in 2018.

	c c c. The most common specie													
exotic	Scientific Name	Common Name	Habit	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	IronWood1	WBWood1	Total	GBWood1	GBWood2	GBWood3
	Bothriochloa macra	Red-leg Grass	g	1	1	1	1	1		1	6			
	Cheilanthes sieberi subsp. sieberi	Rock Fern	f		1	1	1	1	1	1	6			
*	Arctotheca calendula	Capeweed	h	1	1	1	1	1			5			
	Aristida ramosa	Threeawn Grass	g	1		1	1	1		1	5		1	
*	Hypochaeris glabra	Smooth Catsear	h	1	1	1	1	1			5			
	Oxalis perennans	Yellow Wood-sorrel	h	1	1	1	1	1			5			1
*	Trifolium subterraneum	Subterraneum Clover	h	1	1	1	1	1			5			
*	Briza minor	Shivery Grass	g	1		1	1	1			4			
*	Echium plantagineum	Paterson's Curse	h	1		1	1	1			4			
	Panicum sp.		g	1	1		1	1			4		•	
*	Petrorhagia nanteuilii	Proliferous Pink	h	1		1	1	1			4		•	
	Triptilodiscus pygmaeus	Austral Sunray	h		1	1	1	1			4			

Note: "1: denotes the presence of that species and is not a measure of cover abundance

Key to habit legend: t = tree; s = shrub; ss =sub-shrub; h = herb; g = grass, r = reed; v = vine; f = fern; p = parasite

# 8.10 Most abundant species

The most abundant species recorded in each of the Grey Box monitoring sites this year are provided in Table 8-7. The most abundant species were those that collectively summed to a Braun-blanquet total of 10 or more from the five replicated sub-plots along the vegetation transect. The maximum score that can be obtained by an individual species is 30.

No species was particularly abundant in the understorey in the Grey Box woodland reference sites with only *Rytidosperma racemosum* (Wallaby Grass) meeting the required abundance criteria in GBWood3 this year. *Rytidosperma racemosum* was also the most abundant species in GBReveg2 this year. *Hypochaeris glabra* (Smooth Catsear) an exotic annual was the most abundant species in four of the five grassland sites, while the native perennial grass *Bothriochloa macra* (Red-leg Grass) was recorded as the most abundant species three sites.

Table 8-7. The most abundant sp	pecies recorded in the Gre	y Box monitoring sites in 2018.

Scientific Name	Common Name	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	WBWood1	IronWood 1	GBWood1	GBWood2	GBWood3
*Hypochaeris glabra	Smooth Catsear	16		11	12	11					
Bothriochloa macra	Red-leg Grass			18	10	12					
Rytidosperma racemosum	Wallaby Grass		15								10

# 8.11 Soil analyses

### 8.11.1 pH

Figure 8-15 shows the pH recorded in the Grey Box monitoring sites compared to the "desirable" range in medium or clay loam soils as prescribed by the agricultural industry for growing introduced pastures and crops. There was minimal change in the soil pH range recorded in the woodland reference sites and they continued to remain lower than desirable agricultural ranges. With soil pH ranging from 5.1 – 5.6 the soils were strongly to moderately acidic (Bruce & Rayment 1982).

In GBReveg2 and the Ironbark woodland, the soil pH was similar to the reference sites with pHs of 5.3 and 5.1 respectively and were also strongly acidic. The White Box woodland and remaining derived grassland areas had a slightly higher pH which ranged from 6.0 (GBReveg4) to 6.6 (GBReveg1) with these soils being moderately acidic to neutral and within desirable agricultural ranges.

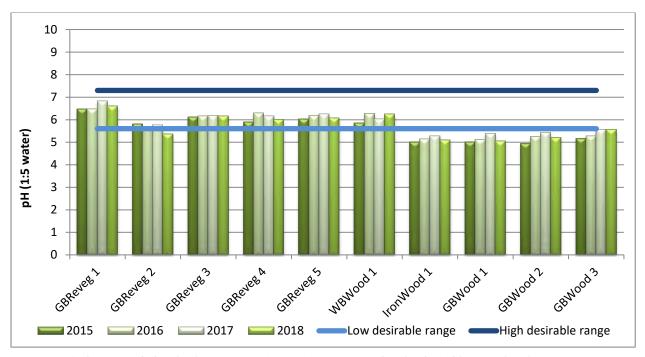


Figure 8-15. Soil pH recorded in the Grey Box monitoring sites compared to the desirable agricultural range.

# 8.11.2 Conductivity

Figure 8-16 shows the Electrical Conductivity (EC) recorded in the Grey Box monitoring sites compared to the "desirable" range in medium or clay loam soils as prescribed by the agricultural industry for growing introduced pastures and crops. The EC recorded across the range of sites was well below the agricultural threshold

indicating there are very low levels of soluble salts in the soil profile and that they are non saline. The highest EC readings were recorded in the reference sites which ranged from 0.059 – 0.067 dS/m. In the remaining sites EC ranged from a low of 0.015 dS/m in GBReveg5 to a high of 0.064 dS/m in GBReveg2.

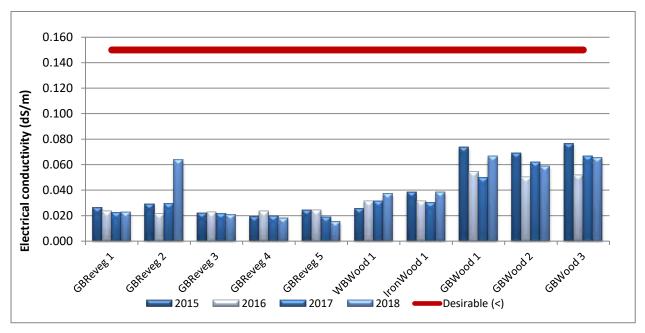


Figure 8-16. Electrical Conductivity recorded in the Grey Box monitoring sites compared to the desirable agricultural levels.

### 8.11.3 Organic Matter

In the Grey Box woodland reference sites Organic Matter (OM) levels were at or higher than desirable agricultural threshold of 4.5%, with OM concentrations ranging from 4.5 - 7.5% (Figure 8-17). At GBReveg2, there was 5.2% OM recorded this year with these being similar to the local woodlands and desirable ranges. OM in the remaining sites were lower than the Grey Box woodlands and ranged from a low of 1.8% in GBReveg5 to a high of 3.6% in the Ironbark woodland.

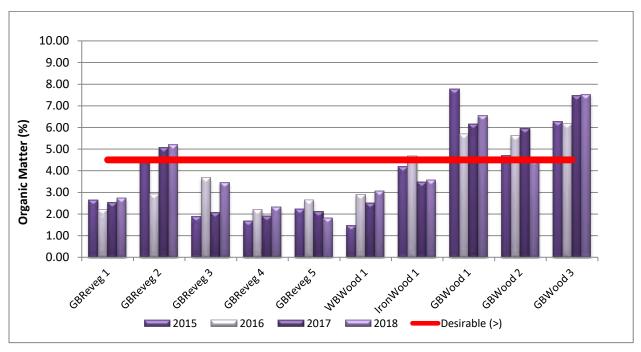


Figure 8-17. Organic Matter concentrations recorded in the Grey Box monitoring sites compared to desirable agricultural levels.

### 8.11.4 Phosphorous

Phosphorous levels were lower than the agricultural standards across all Grey Box monitoring sites and this year there was a decrease in P recorded across all sites. They remained the highest within the woodland reference sites which had a P range of 11 – 26 mg/kg this year. P concentrations in the remaining revegetation sites, WBWood1 and IronWood1 were lower than this range and were lowest at GBReveg5 with 5 mg/kg to a high of 9 in GBReveg2 (Figure 8-18).

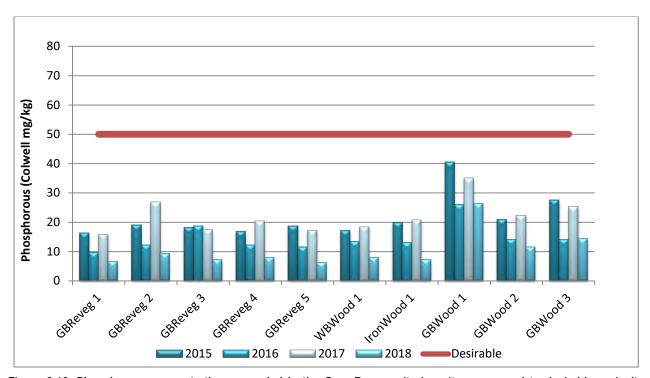


Figure 8-18. Phosphorous concentrations recorded in the Grey Box monitoring sites compared to desirable agricultural levels.

#### 8.11.5 Nitrate

Nitrate levels were lower than the agricultural standards across all Grey Box monitoring sites and there continued to be little differences between the sites, with the exception of a small spike in GBReveg2 this year with 8.0 mg/kg. In the reference sites N ranged from 0.5 – 1.7 mg/kg and the remaining sites had N concentrations which fell within this range (Figure 8-19).

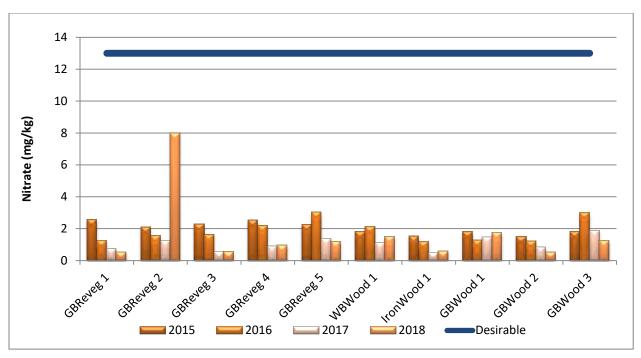


Figure 8-19. Nitrate concentrations recorded in the Grey Box monitoring sites compared to desirable agricultural levels.

### 8.11.6 Cation Exchange Capacity

Cation Exchange Capacity (CEC) is the capacity of the soil to hold the major cations (calcium, magnesium, sodium and potassium) and is also a measure of the potential fertility of the soil. All of the Grey Box monitoring sites had a low CEC and in the reference sites CEC ranged from 4.2 – 8.6 cmol/kg (Figure 8-20). Sites GBReveg1, GBReveg2 and WBWood1 had a CEC which were similar to the reference sites. The remaining sites had a low CEC ranging from a low of 2.9 cmol/kg (GBReveg4) to a high of 3.8 cmol/kg (GBReveg2).

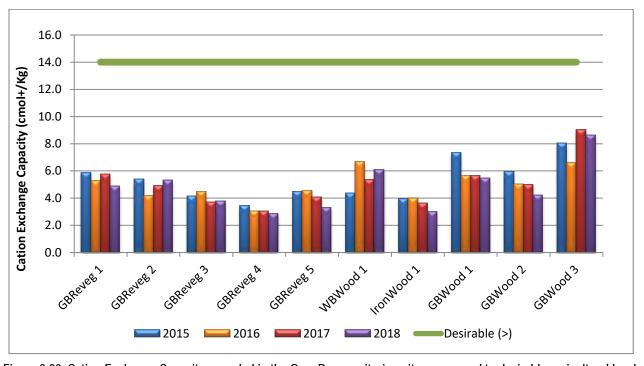


Figure 8-20. Cation Exchange Capacity recorded in the Grey Box monitoring sites compared to desirable agricultural levels.

### 8.11.7 Exchangeable Sodium Percentage

Sodicity refers to a significant proportion of sodium in the soil compared to other cations with soil considered to be sodic when there is sufficient sodium to interfere with its structural stability which often interferes with plant growth. Sodic soils tend to suffer from poor soil structure including hard soil, hardpans, surface crusting and rain pooling on the surface, which can affect water infiltration, drainage, plant growth, cultivation and site accessibility.

ESP recorded in the woodland reference sites was highly variable and ranged from 0.9 – 5.8% (Figure 8-21), with site GBWood2 slightly exceeding the minimum 5% threshold for sodicity. This year all remaining sites had an ESP that was well below the 5% threshold for sodicity and ranged from a low of 0.3% in GBReveg1 to a high of 3.7% in GBReveg2 indicating the soils are non sodic (Isbell 1996).

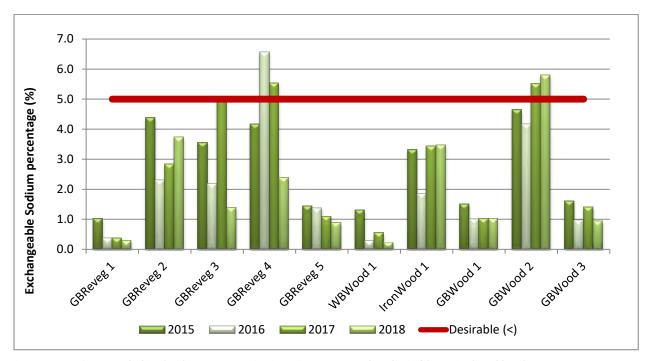


Figure 8-21. ESP recorded in the Grey Box monitoring sites compared to desirable agricultural levels.

# 8.12 Grey Box woodland site performance towards meeting woodland completion criteria targets

Table 8-8 indicates the performance of the Kokoda Grey Box monitoring sites against a selection of proposed Completion Performance Indicators during the 2018 monitoring period. The selection of criteria has been presented in order of ecosystem successional processes, beginning with landform establishment and stability (orange) and ending with indicators of ecosystem and landuse sustainability (blue). The range values are amended annually.

Monitoring sites meeting or exceeding the range values of the Grey Box woodland reference sites have been identified with a <u>shaded</u> colour box and have therefore been deemed to meet completion criteria targets. In the case of "growth medium development", upper and lower soil property indicators are also based on results obtained from the respective reference sites sampled in 2018. In some cases, the site may not fall within ranges based on these data, but may be within "desirable" levels as prescribed by the agricultural industry. If this scenario occurs, the rehabilitation site has been identified using a <u>striped shaded</u> box to indicate that it falls within "desirable" ranges but does not fall within specified completion criteria targets using the adopted methodology.

Table 8-8. Performance of the Grey Box revegetation monitoring sites against the Primary and Secondary Performance Indicators in 2018.

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	Wood	Box dland ystem 2018	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
Pe	erformance indic	ators are quantii	fied by the range	of values obtained fi	rom replicated referenc	e sites		2018		Lower	Upper				2018			
Phase 2: Landform establishment and stability	Landform slope, gradient	Landform suitable for final landuse and generally compatible with surrounding topography	Slope	Landform is generally compatible within the context of the local topography.		< Degrees (18°)	2	3	1	1	3	5	4	3	4	3	3	4
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	Number of gullies or rills >0.3m in width or depth in a 50m transect are limited and stabilising		No.	0	0	0	0	0	0	0	0	0	0	0	0
			Cross- sectional area of rills		Provides an assessment of the extent of soil loss due to gully and rill erosion and that it is limited and/or is stabilising	m2	0	0	0	0	0	0	0	0	0	0	0	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	Wood	/ Box dland ystem e 2018	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
Phase 3: Growth medium development	Soil chemical, physical properties and amelioration	Soil properties are suitable for the establishment and maintenance of selected	pH	pH is typical of that of the surrounding landscape or falls within desirable ranges provided by the agricultural industry		рН (5.6 - 7.3)	5.1	5.2	5.6	5.1	5.6	6.6	5.3	6.1	6.0	6.1	6.2	5.1
		vegetation species	EC		Electrical Conductivity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	< dS/m (<0.150)	0.067	0.059	0.065	0.059	0.067	0.023	0.064	0.021	0.018	0.015	0.037	0.038
			Organic Matter	Organic Carbon levels are typical of that of the surrounding landscape, increasing or fall within desirable ranges provided by the agricultural industry		% (>4.5)	6.5	4.5	7.5	4.5	7.5	2.7	5.2	3.4	2.3	1.8	3.1	3.6
			Phosphorous	Available Phosphorus is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry		ppm (50)	26.2	11.5	14.4	11.5	26.2	6.6	9.2	7.2	7.9	6.2	7.9	7.2
			Nitrate		Nitrate levels are typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	ppm (>12.5)	1.7	0.5	1.3	0.5	1.7	0.5	8.0	0.5	1.0	1.2	1.5	0.6

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	ecosy	dland	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
			CEC		Cation Exchange Capacity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	Cmol+/kg (>14)	5.5	4.2	8.6	4.2	8.6	4.9	5.3	3.8	2.9	3.3	6.1	3.0
			ESP		Exchangeable Sodium Percentage (a measure of sodicity) is typical of the surrounding landscape or is less than the 5% threshold for sodicity	% (<5)	1.0	5.8	0.9	0.9	5.8	0.3	3.7	1.4	2.4	0.9	0.2	3.5
Phase 4: Ecosystem & Landuse Establishment	Landscape Function Analysis (LFA): Landform stability and organisation	Landform is stable and performing as it was designed to do	LFA Stability	The LFA stability index provides an indication of the sites stability and is comparable to or trending towards that of the local remnant vegetation		%	63.5	64.7	70.1	63.5	70.1	71.1	68.5	73.1	69.0	74.4	61.0	66.3
			LFA Landscape organisation	The Landscape Organisation Index provides a measure of the ability of the site to retain resources and is comparable to that of the local remnant vegetation		%	100	97	100	97	100	100	100	100	100	100	100	100
	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the local remnant vegetation	Diversity of shrubs and juvenile trees	The diversity of shrubs and juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation.		species/area	1	3	3	1	3	1	0	0	0	0	3	6

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	Wood	Box dland ystem 2018	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
				The percentage of shrubs and juvenile trees with a stem diameter < 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		% population	100	100	100	100	100	100	0	0	0	0	100	100
			Total species richness		The total number of live plant species provides an indication of the floristic diversity of the site and is comparable to the local remnant vegetation	No./area	7	15	14	7	15	23	18	22	23	26	28	23
			Native species richness		The total number of live native plant species provides an indication of the native plant diversity of the site and that it is greater than or comparable to the local remnant vegetation	>No./area	7	15	13	7	15	10	12	11	11	13	28	23
			Exotic species richness	The total number of live exotic plant species provides an indication of the exotic plant diversity of the site and that it is less than or comparable to the local remnant vegetation		<no. area<="" td=""><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>13</td><td>6</td><td>11</td><td>12</td><td>13</td><td>0</td><td>0</td></no.>	0	0	1	0	1	13	6	11	12	13	0	0
	Vegetation density	Vegetation contains a density of species comparable to that of the local remnant	Density of shrubs and juvenile trees	The density of shrubs or juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant		No./area	1	19	4	1	19	1	0	0	0	0	5	139

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	Wood	Box dland ystem 2018	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
		vegetation		vegetation														
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable to that of the local remnant vegetation	Trees	The number of tree species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	1	2	2	1	2	1	0	0	0	0	3	4
			Shrubs	The number of shrub species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	1	3	2	1	3	0	0	0	0	0	2	3
			Sub-shrubs		The number of sub- shrub species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	1	0	0	1	0	0	0	0	0	2	4
			Herbs	The number of herbs or forb species comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	3	4	7	3	7	15	14	15	13	19	14	7
			Grasses		The number of grass species comprising the vegetation community is	No./area	2	4	3	2	4	7	3	6	8	5	6	4

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	Woo	/ Box dland ystem e 2018	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
					comparable to that of the local remnant vegetation													
			Reeds		The number of reed, sedge or rush species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	1	0	0	1	0	0	0	1	1	0	0
			Ferns		The number of ferns comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	0	0	0	0	0	1	1	1	1	1	1
			Vines		The number of vines or climbing species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	0	0	0	0	0	0	0	0	0	0	0
			Parasite		The number of parasite species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	0	0	0	0	0	0	0	0	0	0	0
Phase 5: Ecosystem & Landuse Sustainability	Landscape Function Analysis (LFA): Landform function and ecological performance	Landform is ecologically functional and performing as it was designed to do	LFA Infiltration	LFA infiltration index provides an indication of the sites infiltration capacity and is comparable to or trending towards that of the local remnant vegetation		%	50.6	55.7	54.5	50.6	55.7	44.3	37.6	46.5	43.3	47	50.6	52.5

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	Wood	Box dland ystem 2018	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
			LFA Nutrient recycling	LFA nutrient recycling index provides an indication of the sites ability to recycle nutrient and is comparable to or trending towards that of the local remnant vegetation		%	47.8	50.7	51.5	47.8	51.5	44.1	36.2	44.6	39	45.5	49.8	49.8
	Protective ground cover	Ground layer contains protective ground cover and habitat structure	Litter cover		Percent ground cover provided by dead plant material is comparable to that of the local remnant vegetation	%	87	98	90	87	98	59.5	53.5	54.5	69.5	68.5	95	84
		comparable with the local remnant vegetation	Annual plants		Percent ground cover provided by live annual plants is comparable to that of the local remnant vegetation	<%	0	0	0	0	0	24	4.5	19	23.5	22.5	0	0
			Cryptogam cover		Percent ground cover provided by cryptogams (eg mosses, lichens) is comparable to that of the local remnant vegetation	%	0	0	0	0	0	7	29.5	3.5	0.5	2	0	3.5
			Rock		Percent ground cover provided by stones or rocks (> 5cm diameter) is comparable to that of the local remnant vegetation	%	0	0	0	0	0	0	0	0	0	0	0	0
			Log		Percent ground cover provided by fallen branches and logs (>5cm) is comparable to that of the local remnant vegetation	%	6.5	0.5	2.5	1	7	0	0	0	0	0	0	4
			Bare ground		Percentage of bare ground is less than or comparable to	< %	6	2	4	2	6	0	6	2.5	1	1	0.5	6

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	Wood	/ Box dland ystem e 2018	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
					that of the local remnant vegetation													
			Perennial plant cover (< 0.5m)	Percent ground cover provided by live perennial vegetation (< 0.5m in height) is comparable to that of the local remnant vegetation		%	1	0	4	0	4	9.5	6.5	20.5	5.5	6	4.5	2.5
			Total Ground Cover	Total groundcover is the sum of protective ground cover components (as described above) and that it is comparable to that of the local remnant vegetation		%	94	98	97	94	98	100	94	97.5	99	99	99.5	94
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance		The abundance of native species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has more than or an equal number of native species as the local remnant vegetation	> species/m²	1.4	1.6	2.0	1	2	3.6	4	2.2	3.6	3.4	4.8	3.2
			Exotic understorey abundance		The abundance of exotic species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has less than or an equal number of exotic species as the local remnant	< species/m²	0	0	0	0	0	5.2	1.4	4.2	3.6	4	0	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	Wood	/ Box dland ystem e 2018	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
					vegetation													
	Native ground cover abundance	Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	The percent ground cover abundance of native species (<0.5m height) compared to exotic species is comparable to that of the local remnant vegetation		%	100	100	100	100	100	46.6	75	47.2	51.9	49.1	100	100
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of the local remnant vegetation	shrubs and juvenile trees 0 - 0.5m in height	The number of shrubs or juvenile trees < 0.5m in height provides an indication of establishment success and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	1	9	2	1	9	1	0	0	0	0	4	99
			shrubs and juvenile trees 0.5 - 1m in height	·	The number of shrubs or juvenile trees 0.5-1m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	8	1	0	8	0	0	0	0	0	1	36

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	Wood	Box dland ystem 2018	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
			shrubs and juvenile trees 1 - 1.5m in height		The number of shrubs or juvenile trees 1-1.5m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	2	0	0	2	0	0	0	0	0	0	2
			shrubs and juvenile trees 1.5 - 2m in height	The number of shrubs or juvenile trees 1.5-2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	0	0	0	0	0	0	0	0	0	0	0	1
			shrubs and juvenile trees >2m in height		The number of shrubs or juvenile trees > 2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	0	1	0	1	0	0	0	0	0	0	1
	Ecosystem structure	The vegetation is developing in structure and complexity comparable to that of the	Foliage cover 0.5 - 2 m	Projected foliage cover provided by perennial plants in the 0.5 - 2m vertical height stratum indicates the community		% cover	0	5	0	0	5	0	0	0	0	0	0	1

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	ecosy	dland	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
		local remnant vegetation		structure is comparable to that of the local remnant vegetation														
			Foliage cover 2 - 4m		Projected foliage cover provided by perennial plants in the 2 - 4m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	6	3	0	0	6	0	0	0	0	0	0	4
			Foliage cover 4 - 6m		Projected foliage cover provided by perennial plants in the 4 -6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	26	3	7	3	26	0	0	0	0	0	15	6
			Foliage cover >6m	Projected foliage cover provided by perennial plants > 6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	44	49	50	44	50	0	0	0	0	0	53	46
	Tree diversity	Vegetation contains a diversity of maturing tree and shrubs species comparable to that of the local remnant vegetation	Tree diversity	·	The diversity of trees or shrubs with a stem diameter > 5cm is comparable to the local remnant vegetation. Species used in rehabilitation will be endemic to the local area	species/area	1	2	2	1	2	0	0	0	0	0	3	4

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	ecosy	dland	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
				The percentage of maturing trees and shrubs with a stem diameter > 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		%	100	100	100	100	100	0	0	0	0	0	100	100
	Tree density	Vegetation contains a density of maturing tree and shrubs species comparable to that of the	Tree density	The density of shrubs or trees with a stem diameter > 5cm is comparable to that of the local remnant vegetation		No./area	8	23	20	8	23	0	0	0	0	0	8	40
		local remnant vegetation	Average dbh		Average tree diameter of the tree population provides a measure of age, (height) and growth rate and that it is trending towards that of the local remnant vegetation.	cm	34	17	24	17	34	0	0	0	0	0	30	17
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant vegetation.	Live trees	The percentage of the tree population which are live individuals and that the percentage is comparable to the local remnant vegetation		% population	100	100	85	85	100	0	0	0	0	0	100	72.5
			Healthy trees	The percentage of the tree population which are in healthy condition and that the percentage is comparable to the local remnant vegetation		% population	0	30	15	0	30	0	0	0	0	0	12.5	2.5

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	Wood	Box dland ystem 2018	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
			Medium health		The percentage of the tree population which are in a medium health condition and that the percentage is comparable to the local remnant vegetation	% population	75	43	50	43	75	0	0	0	0	0	62.5	32.5
			Advanced dieback		The percentage of the tree population which are in a state of advanced dieback and that the percentage is comparable to the local remnant vegetation	<% population	25	26	20	20	26	0	0	0	0	0	25	37.5
			Dead Trees		The percentage of the tree population which are dead (stags) and that the percentage is comparable to the local remnant vegetation	% population	0	0	15	0	15	0	0	0	0	0	0	27.5
			Mistletoe		The percentage of the tree population which have mistletoe provides an indication of community health and habitat value and that the percentage is comparable to the local remnant vegetation	% population	0	0	0	0	0	0	0	0	0	0	0	0
			Flowers/fruit: Trees	The percentage of the tree population with reproductive structures such as buds, flowers or fruit provides evidence that the ecosystem is maturing, capable		% population	13	0	50	0	50	0	0	0	0	0	50	22.5

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measurement	GBWood1	GBWood2	GBWood3	Wood	Box dland ystem 2018	GBReveg 1	GBReveg 2	GBReveg 3	GBReveg 4	GBReveg 5	WBWood 1	IronWood 1
				of recruitment and can provide habitat resources comparable to that of the local remnant vegetation														
			Hollows: Trees		The percentage of the tree population which have hollows provides an indication of the habitat value and that the percentage is comparable to the local remnant vegetation	% population	50	52	0	0	52	0	0	0	0	0	0	0

# 9 Results Dwyer's Red Gum monitoring sites

This section provides the results of the monitoring within the Dwyer's Red Gum monitoring sites and demonstrates ecological trends and performance of the revegetation sites against a selection of ecological performance indicators. This section has also included the Low Quality Dwyer's Red Gum woodland.

# 9.1 Photo-points

General descriptions of the Dwyer's Red Gum Woodland monitoring sites established at Kokoda in 2015 including photographs taken along the vegetation transect are provided Table 9-1.

Table 9-1. General site descriptions and permanent photo-points of the Dwyer's Red Gum monitoring sites at Kokoda.

2015	2016	2017	2018
		Grass, but the exotic annuals Hypochaeris glabra	
Fescue) were also abundant. The site was relative	ely diverse and maintained good ground cover. Mos	sses and cryptogam were common and there was s	ome scattered <i>E. dwyeri</i> regeneration 0.5 – 2.0m
in height. In 2016 there was slightly more bioma	ss and the eucalypt saplings had grown. In 2017,	the grass was grazed low except for scattered str	essed tussocks of Aristida and scattered annual
		remnant grass tussocks were very stressed and the	e ground cover in between was grazed very low.
There continued to be a lot of moss cover (dead) a	and the eucalypt saplings had grown.		
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2015 2016 2017 2018

**DReveg2**: Degraded native pasture dominated by *Aristida racemosa* (three-awn Grass, but the exotic annuals *Hypochaeris glabra* (Smooth Catsear) and *Vulpia muralis* (Rats-tail Fescue) were also abundant. The site was relatively diverse and maintained relatively good ground cover. Mosses and cryptogam were scattered throughout. Presently there was no tree or shrub regeneration. In 2016 there was slightly more biomass but little other change was apparent. In 2017, the grass was grazed low except for scattered stressed tussocks of Aristida leaving limited ground cover apart from litter and cryptogams and some small bare patches have developed. There was evidence of rabbits (scratchings). In 2018, the remnant grass tussocks were very stressed and the ground cover in between was grazed very low. There was a decline in cryptogam cover and bare patches were developing. There continued to be a lot of moss cover (dead) and a lot of macropod/rabbit scat had accumulated.



DReveg3: Degraded native pasture dominated by the exotic annuals *Hypochaeris glabra* (Smooth Catsear), *Vulpia muralis* (Rats-tail Fescue), *Aira cupaniana* (Silvery Hairgrass) and *Parentucellia latifolia* (Red Bartsia). The site was however relatively diverse and maintained relatively good ground cover. Mosses and cryptogam were scattered throughout. Presently there was no tree or shrub regeneration. In 2016 there was slightly more biomass but little other change was apparent. In 2017, the grass was grazed low except for scattered stressed tussocks of Aristida but good ground cover has been maintained. In 2018, the remnant grass tussocks were very stressed and the ground cover in between was grazed very low and bare patches were starting to develop.



2015 2016 2017 2018

**DWoodLQ:** Open regrowth *E. dwyeri* woodland with occasional *E. albens* on the cleared grazing ecotone. The understorey was diverse but contained an abundance of annual grasses and forbs. The site maintained good ground cover with leaf litter dominant under the mature trees canopies. In 2016 there was a significant increase in live ground cover and the trees appeared healthier. In 2017, there was a good cover of eucalypt leaf litter and scattered native grasses. The majority of trees were in medium health. In 2018, the remnant grass tussocks were very stressed and the ground cover in between was grazed very low and bare patches were starting to develop.



**DWood1:** Regrowth *E. dwyeri – Callitris* endlicheri woodland with scattered *E. dwyeri* and *E. dealbata* trees and a moderate density of *Callitris* endlicheri saplings. Many saplings have recently died probably over the prolonged summer which has opened up the canopy. *Gonocarpus tetragynus* (Hill Raspwort), *Cheilanthes sieberi* (Rock fern) and *Hypochaeris glabra* (Smooth Catsear) are dominant in the understorey and there is a god cover of leaf litter. There are many fallen branches and Cypress trunks and there is an adjacent rocky granite outcrop. There were numerous *Callitris* seedlings. In 2016 there was little apparent change. In 2017, there was typically a good cover of leaf litter and scattered native grasses and perennial forbs with these being stressed. The trees appeared healthy. More mature Callitris have died with more also having fallen over. In 2018 the site had opened up with remaining trees appearing to be healthy. There was little live ground cover and some Callitris regeneration has persisted.



2015 2016 2017 2018

**DWood2**: Relatively open regrowth woodland of *Callitris endlicheri* and occasional *E. sideroxylon* (Mugga Ironbark). There were many Callitris stags with some having fallen down. There were scattered pockets of *Brachyloma daphnoides* (Daphne Heath) and a range of sparsely scattered native herbs however *Vulpia muralis* (Rat's Tail Fescue) was also common in pockets. There was extensive Callitris regeneration ~ 5cm in height. Coral Lichen was common throughout the larger woodland area and were present at the end of the vegetation transect. There was an extensive network of ant tunnels. In 2016 there was a significant increase in live ground cover. In 2017, there was typically a good cover of leaf litter, scattered sub-shrubs but live ground cover was limited. Occasional patches of lichens and mosses. At end of the veg transect the ground felt spongy, probably as a result of past ant activity. In 2018 there was little live ground cover and some Callitris regeneration has persisted.



**DWood3:** A grassy clearing with low density *E. dwyeri – Callitris endlicheri* in the bottom of the slope within a major drainage depression. There were scattered patches of *Calytrix tetragona* and a significant number of small *Callitris* and *Calytrix* seedlings. The understorey contained a wide diversity of native herbs. There was extensive sedimentation within the site as a result of extensive overland erosion from the adjacent slopes which had low ground cover. In 2016 there was a significant increase in live ground cover and the understorey shrubs were flowering. In 2017, site had been heavily grazed. Typically good ground cover had been retained but there was limited live ground cover and the Calytrix were very stressed. The mature trees also appeared to be drought stressed, there continued to be a significant number of small *Callitris* seedlings. In 2018 there was little apparent change.



# 9.2 Landscape Function Analyses

### 9.2.1 Landscape Organisation

A patch is an area within an ecosystem where resources such as soil and litter tend to accumulate, while areas where resources are mobilised and transported away are referred to as interpatches. Landscape Organisation Indices (LOI) are calculated by the length of the patches divided by the length of the transect to provide an index or percent of the transect which is occupied by functional patch areas (Tongway and Hindley 2004).

The three Dwyer's Red Gum woodland reference sites were characterised by having a mature tree canopy and a well developed decomposing leaf litter layer and a sparse cover of native perennial forbs and grasses and collectively provided a highly functional patch area. This year heavy grazing and disturbance by animals resulted in a reduction in patch area in DWood3, to provide a slightly lower target LO range of 92 - 100%.

While the Dwyer's Red Gum revegetation sites presently existed as degraded pastures and were structurally different to the woodland reference sites, they typically had good ground cover comprised of a combination of annual and perennial plants and cryptogams. These sites also had a high functional patch areas had 100% LO except for DReveg2 which had slightly declined to 86% LO this year due to heavy grazing (Figure 9-1).

The low quality Dwyer's Red Gum woodland site was characterised with having an open mature tree canopy, moderate cover of annual and perennial ground cover species and typically had a well developed leaf litter layer but this was patchy. This site also had a high functional patch area and continued to score an LO of 100%.

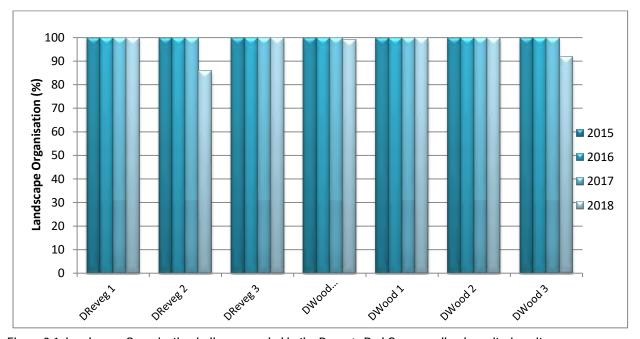


Figure 9-1. Landscape Organisation Indices recorded in the Dwyer's Red Gum woodland monitoring sites.

#### 9.2.2 Soil surface assessments

# 9.2.2.1 Stability

LFA stability indices in the Dwyer's Red Gum reference sites were previously demonstrating an increasing trend however this year slight decreases were recorded in DWood2 and DWood3 to provide a range of 62.2 – 74.0. The stability in these sites was being provided by the perennial tree and ground cover, moderately deep and

decomposing litter layers and cryptogams were often moderately abundant. This year however, heavy grazing and disturbance by animals has tended to reduce the integrity of the ground covers and litter layers where the soils become more susceptible to erosion and deposition. In the low quality woodland the stability index had also slightly decreased to 65.2 however it remained comparable to the woodland reference sites (Figure 9-2).

In the Dwyer's Red Gum derived native grasslands stability also tended to decline in all sites except DReveg1 and stability indices ranged from a low of 65.5 (DReveg3) to a high of 74.1 (DReveg1) and all sites continued to have a stability which was similar to or more stable than the reference sites. Despite the lack of a mature tree canopy, the high stability indices can be attributed to the high abundance of perennial ground covers, very hard soil crusts which usually contained a significant abundance of cryptogam cover. The sandy clay soils were subjected to some slaking but there tended to be less recent evidence of erosion or deposition within these sites in comparison to the reference sites.

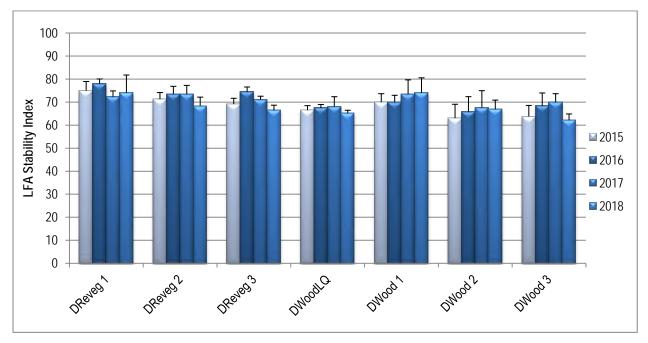


Figure 9-2. LFA stability indices recorded in the Dwyer's Red Gum woodland monitoring sites.

#### 9.2.2.2 Infiltration

The infiltration capacity of the Dwyer's Red Gum and the low quality woodland (DWoodLQ) were quite similar to each other and these have demonstrated an increasing trend up until this year. The drought conditions have resulted in the deterioration of the litter and an increased resistance of the soils crusts. This year the infiltration capacity of the reference sites was 49.7 – 54.8, with the low quality woodland site having a comparable index of 54.5 (Figure 9-3).

In the derived grassland revegetation sites, the litter layer was undeveloped and there typically was a hard surface crust which reduces the infiltration capacity of moisture to enter the soil profile, but cryptogams were often abundant. Over the past two years however, there has tended to be an increase in leaf litter and cryptogams and the soils had become more coherent and stable. In the grassland revegetation sites the dry conditions, combined with heavy grazing has resulted in a reduction in integrity of the herbaceous ground covers and litter and cryptogam layers. Thus the infiltration capacity in these sites has declined to provide indices ranging from 38.4 – 45.7. All Dwyer's Red Gum revegetation sites therefore had a low infiltration capacity compared to the reference sites again this year.

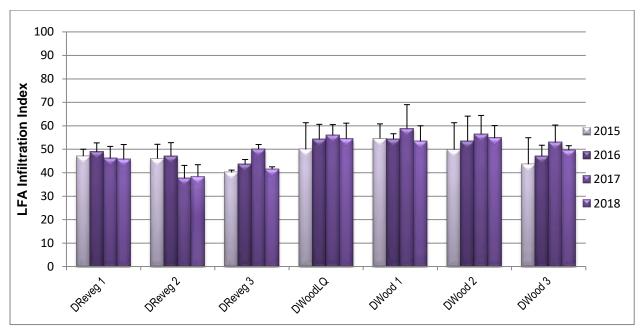


Figure 9-3. LFA infiltration indices recorded in the Dwyer's Red Gum woodland monitoring sites.

### 9.2.2.3 Nutrient recycling

The nutrient recycling capacity is influenced by the degree of perennial plant cover and accumulation and decomposition of the litter layers, which is in turn influenced by the degree of soil compaction and soil surface crusting. In the Dwyer's Red Gum woodland reference sites and the low quality woodland, there was a mature overstorey and there tended to be a low abundance of perennial ground cover but there were well developed litter layers though the sites were patchy. Similarly the drought conditions has resulted in a decrease in nutrient recycling capacity in the Dwyer's Red Gum woodland reference sites to provide a range of 47.6 – 51.3 with the low quality woodland scoring 53.7 this year (Figure 9-4).

In the Dwyer's Red Gum revegetation sites there was also a reduction in nutrient recycling capacity this year with a low of 36.2 in DReveg3 and a high of 42.7 in DReveg1.

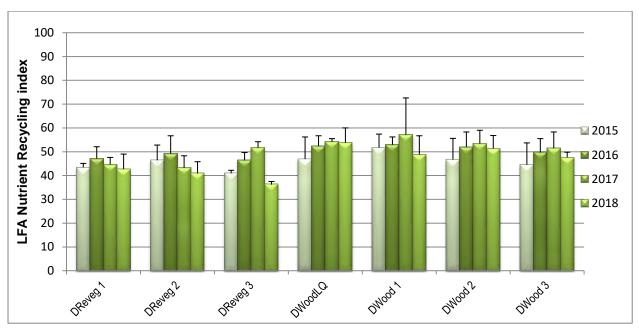


Figure 9-4. LFA nutrient recycling indices recorded in the Dwyer's Red Gum woodland monitoring sites.

#### 9.2.3 Most functional sites

The sum of the LFA stability, infiltration and nutrient recycling components provide an indication of the most functional to least functional monitoring sites recorded this year and is provided in Figure 9-5. The maximum score possible is 300 with the Dwyer's Red Gum reference site DWood1 continuing to be the most ecologically functional site with a total score of 176. The low quality woodland DWoodLQ and DWood2 were very similar to each other with a sum of scores of 173. This was followed by DReveg1 and DWood3 with163 and 160 respectively. DReveg2 and DReveg3 were the least functional sites this year with scores of 148 and 144.

Examples of the various combinations of ground covers which are critical to overall ecosystem function have been provided in Table 9-2.

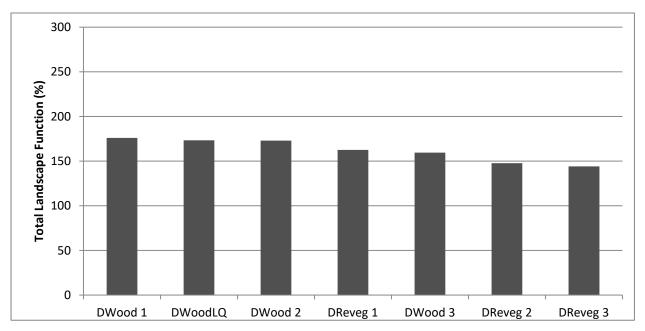


Figure 9-5. Sum of the LFA stability, infiltration and nutrient recycling components indicating the most functional to least functional monitoring site recorded in 2018.

DReveg1

DReveg2

Table 9-2. Examples of the different ground covers in the Kokoda Dwyer's Red Gum monitoring sites in 2018.



# 9.3 Trees and mature shrubs

### 9.3.1 Population density

Trees and mature shrubs with a stem diameter >5cm dbh were recorded in the three Dwyer's Red Gum woodland reference sites as well as the low quality Dwyer's Red Gum woodland. This year there were 8 – 27 live individuals in the reference sites, equating to a density of 200 – 725 stems per hectare (Figure 9-6). An additional tree was recorded in DWood3, but in DWood2, two individuals had died. There continued to be nine individuals in the low quality woodland. One juvenile eucalypt continued to be recorded in DReveg1, but no trees or mature shrubs were present in the other two derived native grassland sites.

## 9.3.2 Diameter at breast height

The average dbh recorded in the Dwyer's Red Gum reference sites continued to be 11 – 23cm but ranged from 5 – 50cm (Table 9-3). The small trunk diameters indicate the trees are relatively young and indicative of their regrowth status. In the low quality woodland the average dbh was 22 cm with the maximum dbh of 26cm. In DReveg1, the sapling had a slightly larger dbh of 6 cm.

#### 9.3.3 Condition

The trees and mature shrubs in the Dwyer's Red Gum woodland reference sites were typically in moderate health but 67% of the population were (dead) stags in DWood1, while in DWood2 and DWood3 20 – 22% were stags. A small percentage of the population in all three sites were bearing reproductive structures such as buds, flowers or fruit this year. Mistletoe was recorded in DWood3 while in DWood1 a small percentage of individuals contained hollows suitable for nesting sites (>10cm). In the low quality woodland all trees were typically in medium health with some in a state of advanced dieback. Most eucalypts were bearing mature fruit. The eucalypt sapling in DReveg1 was considered to be healthy.

## 9.3.4 Species composition

The Dwyer's Red Gum reference sites were dominated by *Callitris endlicheri* (Black Cypress Pine) although there may also have been scattered individuals of *Allocasuarina verticillata* (Drooping Sheoak), *E. dealbata* (Tumbledown Red Gum), *E. sideroxylon* and/or *E. albens*. The low quality woodland was dominated by *E. dwyeri* and contained one *E. albens* (White Box). The single individual in DReveg1 was an *E. dwyeri* sapling.

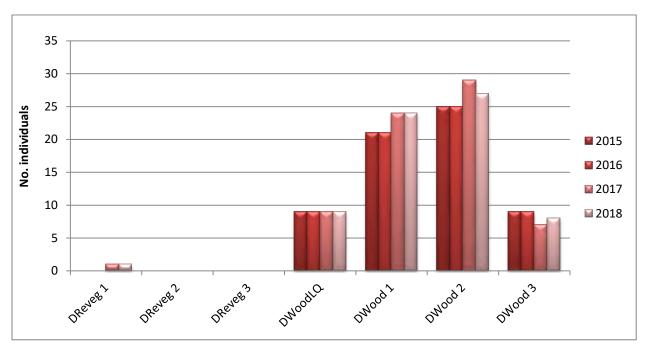


Figure 9-6. Tree and mature shrub densities (>5cm dbh) in the Kokoda Dwyer's Red Gum woodland monitoring sites.

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Site Name	No species	Average dbh (cm)	Max dbh (cm)	Min dbh (cm)	Total trees	No. with multiple limbs	% Live trees	% Healthy	% Medium Health	% Advanced Dieback	% Dead	% Mistletoe	% Flowers / fruit	%. Trees with hollows
DReveg1	1	6	6	6	1	1	100	100	0	0	0	0	0	0
DReveg2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DReveg3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DWoodLQ	2	22	26	16	9	7	100	0	33	67	0	0	67	0
DWood1	3	11	29	5	73	1	33	8	21	4	67	0	18	4
DWood2	3	17	50	5	37	1	73	3	54	16	27	0	35	0
DWood3	3	23	32	7	10	2	80	20	30	30	20	10	70	0

Table 9-3. Trunk diameters and condition of the trees and mature shrubs in the Dwyer's Red Gum monitoring sites in 2018.

# 9.4 Shrubs and juvenile trees

# 9.4.1 Population density

There was a large variation on the number of shrubs and juvenile trees (<5cm dbh) recorded in the Dwyer's Red Gum reference sites with densities ranging from 208 – 1566 individuals (Figure 9-7). In the low quality woodland there were 11 shrubs and juvenile trees this year. In the derived grasslands, there were 11 seedlings recorded in DReveg1, two in DReveg2 and in DReveg3 there was one *Allocasuarina verticillata* seedling with these being the result of natural regeneration.

## 9.4.2 Height class

In the reference sites the vast majority of individuals were less than 0.5m in height, with some individuals being >2.0m in height in DWood3 (Table 9-4). In DReveg2, DReveg3 and the low quality woodland (DWoodLQ) all individuals were less than 0.5m in height. In DReveg1 all height classes continue to be represented.

# 9.4.3 Species diversity

In the woodland reference sites there were 3 - 7 species of shrubs and juvenile trees with the most abundant species being young *Callitris endlicheri* seedlings. There were also low occurrences of a range of other species including *Acacia spp* (Spearwood?), *Brachyloma daphnoides* (Daphne Heath), *E. dealbata, Allocasuarina verticillata* (Drooping She oak), *Cassinia laevis* (Cough Bush). In DWood3 there was a high density of *Callitris endlicheri* seedlings and *Calytrix tetragona* (Fringe Myrtle). In DWoodLQ, there were nine scattered *E. dwyeri*, one *A. lanigera* (Varnish Wattle) and one *A. implexa* Hickory) seedlings.

In DReveg1 most individuals were *E. dwyeri* saplings but one *A. decora* seedlings continued to be recorded. One *A. decora* and one *Cassinia laevis* seedling was also recorded in DReveg2. In DReveg3, one *Allocasuarina verticillata* was present which had been heavily browsed.

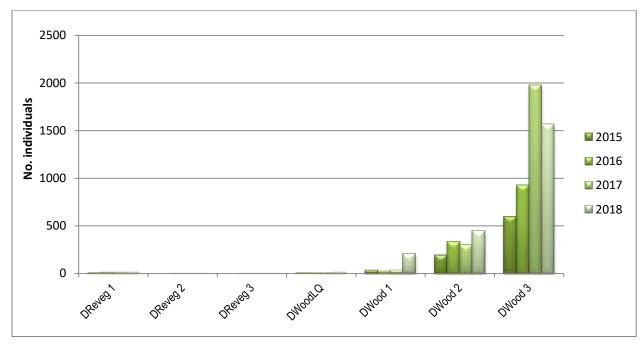


Figure 9-7. Total shrubs and juvenile trees recorded in the Dwyer's Red Gum monitoring sites.

Table 9-4 Number of individuals represented in each height class across the range of monitoring sites.

Site Name	0-0.5m	0.5-1.0m	1.0-1.5m	1.5-2.0m	>2.0m	Total	No. species	% Endemic
DReveg1	1	1	3	4	2	11	2	100
DReveg2	2	0	0	0	0	2	2	100
DReveg3	1	0	0	0	0	1	1	100
DWoodLQ	11	0	0	0	0	11	3	100
DWood1	208	0	0	0	0	208	3	100
DWood2	404	44	0	0	0	448	3	100
DWood3	1244	262	58	0	2	1566	7	100

# 9.5 Total ground Cover

Total ground cover, which is a combination of leaf litter, annual plants, cryptogams, rocks, logs and live perennial plants (<0.5m in height) was relatively high in the Dwyer's Red Gum woodland reference sites. This year ground cover decreased in two of the three reference sites due to overgrazing and ant nests, while a marginal increase was recorded in DWood02. This year the target range was 85.5 – 96.5% total ground cover (Figure 9-8). Heavy grazing also caused a reduction on total ground cover in the grassland areas however they ranged from a low of 87.5% in DReveg2 to a high of 98% in DReveg1, with all revegetation sites and the low quality woodland having total ground cover that was similar to or better than the reference sites this year.

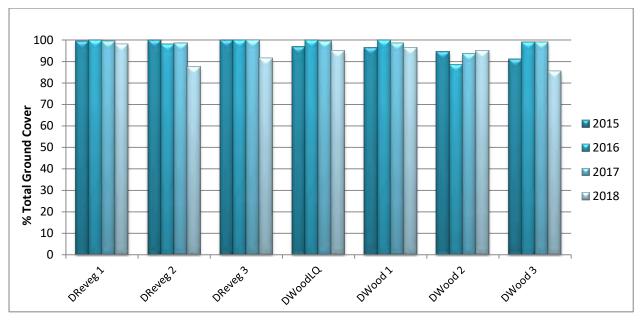


Figure 9-8. Total ground cover recorded in the Dwyer's Red Gum woodland monitoring sites.

# 9.6 Structural composition

The various combinations of the ground covers and structural compositions of the woodland sites are provided in Figure 9-9. In the Dwyer's Red Gum woodland reference sites the most dominant form of ground cover continued to be dead leaf litter with these providing 71 - 86.5% of the total ground cover. This year there was 2.5 - 6.5% perennial vegetation cover and there was no annual ground cover as a result of the prolonged dry conditions. There continued to be a small contribution provided by cryptogams which provided 1.0 - 7.0% ground cover. There was up to 7.0% cover provided by fallen branches, and in DWood1 there were scattered rocks.

The low quality woodland had similar features and in similar proportions to the reference sites but did not tend to have fallen branches or rocks. The reference sites and the low quality woodland were also characterised by having a mature canopy cover which exceeded 6.0m in height with low hanging branches (and scattered shrubs) also providing occasional projected cover in the lower height classes.

In comparison the revegetation sites continued to be dominated by various proportions of annual and perennial plants and dead leaf litter and this year all three sites had adequate covers of perennial plants and cryptogams. No cover >0.5m in height was recorded this year due to heavy grazing and lack of shrub or tree canopies. Examples of the various structural compositions of the individual sites have been provided in Table 9-5.

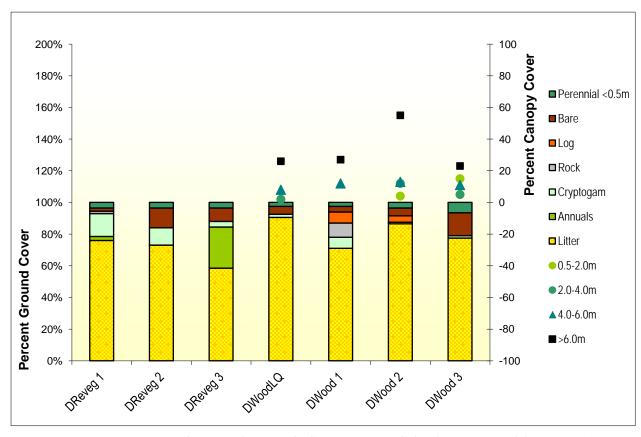


Figure 9-9. Average percent ground cover and projected foliage cover recorded in the Dwyer's Red Gum monitoring sites.

Table 9-5. Structural compositions of the Dwyer's Red Gum monitoring sites in 2018.

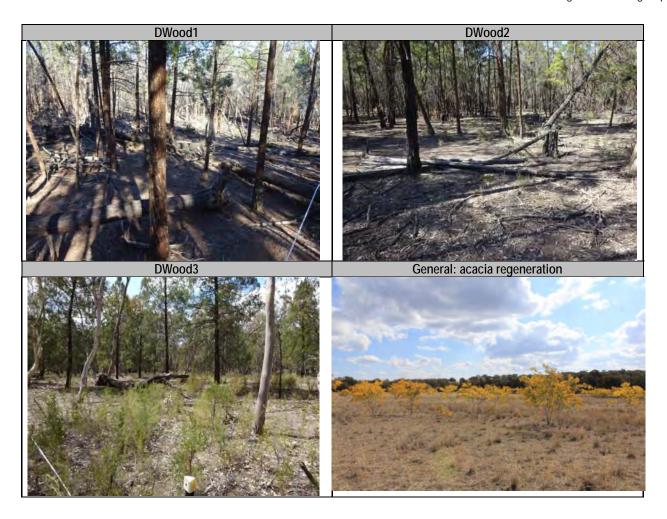
DReveg1

DReveg2

DReveg3

DReveg3

DWoodLQ



# 9.7 Floristic Diversity

Total floristic diversity recorded within the 20 x 20m Dwyer's Red Gum monitoring sites significantly increased in 2016 as result of the favourable seasonal conditions with 46 - 52 species being recorded, with increased diversity typically being recorded across all monitoring sites (Figure 9-10). Since 2017 there have been prolonged dry conditions and floristic diversity continued to decline with only 19 - 31 species recorded in the reference sites this year.

In the low quality woodland there were a total of 17 species which was slightly low compared to the reference sites. All other revegetation monitoring sites demonstrated a similar reduction in diversity, however only nine species were recorded in DReveg2 this year which was significantly lower than was recorded in previous years and much lower than the reference sites. There were 23 and 32 species in DReveg1 and DReveg3 respectively, with these having a similar or higher total diversity than the reference sites.

In the Dwyer's Red Gum woodland reference sites, native species continued to be more diverse than exotic species with 19 – 28 native species and only 0 – 3 exotic species being recorded this year. There were 17 native species in the low quality woodland which was slightly lower than was recorded in the reference sites, however no exotic species were recorded (Figure 9-11, Figure 9-12). In the revegetation grassland sites there were more native species than exotics this year. While no exotic species were recorded in DReveg2, there were seven and 12 in DReveg1 and DReveg3 respectively.

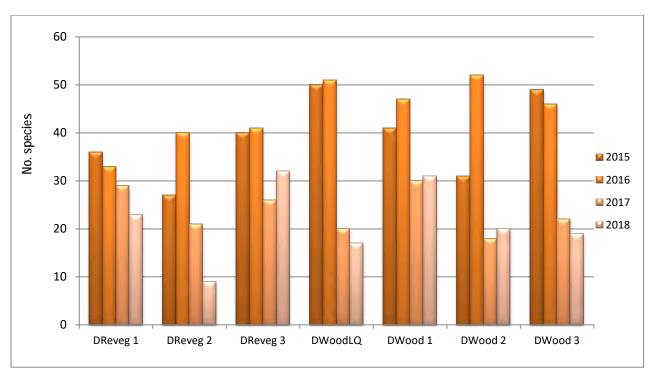


Figure 9-10. Total species diversity recorded in the Dwyer's Red Gum monitoring sites.

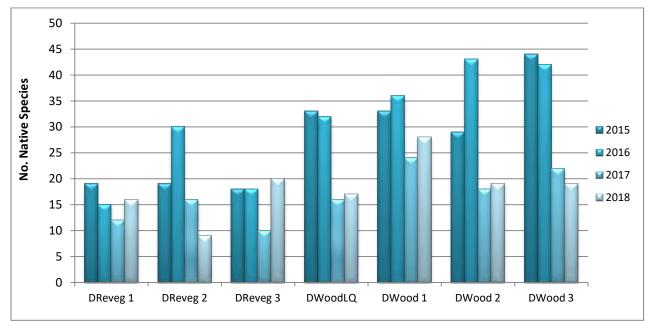


Figure 9-11. Total native species recorded in the Dwyer's Red Gum monitoring sites.

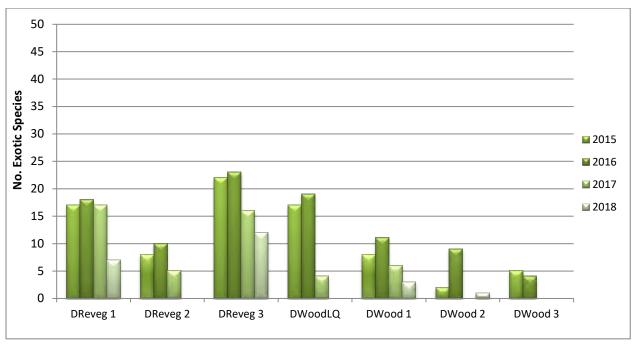


Figure 9-12. Total exotic species recorded in the Dwyer's Red Gum monitoring sites.

#### 9.7.1 Percent endemic ground cover

The percent endemic ground cover is an ecological indicator used to provide some measure of the cover abundance of the live native vegetation along the vegetation transect and therefore indicates the level of weediness at the monitoring sites. While it is only estimation the percent cover of endemic ground cover species has been derived by the following equation.

Percent cover endemic species = sum of the five Braun- blanquet scores for native species / (sum of the five Braun- blanquet scores of exotic species + native species) x 100

In the Dwyer's Red Gum woodland reference sites most of the live plant cover has been provided by native species, however cover provide by native plants in 2016 was slightly lower due to the increase in exotic annual plant cover. Since 2017, there has been a decline in exotic plant cover, with 96 – 100% of the live plant cover being native species this year (Figure 9-13).

This increase in native plant cover has also occurred in the revegetation sites this year, as the dry conditions and heavy grazing had resulted in the loss of or absence of exotic species, leaving mostly hardy perennial native species. There was no change in DWoodLQ. Native plants provided 100% cover in DReveg2 and DWoodLQ this year. In DReveg1 and DReveg3 native plants provided 64% and 50% of the live ground cover and therefore were weedier than desired.

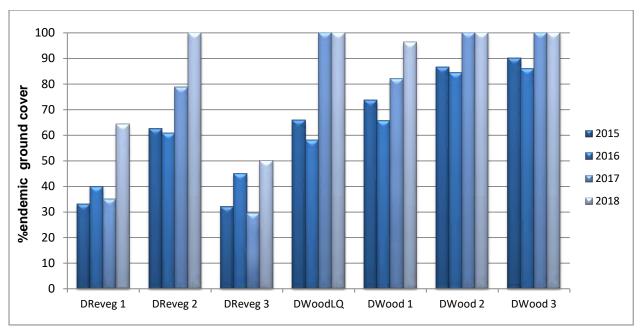


Figure 9-13. Percent endemic ground cover recorded in the Dwyer's Red Gum monitoring sites.

# 9.8 Vegetation composition

The composition of the vegetation as categorised by eight different growth forms is given in Figure 9-14. In the Dwyer's Red Gum woodland reference sites herbs were the most diverse plant group with 3 - 15 different species followed by grasses with 3 - 7 species. There were 3 - 4 tree species, 2 - 4 shrub species and 2 subshrubs were recorded in the reference sites. There were 0 - 2 reed species, 0 - 1 species of fern, while DWood3 also had one parasite species i.e. (Mistletoe).

The low quality woodland site had similar composition of the herbaceous ground covers, but it had a low diversity of tree species and no sub – shrubs were recorded. In the grassland revegetation areas there was presently a low diversity of trees and no sub-shrubs were recorded. In DReveg1 and DReveg3 there was also a low diversity of shrubs.

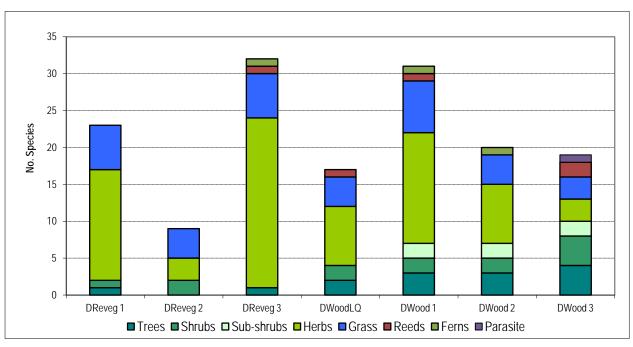


Figure 9-14. Composition of the vegetation recorded in the Dwyer's Red Gum monitoring sites in 2018.

# 9.9 Most common species

The most common species recorded in the revegetation sites is provided in (Table 9-6). This year the native perennial ground covers *Bothriochloa macra* (Red-leg Grass) and *Haloragis heterophylla* (Rough Raspwort) were recorded in all sites, however they were not present in the reference sites.

Other common native perennials included *Aristida ramosa* (Threeawn Grass) and *Tricoryne elatior* (Yellow Autumn-lily), while common annual natives included *Triptilodiscus pygmaeus* (Austral Sunray) and Xerochrysum bracteatum (Golden Everlasting). A comprehensive list of species recorded in all monitoring sites has been included in Appendix 1.

Table 9-6. The most common species recorded in the Dwyer's Red Gum monitoring sites in 2018.

exotic	Scientific Name	Common Name	Habit	DReveg1	DReveg2	DReveg3	DWoodLQ	Total	DWood1	DWood2	DWood3
	Bothriochloa macra	Red-leg Grass	g	1	1	1	1	4			
	Haloragis heterophylla	Rough Raspwort	h	1	1	1	1	4			
	Aristida ramosa	Threeawn Grass	g	1	1	1		3			1
	Tricoryne elatior	Yellow Autumn-lily	h	1	1		1	3	1		
	Triptilodiscus pygmaeus	Austral Sunray	h	1		1	1	3	1		
	Xerochrysum bracteatum	Golden Everlasting	h	1		1	1	3			

Note: "1: denotes the presence of that species and is not a measure of cover abundance

Key to habit legend: t = tree; s = shrub; ss =sub-shrub; h = herb; g = grass, r = reed; v = vine; f = fern; p = parasite

# 9.10 Most abundant species

The most abundant species recorded in each of the Dwyer's Red Gum monitoring sites this year are provided in Table 9-7. The most abundant species were those that collectively summed to a Braun-blanquet total of 10 or more from the five replicated sub-plots along the vegetation transect. The maximum score that can be obtained by an individual species is 30.

No species were sufficiently abundant to meet the criteria in the Dwyer's Red Gum reference sites or in DReveg1 or DWoodLQ this year. *Aristida ramosa* (Threeawn Grass) a native grasses provided the most plant cover in DReveg2, while *Hypochaeris glabra* (Smooth Catsear) an exotic annual weed was the most abundant species in DReveg3 this year.

Table 9-7. The most abundant species recorded in the Dwyer's Red Gum monitoring sites in 2018.

Scientific Name	Common Name	DReveg1	DReveg2	DReveg3	DWoodLQ	DWood1	DWood2	DWood3
Aristida ramosa	Threeawn Grass		10					
*Hypochaeris glabra	Smooth Catsear			12				

## 9.11 Soil analyses

#### 9.11.1 pH

Figure 9-15 shows the pH recorded in the Dwyer's Red Gum monitoring sites compared to the "desirable" range in medium or clay loam soils as prescribed by the agricultural industry for growing introduced pastures and crops. There has continued to be negligible change in the soil pH range across the sites and this year pH in the woodland reference sites remained slightly lower than or just within the threshold desirable agricultural ranges. With soil pH ranging from 5.0 – 5.5 the soils were strongly to very strongly acidic (Bruce & Rayment 1982).

In the remaining sites the soil pH ranged from a low of 5.2 in DReveg3 to a high of 5.7 in DReveg2 indicating the soils were moderately to strongly acidic. Soil pH in the revegetation sites and low quality woodland (DWoodLQ) were therefore comparable to the local woodlands and just within the desirable agricultural range.

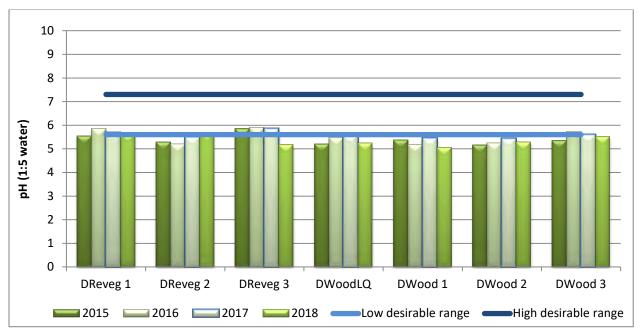


Figure 9-15. Soil pH recorded in the Dwyer's Red Gum monitoring sites compared to the desirable agricultural range.

#### 9.11.2 Conductivity

Figure 9-16 shows the Electrical Conductivity (EC) recorded in the Dwyer's Red Gum monitoring sites compared to the "desirable" range in medium or clay loam soils as prescribed by the agricultural industry for growing introduced pastures and crops. The EC recorded across the range of sites remained well below the agricultural threshold indicating there are very low levels of soluble salts in the soil profile and that they are non saline. The EC readings in the reference sites ranged from 0.022 – 0.031 dS/m. In the remaining sites EC ranged from a low of 0.012 dS/m in DReveg3 to a high of 0.029 dS/m in DWoodLQ.

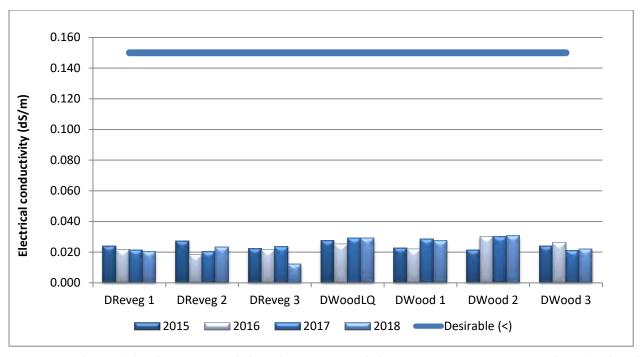


Figure 9-16. Electrical Conductivity recorded in the Dwyer's Red Gum monitoring sites compared to the desirable agricultural levels.

## 9.11.3 Organic Matter

In the Dwyer's Red Gum woodland reference sites OM levels ranged from 2.9 - 5.5% with high OM content recorded in DWood1 and DWood2 which were close to or slightly exceeding the desirable agricultural threshold of 4.5% (Figure 9-17). OM in the derived grassland sites were lower than the Dwyer's Red Gum woodland reference sites with OM concentrations of 2.2 - 3.5%, and so was OM in the low quality woodland which had 3.2% OM.

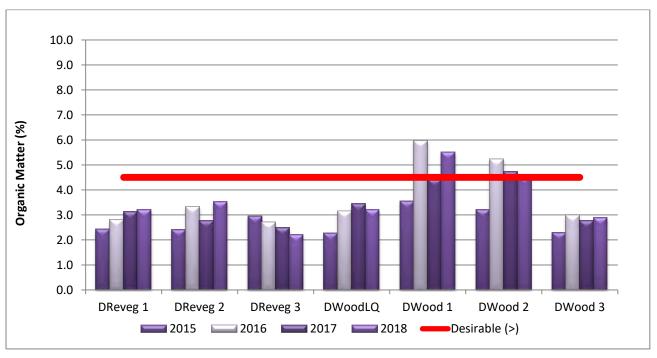


Figure 9-17. Organic Matter concentrations recorded in the Dwyer's Red Gum monitoring sites compared to desirable agricultural levels.

## 9.11.4 Phosphorous

Phosphorous levels were lower than the agricultural standards across all Dwyer's Red Gum monitoring sites and these had decreased over the past year. In the woodland reference sites P concentrations were 7-8 mg/kg. P in the derived grassland sites was similar to Dwyer's Red Gum woodland reference sites with concentrations of 8-9 mg/kg. P in the low quality woodland was slightly lower than the references sites with 5 mg/kg (Figure 9-18).

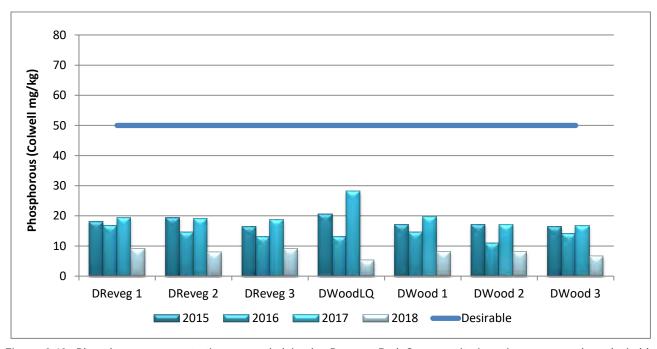


Figure 9-18. Phosphorous concentrations recorded in the Dwyer's Red Gum monitoring sites compared to desirable agricultural levels.

#### 9.11.5 Nitrate

Nitrate levels were lower than the agricultural standards across all Dwyer's Red Gum monitoring sites and there were little differences between the sites. In the reference sites N ranged from 0.5 - 3.5 mg/kg and most of the other sites were similar, ranging from a low of 0.5 mg/kg in DReveg3 to a high of 1.9 mg/kg in DReveg2 (Figure 9-19).

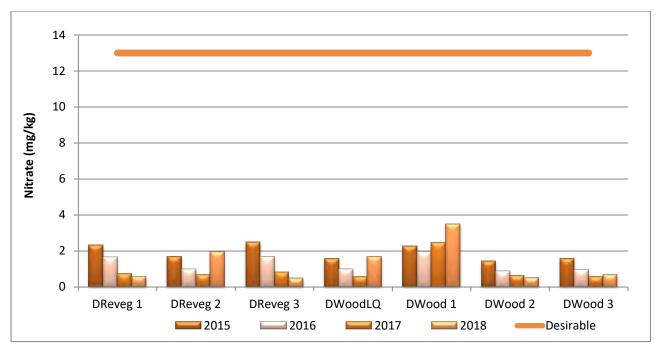


Figure 9-19. Nitrate concentrations recorded in the Dwyer's Red Gum monitoring sites compared to desirable agricultural levels.

### 9.11.6 Cation Exchange Capacity

Cation Exchange Capacity (CEC) is the capacity of the soil to hold the major cations (calcium, magnesium, sodium and potassium) and is also a measure of the potential fertility of the soil. All of the Dwyer's Red Gum monitoring sites had a low CEC and in the reference CEC ranged from 2.4 – 4.2 cmol/kg. In the remaining sites CEC ranged from a low of 2.6 cmol/kg in DReveg3 to a high of 3.1 cmol/kg in DReveg1 (Figure 9-20).

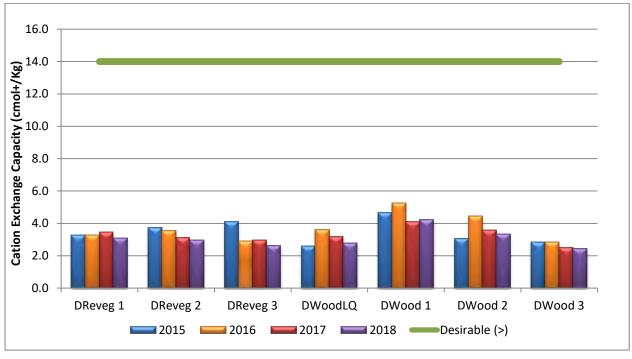


Figure 9-20. Cation Exchange Capacity recorded in the Dwyer's Red Gum monitoring sites compared to desirable agricultural levels.

# 9.11.7 Exchangeable Sodium Percentage

Sodicity refers to a significant proportion of sodium in the soil compared to other cations with soil considered to be sodic when there is sufficient sodium to interfere with its structural stability which often interferes with plant growth. Sodic soils tend to suffer from poor soil structure including hard soil, hardpans, surface crusting and rain pooling on the surface, which can affect water infiltration, drainage, plant growth, cultivation and site accessibility.

ESP recorded in the woodland reference sites was highly variable and this year ranged from 0.6 – 4.1% and these remained below the 5% threshold for sodicity (Figure 9-21). In the low quality woodland the ESP continued to be elevated and with ESP of 5.0% the soils may be sodic (Isbell 1996). ESP in the remaining sites ranged from 1.3 in DReveg3 to a high of 3.1 in DReveg2, with these being classified as non sodic.

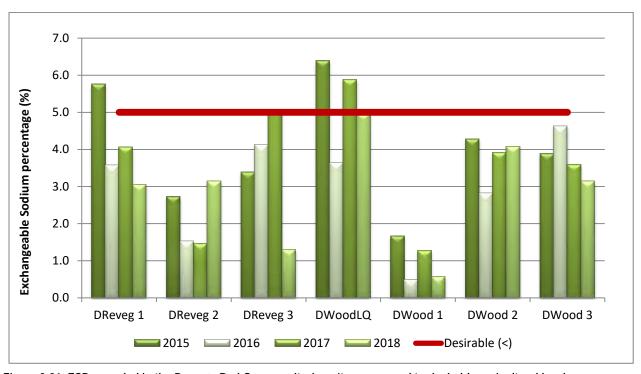


Figure 9-21. ESP recorded in the Dwyer's Red Gum monitoring sites compared to desirable agricultural levels.

# 9.12 Dwyer's Red Gum: Site performance towards meeting woodland completion criteria targets

Table 9-8 indicates the performance of the Kokoda Dwyer's Red Gum monitoring sites against a selection of proposed Completion Performance Indicators during the 2018 monitoring period. The selection of criteria has been presented in order of ecosystem successional processes, beginning with landform establishment and stability (orange) and ending with indicators of ecosystem and landuse sustainability (blue). The range values are amended annually.

Monitoring sites meeting or exceeding the range values of the Dwyer's Red Gum woodland reference sites have been identified with a <u>shaded</u> colour box and have therefore been deemed to meet completion criteria targets. In the case of "growth medium development", upper and lower soil property indicators are also based on results obtained from the respective reference sites sampled in 2018. In some cases, the site may not fall within ranges based on these data, but may be within "desirable" levels as prescribed by the agricultural industry. If this scenario occurs, the rehabilitation site has been identified using a <u>striped shaded</u> box to indicate that it falls within "desirable" ranges but does not fall within specified completion criteria targets using the adopted methodology.

Table 9-8. Performance of the Dwyer's Red Gum revegetation monitoring sites against the Primary and Secondary Performance Indicators in 2018.

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measure	DWood1	DWood2	DWood3	Gum We	's Red codland ystem 2018	DReveg1	DReveg2	DReveg3	DWoodLQ
	Performance in	dicators are qua	ntified by the ran	ige of values obtained from i	replicated reference sites		2018	2018	2018	Lower	Upper	2018	2018	2018	20185
Phase 2: Landform establishment and stability	Landform slope, gradient	Landform suitable for final landuse and generally compatible with surrounding topography	Slope	Landform is generally compatible within the context of the local topography.		< Degrees (18°)	4	3	3	3	4	4	3	4	3
	Active erosion	Areas of active erosion are limited	No. Rills/Gullies	Number of gullies or rills >0.3m in width or depth in a 50m transect are limited and stabilising		No.	0	0	0	0	0	0	0	0	0
			Cross- sectional area of rills		Provides an assessment of the extent of soil loss due to gully and rill erosion and that it is limited and/or is stabilising	m2	0	0	0	0	0	0	0	0	0
Phase 3: Growth medium development	Soil chemical, physical properties and	Soil properties are suitable for the establishmen	рН	pH is typical of that of the surrounding landscape or falls within desirable ranges provided by the agricultural industry		pH (5.6 - 7.3)	5.0	5.3	5.5	5.0	5.5	5.6	5.7	5.2	5.3

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measure	DWood1	DWood2	DWood3	Gum W	's Red oodland ystem e 2018	DReveg1	DReveg2	DReveg3	DWoodLQ
	amelioration	t and maintenance of selected vegetation species	EC		Electrical Conductivity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	< dS/m (<0.150)	0.028	0.031	0.022	0.022	0.031	0.020	0.023	0.012	0.029
			Organic Matter	Organic Carbon levels are typical of that of the surrounding landscape, increasing or fall within desirable ranges provided by the agricultural industry		% (>4.5)	5.5	4.5	2.9	2.9	5.5	3.2	3.5	2.2	3.2
			Phosphorous	Available Phosphorus is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry		ppm (50)	8.2	8.2	6.6	6.6	8.2	9.2	7.9	9.2	5.2
			Nitrate		Nitrate levels are typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	ppm (>12.5)	3.5	0.5	0.7	0.5	3.5	0.6	1.9	0.5	1.7
			CEC		Cation Exchange Capacity is typical of that of the surrounding landscape or fall within desirable ranges provided by the agricultural industry	Cmol+/kg (>14)	4.2	3.4	2.4	2.4	4.2	3.1	3.0	2.6	2.8
			ESP		Exchangeable Sodium Percentage (a measure of sodicity) is typical of the surrounding landscape or is less than the 5% threshold for sodicity	% (<5)	0.6	4.1	3.1	0.6	4.1	3.0	3.1	1.3	5.0
Phase 4: Ecosystem & Landuse Establishment	Landscape Function Analysis (LFA): Landform stability and	Landform is stable and performing as it was designed to do	LFA Stability	The LFA stability index provides an indication of the sites stability and is comparable to or trending towards that of the local remnant vegetation		%	74.0	66.9	62.2	62.2	74.0	74.1	68.4	66.5	65.2

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measure	DWood1	DWood2	DWood3	Gum W ecos	r's Red oodland ystem e 2018	DReveg1	DReveg2	DReveg3	DWoodLQ
	organisation		LFA Landscape organisation	The Landscape Organisation Index provides a measure of the ability of the site to retain resources and is comparable to that of the local remnant vegetation		%	100	100	92	92	100	100	86	100	99
	Vegetation diversity	Vegetation contains a diversity of species comparable to that of the	Diversity of shrubs and juvenile trees	The diversity of shrubs and juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation.		species/ area	3	3	7	3	7	2	2	1	3
		local remnant vegetation		The percentage of shrubs and juvenile trees with a stem diameter < 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		% population	100	100	100	100	100	100	100	100	100
			Total species richness	·	The total number of live plant species provides an indication of the floristic diversity of the site and is comparable to the local remnant vegetation	No./area	31	20	19	19	31	23	9	32	17
			Native species richness		The total number of live native plant species provides an indication of the native plant diversity of the site and that it is greater than or comparable to the local remnant vegetation	>No./area	28	19	19	19	28	16	9	20	17
			Exotic species richness	The total number of live exotic plant species provides an indication of the exotic plant diversity of the site and that it is less than or comparable to the local remnant vegetation		<no. area<="" td=""><td>3</td><td>1</td><td>0</td><td>0</td><td>3</td><td>7</td><td>0</td><td>12</td><td>0</td></no.>	3	1	0	0	3	7	0	12	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measure	DWood1	DWood2	DWood3	Gum W	r's Red oodland ystem e 2018	DReveg1	DReveg2	DReveg3	DWoodLQ
	Vegetation density	Vegetation contains a density of species comparable to that of the local remnant vegetation	Density of shrubs and juvenile trees	The density of shrubs or juvenile trees with a stem diameter < 5cm is comparable to that of the local remnant vegetation		No./area	208	448	1566	208	1566	11	2	1	11
	Ecosystem composition	The vegetation is comprised by a range of growth forms comparable	Trees	The number of tree species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	3	3	4	3	4	1	0	1	2
		to that of the local remnant vegetation	Shrubs	The number of shrub species regardless of age comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	2	2	4	2	4	1	2	0	2
			Sub-shrubs		The number of sub-shrub species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	2	2	2	2	2	0	0	0	0
			Herbs	The number of herbs or forb species comprising the vegetation community is comparable to that of the local remnant vegetation		No./area	15	8	3	3	15	15	3	23	8
			Grasses		The number of grass species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	7	4	3	3	7	6	4	6	4
			Reeds		The number of reed, sedge or rush species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	1	0	2	0	2	0	0	1	1
			Ferns		The number of ferns comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	1	1	0	0	1	0	0	1	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measure	DWood1	DWood2	DWood3	Gum W ecos	r's Red oodland ystem e 2018	DReveg1	DReveg2	DReveg3	DWoodLQ
			Vines		The number of vines or climbing species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	0	0	0	0	0	0	0	0
			Parasite		The number of parasite species comprising the vegetation community is comparable to that of the local remnant vegetation	No./area	0	0	1	0	1	0	0	0	0
Phase 5: Ecosystem & Landuse Sustainability	Landscape Function Analysis (LFA): Landform function and ecological	Landform is ecologically functional and performing as it was designed to	LFA Infiltration	LFA infiltration index provides an indication of the sites infiltration capacity and is comparable to or trending towards that of the local remnant vegetation		%	53.3	54.8	49.7	49.7	54.8	45.7	38.4	41.5	54.5
	performanc e	do	LFA Nutrient recycling	LFA nutrient recycling index provides an indication of the sites ability to recycle nutrient and is comparable to or trending towards that of the local remnant vegetation		%	48.8	51.3	47.6	47.6	51.3	42.7	40.9	36.2	53.7
	Protective ground cover	Ground layer contains protective ground cover and habitat	Litter cover	,	Percent ground cover provided by dead plant material is comparable to that of the local remnant vegetation	%	71	87	78	71	87	76	73	58.5	90.5
		structure comparable with the local remnant vegetation	Annual plants		Percent ground cover provided by live annual plants is comparable to that of the local remnant vegetation	<%	0	0	0	0	0	3	0	26	0
			Cryptogam cover		Percent ground cover provided by cryptogams (eg mosses, lichens) is comparable to that of the local remnant vegetation	%	7	1	2	1	7	14.5	11	3.5	2
			Rock		Percent ground cover provided by stones or rocks (> 5cm diameter) is comparable to that of the local remnant vegetation	%	9	0	0	0	9	1.5	0	0	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measure	DWood1	DWood2	DWood3	Gum W ecos	's Red oodland ystem 2018	DReveg1	DReveg2	DReveg3	DWoodLQ
			Log		Percent ground cover provided by fallen branches and logs (>5cm) is comparable to that of the local remnant vegetation	%	7	4	0	0	7	0	0	0	0
			Bare ground		Percentage of bare ground is less than or comparable to that of the local remnant vegetation	< %	4	5	15	4	15	2	12.5	8.5	5
			Perennial plant cover (< 0.5m)	Percent ground cover provided by live perennial vegetation (< 0.5m in height) is comparable to that of the local remnant vegetation		%	3	4	7	3	7	3.5	3.5	3.5	2.5
			Total Ground Cover	Total groundcover is the sum of protective ground cover components (as described above) and that it is comparable to that of the local remnant vegetation		%	97	95	86	86	97	98	87.5	91.5	95
	Ground cover diversity	Vegetation contains a diversity of species per square meter comparable to that of the local remnant vegetation	Native understorey abundance		The abundance of native species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has more than or an equal number of native species as the local remnant vegetation	> species/m <sup>2</sup>	4.0	1.6	2.4	2	4	3	3	4.6	1.6
			Exotic understorey abundance		The abundance of exotic species per square metre averaged across the site provides an indication of the heterogeneity of the site and that it is has less than or an equal number of exotic species as the local remnant vegetation	< species/m²	0.2	0.0	0.0	0	0	1.6	0	4	0
	Native ground cover abundance	Native ground cover abundance is comparable to that of the local remnant vegetation	Percent ground cover provided by native vegetation <0.5m tall	The percent ground cover abundance of native species (<0.5m height) compared to exotic species is comparable to that of the local remnant vegetation		%	96	100	100	96	100	64.3	100	50	100

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measure	DWood1	DWood2	DWood3	Gum W ecos	r's Red oodland ystem e 2018	DReveg1	DReveg2	DReveg3	DWoodLQ
	Ecosystem growth and natural recruitment	The vegetation is maturing and/or natural recruitment is occurring at rates similar to those of	shrubs and juvenile trees 0 - 0.5m in height	The number of shrubs or juvenile trees < 0.5m in height provides an indication of establishment success and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	208	404	1244	208	1244	1	2	1	11
		the local remnant vegetation	shrubs and juvenile trees 0.5 - 1m in height		The number of shrubs or juvenile trees 0.5-1m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	44	262	0	262	1	0	0	0
			shrubs and juvenile trees 1 - 1.5m in height		The number of shrubs or juvenile trees 1-1.5m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	0	58	0	58	3	0	0	0
			shrubs and juvenile trees 1.5 - 2m in height	The number of shrubs or juvenile trees 1.5-2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation		No./area	0	0	0	0	0	4	0	0	0
			shrubs and juvenile trees >2m in height		The number of shrubs or juvenile trees > 2m in height provides an indication of establishment success, growth and/or natural ecosystem recruitment and that it is comparable to that of the local remnant vegetation	No./area	0	0	2	0	2	2	0	0	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measure	DWood1	DWood2	DWood3	Gum W	's Red oodland ystem 2018	DReveg1	DReveg2	DReveg3	DWoodLQ
	Ecosystem structure	The vegetation is developing in structure and complexity comparable to that of the local remnant	Foliage cover 0.5 - 2 m	Projected foliage cover provided by perennial plants in the 0.5 - 2m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	0	4	15	0	15	0	0	0	0
		vegetation	Foliage cover 2 - 4m		Projected foliage cover provided by perennial plants in the 2 - 4m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	0	12	5	0	12	0	0	0	2
			Foliage cover 4 - 6m		Projected foliage cover provided by perennial plants in the 4 -6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation	% cover	12	13	11	11	13	0	0	0	8
			Foliage cover >6m	Projected foliage cover provided by perennial plants > 6m vertical height stratum indicates the community structure is comparable to that of the local remnant vegetation		% cover	27	55	23	23	55	0	0	0	26
	Tree diversity	Vegetation contains a diversity of maturing tree and shrubs species comparable to that of the	Tree diversity		The diversity of trees or shrubs with a stem diameter > 5cm is comparable to the local remnant vegetation. Species used in rehabilitation will be endemic to the local area	species/ar ea	3	3	3	3	3	1	0	0	2
		local remnant vegetation		The percentage of maturing trees and shrubs with a stem diameter > 5cm dbh which are local endemic species and these percentages are comparable to the local remnant vegetation		%	100	100	100	100	100	100	0	0	100

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measure	DWood1	DWood2	DWood3	Dwyer's Red Gum Woodland ecosystem range 2018		DReveg1	DReveg2	DReveg3	DWoodLQ
	Tree density	Vegetation contains a density of maturing tree and shrubs	Tree density	The density of shrubs or trees with a stem diameter > 5cm is comparable to that of the local remnant vegetation		No./area	73	37	10	10	73	1	0	0	9
	spec com to th local	species comparable to that of the local remnant vegetation	Average dbh		Average tree diameter of the tree population provides a measure of age, (height) and growth rate and that it is trending towards that of the local remnant vegetation.	cm	11	17	23	11	23	6	0	0	22
	Ecosystem health	The vegetation is in a condition comparable to that of the local remnant	Live trees	The percentage of the tree population which are live individuals and that the percentage is comparable to the local remnant vegetation		% population	33	73	80	33	80	100	0	0	100
		vegetation.	Healthy trees	The percentage of the tree population which are in healthy condition and that the percentage is comparable to the local remnant vegetation		% population	8.2	2.7	20.0	3	20	100	0	0	0
			Medium health		The percentage of the tree population which are in a medium health condition and that the percentage is comparable to the local remnant vegetation	% population	20.5	54.1	30.0	21	54	0	0	0	33.3
			Advanced dieback		The percentage of the tree population which are in a state of advanced dieback and that the percentage is comparable to the local remnant vegetation	<% population	4.1	16.2	30.0	4	30	0	0	0	66.7
			Dead Trees		The percentage of the tree population which are dead (stags) and that the percentage is comparable to the local remnant vegetation	% population	67.1	27.0	20.0	20	67	0	0	0	0

Rehabilitation Phase	Aspect or ecosystem component	Completion criteria	Performance Indicators	Primary Performance Indicators Description	Secondary Performance Indicators Description	Unit of measure	DWood1	DWood2	DWood3	Gum W	r's Red oodland ystem e 2018	DReveg1	DReveg2	DReveg3	DWoodLQ
			Mistletoe		The percentage of the tree population which have mistletoe provides an indication of community health and habitat value and that the percentage is comparable to the local remnant vegetation	% population	0	0	10	0	10	0	0	0	0
			Flowers/fruit: Trees	The percentage of the tree population with reproductive structures such as buds, flowers or fruit provides evidence that the ecosystem is maturing, capable of recruitment and can provide habitat resources comparable to that of the local remnant vegetation	·	% population	18	35	70	18	70	0	0	0	66.7
			Hollows: Trees		The percentage of the tree population which have hollows provides an indication of the habitat value and that the percentage is comparable to the local remnant vegetation	% population	4	0	0	0	4	0	0	0	0

# 10 Priority weeds

No priority weed species of the Central Tablelands LLS were recorded in the range of monitoring sites.

# 11 Orchid and other wildflower observations

A map showing the locations of orchids observed in 2015 and 2016 is provided in Figure 11-1. Due to the dry conditions no orchids were observed this year.

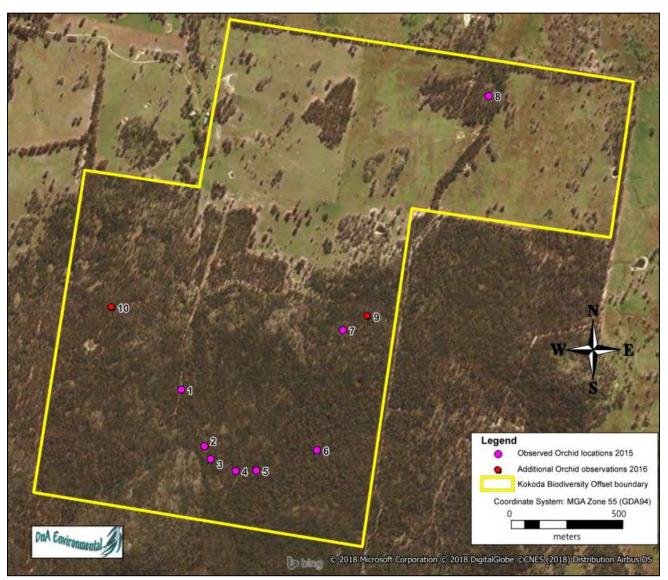


Figure 11-1. A map showing the approximate locations of orchid species sighted around the Kokoda property in 2015 and 2016.

Table 11-1. Approximate coordinates and Orchid species observed at Kokoda in 2015 and 2016.

Location	Easting	Northing	Orchid Species
1	55 635441	6317088	Caladenia aff. tentaculata (Greencomb Spider Orchid)
2	55 635541	6316835	Caladenia aff. tentaculata (Greencomb Spider Orchid), Glossodia major (Wax-lip Orchid), Diuris goonooensis (Western Donkey Orchid)
3	55 635568	6316778	Caladenia aff. tentaculata (Greencomb Spider Orchid), Diuris goonooensis (Western Donkey Orchid)
4	55 635679	6316724	Glossodia major (Wax-lip Orchid)
5	55 635771	6316725	Glossodia major (Wax-lip Orchid)
6	55 636043	6316811	Thelymitra spp., Glossodia major (Wax-lip Orchid)
7	55 636166	6317342	Caladenia aff. tentaculata (Greencomb Spider Orchid)
8	55 636830	6318372	Prasophyllum campestre (Inland Leek Orchid), Caladenia carnea (Pink Fingers), Diuris goonooensis (Western Donkey Orchid), Pterostylis nana (Dwarf Greenhood)
9	55 636276	6317402	Calochilus robertsonii (Purplish Beard Orchid)
10	55 635136	6317457	Calochilus robertsonii (Purplish Beard Orchid), Caladenia gracilis (Musky Caladenia), Thelymitra spp.

## 12 Discussion

#### **Grey Box woodlands**

The Grey Box woodland reference sites were characterised by having a mature tree canopy and a well developed decomposing leaf litter layer with a sparse cover of native perennial forbs and grasses which collectively provided a highly functional patch area. The White Box and Ironbark woodlands also had a mature tree canopy and while both sites had a well developed leaf litter layer, native grasses and forbs were more abundant in the White Box woodland whereas in the Ironbark woodland there was an understorey of low and scattered shrubs with both sites having high functional patch areas. While the Grey Box revegetation sites presently existed as degraded pastures and were structurally different to the woodland reference sites, they typically had good ground cover comprised of a combination of annual and perennial plants and cryptogams and also had a high functional patch areas.

This year, drought conditions and heavy grazing has resulted in a reduction in the stability, infiltration and nutrient recycling capacity of all sites. There was limited live ground cover vegetation and often the integrity of the litter and cryptogam layers had declined. All sites however all sites continued to maintain high functional patch areas.

The woodland reference site GBWood3 continued to be the most ecologically functional site with a total score of 176, followed by GBWood2 with 171, followed closely by Ironwood1 with a sum of scores of 169. These sites contained high patch area, a mature tree canopy and well developed grassy ground cover layer, with high levels of decomposing litter and had very spongy and stable soils. Despite the lack of perennial overstorey there was relatively high functionality in GBReveg5 and GBReveg3 and with a sum of scores of 167 and 164 respectively, were more functional than the woodland sites GBWood1 (162) and WBWood1 (161). The derived native grassland revegetation areas, GBReveg1 scored 160, GBReveg4 scored 151 while the least functional community continued to be GBReveg2 which scored 142.

The resultant population densities of trees and mature shrubs recorded in the Grey Box reference sites were 8 - 23, equating to a density of 200 – 575 stems per hectare. There continued to be eight individuals in the White Box woodland site and there were 29 in the Ironbark woodland. No trees or mature shrubs were yet present in the derived native grassland sites.

In the woodland reference sites there were 1 - 21 shrubs and juvenile trees, equating to a density of 25 - 525 stems per hectare represented by 1 - 3 species. In the White Box woodland some seedlings had died with only five individuals recorded this year as a result of the prolonged dry conditions. In the Ironbark woodland there were 139 individuals. One seedling continued to be recorded in GBReveg1 this year, while no shrubs or juvenile trees were recorded in the remaining sites.

In the Grey Box woodland reference sites the most dominant form of ground cover continued to be provided by dead leaf litter which were largely derived from fallen eucalypt leaves and twigs. As a result of the dry conditions there was much less perennial ground cover and there were no annual plants. The reference sites were also characterised by having a mature canopy cover which exceeded 6.0m in height with low hanging braches also providing occasional projected cover in the lower height classes. The White Box and Ironbark woodlands had a similar community structure.

In the derived grassland revegetation sites, annual plant cover had declined in all sites and all sites were dominated by dead litter, derived from dead ground cover plants. Annual plants however continued to be recorded in low abundances in all sites. Cryptogams were also recorded in high abundance in GBReveg2 and were also present in the remaining revegetation sites. Perennial plant cover ranged from 5.5 – 20.5 % with

these exceeding minimum perennial ground cover requirements. Presently there is no vertical structure > 0.5m in height in the derived grassland revegetation areas.

This year prolonged dry conditions resulted in the further decline in species richness across all monitoring sites, where 7 – 15 species were recorded in the Grey Box woodland reference sites. The White Box and Iron Bark woodlands as well as the grassland revegetation sites were more diverse than the reference sites this year. All grassland revegetation sites had an acceptable diversity of native species however there was higher diversity of exotic species compared to the reference sites. In the derived grasslands, there has been an increasing trend in native plant abundance in numerous sites however GBReveg2 was the only site dominated by native species. The remaining grassland sites were weedier than desired.

#### Dwyer's Red Gum woodland

The Dwyer's Red Gum (DRG) woodland reference sites were also characterised by having a mature tree canopy and a well developed decomposing leaf litter layer and a sparse cover of native perennial forbs and grasses. The low quality Dwyer's Red Gum woodland site was characterised with having an open mature tree canopy, moderate cover of annual and perennial ground cover species and typically had a well developed leaf litter layer but this was patchy. The Dwyer's Red Gum derived grassland revegetation sites presently existed as degraded native grasslands but they typically had good ground cover comprised of a combination of annual and perennial plants and cryptogams and also had a high functional patch areas.

This year, drought conditions and heavy grazing has resulted in a reduction in the stability, infiltration and nutrient recycling capacity of all sites. Heavy grazing and disturbance by animals has tended to reduce the integrity of the ground covers and litter layers where the soils become more susceptible to erosion and deposition. All sites with the exception of DReveg2 and DWood3 continued to maintain high functional patch areas.

The Dwyer's Red Gum reference site DWood1 continued to be the most ecologically functional site with a total score of 176. The low quality woodland DWoodLQ and DWood2 were very similar to each other with a sum of scores of 173. This was followed by DReveg1 and DWood3 with 163 and 160 respectively. DReveg2 and DReveg3 were the least functional sites this year with scores of 148 and 144 respectively.

This year there were 8 – 29 live trees and mature shrubs (>5cm dbh), equating to a density of 200 – 725 stems per hectare. There continued to be nine individuals in the low quality woodland. One juvenile eucalypt continued to be recorded in DReveg1, but no trees or mature shrubs were present in the other two derived native grassland sites.

There was a large variation on the number of shrubs and juvenile trees (<5cm dbh) recorded in the Dwyer's Red Gum reference sites with densities ranging from 208 – 1566 individuals. In the woodland reference sites there were 3 - 7 species of shrubs and juvenile trees with the most abundant species being young *Callitris endlicheri* seedlings. In the low quality woodland there were 11 shrubs and juvenile trees this year. In the derived grasslands, there were 11 seedlings recorded in DReveg1, two in DReveg2 and in DReveg3 there was one seedling with these being the result of natural regeneration.

In the Dwyer's Red Gum woodland reference sites the most dominant form of ground cover continued to be dead leaf litter largely derived from fallen leaves and twigs. There were scattered perennial ground covers, cryptogams and logs however no annual ground covers were recorded this year. In DWood1 there were also scattered rocks. The low quality woodland had similar features and in similar proportions to the reference sites but did not tend to have fallen branches or rocks. In comparison the revegetation sites continued to be dominated by various proportions of annual and perennial plants and dead leaf litter and this year all three sites had adequate covers of perennial plants and cryptogams. No cover >0.5m in height was recorded this year due to heavy grazing and lack of shrub or tree canopies.

Since 2017 there have been prolonged dry conditions and floristic diversity continued to decline with only 19 - 31 species recorded in the reference sites this year. In the low quality woodland there were a total of 17 species which was slightly low compared to the reference sites. All other revegetation monitoring sites demonstrated a similar reduction in diversity, however only nine species were recorded in DReveg2 this year which was significantly lower than was recorded in previous years and much lower than the reference sites. There were 23 and 32 species in DReveg1 and DReveg3 respectively, with these having a similar or higher total diversity than the reference sites. In the revegetation grassland sites there were more native species than exotics this year. While no exotic species were recorded in DReveg2, there continued to be too many in DReveg1 and DReveg3.

Of the total live plant cover there was an increase in native plant percent cover in DWoodLQ and the revegetation sites this year, as the dry conditions and heavy grazing had resulted in the loss of or absence of exotic species, leaving mostly hardy perennial native species. Native plants provided 100% of the cover in DReveg2 and DWoodLQ, while DReveg1 and DReveg3 were weedier than desired.

All derived grassland revegetation sites presently did not meet many completion targets related to the mature tree population and the structural complexity of the sites due to the lack of a well developed overstorey and in the DRG revegetation sites, the lack of a shrub understorey. Other primary ecological attributes which fell short of meeting completion performance target tended to be largely associated with low density and diversity of trees and shrubs. Most of the derived grassland sites were dominated by exotic annual species and were presently weedier than desired.

The results of the soil analyses indicate that the soils associated with the Grey Box and Dwyer's Red Gum woodland and derived native grasslands are naturally moderately to very strongly acidic and low in organic matter, phosphorous and nitrate. They tended to have a low cation exchange capacity and are non saline and non sodic.

## 13 Conclusion

The proposed revegetation activities within the derived grassland areas as described in the BOMP aim to increase biodiversity and habitat values through the removal of livestock grazing to allow natural regeneration, supplemented with tubestock planting. These activities are likely to result in the derived grassland areas developing into woodland communities and therefore meeting most ecological performance indicators in the medium to longer term. The reference sites at Kokoda are typically degraded and of low quality which subsequently have provided low performance targets. In the Grey Box woodlands in particular, there was limited abundance and diversity of the grassy understorey and there were limited shrubs and juvenile trees. Subsequently the revegetation activities proposed should include a range of species known to occur within these communities and not just restricted to those occurring within the existing reference sites. Where reasonable and feasible and to promote good establishment success, revegetation practices should follow Best Practice Revegetation Guidelines (Sydes *et al* Greening Australia 2003). Revegetation works should aim to create a mosaic of shrub thickets, open woodland and grassy clearings. Heterogeneity of different habitat types will increase biodiversity and promote the long-term sustainability of the various woodland communities.

While floristic diversity targets were often met, the revegetation sites tended to be dominated by exotic annual species, which are likely to decline in the medium to longer-term as perennial plants become more abundant. Strategic grazing is likely to be a critical management strategy which will be required to maintain biodiversity, encourage tree and shrub regeneration and to reduce fuel loads as part of the integrated and adaptive management strategy for the Kokoda Offset Area in the longer-term. This process has however been affected by drought conditions and heavy grazing. Presently, extensive disturbance and herbivory by feral and pests species especially macropods and goats has become an important management issue. A control program may need to be implemented with the most beneficial outcomes being obtained by seeking advice from the Local Land Services and a cooperative approach with neighbouring landholders. Exclusion fencing in strategic locations may be required in order to achieve successful revegetation outcomes.

In 2015 and 2016 several species of orchids were observed at various locations around the property. As part of the management of the Kokoda property, the location of these populations should be considered when undertaking revegetation, weed control and strategic grazing, particularly as most orchids are only identifiable during a limited time period. As a result of the dry conditions experienced throughout most of 2017 and 2018, none of these populations were observed to be flowering, thus emphasising the need to continue to map their known locations.

Other potential management issues may be related to high density *E. dwyeri* and *Callitris endlicheri* regeneration which was observed to be occurring within and adjacent to woodland areas where mature trees were present. The increase in competition from high density stands is likely to suppress the herbaceous understorey as they become more established, thereby adversely affecting floristic and biodiversity targets in the medium to longer term. Strategic grazing may reduce the density of existing seedlings and regulate the degree of Callitris regeneration through manipulation of the herbaceous understorey and germination niches, in more favourable seasonal conditions.

Safe and easy access should always be maintained around main access tracks and boundary fences to facilitate monitoring, property maintenance and bushfire management. Regular inspections should be undertaken with slashing and/or strategic grazing management implemented on a needs basis. Several areas of boundary fence also require maintenance to ensure neighbouring livestock cannot freely access the property.

There were little other management issues that have not already been addressed in the BOMP.

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# Appendix 1. List of flora species recorded in the Kokoda monitoring sites in 2018

Group	Family	exotic	Scientific Name	Common Name	Habit	DWood1	DWood2	DWood3	DReveg1	DReveg2	DReveg3	DWoodLQ	GBWood1	GBWood2	GBWood3	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	IronWood1	WBWood1
Coniferopsida	Cupressaceae		Callitris endlicheri	Black Cypress Pine	t	1	1	1								1					1	1
Dicotyledon	Apiaceae		Daucus glochidiatus	Australian Carrot	h		1							1								
Dicotyledon	Araliaceae		Hydrocotyle laxiflora	Stinking Pennywort	h	1	1	1				1		1	1							1
Dicotyledon	Asteraceae	*	Arctotheca calendula	Capeweed	h						1					1	1	1	1	1		
Dicotyledon	Asteraceae		Calotis lappulacea	Yellow Burr Daisy	h				1		1		1		1	1	1					
Dicotyledon	Asteraceae	*	Carthamus lanatus	Saffron Thistle	h													1				,
Dicotyledon	Asteraceae		Cassinia laevis	Cough Bush	S			1		1			1		1						1	
Dicotyledon	Asteraceae	*	Chondrilla juncea	Skeleton Weed	h				1		1					1			1	1		
Dicotyledon	Asteraceae		Cymbonotus lawsonianus	Bear's Ear	h																	1
Dicotyledon	Asteraceae	*	Hypochaeris glabra	Smooth Catsear	h	1	1		1		1					1	1	1	1	1		
Dicotyledon	Asteraceae	*	Hypochaeris radicata	Flatweed	h															1		,
Dicotyledon	Asteraceae		Isoetopsis graminifolia	Grass Cushion	h						1							1				,
Dicotyledon	Asteraceae		Solenogyne bellioides		h							1										1
Dicotyledon	Asteraceae	*	Sonchus oleraceus	Milk Thistle	h										1							
Dicotyledon	Asteraceae	*	Tolpis umbellata	Yellow Hawkweed	h						1						1	1	1			
Dicotyledon	Asteraceae		Triptilodiscus pygmaeus	Austral Sunray	h	1			1		1	1					1	1	1	1		
Dicotyledon	Asteraceae		Vittadinia gracilis	A Fuzzweed	h						1				1	1	1					
Dicotyledon	Asteraceae		Vittadinia spp.	Fuzzweed	h						1		1							1		
Dicotyledon	Asteraceae		Xerochrysum bracteatum	Golden Everlasting	h				1		1	1		1							1	
Dicotyledon	Campanulaceae		Wahlenbergia communis	Tufted Bluebell	h						1											
Dicotyledon	Campanulaceae		Wahlenbergia gracilis	Sprawling Bluebell	h						1											
Dicotyledon	Campanulaceae		Wahlenbergia spp.	Bluebell	h												1					
Dicotyledon	Caryophyllaceae	*	Petrorhagia nanteuilii	Proliferous Pink	h				1		1					1		1	1	1		
Dicotyledon	Casuarinaceae		Allocasuarina verticillata	Drooping Sheoak	t	1		1			1											
Dicotyledon	Chenopodiaceae		Einadia nutans subsp. nutans	Climbing Saltbush	h								1		1							
Dicotyledon	Dilleniaceae		Hibbertia obtusifolia	Hoary Guinea Flower	SS																1	1
Dicotyledon	Dilleniaceae		Hibbertia riparia	Silky Guinea Flower	SS									1							1	
Dicotyledon	Droseraceae		Drosera peltata	Pale Sundew	h						1							1				
Dicotyledon	Epacridaceae		Astroloma humifusum	Native Cranberry	SS	1	1	1													1	
Dicotyledon	Epacridaceae		Brachyloma daphnoides	Daphne Heath	S	1	1	1						1							1	
Dicotyledon	Epacridaceae		Lissanthe strigosa	Peach Heath	SS		1	1													1	1

Group	Family	exotic	Scientific Name	Common Name	Habit	DWood1	DWood2	DWood3	DReveg1	DReveg2	DReveg3	DWoodLQ	GBWood1	GBWood2	GBWood3	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	IronWood1	WBWood1
Dicotyledon	Euphorbiaceae		Euphorbia drummondii	Caustic Weed	h				1													
Dicotyledon	Euphorbiaceae		Poranthera microphylla	Small Poranthera	h	1																
Dicotyledon	Fabaceae (Faboideae)		Bossiaea buxifolia	Box-leaved Bitter-pea	S			1														
Dicotyledon	Fabaceae (Faboideae)		Glycine clandestina	Climbing Glycine	h																	1
Dicotyledon	Fabaceae (Faboideae)	*	Trifolium arvense	Haresfoot Clover	h											1				1		
Dicotyledon	Fabaceae (Faboideae)	*	Trifolium campestre	Hop Clover	h													1	1	1		
Dicotyledon	Fabaceae (Faboideae)	*	Trifolium dubium	Yellow Suckling Clover	h				1													
Dicotyledon	Fabaceae (Faboideae)	*	Trifolium repens	White Clover	h												1					
Dicotyledon	Fabaceae (Faboideae)	*	Trifolium spp.	A Clover	h	1										1						
Dicotyledon	Fabaceae (Faboideae)	*	Trifolium subterraneum	Subterraneum Clover	h				1		1					1	1	1	1	1		
Dicotyledon	Fabaceae (Mimosoideae)		Acacia decora	Western Golden Wattle	S				1	1												1
Dicotyledon	Fabaceae (Mimosoideae)		Acacia implexa	Hickory	S							1		1	1						1	1
Dicotyledon	Fabaceae (Mimosoideae)		Acacia lanigera	Woolly Wattle	S							1										
Dicotyledon	Fabaceae (Mimosoideae)		Acacia paradoxa	Kangaroo Thorn	S									1								
Dicotyledon	Fabaceae (Mimosoideae)		Acacia spp.	A Wattle	S	1																
Dicotyledon	Gentianaceae	*	Cicendia quadrangularis		h						1											
Dicotyledon	Geraniaceae	*	Erodium botrys	Long Storksbill	h						1					1						
Dicotyledon	Geraniaceae	*	Erodium cicutarium	Common Crowsfoot	h				1		1					1	1			1		
Dicotyledon	Geraniaceae		Erodium crinitum	Blue Storksbill	h															1		
Dicotyledon	Geraniaceae		Geranium solanderi	Native Geranium	h																	1
Dicotyledon	Goodeniaceae		Goodenia hederacea	Forest Goodenia	h																1	ш
Dicotyledon	Haloragaceae		Gonocarpus tetragynus	Raspwort	h	1	1	1		1		1								1	1	1
Dicotyledon	Haloragaceae		Haloragis heterophylla	Rough Raspwort	h				1	1	1	1					1	1	1			
Dicotyledon	Hypericaceae		Hypericum gramineum	Small St. John's Wort	h															]		1
Dicotyledon	Lamiaceae		Ajuga australis	Australian Bugle	h																	1
Dicotyledon	Lamiaceae	*	Salvia verbenaca	Wild Sage	h											1						

Group	Family	exotic	Scientific Name	Common Name	Habit	DWood1	DWood2	DWood3	DReveg1	DReveg2	DReveg3	DWoodLQ	GBWood1	GBWood2	GBWood3	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	IronWood1	WBWood1
Dicotyledon	Loranthaceae		Amyema miquelii	Box Mistletoe	р			1														
Dicotyledon	Myrtaceae		Calytrix tetragona	Common Fringe Myrtle	S		1	1														
Dicotyledon	Myrtaceae		Eucalyptus albens	White Box	t			1				1									1	1
Dicotyledon	Myrtaceae		Eucalyptus blakelyi	Blakely's Red Gum	t																	1
Dicotyledon	Myrtaceae		Eucalyptus dealbata	Tumbledown Gum	t	1	1	1													1	
Dicotyledon	Myrtaceae		Eucalyptus dwyeri	Dwyer's Red Gum	t				1			1										
Dicotyledon	Myrtaceae		Eucalyptus microcarpa	Grey Box	t								1	1	1							
Dicotyledon	Myrtaceae		Eucalyptus sideroxylon	Mugga Ironbark	t		1							1	1						1	
Dicotyledon	Myrtaceae		Platysace ericoides	Heathy Platysace	SS	1																,
Dicotyledon	Orobanchaceae	*	Parentucellia latifolia	Red Bartsia	h											1						
Dicotyledon	Oxalidaceae		Oxalis perennans	Yellow Wood-sorrel	h	1			1		1				1	1	1	1	1	1		
Dicotyledon	Plantaginaceae	*	Echium plantagineum	Paterson's Curse	h						1					1		1	1	1		,
Dicotyledon	Plantaginaceae		Plantago varia	Variable Plantain	h	1																,
Dicotyledon	Polygonaceae		Rumex brownii	Swamp Dock	h				1			1								1		,
Dicotyledon	Polygonaceae		Rumex tenax	Shiny Dock	h	1																,
Dicotyledon	Primulaceae	*	Anagallis arvensis	Scarlet Pimpernel	h													1	1	1		
Dicotyledon	Rubiaceae		Asperula conferta	Common Woodruff	h													1				
Dicotyledon	Stackhousiaceae		Stackhousia monogyna	Creamy Candles	h															1		1
Monocotyledon	Anthericaceae		Arthropodium minus	Small Vanilla Lily	h										1							
Monocotyledon	Anthericaceae		Arthropodium spp.?	Vanilla Lily	h	1																
Monocotyledon	Anthericaceae		Dichopogon spp.?	Chocolate Lily	h	1																,
Monocotyledon	Anthericaceae		Dichopogon strictus	Chocolate Lily	h		1							1								1
Monocotyledon	Anthericaceae		Laxmannia gracilis	Slender Wire Lily	h	1	1														1	
Monocotyledon	Anthericaceae		Thysanotus patersonii	Twining Fringe Lily	h	1	1		1												1	1
Monocotyledon	Anthericaceae		Tricoryne elatior	Yellow Autumn-lily	h	1			1	1		1							1			1
Monocotyledon	Cyperaceae		Carex inversa	Knob Sedge	r						1											
Monocotyledon	Cyperaceae		Fimbristylis dichotoma	Common Fringe Rush	r			1														
Monocotyledon	Cyperaceae		Lepidosperma laterale	Broad Sword-sedge	r	1																
Monocotyledon	Iridaceae	*	Romulea rosea	Onion Grass	h						1											
Monocotyledon	Juncaceae		Juncus spp.	A Rush	r														1	1		
Monocotyledon	Juncaceae		Juncus usitatus		r			1				1		1								
Monocotyledon	Juncaceae		Luzula spp.		h																	1
Monocotyledon	Ophioglossaceae		Ophioglossum lusitanicum	Adders Tongue	h						1						1			1		

Group	Family	exotic	Scientific Name	Common Name	Habit	DWood1	DWood2	DWood3	DReveg1	DReveg2	DReveg3	DWoodLQ	GBWood1	GBWood2	GBWood3	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	IronWood1	WBWood1
Monocotyledon	Orchidaceae		Caladenia carnea	Pink Fingers	h		1														1	
Monocotyledon	Orchidaceae		Caladenia spp.	Spider Orchid	h	1																
Monocotyledon	Orchidaceae		Calochilus robertsonii	Brown-bearded Orchid, Pale Beard Orchid	h			1													1	
Monocotyledon	Orchidaceae		Pterostylis bicolor	Bicolor Greenhood	h												1					
Monocotyledon	Phormiaceae		Dianella longifolia	Blueberry Lily	h																	1
Monocotyledon	Poaceae		Aristida jerichoensis var. jerichoensis	Jericho Wiregrass	g	1																
Monocotyledon	Poaceae		Aristida ramosa	Threeawn Grass	g			1	1	1	1			1		1		1	1	1		1
Monocotyledon	Poaceae		Aristida spp.	Wire Grass	g																1	
Monocotyledon	Poaceae		Austrostipa densiflora	Foxtail Speargrass	g	1																
Monocotyledon	Poaceae		Austrostipa scabra subsp. scabra	Rough Speargrass	g	1	1	1	1			1	1		1	1						1
Monocotyledon	Poaceae		Bothriochloa macra	Red-leg Grass	g				1	1	1	1				1	1	1	1	1		1
Monocotyledon	Poaceae	*	Briza minor	Shivery Grass	g						1					1		1	1	1		
Monocotyledon	Poaceae	*	Bromus molliformis	Soft Brome	g				1										1	1		
Monocotyledon	Poaceae	*	Bromus spp.	A Brome	g														1			
Monocotyledon	Poaceae		Chloris truncata	Windmill Grass	g				1							1						
Monocotyledon	Poaceae		Dichelachne spp.	A Plumegrass	g																1	
Monocotyledon	Poaceae		Echinopogon ovatus	Forest Hedgehog Grass	g		1														1	
Monocotyledon	Poaceae		Elymus scaber	Common Wheatgrass	g									1								
Monocotyledon	Poaceae		Eragrostis spp.	Lovegrass	g	1		1			1							1				
Monocotyledon	Poaceae		Microlaena stipoides	Weeping Rice-grass	g	1						1										1
Monocotyledon	Poaceae		Panicum spp.		g					1	1					1	1		1	1		
Monocotyledon	Poaceae		Rytidosperma caespitosum	Wallaby Grass	g		1															
Monocotyledon	Poaceae		Rytidosperma fulvum	Wallaby Grass	g									1								
Monocotyledon	Poaceae		Rytidosperma racemosum	Wallaby Grass	g							1		1	1	1	1		1			
Monocotyledon	Poaceae		Rytidosperma spp.	Wallaby Grass	g	1	1			1	1		1		1						1	1
Monocotyledon	Poaceae		Sporobolus creber	Western Rat's-tail Grass	g				1									1	1	]		1
Monocotyledon	Poaceae	*	Vulpia spp.	Rat's-tail Fescue	g	1												1				
Pteridophyta	Adiantaceae		Cheilanthes sieberi subsp. sieberi	Rock Fern	f	1	1				1						1	1	1	1	1	1

Note: "1: denotes the presence of that species and is not a measure of cover abundance Key to habit legend: t = tree; s = shrub; ss =sub-shrub; h = herb; g = grass, r = reed; v = vine; f = fern; p = parasite

# Appendix 2. ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT- Grey Box Woodland Sites Kokoda Offset Area 2018

Soil samples supplied by DnA Environmental on 3rd October, 2018 - Lab Job No. H4553

_	on samples supplied	DY DITA L	nvironmental on 3 <sup>rd</sup> October, 20	io - Lau	און מטל.	14333											
			Site	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	GBWood1	GBWood2	GBWood3	WBWood1	IronWood1	Heavy Soil Clay	Medium Soil Clay Loam	<b>Light Soil</b> Loam	Sandy Soil Loamy Sand
	Parameter		Method reference	H4553/ 4	H4553/ 5	H4553/ 6	H4553/ 7	H4553/ 8	H4553/1 2	H4553/1 3	H4553/1 4	H4553/1 5	H4553/1 6			delines 6 and 8	
	Soluble Calcium (mg/kg)			495	357	348	215	312	218	144	468	457	88	115 0	750	375	175
	Soluble Magnesium (mg/	'kg)	**Inhouse S10 - Morgan 1	58	87	82	71	54	139	86	210	91	38	160	105	60	25
	Soluble Potassium (mg/k	(g)	ililiouse 310 - Worgan 1	86	72	72	85	68	120	71	134	105	77	113	75	60	50
	Soluble Phosphorus (mg	ı/kg)		1.4	1.2	<1	<1	<1	2.0	1.4	2.1	1.7	<1	15	12	10	5.0
			**Rayment & Lyons 2011 - 9E2 (Bray 1)	1.7	2.6	1.2	1.3	1.0	13.5	2.9	4.9	1.6	1.4	45 <sup>not</sup> e 8	30 <sup>not</sup> e 8	24 <sup>not</sup> e 8	20 <sup>not</sup> e 8
	Phosphorus (mg/kg P)		**Rayment & Lyons 2011 - 9B2 (Colwell)	7	9	7	8	6	26	11	14	8	7	80	50	45	35
			**Inhouse S3A (Bray 2)	2	4	2	2	1	20	3	8	2	2	90 <sup>not</sup> e 8	60 <sup>not</sup> e 8	<b>48</b> not e 8	40 <sup>not</sup> e 8
	Nitrate Nitrogen (mg/kg N	N)		0.5	8.0	0.5	1.0	1.2	1.7	0.5	1.3	1.5	0.6	15	13	10	10
	Ammonium Nitrogen (mg	g/kg N)	**Inhouse S37 (KCI)	2.2	5.6	5.5	3.2	3.0	7.6	3.1	5.3	8.7	3.8	20	18	15	12
	Sulfur (mg/kg S)			<1	5.9	1.5	1.4	1.3	6.2	5.5	2.9	2.6	1.7	10.0	8.0	8.0	7.0
	рН		Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.60	5.34	6.14	6.00	6.07	5.05	5.20	5.55	6.24	5.09	6.5	6.5	6.3	6.3
	Electrical Conductivity (c	dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.023	0.064	0.021	0.018	0.015	0.067	0.059	0.065	0.037	0.038	0.20 0	0.15 0	0.12 0	0.10 0
	Estimated Organic Matte	r (% OM)	**Calculation: Total Carbon x 1.75	2.7	5.2	3.4	2.3	1.8	6.5	4.5	7.5	3.1	3.6	> 5.5	>4 .5	> 3.5	> 2.5
		(cmol₊/k g)		3.83	3.22	2.52	1.53	2.28	2.03	1.37	4.92	4.38	0.74	15.6	10.8	5.0	1.9
	Exchangeable Calcium	(kg/ha)		1720	1446	1132	688	1022	910	616	2207	1967	331	700 0	481 6	224 0	840
		(mg/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	768	646	505	307	456	406	275	985	878	148	312 5	215 0	100 0	375
	Exchangeable	(cmol <sub>+</sub> /k g)		0.64	1.02	0.84	0.73	0.59	1.70	1.07	2.80	1.19	0.43	2.4	1.7	1.2	0.60
	Magnosium	(kg/ha)		175	278	228	199	161	462	290	763	323	116	650	448	325	168

		Site	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	GBWood1	GBWood2	GBWood3	WBWood1	IronWood1	Heavy Soil Clay	Medium Soil Clay Loam	<b>Light Soil</b> Loam	Sandy Soil Loamy Sand
	(mg/kg)		78	124	102	89	72	206	129	340	144	52	290	200	145	75
	(cmol₊/k g)		0.38	0.35	0.29	0.36	0.35	0.55	0.37	0.64	0.48	0.34	0.60	0.50	0.40	0.30
Exchangeable Potassium	(kg/ha)		335	303	255	313	304	478	323	564	418	301	526	426	336	224
	(mg/kg)		150	135	114	140	136	214	144	252	187	135	235	190	150	100
	(cmol₊/k g)		<0.065	0.20	<0.065	0.07	<0.065	<0.065	0.24	0.08	<0.065	0.10	0.3	0.26	0.22	0.11
Exchangeable Sodium	(kg/ha)		<33	102	<33	35	<33	<33	126	42	<33	54	155	134	113	57
	(mg/kg)		<15	46	<15	16	<15	<15	56	19	<15	24	69	60	51	25
	(cmol₊/k g)		0.02	0.34	0.04	0.10	0.03	0.84	0.88	0.13	0.02	0.97	0.6	0.5	0.4	0.2
Exchangeable Aluminium	(kg/ha)	**Inhouse S37 (KCI)	4	69	9	20	5	168	178	26	4	196	121	101	73	30
	(mg/kg)		2	31	4	9	2	75	79	12	2	87	54	45	32	14
	(cmol₊/k g)		0.00	0.18	<0.01	0.07	0.02	0.29	0.29	0.07	<0.01	0.41	0.6	0.5	0.4	0.2
Exchangeable Hydrogen	(kg/ha)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<1	4	<1	2	<1	7	7	2	<1	9	13	11	8	3
	(mg/kg)		<1	2	<1	<1	<1	3	3	<1	<1	4	6	5	4	2
Effective Cation Exchange Capacity (ECEC) (cmol./kg)	ge	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol./kg)	4.89	5.31	3.75	2.86	3.29	5.45	4.23	8.64	6.09	3.00	20.1	14.3	7.8	3.3
Calcium (%)			78.3	60.6	67.2	53.6	69.3	37.2	32.4	56.9	72.0	24.6	77.6	75.7	65.6	57.4
Magnesium (%)			13.1	19.2	22.3	25.6	18.0	31.1	25.2	32.4	19.5	14.3	11.9	11.9	15.7	18.1
Potassium (%)		**Base Saturation Calculations -	7.8	6.5	7.8	12.5	10.5	10.0	8.7	7.5	7.8	11.5	3.0	3.5	5.2	9.1
Sodium - ESP (%)		Cation cmol <sub>+</sub> /kg / ECEC x 100	0.3	3.7	1.4	2.4	0.9	1.0	5.8	0.9	0.2	3.5	1.5	1.8	2.9	3.3
Aluminium (%)			0.4	6.5	1.1	3.5	0.8	15.3	20.9	1.5	0.3	32.4	6.0	7.1	10.5	12.1
Hydrogen			0.0	3.5	0.2	2.5	0.5	5.3	7.0	0.8	0.1	13.8	0.0	7.1	10.5	12.1
Calcium/Magnesium Rat	io	**Calculation: Calcium / Magnesium (cmol <sub>+</sub> /kg)	6.0	3.2	3.0	2.1	3.8	1.2	1.3	1.8	3.7	1.7	6.5	6.4	4.2	3.2
Zinc (mg/kg)		Rayment & Lyons 2011 - 12A1 (DTPA)	<0.5	1.2	<0.5	<0.5	<0.5	0.9	0.7	0.8	<0.5	<0.5	6.0	5.0	4.0	3.0
Manganese (mg/kg)		Raymoni a Lyons 2011 - 12A1 (DTPA)	7	27	5	5	14	15	16	25	7	13	25	22	18	15

	Site	GBReveg1	GBReveg2	GBReveg3	GBReveg4	GBReveg5	GBWood1	GBWood2	GBWood3	WBWood1	IronWood1	Heavy Soil Clay	Medium Soil Clay Loam	<b>Light Soil</b> Loam	Sandy Soil Loamy Sand
Iron (mg/kg)		49	264	118	134	94	301	423	243	117	248	25	22	18	15
Copper (mg/kg)		0.1	0.2	0.4	0.2	0.2	0.3	0.3	0.3	0.2	0.1	2.4	2.0	1.6	1.2
Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot CaCl <sub>2</sub> )	0.31	0.33	0.31	0.23	0.28	0.59	0.39	0.84	0.44	0.32	2.0	1.7	1.4	1.0
Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	23	32	21	21	25	33	33	32	24	22	50	45	40	35
Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	1.56	2.97	1.97	1.32	1.03	3.74	2.57	4.30	1.75	2.04	> 3.1	> 2.6	> 2.0	> 1.4
Total Nitrogen (%)	illilouse 34a (LLCO Trulliac Allaiyser)	0.10	0.16	0.11	0.08	0.06	0.22	0.10	0.22	0.09	0.08	> 0.30	> 0.25	> 0.20	> 0.15
Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	16.4	18.3	18.2	16.3	17.5	17.3	24.7	19.7	18.8	26.5	10- 12	10- 12	10- 12	10- 12
Basic Texture	**1.1	Loam													
Basic Colour	**Inhouse S65	Brownis h		:											
Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	14	41	13	12	10	43	38	42	24	25				;

# Appendix 3. ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT- Dwyer's Red Gum Sites Kokoda Offset Area 2018

Soil samples supplied by DNA Environmental on 3<sup>rd</sup> October, 2018 - Lab Job No. H4533

Some samples supplied by E	The Control	Site	DReveg1	DReveg2	DReveg3	DWood1	DWood2	DWood3	DWoodLQ	Heavy Soil Clay	Medium Soil Clay Loam	Light Soil Loam	Sandy Soil Loamy Sand
Parameter		Method reference	H4553/1	H4553/2	H4553/3	H4553/9	H4553/10	H4553/11	H4553/17	Indic	ative guide Notes 6		efer to
Soluble Calcium (mg/kg)			195	206	87	227	104	139	84	1150	750	375	175
Soluble Magnesium (mg/kg)		**Inhouse S10 - Morgan 1	46	63	24	37	70	45	58	160	105	60	25
Soluble Potassium (mg/kg)		Illilouse 510 - Morgan 1	58	56	41	41	71	62	58	113	75	60	50
Soluble Phosphorus (mg/kg)			1.0	<1	<1	<1	<1	1.1	<1	15	12	10	5.0
		**Rayment & Lyons 2011 - 9E2 (Bray 1)	1.2	1.3	3.4	1.2	<1	<1	1.6	45 <sup>note</sup> 8	30 <sup>note 8</sup>	24 <sup>note</sup> 8	20 <sup>note 8</sup>
Phosphorus (mg/kg P)		**Rayment & Lyons 2011 - 9B2 (Colwell)	9	8	9	8	8	7	5	80	50	45	35
		**Inhouse S3A (Bray 2)	2	2	4	1	1	1	3	90 <sup>note</sup> 8	60 <sup>note 8</sup>	48 <sup>note</sup>	40 <sup>note 8</sup>
Nitrate Nitrogen (mg/kg N)			0.6	1.9	0.5	3.5	0.5	0.7	1.7	15	13	10	10
Ammonium Nitrogen (mg/kg N	l)	**Inhouse S37 (KCI)	2.6	3.2	1.9	4.0	2.8	3.9	3.1	20	18	15	12
Sulfur (mg/kg S)			4.0	3.4	<1	4.2	2.5	2.4	2.7	10.0	8.0	8.0	7.0
рН		Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.63	5.65	5.18	5.04	5.29	5.51	5.25	6.5	6.5	6.3	6.3
Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.020	0.023	0.012	0.028	0.031	0.022	0.029	0.200	0.150	0.120	0.100
Estimated Organic Matter (% 0	OM)	**Calculation: Total Carbon x 1.75	3.2	3.5	2.2	5.5	4.5	2.9	3.2	> 5.5	>4.5	> 3.5	> 2.5
	(cmol <sub>+</sub> /kg)		1.50	1.52	0.62	1.97	0.88	1.11	0.59	15.6	10.8	5.0	1.9
Exchangeable Calcium	(kg/ha)		675	680	278	885	393	498	267	7000	4816	2240	840
	(mg/kg)	Rayment & Lyons 2011 - 15D3	301	304	124	395	175	222	119	3125	2150	1000	375
	(cmol <sub>+</sub> /kg)	(Ammonium Acetate)	0.54	0.67	0.25	0.43	0.78	0.48	0.65	2.4	1.7	1.2	0.60
Exchangeable Magnesium	(kg/ha)		148	183	69	116	212	131	176	650	448	325	168
	(mg/kg)		66	82	31	52	94	58	79	290	200	145	75

		Site	DReveg1	DReveg2	DReveg3	DWood1	DWood2	DWood3	DWoodLQ	Heavy Soil Clay	Medium Soil Clay Loam	Light Soil Loam	Sandy Soil Loamy Sand
	(cmol₊/kg)		0.28	0.25	0.19	0.22	0.32	0.25	0.27	0.60	0.50	0.40	0.30
Exchangeable Potassium	(kg/ha)		249	221	170	194	281	215	238	526	426	336	224
	(mg/kg)		111	99	76	87	126	96	106	235	190	150	100
	(cmol₊/kg)		0.09	0.09	<0.065	<0.065	0.14	0.08	0.14	0.3	0.26	0.22	0.11
Exchangeable Sodium	(kg/ha)		48	48	<33	<33	70	39	72	155	134	113	57
	(mg/kg)		22	21	<15	<15	31	18	32	69	60	51	25
	(cmol <sub>+</sub> /kg)		0.20	0.21	1.12	1.27	0.88	0.36	0.78	0.6	0.5	0.4	0.2
Exchangeable Aluminium	(kg/ha)	**Inhouse S37 (KCI)	41	42	225	257	178	73	158	121	101	73	30
	(mg/kg)		18	19	101	115	79	32	71	54	45	32	14
	(cmol <sub>+</sub> /kg)		0.46	0.21	0.42	0.31	0.36	0.16	0.36	0.6	0.5	0.4	0.2
Exchangeable Hydrogen	(kg/ha)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	10	5	9	7	8	4	8	13	11	8	3
	(mg/kg)	( county contains	5	2	4	3	4	2	4	6	5	4	2
Effective Cation Exchange Ca (ECEC) (cmol,/kg)	pacity	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol,/kg)	3.09	2.95	2.64	4.23	3.35	2.43	2.80	20.1	14.3	7.8	3.3
Calcium (%)			48.7	51.3	23.5	46.6	26.1	45.6	21.2	77.6	75.7	65.6	57.4
Magnesium (%)			17.6	22.7	9.5	10.1	23.2	19.7	23.1	11.9	11.9	15.7	18.1
Potassium (%)		**Base Saturation Calculations -	9.2	8.5	7.3	5.2	9.6	10.1	9.7	3.0	3.5	5.2	9.1
Sodium - ESP (%)		Cation cmol <sub>+</sub> /kg / ECEC x 100	3.0	3.1	1.3	0.6	4.1	3.1	5.0	1.5	1.8	2.9	3.3
Aluminium (%)			6.5	7.1	42.3	30.1	26.3	14.8	28.0	6.0	7.1	10.5	12.1
Hydrogen			14.9	7.2	16.0	7.3	10.7	6.6	13.0	0.0	7.1	10.5	12.1
Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol <sub>+</sub> /kg)	2.8	2.3	2.5	4.6	1.1	2.3	0.9	6.5	6.4	4.2	3.2
Zinc (mg/kg)			<0.5	0.6	<0.5	0.6	<0.5	<0.5	0.6	6.0	5.0	4.0	3.0
Manganese (mg/kg)		Rayment & Lyons 2011 - 12A1 (DTPA)	4	6	2	20	9	11	7	25	22	18	15
Iron (mg/kg)		Naymoni a Lyons 2011 - 12A1 (DTPA)	308	233	253	199	299	222	352	25	22	18	15
Copper (mg/kg)			0.2	0.2	0.1	0.2	0.2	0.2	0.1	2.4	2.0	1.6	1.2

	Site	DReveg1	DReveg2	DReveg3	DWood1	DWood2	DWood3	DWoodLQ	Heavy Soil Clay	Medium Soil Clay Loam	Light Soil Loam	Sandy Soil Loamy Sand
Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot CaCl <sub>2</sub> )	0.35	0.29	0.25	0.41	0.34	0.26	0.32	2.0	1.7	1.4	1.0
Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	25	21	15	21	21	22	23	50	45	40	35
Total Carbon (%)	Inhauga CAa /I FCO Trumaa Analyaan	1.83	2.02	1.26	3.15	2.59	1.65	1.83	> 3.1	> 2.6	> 2.0	> 1.4
Total Nitrogen (%)	Inhouse S4a (LECO Trumac Analyser)	0.14	0.12	0.06	0.15	0.09	0.06	0.12	> 0.30	> 0.25	> 0.20	> 0.15
Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	13.1	17.4	21.4	20.5	29.1	26.6	15.4	10- 12	10–12	10- 12	10–12
Basic Texture	**Inhouse S65	Loam	:	:	:							
Basic Colour	IIIIIUuse 505	Brownish	:									
Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	13	15	8	18	20	14	19				

#### Notes:

- 1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- 2. Methods from Rayment and Lyons, 2011. Soil Chemical Methods Australasia. CSIRO Publishing: Collingwood.
- 3. Soluble Salts included in Exchangeable Cations NO PRE-WASH (unless requested).
- 4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
- 5. Guidelines for phosphorus have been reduced for Australian soils.
- 6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
- 7. Total Acid Extractable Nutrients indicate a store of nutrients.
- 8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,

Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.

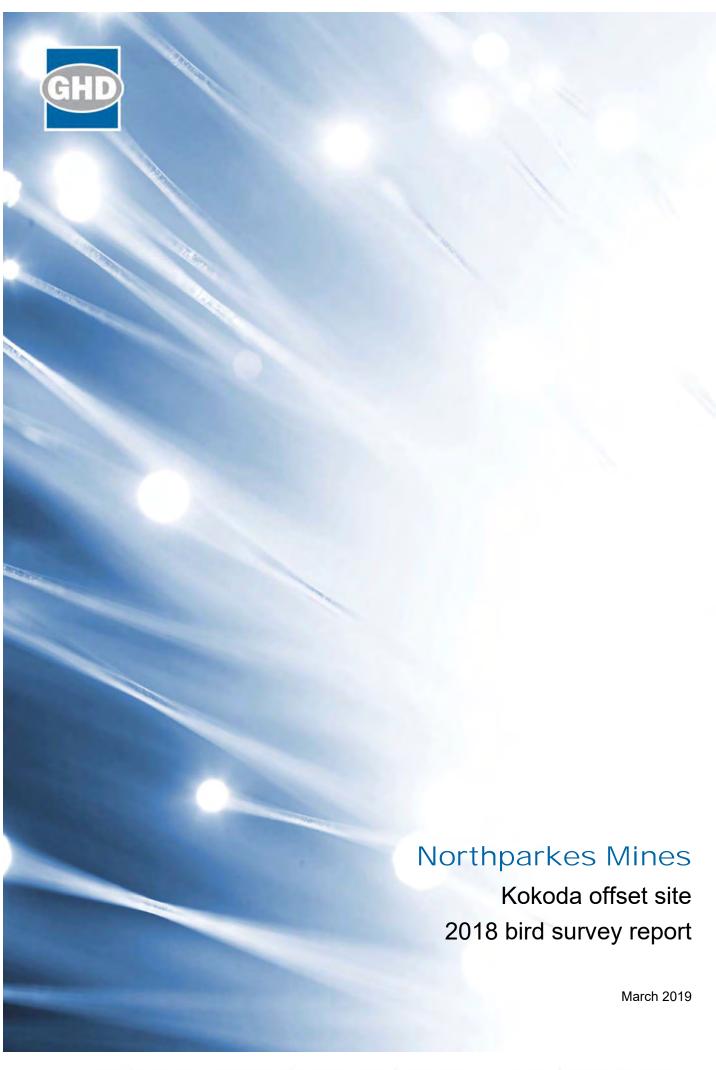
- 9. Information relating to testing colour codes is available on sheet 2 'Understanding your agricultural soil results'.
- 10. Conversions for 1 cmol<sub>+</sub>/kg = 230 mg/kg Sodium, 390 mg/kg Potassium,

122 mg/kg Magnesium, 200 mg/kg Calcium

- **11.** Conversions to kg/ha =  $mg/kg \times 2.24$
- 12. The chloride calculation of CI mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
- 13. \*\* NATA accreditation does not cover the performance of this service.
- 14. Analysis conducted between sample arrival date and reporting date.
- **15.** This report is not to be reproduced except in full.

Quality Checked: Kris Saville Agricultural Co-Ordinator





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# **Appendices**

Appendix A – Database searches

Appendix B - 2018 bird species list

### 1. Introduction

The Northparkes copper and gold mine (Northparkes) is located approximately 27 kilometres north-west of Parkes in central western New South Wales. Northparkes is a joint venture between China Molybdenum Co. Ltd (CMOC) and the Sumitomo Group, with CMOC as managers of the mine. In 2018 Northparkes processed 6.48 million tonnes of ore, and metal recovery was 77.94% copper and 87.59% gold.

Northparkes consists of underground operations accessing several copper sulphide porphyry ore bodies. In addition, Northparkes farms over 6,000 hectares of farming country including land within its three existing mining leases.

#### 1.1 Project background

The Northparkes Mines Step Change Project (the Project) was approved with conditions under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) (PA11\_0060) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (2013/6788) in 2014. Key elements of the Project included:

- Continued underground block cave mining in two existing ore bodies
- The development of an additional underground block cave mine, under one of the existing open cut pits
- Additional campaign open cut mining in existing mine leases
- Augmenting approved Tailings Storage facilities (TSFs); moving the existing access road; construction of the new TSF (Rosedale)
- Extending the life of the mine by seven years to 2032.

As part of the Step Change Project approval conditions, residual impacts resulting from the Project required offsetting. To fulfil this requirement, Northparkes secured the Kokoda Offset area (Kokoda), a 350 hectare site located in the Mandagery locality of the Central West Slopes of NSW.

A Biodiversity Offset Management Plan (BOMP) was prepared in 2014 (Umwelt 2014), which guides the short, medium and long term conservation and management actions at Kokoda. The BOMP was prepared in accordance with the NSW Project Approval (PA11\_0060) and Commonwealth Project Approval (EPBC 2013/6788) requirements and provides a framework for the implementation of ecological management actions, regeneration strategies, controls and monitoring programs at Kokoda.

#### 1.2 Purpose of this report

During ecological surveys for the Step Change Project Environmental Assessment, two threatened fauna species were observed within the Project area:

- Superb Parrot (Polytelis swainsonii) (vulnerable BC Act and EPBC Act)
- Grey-crowned Babbler (eastern subspecies) (Pomatostomus temporalis temporalis) (vulnerable - BC Act).

Suitable habitat for the following Matters of National Environmental Significance (MNES) were identified within the Mine Extension Project area:

Swift Parrot (*Lathamus discolour*) (endangered - BC Act and critically endangered - EPBC Act)

• Regent Honeyeater (Anthochaera phrygia) (critically endangered – BC Act and EPBC Act

This report outlines the results of the winter and spring 2018 bird surveys undertaken at Kokoda, to fulfil the requirements outlined in the BOMP.

Winter surveys were undertaken in July and spring surveys in October to be consistent with surveys undertaken in 2014 to 2017.

In addition to the bird survey in the winter period, in 2017 the NSW Office of Environment and Heritage (OEH) requested during the revision of the Biodiversity Offset Management plan that a survey be conducted of Kangaroos in the derived native grasslands of the Kokoda offset area. Kangaroo surveys were conducted again in the 2018 survey period.

The Project approval or the BOMP did not provided a preferred methodology for the Kangaroo survey and one was developed for the 2017 surveys which was repeated for the current 2018 surveys.

#### 1.3 Scope and limitations

This report has been prepared by GHD for Northparkes and may only be used and relied on by Northparkes for the purpose agreed between GHD and Northparkes as set out in section 0 and 0 of this report.

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

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

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

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 0 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

#### 1.4 Assumptions

Although the Project approvals were issued under the NSW *Threatened Species Conservation Act 1995* (TSC Act), on the 25 August 2017, this act was repealed and replaced with the NSW *Biodiversity Conservation Act 2016* (BC Act). All state listed threatened species formerly listed under the TSC Act are now listed under the BC Act. Any reference to state listed species from here on, should refer to the BC Act rather than the TSC Act.

All survey locations are the same as those completed in previous years monitoring with the exception of one location change in the spring survey. GHD assumes that these locations and habitat types remain consistent based on the location data provided by Northparkes.

### 2. Site and survey background

The Kokoda offset area is a 350 hectare site located in the Mandagery locality of the Central West Slopes of NSW. Kokoda is located within the Cabonne Council area which is known for its agriculture, mining, ballooning, food and wine industries.

Prior to purchase by Northparkes, Kokoda was a hobby farm, with the areas of grassy woodland used for sheep grazing and large patches of remnant vegetation occurring in the southern section of the property. The Kokoda offset area was strategically selected as it is located along a north-south vegetation corridor, connecting remnant woodland and forest vegetation along the ridges and hills from north of Eugowra in the south to east of Narromine in the north. This vegetation corridor includes Goobang National Park, the largest conserved remnant patch of woodland and forest vegetation in the Central West region of NSW..

#### 2.1 Weather conditions

The 2018 weather conditions and dates are detailed below in Table 2-1.

Table 2-1: 2018 survey weather conditions

Date	Survey type	Max. temperature (°C)	Min. temperature (°C)	Rainfall (mm)
Winter surv	ey period			
23/07/2018	Kangaroo count	15.5	-5.3	0
24/07/2018	Kangaroo count	19.3	2.9	0
2 110172010	Winter bird surveys	19.3	2.9	0
25/07/2018	Winter bird surveys	19.0	0	0
Spring surv	ey period			
22/10/2018	Kangaroo count	28.5	5.3	0
23/10/2018	Kangaroo counts	32.6	7.6	0
257.372010	Spring bird surveys	32.6	7.6	0
24/10/2018	Spring bird survey	27.7	10.7	0

The 2018 rainfall was below average for the Parkes area at 328 millimetres. The 2017 rainfall for the area was also below the average of 636 millimetres.

#### 2.2 Personnel

Field surveys described in the report were undertaken by Leigh Maloney, Senior Ecologist, GHD, Wagga Wagga. Leigh has previously completed the 2017 surveying and report for the Kokoda offset site, and as such has prior knowledge of the site and expectations of the report.

### 3. Methods

#### 3.1 Desktop and literature review

A desktop review of relevant literature, ecological databases and reports was completed before conducting the site visit in order to identify the existing avian biodiversity values within the Kokoda offset site (Table 3-1 and Appendix A).

Table 3-1: Desktop and literature review resources

Source	Data	Description of source	Search area
Department of the Environment and Energy (DotE) Protected Matters Search Tool (PMST)	Information on species and communities listed under the EPBC Act	This search tool does not produce species records, it uses data on species and communities listed under the EPBC Act to produce indicative distribution maps, which are used to inform the likelihood of species presence within an area.	10 kilometres buffer around polygon of property. Only included known and likely to occur species
NSW Bionet	Government-held information about plants and animals in NSW	This search tool provides records from a variety of sources, including from members of the public and scientific surveys.	Search criteria: Public Report of all Valid Records of Threatened (Listed under BC Act), Commonwealth listed, CAMBA listed, JAMBA listed or ROKAMBA listed Entities in selected area (North: -33.22 West: 148.40 East: 148.50 South: - 33.32) returned a total of 231 records and 94 species including 11 threatened species
Birds Australia (BA)	Bird data only	Generates a list of species records for a one degree square around a central point. No date or location information provided with records.	Birds listed for a polygon covering the Kokoda property

Source	Data	Description of source	Search area
Northparkes Mines winter and spring bird survey 2017 report	Reports the desktop and field survey results from the ecological surveys undertaken at Kokoda in 2017	Surveys and reporting undertaken by GHD senior ecologist in 2017	Bird species recorded during targeted bird surveys at Kokoda in 2017.
Northparkes Mines winter and spring bird survey 2016 report	Reports the desktop and field survey results from the ecological surveys undertaken at Kokoda in 2016	Surveys and reporting undertaken in-house by Northparkes Mines environment team.	Bird species recorded during targeted bird surveys at Kokoda in 2016.
Northparkes Mines winter and spring bird survey 2015 report	Reports the desktop and field survey results from the ecological surveys undertaken at Kokoda in 2015	Surveys and reporting undertaken in-house by Northparkes Mines environment team.	Bird species recorded during targeted bird surveys at Kokoda in 2015.
Northparkes Mines Ecological Monitoring Baseline Survey – Winter and Spring 2014 (Umwelt 2014)	Reports the desktop and field survey results from ecological surveys undertaken at Kokoda in 2014	Surveys and reporting undertaken by Umwelt.	Bird species recorded during targeted bird surveys at Kokoda in 2014 (Umwelt 2014).

#### 3.2 Field surveys

Winter bird surveys at Kokoda were designed to target the Regent Honeyeater and Swift Parrot. Spring bird surveys were designed to target the Superb Parrot and eastern subspecies of the Grey-crowned Babbler. Table 3-2 outlines the recommended survey methods for these species (excluding the Grey-crowned Babbler which is only listed under the BC Act) as outlined in the Survey Guidelines for Australia's Threatened Birds (DEWHA 2010).

Table 3-2: Recommended methods for surveying target species as outlined in DEWHA 2010

Species	Recommended survey methods (DEWHA 2010)
Winter target species	
Regent Honeyeater  Anthochaera phrygia	Area searches in suitable habitat, preferably in the morning but other times may also be appropriate. Detection by call is possible when birds are most vocal (outside the breeding season). Otherwise, detection is by sighting. Targeted searches of woodland patches with heavily flowering trees is useful, especially around water points such as dams and creek lines. Also check among flocks of other blossom nomads such as lorikeets and other honeyeaters. Broadcast

Species	Recommended survey methods (DEWHA 2010)
	surveys immediately before and during the breeding season may also be useful.
Swift Parrot  Lathamus discolor	Area searches or transect surveys of suitable habitat, preferably in the early morning and afternoon when birds are most active and vocal. Detection by sighting or call. Slow-moving vehicle transects also effective in expansive areas, detecting loud, distinctive 'clinking' call that can be heard over noise of engine. Targeted surveys of patches of heavily flowering eucalypts may be useful. Timing: surveys on the mainland should be conducted between March and July.
Spring target species	
Superb Parrot  Polytelis swainsonii	Area searches or transect surveys of suitable habitat, preferably in the early morning (sunrise to 10 am) and evening (4 pm to sunset). Morning surveys may be of greater value as the species' movements is more coordinated at this time. Detection by sighting or call, usually of flying birds. Vehicle-based transects appropriate in areas where most habitat is restricted to roadside remnants. Survey effort will need to be increased outside the breeding season, as dispersal makes the species more difficult to detect.
Grey-crowned Babbler (eastern subspecies) Pomatostomus temporalis temporalis	None given.  However, the following methods for passerines, including babblers in general, is listed in DEWHA 2010.  Diurnal area searches or transect-point surveys in areas of favoured habitat in and around the study area. Detection mostly by sighting and calls, though ravens, swallows and bowerbirds may be detected by nests or bowers.

#### 3.2.1 Winter surveys

As outlined in the BOMP, the winter bird monitoring consists of:

'Site based diurnal winter bird surveys for regent honeyeater and swift parrot. As a minimum 2 x 20 minute bird surveys will be undertaken at six reference sites (consistent with flora monitoring where possible). Winter bird surveys will be undertaken at DNG regeneration sites once the regenerating canopy species reach a minimum height of four meters.'

At the time of the 2018 winter survey period the canopy species present at the DNG regeneration sites had not reached the minimum height of four meters.

Targeted bird surveys were undertaken at the six existing winter bird survey sites (Figure 3-1). Surveys consisted of two, two hectare area searches for 20 minutes in suitable habitat at each winter survey site. All bird surveys were undertaken by one ecologist. During targeted bird surveys, all birds seen (using binoculars) or heard (using diagnostic calls) were recorded. Targeted bird surveys were undertaken at each survey site twice, in the early morning when birds are most active and vocal to maximise detectability. Any opportunistic bird species identified during surveys were also recorded.

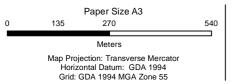
Consistent with surveys in winter 2014 to 2017, as the regeneration areas do not meet the height requirements for monitoring at this stage, surveys were only undertaken at woodland locations within Kokoda. The six surveys sites were positioned in areas of suitable habitat for both targeted species.

In the previous 2017 winter survey period the ecologist had noted that there was also abundant flowering eucalypts (e.g. *Eucalyptus sideroxylon* – Mugga Ironbark) at three of the remnant spring bird survey sites. These three sites were surveyed additionally on two separate mornings in winter to target the Regent Honeyeater and Swift Parrot. In 2018, after a lower than average rainfall, these eucalypts were not flowering as abundantly and as such were not considered as additional survey sites for the winter survey period.



Legend

★ Winter bird survey sites Kokoda property boundary











Northparkes Mine Kokoda bird surveys - 2018 Job Number | 23-16426 Revision

Date 21 Jan 2019

Winter bird survey sites

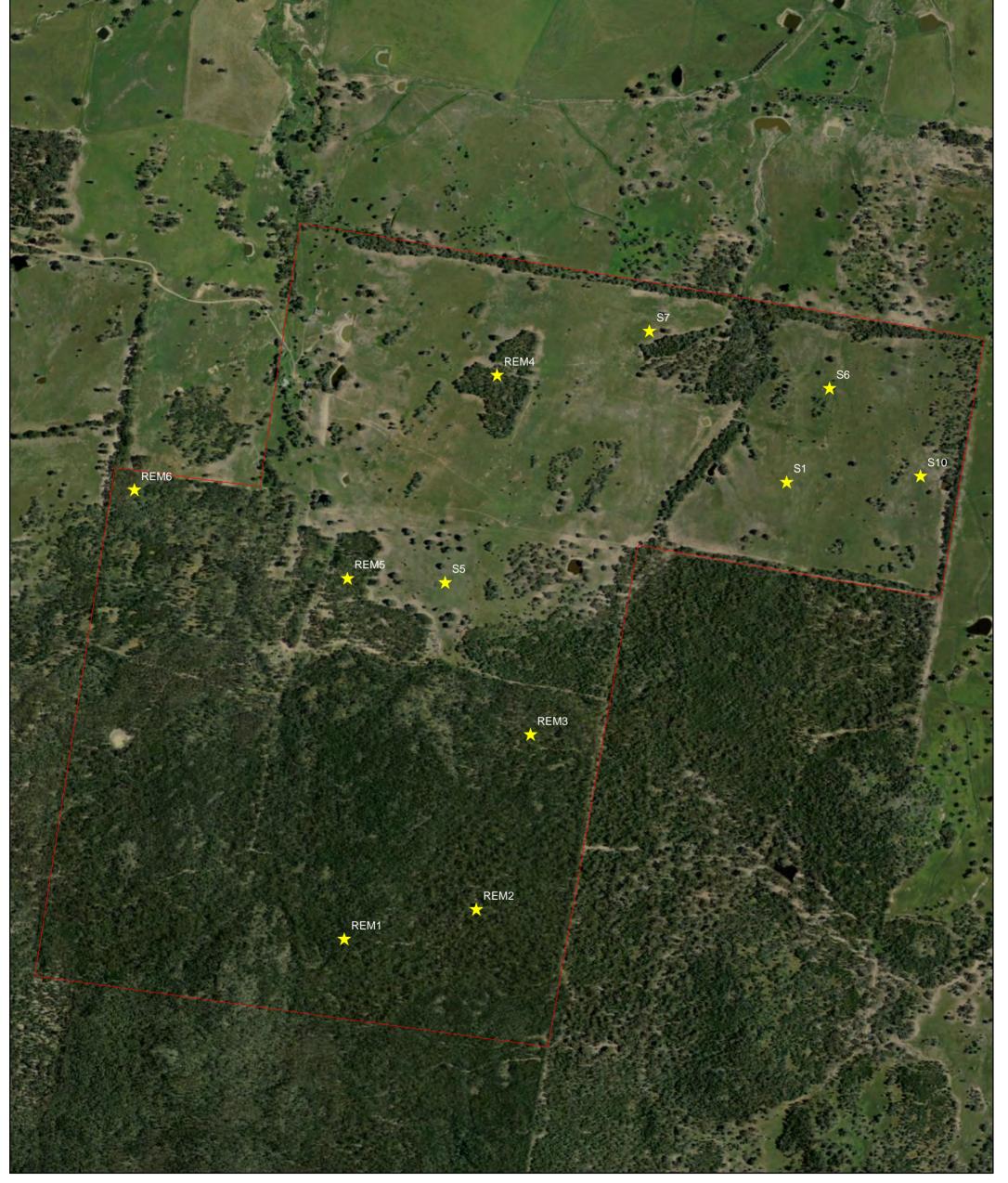
#### 3.2.2 Spring surveys

As outlined in the BOMP, the spring bird monitoring consists of:

'Site based diurnal spring woodland bird surveys. As a minimum, 2 x 20 minute bird surveys will be undertaken at six reference sites (in target woodland community remnants) and six DNG regeneration sites (consistent with flora monitoring sites where possible). Spring woodland bird surveys will be undertaken in DNG regeneration sites during all growth stages as Grey-crowned Babblers may occur in both DNG and woodland areas and Superb Parrots may forage in DNG areas.

Targeted bird surveys were undertaken at 11 of the existing spring bird survey sites (Figure 3-2). As per the recommendation in the 2017 survey report, due to the close proximity of sites SP5, SP3 and REM4 to each other and the overlap in bird species sightings between these sites, site SP5 was moved approximately 750 meters south of its original position. Site SP3 was combined with site REM4, to avoid species overlapping.

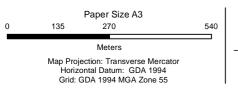
Surveys consisted of two by two hectare area searches for 20 minutes in suitable habitat within Kokoda. During targeted bird surveys, all birds seen (using binoculars) or heard (using diagnostic calls) were recorded. Targeted bird surveys were undertaken at each survey site twice, in the early morning when birds are most active and vocal to maximise detectability. Any opportunistic bird species identified during surveys were also recorded.



Legend

Spring bird survey sites

Kokoda property boundary







Northparkes Mine Kokoda bird surveys - 2018 Job Number | 23-16426 Revision Date 21 Jan 2019

Figure 3-2

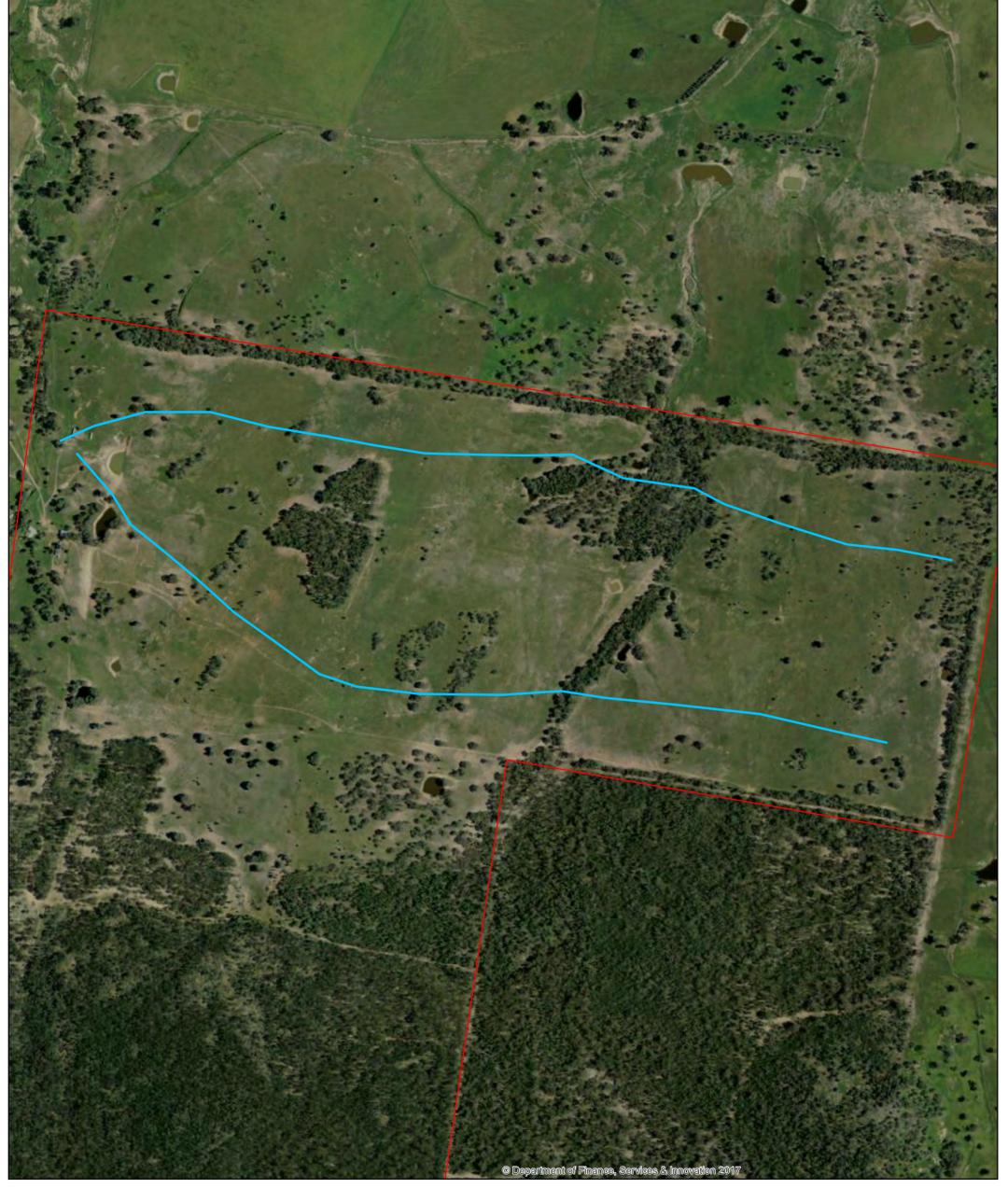
#### 3.2.3 Kangaroo counts

The following statement has been made in the approved BOMP at the request of OEH:

'Kangaroo monitoring will be undertaken biannually within the regenerating woodland area. Monitoring is intended to give an indication of relative presence of kangaroo populations within the regenerating area over time. If a significant increase in the kangaroo population is recorded over two consecutive monitoring periods adaptive management will be investigated. Kangaroo monitoring will commence in 2017, at which point a suitable, repeatable survey methodology will be developed and documented in the Annual Environmental Monitoring Reort (AEMR). All adaptive management actions undertaken are to be documented in the AEMR.'

Numbers of kangaroos were counted by completing two walking transects from east to west (one direction) and then west to east (return transect) across the DNG areas in the north of the property (see Figure 3-3). Numbers of individuals observed along each transect were recorded. Species were also recorded but not numbers of individual species.

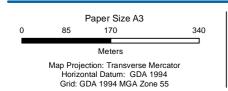
Walking transects were completed at dusk on two separate days in both winter and spring.



LEGEND

Kokoda property boundary

Kangaroo count walking transect











Northparkes Mine Kokoda bird surveys - 2018 Job Number | 23-16426 Revision

Date 21 Jan 2019

### 4. Results

#### 4.1 Desktop results

Fauna desktop assessments conducted for the Kokoda 2018 bird survey revealed the following:

- BioNet A total of 96 bird species were recorded within the BioNet search area of which 12 are listed under the BC Act were recorded within the BioNet search area (see Table 4-1 and Appendix A) Additionally, one species listed as migratory and/ or marine under the EPBC Act were recorded within the BioNet search extent for the site. Refer to Appendix A for full species list of desktop search results)
- PMST Nine threatened bird species listed under the EPBC Act were predicted to occur by
  the PMST within the search area, one as known to occur, three as likely to occur and four
  as may occur. Additionally, one bird species listed as migratory under the EPBC Act were
  listed as known, likely or may occur (see Appendix A and Table 4-1)
- Birds Australia (BA) A total of 125 bird species were recorded within the BA search area.
   Twelve species listed under the BC and/or EPBC Act were recorded within the BA search area (see Table 4-1 and Table 4-1).
- Baseline A total of 59 bird species were recorded within Kokoda during baseline surveys (Umwelt 2014), including six species listed as vulnerable under the BC Act and/ or EPBC Act (see Table 4-1).
- Baseline A total of 60 species were recorded during the 2017 winter surveys and 68 species in the spring surveys. Five species listed under the BC Act and/or EPBC Act were recorded.

Table 4-1: Listed threatened bird species recorded in the desktop, baseline and monitoring surveys.

Common Name	Scientific Name	BC Act status*	EPBC Act status*	BioNet	PMST	ВА	Baseline 2014	2015	2016	2017	2018
Australian Painted Snipe	Rostratula australis	Е	E , Mi		May		-				
Australasian Bittern	Botaurus poiciloptilus	Е	Е		May		-				
Black Falcon	Falco subniger	V	-	✓			-				
Black-chinned Honeyeater	Melithreptus gularis	V	-	✓		✓	-				
Brown Treecreeper (eastern subspecies)	Climacteris picumnus victoriae	V	-	<b>√</b>		<b>✓</b>	<b>√</b>				<b>√</b>
Common Sandpiper	Actitis hypoleucos	-	Mi		May						
Curlew Sandpiper	Calidris ferruginea	Е	CE, Mi		May						
Diamond Firetail	Stagonopleura guttata	V	-	✓		✓	-	✓			✓
Dusky Woodswallow	Artamus cyanopterus	V	-	✓		✓					
Eastern Curlew	Numenius madagascariensis	-	CE, Mi		May						
Flame Robin	Petroica phoenicea	V	-							✓	✓
Fork-tailed Swift	Apus pacificus	-	Mi		Likely						
Grey-crowned Babbler (eastern subspecies)	Pomatostomus temporalis temporalis	V	-			✓	✓	<b>✓</b>	<b>√</b>	<b>~</b>	<b>✓</b>
Hooded Robin	Melanodryas cucullata	V	-	✓		<b>√</b>	<b>✓</b>				

Common Name	Scientific Name	BC Act status*	EPBC Act status*	BioNet	PMST	ВА	Baseline 2014	2015	2016	2017	2018
Latham's Snipe	Gallinago hardwickii	-	Mi		May						
Little Lorikeet	Glossopsitta pusilla	V	-	✓		✓	✓				✓
Major Mitchell's Cockatoo	Lophochroa leadbeateri	V	-			✓	-				
Malleefowl	Leipoa ocellata	Е	V		Known		-				
Osprey	Pandion haliaetus	-	Mi		May						
Painted Honeyeater	Grantiella picta	V	V		Likely		-				
Pectoral Sandpiper	Calidris melanotus	-	Mi		May						
Regent Honeyeater	Anthochaera phrygia	CE	CE		Known		-				
Rufous Fantail	Rhipidura rufifrons	-	Mi		May						
Satin Flycatcher	Myiagra cyanoleuca	-	Mi		Known					✓	✓
Sharp-tailed Sandpiper	Calidris acuminata	-	Mi		Likely						
Speckled Warbler	Chthonicola sagittata	V	-			✓	✓			✓	✓
Superb Parrot	Polytelis swainsonii	V	V		Likely	✓	✓	✓	✓	✓	✓
Swift Parrot	Lathamus discolor	CE	CE		Likely		-				
White-fronted Needletail	Hirundapus caudacutus	-	Mi		May						
Yellow Wagtail	Motacilla flava	-	Mi		May						

#### 4.2 Bird diversity

A total of 50 species were recorded during the 2018 winter surveys and 61 species in the spring surveys. The winter survey identified seven BC and EPBC Act listed species, and the spring surveys identified three listed species.

Table 4-2: Threatened and migratory species recorded during 2018 Kokoda bird surveys

Species	BC Act status *	EPBC Act status *	Winter – site ID where recorded	Spring – site ID where recorded
Brown Treecreeper (Climacteris picumnus picumnus)	V	-	W1	Not recorded
Diamond Firetail (Stagonopleura guttata)	V	-	W6	Not recorded
Flame Robin (Petroica phoenicea)	V	-	W6	Not recorded
Grey-crowned Babbler (Pomatostomus temporalis temporalis)	V	-	W5, W6	REM4, REM5, SP1, SP5, SP10
Little Lorikeet (Glossopsitta pusilla)	V	-	W4, W5	Not recorded
Speckled Warbler (Chthonicola sagittata)	V	-	W2, W6	REM1, REM3, REM6
Superb Parrot (Polytelis swainsonii)	V	V	W4	REM4, REM6, SP1, SP5, SP6, SP7

The Grey-crowned Babbler, Superb Parrot and Speckled Warbler were recorded at multiple sites during the spring survey period.

Seven threatened species were recorded on site during the winter survey period. Most notably the Little Lorikeet which has not been recorded at the site since the 2014 baseline surveys. Large flocks of up to 20 individuals were observed feeding on flowering Mugga Ironbark.

A full list of bird species recorded during 2018 field surveys is in Appendix B.

#### 4.2.1 Comparison of years and species

A comparative analysis of the species observed between different survey periods and years is shown in Table 4-1. A slightly higher number of species are recorded during the spring survey periods compared with winter periods over all four years. This is likely to be a function of the greater number of survey sites in the spring than winter (12 in spring versus six in winter), rather than more species occurring in spring.

The most commonly recorded threatened species across all survey years was the Greycrowned Babbler. The Superb Parrot, Brown Treecreeper and Speckled Warbler were also recorded a number of times in both the winter and spring survey periods on multiple occasions.

Table 4-3: Species comparison across survey periods

Survey period	Number of bird species	Number of threatened bird species	Threatened species
Baseline	59	6	Brown Treecreeper, Grey-crowned Babbler, Hooded Robin, Little Lorikeet, Speckled Warbler and Superb Parrot
Winter 2015	42	2	Brown Treecreeper and Grey- crowned Babbler
Spring 2015	53	3	Diamond Firetail, Grey-crowned Babbler and Superb Parrot
Winter 2016	41	1	Grey-crowned Babbler
Spring 2016	51	2	Grey-crowned Babbler and Superb Parrot
Winter 2017	52 (+ 8 from x3 spring survey sites)	5	Grey-crowned Babbler, Speckled Warbler, Superb Parrot, Flame Robin and Satin Flycatcher (migratory)
Spring 2017	68	3	Grey-crowned Babbler, Speckled Warbler and Superb Parrot
Winter 2018	50	7	Superb Parrot, Diamond Firetail, Flame Robin, Speckled Warbler, Brown Treecreeper, Grey-crowned Babbler, Little Lorikeet
Spring 2018	61	3 ( +1 migratory)	Grey-crowned Babbler, Superb Parrot, Speckled Warbler, Satin Flycatcher (Migratory)

#### 4.3 Kangaroo populations

Kangaroo surveys were previously undertaken during both spring and winter 2017 surveys. Data collected during these surveying periods will be used as a baseline for monitoring Kangaroo populations on site.

The 2017 survey period recorded a total of 683 individuals across both survey periods, with 305 being recorded during the winter surveys and 378 recorded during the spring surveys (see Table 4-4 and Table 4-5).

The 2018 survey period recorded a total of 1041 individuals were recorded across both survey periods, with 583 being recorded during the winter surveys and 458 recorded during the spring survey period.

In comparison to the data obtained during the 2017 survey period, the site has seen a 52 per cent increase in kangaroo numbers in 2018 (see Table 4-5).

The majority of species recorded were Eastern Grey Kangaroos (Macropus giganteus).

Table 4-4: Kangaroo population numbers 2018

Date	Species	Total
23/07/2018 (winter)	Eastern Grey Kangaroo	324
24/07/2018 (winter)	Eastern Grey Kangaroo	259
	TOTAL (winter)	583
22/10/2018 (spring)	Eastern Grey Kangaroo	323
22/10/2016 (spiling)	Swamp Wallaby	1
23/10/2018 (spring)	Eastern Grey Kangaroo	134
	TOTAL (spring)	458

Table 4-5: Kangaroo population numbers over years and seasons at Kokoda

Year	Season	Total
2017	Winter	305
2018	Winter	583
2017	Spring	378
2018	Spring	458

### 5. Recommendations

Northparkes have developed an Excel based spreadsheet to enable the winter and spring bird survey data to be entered into each year. This has created an efficient way in which to review species recorded, numbers and locations of individuals as more data is collected each year. The spreadsheet will continue to be utilised in the future surveys to monitor species composition at each site and across seasons and years.

#### 5.1 Winter bird surveys

The six winter bird survey sites have been selected based on the target species of Swift Parrot and Regent Honeyeater. These species rely on heavily flowering Box-Ironbark eucalypt forests for their seasonal movements to feeding areas.

A reconnaissance of survey sites was conducted prior to commencing the 2017 winter bird surveys.

In 2018, the Parkes area of NSW experienced much lower than average rainfall. This in turn impacted on the abundance of flowering eucalyptus, including Mugga Ironbark (*Eucalyptus sideroxylon*) in the area. While the Mugga Ironbark was flowering on site in 2018, in comparison to 2017 surveys it was much less widespread and abundant. As such, surveying was limited to the six originally selected winter bird survey sites, and the additional three sites surveyed in 2017 were disregarded. Given the suitable habitat that occurs in these additional three sites for the target species, in a suitable year they should continue to be surveyed in future winter surveys.

#### 5.2 Spring bird surveys

All 11 spring survey sites were surveyed twice in 2018. As per the recommendation in the 2017 report survey site SP5 was moved approximately 750 meters south of it previous position, and SP3 was removed entirely as a survey site (see Figure 3-2). Given the mobile nature of bird species and the fact that this isolated, small remnant consists only of canopy and groundcover stratum, it was discovered during the 2017 survey periods that there was considerable overlap between the bird species recorded at these two sites, and as such that future surveys would benefit from combining these two survey sites into one survey site.

#### 5.3 Kangaroo counts

As recommended in the 2017 survey periods, kangaroo counts were again conducted in the 2018 survey periods to monitor the relative presence of kangaroo species on site. These counts indicated a 52 per cent increase in kangaroo abundance across the site.

Following low rainfall in 2017, the Parkes area of NSW again experienced much lower than average rainfall in 2018. Low rainfall and drought conditions may have contributed to increased grazing pressures in nearby woodland and agricultural land, leading to a concentration of kangaroo species at the Kokoda offset site, where grazing by domestic stock does not occur.

It is recommended that the method outlined in this baseline count should continue to be followed for future monitoring.

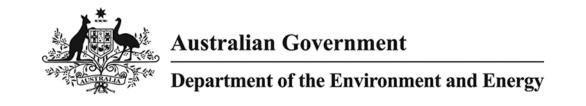
However, other approaches need to be considered should numbers begin to further increase and control methods begin to be considered. This may include:

- Counting of individuals using drones at appropriate times of day. Consideration of night time thermal imagery may also be an option
- Setting up of kangaroo plots to count kangaroo scats in order to calculate approximate densities. This would likely require multiple plot collection and some statistical analysis.

#### 5.4 Additional measures

No additional management recommendations, other than those outlined in the Northparkes BOMP and outlined above in section 5, are required at this stage.

# Appendix A – Database searches



# **EPBC Act Protected Matters Report**

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about <u>Environment Assessments</u> and the EPBC Act including significance guidelines, forms and application process details.

Report created: 10/07/18 16:26:20

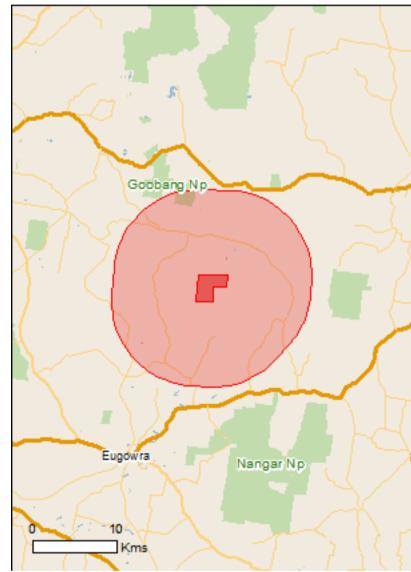
**Summary** 

**Details** 

Matters of NES
Other Matters Protected by the EPBC Act
Extra Information

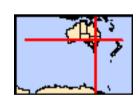
Caveat

<u>Acknowledgements</u>



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 10.0Km



## **Summary**

### Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the <u>Administrative Guidelines on Significance</u>.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	2
Listed Threatened Species:	25
Listed Migratory Species:	12

### Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A <u>permit</u> may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

### **Extra Information**

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	27
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

## **Details**

## Matters of National Environmental Significance

Wetlands of International Importance (Ramsar)	[ Resource Information ]
Name	Proximity
Banrock station wetland complex	700 - 800km upstream
Hattah-kulkyne lakes	500 - 600km upstream
Riverland	600 - 700km upstream
The coorong, and lakes alexandrina and albert wetland	800 - 900km upstream

# Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Nome	Ctotus	Type of Dresense
Name	Status	Type of Presence
Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area
Listed Threatened Species		[ Resource Information ]
Name	Status	Type of Presence
Birds		
Anthochaera phrygia		
Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Grantiella picta		
Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Lathamus discolor		
Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Polytelis swainsonii		
Superb Parrot [738]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species

Name	Status	Type of Presence
		habitat may occur within
Fish		area
Maccullochella peelii		
Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Macquaria australasica		
Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland populat	tion)	
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Nyctophilus corbeni		
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld,	NSW and the ACT)	
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat known to occur within area
Diameter and Paragraph along		
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within
Plants		area
Austrostipa wakoolica		
[66623]	Endangered	Species or species habitat likely to occur within area
Philotheca ericifolia		
[64942]	Vulnerable	Species or species habitat known to occur within area
Prasophyllum petilum  Tanana I a a la Carlaid (554 44)	E a da a sa a d	On a standard and the bit of
Tarengo Leek Orchid [55144]	Endangered	Species or species habitat may occur within area
Prasophyllum sp. Wybong (C.Phelps ORG 5269) a leek-orchid [81964]	Critically Endangered	Species or species habitat may occur within area
		may obtain within area
Swainsona recta Small Purple pea Mountain Swainson pea Small	Endongorod	Species or appeies hebitet
Small Purple-pea, Mountain Swainson-pea, Small Purple Pea [7580]	Endangered	Species or species habitat may occur within area
Tylophora linearis [55231]	Endangered	Species or species habitat may occur within area
Donatha		·
Reptiles Aprasia parapulchella		
Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat likely to occur within area
Delma impar		
Striped Legless Lizard [1649]	Vulnerable	Species or species habitat may occur within area
Listed Migratory Species		[ Resource Information

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus		
White-throated Needletail [682]		Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat may occur within area
Other Matters Protected by the EPBC Act		
<b>,</b>		

Listed Marine Species		[ Resource Information ]
* Species is listed under a different scientific na	me on the EPBC Act - Threat	ened Species list.
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species

Name	Threatened	Type of Presence
		habitat likely to occur within
Ardea ibis		area
Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp toiled Sandpiper [974]		Species or appoint habitat
Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
<u>Calidris ferruginea</u> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat
	omically Endangered	may occur within area
<u>Calidris melanotos</u> Pectoral Sandpiper [858]		Species or species habitat
		may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat
		may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat
Winte semed cod Lagie [e ie]		likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat
writte-timoated recedictan [002]		may occur within area
<u>Lathamus discolor</u> Swift Parrot [744]	Critically Endangered	Species or species habitat
	Offically Efficience	likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat
rambow bee-eater [0/0]		may occur within area
Motacilla flava  Vallow Wagtail [644]		Species or species habitat
Yellow Wagtail [644]		may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat
Satiri Frycatcher [012]		Species or species habitat known to occur within area
Numenius madagascariensis  Factors Curlow For Factors Curlow [947]	Critically Endangered	Species or species habitat
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat may occur within area
Rhipidura rufifrons  Rufous Fontail (502)		Charles ar angeles helitet
Rufous Fantail [592]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato)	□	On a size and a little of
Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

## **Extra Information**

State and Territory Reserves	[Resource Information]
Name	State
Goobang	NSW

## Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Landscape Health Project, National Land and Water i	Nesouces Addit, 2001.	
Name	Status	Type of Presence
Birds		
Alauda arvensis		
Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos		
Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis		
European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus		
House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus		
Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Sturnus vulgaris		
Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula		
Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus		
Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris		
Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus		
Goat [2]		Species or species habitat likely to occur within area
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer		
Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis		
Brown Hare [127]		Species or species habitat

likely to occur

Name	Status	Type of Presence
Mus musculus House Mouse [120]		within area  Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]	]	Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussoc Nassella Tussock (NZ) [18884]	ck,	Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]	s.x reichardtii	Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area

Species or species habitat likely to occur within area

Ulex europaeus

Gorse, Furze [7693]

### Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the gualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

## Coordinates

-33.267033 148.444393,-33.267894 148.474519,-33.278443 148.473833,-33.278514 148.4601,-33.291645 148.460186,-33.290927 148.441904,-33.267104 148.444393,-33.267104 148.444393,-33.267033 148.444393

## Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Data from the BioNet BioNet Atlas website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1°; ^^ rounded to 0.01°). Copyright the State of NSW through the Office of Environment and Heritage. Search criteria: Public Report of all Valid Records of Threatened (listed on TSC Act 1995), Commonwealth listed, CAMBA listed, JAMBA listed or ROKAMBA listed Animals in selected area [North: -33.22 West: 148.40 East: 148.50 South: -33.32] returned a total of 22 records of 12 species. Report generated on 18/01/2019 2:29 PM

Kingdo m	Class	Family	Species Code	Scientific Name	Exotic	Common Name	NSW statu s	Com m. statu s	Recor ds	Inf O
Animalia	Aves	Falconidae	0238	Falco subniger		Black Falcon	V,P		1	i
Animalia	Aves	Psittacidae	0260	Glossopsitta pusilla		Little Lorikeet	V,P		2	i
Animalia	Aves	Psittacidae	0277	^^Polytelis swainsonii		Superb Parrot	V,P,3	V	2	i
Animalia	Aves	Meropidae	0329	Merops ornatus		Rainbow Bee-eater	Р	J	2	
Animalia	Aves	Climacterid ae	8127	Climacteris picumnus victoriae		Brown Treecreeper (eastern subspecies)	V,P		2	i
Animalia	Aves	Acanthizida e	0504	Chthonicola sagittata		Speckled Warbler	V,P		3	i
Animalia	Aves	Meliphagida e	8303	Melithreptus gularis gularis		Black-chinned Honeyeater (eastern subspecies)	V,P		2	i
Animalia	Aves	Pomatosto midae	8388	Pomatostomus temporalis temporalis		Grey-crowned Babbler (eastern subspecies)	V,P		2	i

Animalia	Aves	Artamidae	8519	Artamus cyanopterus cyanopterus	Dusky Woodswallow	V,P	2	i
Animalia	Aves	Petroicidae	8367	Melanodryas cucullata cucullata	Hooded Robin (south- eastern form)	V,P	1	i
Animalia	Aves	Petroicidae	0382	Petroica phoenicea	Flame Robin	V,P	1	i
Animalia	Aves	Estrildidae	0652	Stagonopleura guttata	Diamond Firetail	V,P	2	i

## Appendix B - 2018 bird species list

#### **FAUNA LIST – Winter 2018**

**Bold** denotes threatened species, Opp. = opportunistic observation O = observed, W = heard calling

Common Name	Scientific Name	V	<b>V</b> 1	V	W2 24/07 25/07 W		W3		W4		W5		W6	
		24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	
Apostlebird	Struthidea cinerea							W	O,W		O,W			
Australian Magpie	Cracticus tibicen	W	W		W	W	W	W	O,W	O, W	O,W	W		
Australian Raven	Corvus coronoides		W		W	W		W	W	O, W	O,W		W	
Australian Wood Duck	Chenonetta jubata					W	W	O, W	O,W		O,W		W	
Blue-faced Honeyeater	Entomyzon cyanotis												W	
Brown-headed Honeyeater	Melithreptus brevirostris	0	W	O, W	W	W								
Brown Treecreeper	Climacteris picumnus		O,W											
Brown Thornbill	Acanthiza pusilla			O, W	0									
Buff-rumped Thornbill	Acanthiza reguloides				0							W		
Common Bronzewing	Phaps chalcoptera						0	0	0					
Crested Pigeon	Ocyphaps lophotes					W	W	O, W	W		W			
Diamond Firetail	Stagonopleura guttata												w	
Eastern Rosella	Platycercus eximius	W	W		O,W	W	0	W	0	W	O,W	W	W	
Eastern Spinebill	Acanthorhynchus tenuirostris	W	W	W	W							W		

Common Name	mmon Name Scientific Name		W1		W2		W3		W4		N5	W6		Орр.
		24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	
Eastern Yellow Robin	Eopsaltria australis	0	W	O, W	W	0						W	0	
Flame Robin	Petroica phoenicea													0
Fuscous Honeyeater	Ptilotula fuscus		O,W		W		W						W	
Galah	Eolophus roseicapillus	W	O,W		O,W	O, W	W	O, W	O,W	O, W	W		W	
Golden Whistler	Pachycephala pectoralis	0	W	O, W	W									
Grey Shrike-Thrush	Colluricincla harmonica			W	W									
Grey-crowned Babbler	Pomatostomus temporalis temporalis									O, W	w		w	
Jacky Winter	Microeca fascinans			W	W	W	O,W					W	W	
Laughing Kookaburra	Dacelo novaeguineae			W	W		W	W	W		0	W		
Little Lorikeet	Glossopsitta pusilla							O, W	O,W	O, W				O, W
Magpie-lark	Grallina cyanoleuca						W			O, W		W		
Mistletoe Bird	Dicaeum hirundinaceum		0				W							
Musk Lorikeet	Glossopsitta concinna										O,W		W	
Nankeen Kestrel	Falco cenchroides													0
Noisy Miner	Manorina melanocephala					O, W	O,W	O, W	O,W	O, W	O,W	W	W	
Olive-back Oriole	Oriolus sagittatus											W		

Common Name	Scientific Name	V	V1 W2 W3		/3	,	W4	W5		W6		Орр.		
		24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	
Pied Butcherbird	Cracticus nigrogularis				W		W		O,W	W	W	W		
Pied Currawong	Strepera graculina		W		W		W	W		0		W		
Red Wattlebird	Anthochaera carunculata			W	W	W						W	W	
Red-capped Robin	Petroica goodenovii											O, W		
Red-rumped Parrot	Psephotus haematonotus							0		W	0			
Southern Whiteface	Aphelocephala leucopsis												W	
Speckled Warbler	Chthonicola sagittata			O, W	w							O, W	w	
Spotted Pardalote	Pardalotus punctatus						0							
Striated Pardalote	Pardalotus striatus	0	W	W	O,W				W		W			
Sulphur-crested Cockatoo	Cacatua galerita		W										W	
Superb Fairy Wren	Malurus cyaneus	O, W	W									W		
Superb Parrot	Polytelis swainsonii								0					
Welcome Swallow	Hirundo neoxena									0	O,W			
White-eared Honeyeater	Nesoptilotis leucotis	0	0			0								
White-plumed Honeyeater	Ptilotula penicillatus	0	W	W	W	W	W				0	W	W	
White-throated Treecreeper	Cormobates leucophaea	W	W	W	W	W	W					W	W	

Common Name	Scientific Name	V	<b>V</b> 1	W	/2	V	/3	,	W4	V	V5	V	V6	Орр.
		24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	24/07	25/07	
White-winged Chough	Corcorax melanorhamphos										O,W	W		
Willie Wagtail	Rhipidura leucophrys				W							W	W	
Yellow Thornbill	Acanthiza nana			0	O,W	O, W	W							
Yellow-faced Honeyeater	Caligavis chrysops	W	W	O, W										
Yellow-rumped Thornbill	Acanthiza chrysorrhoa	W	O,W	O, W	W	W						O, W	W	

#### **FAUNA LIST - Spring 2018**

#### **Bold** denotes threatened species

O = observed, W = heard calling

Common	Scientific	RE	M1	RE	M2	RE	М3	RE	M4	RE	M5	RE	M6	S	P1	SI	P5	S	P6	SI	P7	SF	10	
Name	Name	23/ 10	24/ 10	O p																				
Apostle bird	Struthidea cinerea							OW			0					W			OW			OW	OW	
Australian Magpie	Cracticus tibicen				W	W		W	OW	OW	W	W	W	OW	OW	OW	0	OW	OW	OW	OW	OW	OW	
Australian Raven	Corvus coronoides					W		OW				W	W		W				W	OW	W	OW	W	
Australian Wood Duck	Chenonetta jubata																					OW	0	
Black- faced Cuckoo Shrike	Coracina novaehollan diae										0	OW	W		0		W					W		
Blue- faced Honeyeat er	Entomyzon cyanotis								W															
Brown- headed Honeyeat er	Melithreptus brevirostris		W	W	W		W					OW			W									
Brown Thornbill	Acanthiza pusilla					0																		

Common	Scientific	RE	M1	RE	M2	RE	М3	RE	M4	RE	M5	RE	M6	SI	P1	SI	P5	SI	P6	S	P7	SF	P10	
Name	Name	23/ 10	24/ 10	O p																				
Chestnut- rumped Thornbill	Acanthiza uropygialis		0				W																	
Cockatiel	Nymphicus hollandicus							W	OW					OW					OW		W			
Common Bronzewi ng	Phaps chalcoptera		W	W	W				0		W	W		0					0				W	
Common Starling	Sturnus vulgaris*							ow																
Crested Pigeon	Ocyphaps lophotes									W	0				ow	W				0	0	W	OW	
Crested Shrike-tit	Falcunculus frontatus											ow												
Eastern Rosella	Platycercus eximius			W				OW	OW	ow		W		W	ow	0	0	ow	W	W	ow	0	OW	
Eastern Spinebill	Acanthorhyn chus tenuirostris				W																			
Eastern Yellow Robin	Eopsaltria australis	W		W		W	0					OW	W											
Emu	Dromaius novaehollan diae																							0
Fuscous Honeyeat er	Ptilotula fuscus																							0

Common	Scientific	RE	M1	RE	M2	RE	M3	RE	M4	RE	M5	RE	M6	SI	P1	SI	P5	SI	P6	S	P7	SF	P10	
Name	Name	23/ 10	24/ 10	O p																				
Galah	Eolophus roseicapillus				W		OW	OW	OW	W	OW	W	W	OW										
Golden Whistler	Pachycephal a pectoralis				W																			
Grey Fantail	Rhipidura albiscapa	ow	W			OW	W																	
Grey Shrike- Thrush	Colluricincla harmonica				W	0	W																	
Grey- crowned Babbler	Pomatosto mus temporalis temporalis							ow		w					w	w	ow						ow	
Jacky Winter	Microeca fascinans												W											
Laughing Kookaburr a	Dacelo novaeguinea e		W	w				W						W	W			OW					W	
Little Raven	Corvus mellori													W										
Magpie- lark	Grallina cyanoleuca							W	W		OW	W	W		W	W	W	W	W			W	W	
New Holland Honeyeat er	Phylidonyris novaehollan diae	W										OW												
Noisy Friarbird	Philemon corniculatus											W												

Common	Scientific	RE	M1	RE	M2	RE	M3	RE	M4	RE	M5	RE	M6	SI	P1	S	P5	S	P6	S	P7	SF	P10	
Name	Name	23/ 10	24/ 10	O p																				
Noisy Miner	Manorina melanoceph ala							OW	OW	OW	OW	W	W	OW	W	OW								
Pallid Cuckoo	Cacomantis pallidus			W										W	W									
Peaceful Dove	Geopelia placida					W	W			W	W	W	W		W		W							
Pied Butcherbir d	Cracticus nigrogularis	W	W					OW	0		ow			W		W	W	W	W	W	W		W	
Pied Currawon g	Strepera graculina	W	W	W	W			W		W	W									OW				
Rainbow Bee-eater	Merops ornatus					W				W														
Red Wattlebird	Anthochaera carunculata		W		0		W			W			W	0										
Red- capped Robin	Petroica goodenovii						W																	
Red- rumped Parrot	Psephotus haematonotu s							ow							W		W	W	OW					
Rufous Songlark	Megalurus mathewsi													W			W							
Rufous Whistler	Pachycephal a rufiventris	W	W	W	W	W	W				W	W	W											
Satin Flycatcher	Myiagra cyanoleuca	OW		W																				

Common	Scientific	RE	M1	RE	M2	RE	М3	RE	M4	RE	M5	RE	M6	SI	P1	SI	P5	S	P6	S	P7	SF	10	
Name	Name	23/ 10	24/ 10	O p																				
Southern Whiteface	Aphelocepha la leucopsis		W	0	OW																			
Speckled Warbler	Chthonicola sagittata	W				ow	w						w											
Spiny- cheeked Honeyeat er	Acanthageny s rufogularis											W		W										
Spotted Pardalote	Pardalotus punctatus											OW												
Striated Pardalote	Pardalotus striatus								W				W		W			W	W	W			W	
Sulphur- crested Cockatoo	Cacatua galerita							ow							W			ow		OW				
Superb Fairy Wren	Malurus cyaneus											W	W											
Superb Parrot	Polytelis swainsonii							ow					ow	w		w		ow		ow	w			
Weebil	Smicrornis brevirostris			W	W	W								W		W	W	OW	W					
Welcome Swallow	Hirundo neoxena								W															
Western Gerygone	Gerygone fusca					W	W			W	W							W						
White- browed	Artamus superciliosus						OW			W		OW												

Common	Scientific	RE	M1	RE	M2	RE	M3	RE	M4	RE	M5	RE	M6	S	P1	SI	P5	SI	P6	SI	P7	SF	P10	
Name	Name	23/ 10	24/ 10	O p																				
Woodswal low																								
White- eared Honeyeat er	Nesoptilotis leucotis	W	W	W	W		W					W	W	W	W	W								
White- faced Heron	Egretta novaehollan diae														0						0			
White- plumed Honeyeat er	Ptilotula penicillatus		W	OW	0					W	W	W	W	W										
White- throated Treecreep er	Cormobates leucophaea	W	W	W	W	0	W			W	W	W	W		W									
White- winged Triller	Lalage tricolor													W										
White- winged Chough	Corcorax melanorham phos									OW	0							OW		OW		OW	W	
Willie Wagtail	Rhipidura leucophrys											W	OW		W									
Yellow- faced Honeyeat er	Caligavis chrysops		W		W																			

Common Name	Scientific Name	RE	M1	RE	M2	RE	ЕМЗ	RE	M4	RE	M5	RE	M6	SI	P1	SI	P5	S	P6	SI	P7	SF	10	
Name	Name	23/ 10	24/ 10	O p																				
Yellow- rumped Thornbill	Acanthiza chrysorrhoa	W	OW	OW	W									W	W									

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#### **Document Status**

Revision	Author	Reviewer		Approved for I	ssue	
		Name	Signature	Name	Signature	Date
RevA	B.Turner	L. Maloney		D. Mees	On email	23/01/2019
Final	B. Turner	L. Maloney	Fight Malvier	D. Mees	On email	13/03/2019



2018

# Biannual Inspection Report for the Kokoda Biodiversity Offset site







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#### 1. KOKODA BIANNUAL INSPECTION – MAY 2018

Inspection date: 1 May 2018 Recorders: N Jones, D Shaw

Inspection time: 11.00 am - 3.30 pm

#### 1.1 Summary

During the biannual inspection of Kokoda offset property undertaken on 1 May 2018, two items were identified that require attention:

- South-western boundary fence requires repair; and
- Tree down across the track near orchid areas 4 and 5, preventing further access.

Natural regeneration continues to progress across the property, with regeneration 0.5 m to 3 m high in some locations.

Spraying of the Tree of Heaven has been successful.

The northern boundary fence repairs are complete.

5 goats were seen in the forest near orchid areas 3 and 4.

#### 1.2 Outstanding previous actions from December 2017

Management	Observation	
Arrange for removal of debris from fence and reinstate fence Responsible: N Jones Action: 74011980	Two sections of the boundary fence along the left hand side of the access driveway have debris washed onto them creating opportunity for grazing animals to enter the property.	Complete
Investigate and develop a plan for appropriate eradication in consideration with LLS.  Responsible: N Jones Action: 74011981	Rabbit burrows under house.	Meeting scheduled May 2018
Determine the purpose of the infrastructure and if there is a need for maintenance.  Responsible: C Dingle Action: 74011982	Ceiling of house requires repairs. Bedroom, living room and kitchen ceilings have mould present. Vegetation is growing in gutters, which may be impacting the roof/ ceiling drainage issues. Bush on garage need trimming.	Complete - The house will not be maintained.
Arrange for weed spraying to occur. Responsible: M Burkitt Action: 74011983	Various instances of St John's Wort and Patterson's Curse appearing.	Complete
Arrange for weed spraying to occur. Responsible: M Burkitt Action: 74011983 (as above)	Tree of heaven needs to be sprayed – along the creek bed behind the house.	Complete
Investigate best options to undertake rabbit burrow eradication, that maintains creek bank stability and meets all VCA requirements in consideration with LLS.  Responsible: N Jones Action: 74011984	Rabbits and burrows under the blackberry in the creek bed at the northern boundary are to be eradicated, and the creek bed restored and fenced to stop erosion.	Meeting scheduled May 2018
Remove overhanging trees to approximately 3m from fence line to create a fire break & fire access track in conjunction with the new fence installation.  Responsible: M Burkitt Action: 74011985	Overhanging trees along the northern fence line to be removed.	Complete



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Management	Observation	
Investigate the possibility of a firebreak to be installed along the boundary fence line. Liaise with OEH to determine what requirements there are that we need to adhere to	Install a firebreak along the western, southern and eastern boundary fence lines.	In progress
Responsible: N Jones Action: 74011986		
The tracks on the access road and into the creek bed will require to be graded.	Erosion of the access road and the creek bed.	In progress
Responsible: M Burkitt Action: 74011987	200.	

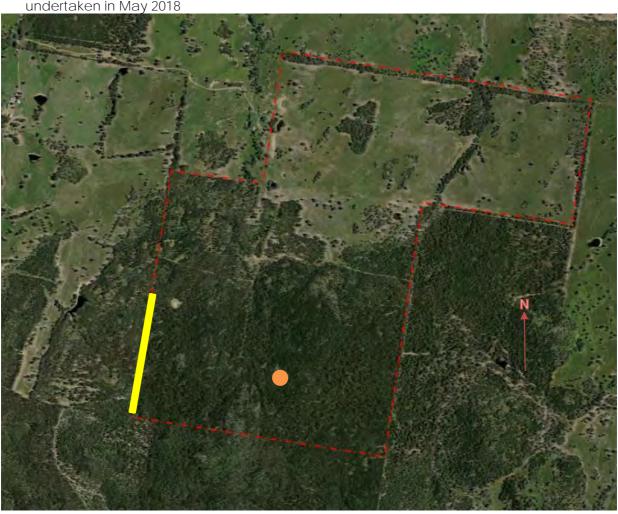
## 1.3 Management requirements observed during the biannual inspection - May 2018

Category	Observation	Photo	Management - PSI - 74012607
Access tracks	Large trees across track	No photo	Arrange to clear the track Responsible: N Jones Action: 74012608
Boundary fencing	Fences need repair in a number of places along the south boundary.	No photo	Arrange to fix the fences Responsible: N Jones Action: 74012609



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Figure 1: Location of management requirements observed during biannual inspection undertaken in May 2018





Boundary fencing needing repair Tree across track



#### 2. KOKODA BIANNUAL INSPECTION – NOVEMBER 2018

Inspection date: 20 November 2018 Recorders: N Jones, M Thomas Inspection time: 9.00 – 11.00 am

#### 2.1 Summary

During the biannual inspection of Kokoda offset property undertaken on 20 November 2018, the following items requiring attention were identified:

- Evidence of unauthorized fire wood harvest activities onsite.
- Some regrowth of tree-of-heaven was identified in the creek behind the house.
- Several areas with potential rabbit burrows were identified. Pest control measures have been implemented and appear to have been successful.
- A fire break along the western, southern and eastern boundary fences needs to be cleared. Discussions with the relevant authority will need to commence as to ensure that all relevant guidelines are adhered to.
- Erosion of access road.
- Erosion of road way into creek crossing.
- Refer to the following sections for additional information on each observed management item. Refer to Figure 2 for the location of the observed management items.

Natural regeneration continues to progress across the property, with regeneration 0.5 m to 1 m high in some locations.

25 goats were seen in the forest near orchid areas 3 and 4.

#### 2.2 Outstanding previous actions from May 2018

Management	Observation	
Investigate and develop a plan for appropriate eradication in consideration with LLS. Responsible: N Jones Action: 74011981	Rabbit burrows under house. Baiting program appears to have been successful.	Complete
Investigate best options to undertake rabbit burrow eradication, that maintains creek bank stability and meets all VCA requirements in consideration with LLS.  Responsible: N Jones Action: 74011984	Rabbits and burrows under the blackberry in the creek bed at the northern boundary are to be eradicated, and the creek bed restored and fenced to stop erosion.	In progress
Investigate the possibility of a firebreak to be installed along the boundary fence line. Liaise with OEH to determine what requirements there are that we need to adhere to Responsible: N Jones Action: 74011986	Install a firebreak along the western, southern and eastern boundary fence lines.	In progress
The tracks on the access road and into the creek bed will require to be graded.  Responsible: M Burkitt  Action: 74011987	Erosion of the access road and the creek bed.	In progress
Arrange to clear the track Responsible: N Jones Action: 74012608	Fallen tree cleared and access reinstated.	Complete



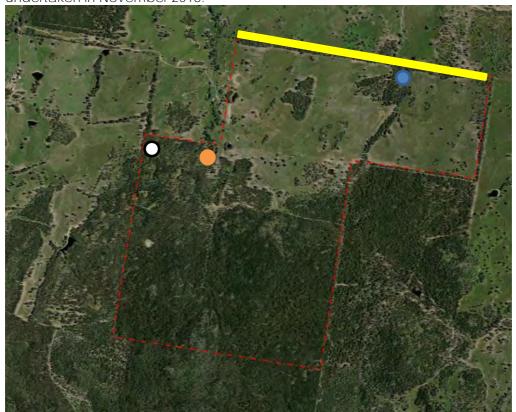
Page 7

Management	Observation	
Arrange to fix the fences along the south-western boundary Responsible: N Jones Action: 74012609	Fence repairs/replacement included in Year 1 management actions for Kokoda.	In progress

## 2.3 Management requirements observed during the biannual inspection – November 2018

Category	Observation	Photo	Management Action
Unauthorised firewood harvest	Evidence of unauthorised firewood harvest activities onsite	No photo	Install additional signage at front gate Responsible: N Jones Complete
Re-spray tree of heaven	Tree of heaven population needs re-spraying.	No photo	Include in next spray program Responsible: N Jones Complete
Firebreaks	Firebreak along northern boundary has large amounts of regrowth	No photo	Include in next spray program Responsible: N Jones Complete

Figure 2: Location of management requirements observed during biannual inspection undertaken in November 2018.





Indicative firebreak – spray re-growth

Un-authorised firewood harvest

Tree of heaven



#### 3. PROGRESS AND COMPLETION TARGETS – 2018

Criteria	Description
Assess the success of completed weed and pest management actions	<ul> <li>Blackberry under control and one new instance of Tree-of-heaven re-growth identified.</li> <li>Weed management measures to occur. St Johns Wort and Patterson's Curse numbers significantly decreased.</li> <li>Pest management measures similar to last biannual inspection. Rabbit population controlled during targeted program in consultation with Local Lands Services.</li> </ul>
Natural Regeneration	
Assess the progress of natural regeneration within the DNG areas	<ul> <li>Additional regeneration observed around the edges of existing larger eucalyptus patches</li> <li>Regeneration between 0.5 – 1 m high in some areas</li> <li>Regeneration slightly improved since last inspection.</li> </ul>



## May 2018 Nest Box Inspections



#### 1. INTRODUCTION

#### 1.1 Background

During April 2017 Northparkes developed and implemented a Habitat Augmentation Works Report, which included the installation of a total of 78 nest boxes, targeting five different animal species, in the farms and offset areas. During May 2018 an inspection was undertaken to determine both the condition of the nest boxes and if there was any evidence of nesting birds utilizing the boxes.

#### 2. RESULTS

The results of the inspection are provided in Table 1 below.

West Beechmore has a of total 10 nest boxes installed. From the inspection three boxes were still in perfect condition with little to no evidence of any animal activity. Five boxes had signs of chewing from birds, most likely caused by Gallahs. Two boxes were in poor condition as the bottom of one of the box has been chewed and the other had the side door open which will require rectification in the future.

Middle Beechmore has a total of 9 nest boxes installed. From the inspection five boxes were still in perfect condition with little to no evidence of any animal activity. Two nest boxes had signs of chewing from birds, most likely Gallahs and two of the boxes side doors have come open.

Brians Billabong has a total of 27 nest boxes installed. From the inspection sixteen boxes were still in perfect condition with little to no evidence of any animal activity. Five boxes had signs of chewing from birds, most likely Gallahs. Five nest boxes were in poor condition with a combination of open side doors and significant damage caused by chewing and one box had fallen out of the tree and has been destroyed.

Escourt Offset has a total of 12 nest boxes installed. Eight boxes were still in perfect condition with little to no evidence of any animal activity. Two nest boxes had been chewed by birds. One nest box has had the lid come off and another side door come open, which will need rectification in the future.

The Kokoda Offset area has a total of 20 nest boxes installed. Eight nest boxes were still in perfect condition with little to no evidence of any animal activity. Nine boxes have been chewed by birds and three have had the side door come open.

Table 1.

Region	ID	Easting	Northing	Nestbox direction facing	Tree type	Condition (Good, Average, Poor)	Comments
West Beechmore	SU01	594412	6356271	SW - Top	GREY	Good	Minor chewing around entrance
West Beechmore	SU02	594412	6356271	Е	GREY	Perfect	
West Beechmore	SU03	594404	6356274	S - Top	GREY	Average	Chewing around entrance and perch missing
West Beechmore	SU04	594404	6356274	NE	GREY	Good	Minor chewing around entrance
West Beechmore	SU05	594381	6356281	N	GREY	Perfect	
West Beechmore	SU06	594381	6356281	SE	GREY	Good	Minor chewing around entrance
West Beechmore	SU07	594358	6356301	W - Top	GREY	Poor	Side door open

West Beechmore	G08	594358	6356301	W - Bottom	GREY	Good	Minor chewing around box
West Beechmore	SU09	594367	6356297	NW	GREY	Perfect	
West Beechmore	B10	594367	6356297	NE	GREY	Poor	Bottom of box chewed
Middle Beechmore	SU11	595627	6356058	NW	GREY	Perfect	
Middle Beechmore	SU12	595627	6356058	W	GREY	Good	Minor chewing on roof
Middle Beechmore	SU13	595628	6356068	W	GREY	Poor	Side door open and minor chewing around entrance
Middle Beechmore	SU14	595628	6356068	N	GREY	Perfect	
Middle Beechmore	SU15	595641	6356051	N - Bottom	GREY	Perfect	
Middle Beechmore	SU16	595641	6356051	Е - Тор	GREY	Perfect	
Middle Beechmore	SU17	595649	6356055	NE	GREY	Poor	Side door open
Middle Beechmore	SU18	595670	6356057	S	GREY	Good	Minor chewing on roof
Middle Beechmore	SU19	595670	6356057	NE	GREY	Perfect	
Brians Billabong	SU20	596301	6355932	S	GREY	Good	Perch is missing
Brians Billabong	SU21	596301	6355932	SE	GREY	Poor	Side door open
Brians Billabong	SU22	596298	6355934	W	GREY	Perfect	
Brians Billabong	SU23	596284	6355934	S	GREY	Perfect	
Brians Billabong	SU24	596286	6355925	S	GREY	Perfect	
Brians Billabong	SU25	596286	6355925	Е	GREY	Poor	Side door open, entrance and bottom of box completely chewed through
Brians Billabong	SU26	596294	6355922	N	GREY	Average	Chewing around entrance and top front corners
Brians Billabong	SU27	596294	6355922	N	GREY	Perfect	
Brians Billabong	SU28	596340	6355920	S	RED RIVER	Perfect	
Brians Billabong	SU29	596340	6355920	N/W - 2nd from top	RED RIVER	Poor	Side door open, chewing around the entire box
Brians Billabong	SU30	596340	6355920	E - 3rd from top	RED RIVER	Perfect	

Brians Billabong	SU31	596340	6355920	N	RED RIVER	Poor	Side door has fallen off, minor chewing
Brians Billabong	SU32	596361	6355917	NE - Bottom	RED RIVER	Average	Minor chewing and perch missing
Brians Billabong	SU33	596361	6355917	W	RED RIVER	Poor	Side door open, chewing around roof of box
Brians Billabong	SU34	596361	6355917	Е	RED RIVER	Perfect	
Brians Billabong	SU35	596361	6355917	W	RED RIVER	Poor	Has fallen to the ground and in pieces
Brians Billabong	SU36	596370	6355891	Е	RED RIVER	Perfect	
Brians Billabong	SU37	596370	6355891	N/W	RED RIVER	Perfect	
Brians Billabong	SU38	596378	635588	N/W	RED RIVER	Perfect	Old wasp nest on underside of box
Brians Billabong	SU39	596378	635588	N	RED RIVER	Good	Side door starting to open
Brians Billabong	SU40	596363	6355879	E - Middle	RED RIVER	Perfect	
Brians Billabong	SU41	596363	6355879	SW - Top	RED RIVER	Perfect	Old wasp nest on underside of box
Brians Billabong	SU42	596363	6355879	NW - Bottom	RED RIVER	Perfect	Minor chewing
Brians Billabong	SU43	596369	6355872	S	RED RIVER	Perfect	
Brians Billabong	SU44	596369	6355872	S/W - Bottom	RED RIVER	Perfect	
Brians Billabong	SU45	596365	6355860	Е - Тор	RED RIVER	Good	Minor chewing around entrance
Brians Billabong	SU46	596365	6355860	S - Bottom	RED RIVER	Perfect	
Escourt Offset	SU47	599037	6361366	N	GREY	Perfect	
Escourt Offset	SU48	599047	6361368	N	YELLOW	Average	Minor chewing around entrance
Escourt Offset	SU49	599097	6361366	Е - Тор	YELLOW	Perfect	
Escourt Offset	G50	599097	6361366	SW - Bottom	YELLOW	Average	Minor chewing around box
Escourt Offset	SU51	599110	6361392	N - Top	YELLOW	Poor	Side door open
Escourt Offset	SU52	599110	6361392	S - Bottom	YELLOW	Perfect	
Escourt Offset	SU53	599121	6361466	Е - Тор	YELLOW	Perfect	

Escourt Offset	SU54	599121	6361466	S - Bottom	YELLOW	Perfect	
Escourt Offset	G55	599074	6361478	W - Top	YELLOW	Poor	Minor chewing and the lid is missing
Escourt Offset	B56	599074	6361478	S - Bottom	YELLOW	Perfect	
Escourt Offset	P57	599084	6361502	SW	YELLOW	Perfect	Old wasp nest on underside of box
Escourt Offset	SU58	599084	6361502	SW	YELLOW	Perfect	
Kokoda Offset	SP59	635511	6317793	W	MUGGA	Good	Minor chewing around box
Kokoda Offset	SU60	635511	6317793	N	MUGGA	Good	
Kokoda Offset	P61	635511	6317793	Е	MUGGA	Good	
Kokoda Offset	SU62	635557	6317829	W	GREY	Poor	Chewing and the side door has come open
Kokoda Offset	B63	635557	6317829	W	GREY	Good	
Kokoda Offset	SU64	635618	6317952	Е - Тор	RED RIVER	Good	Minor chewing and old wasps nest on underside of box
Kokoda Offset	SU65	635618	6317952	NE - Bottom	RED RIVER	Good	Minor evidence of chewing
Kokoda Offset	SU66	636651	6318441	NE	MUGGA	Poor	Side door open and minor chewing around entrance
Kokoda Offset	SU67	636651	6318441	N	MUGGA	Perfect	
Kokoda Offset	SU68	636570	6318458	Е	MUGGA	Perfect	On Trunk
Kokoda Offset	SU69	636570	6318458	NE	MUGGA	Perfect	Out on limb
Kokoda Offset	SU70	636742	6318411	S	MUGGA	Perfect	
Kokoda Offset	SU71	636742	6318411	Е	MUGGA	Perfect	
Kokoda Offset	SP72	636742	6318411	N	MUGGA	Poor	Side door open
Kokoda Offset	SU73	636233	6318576	NE - Top	GREY	Perfect	
Kokoda Offset	SU74	636233	6318576	S - Bottom	GREY	Perfect	
Kokoda Offset	SU75	636224	6318591	N/E - Top	RED RIVER	Good	Minor chewing
Kokoda Offset	SU76	636224	6318591	SE - Bottom	RED RIVER	Perfect	
Kokoda Offset	SP77	636148	6318625	W - Top	GREY	Average	Minor chewing
Kokoda Offset	SU78	636148	6318625	N - Bottom	GREY	Average	Minor chewing

Table 2 identifies that from the 78 installed nest boxes, 41 are still in perfect condition, 23 have been chewed by animals, potentially Gallahs and Cockatoos, 12 need some maintenance work and 2 need replacing.

Approx. only 10% of boxes require maintenance work or to be replaced.

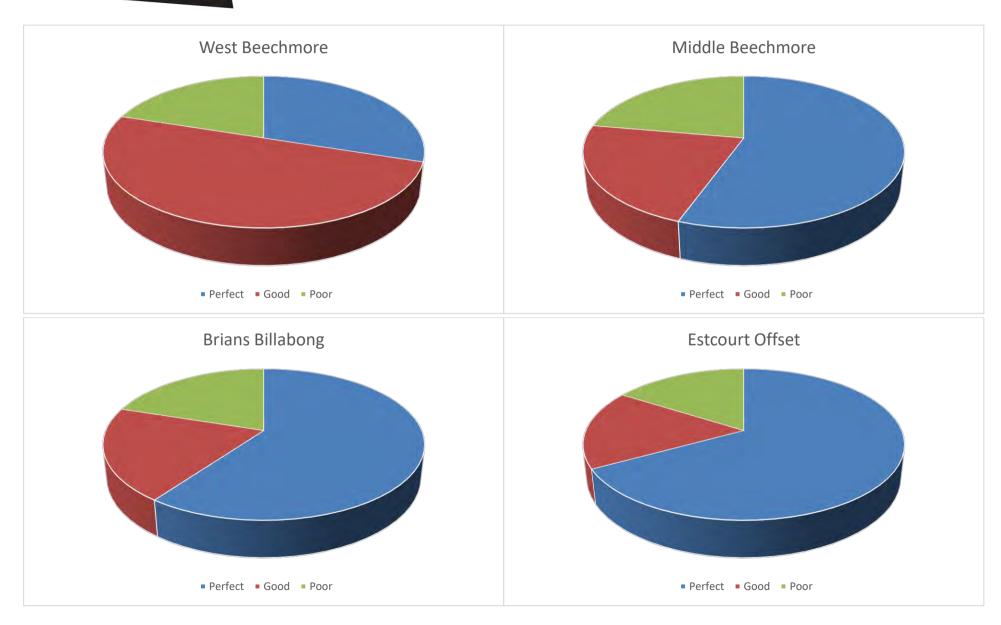
Table 2. Condtion of nest boxes in 2018 compared to 2017.

	Number of Nest boxes 2017	Number of Nest boxes 2018
Perfect condition with little to no evidence of animal activity	42	41
Evidence of chewing by birds	27	23
Occupied	2	0
Side Door Open/poor condition	7	12
Destroyed		2
Total	78	78

Figure 1 below shows that the majority of locations have minimal nest boxes in a poor condition. Due to the high costs involved with the repair of the boxes and the fact that there is only a small number requiring repair, no further action will be taken during H1 of 2019.

The next nest box inspection is scheduled for June 2019.





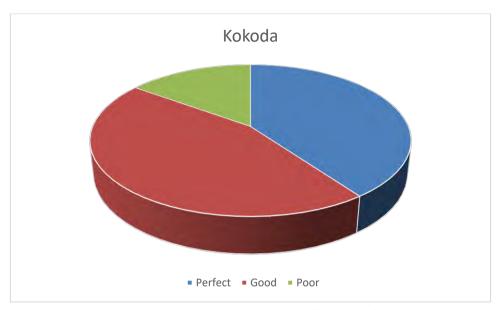


Figure 1. Percentage of nest box condition per location.



Legend —— Proposed Kakoda Offset Site Boundary

Grey Box Grassy Woodland (EEC - TSC Act/CEEC - EPBC Act)

man. Grey Box Grassy Woodland - DNG (EEC - TSC Act/CEEC - EPBC Act)

More White Box Grassy Woodland (EEC - TSC Act/CEEC - EPBC Act)

Dwyer's Red Gum Creekline Woodland

 Dwyer's Red Gum - Grey Box - Mugga Ironbark - Black Cypress Pine Forest
 Dwyer's Red Gum - Grey Box - Mugga Ironbark - Black Cypress Pine Forest DNG

 Dwyer's Red Gum - Grey Box - Mugga Ironbark - Black Cypress Woodland Low Quality Farm Dam Farm Track - Disturbed Land

Grey Box - Ironbark Woodland Mugga Ironbark Woodland Rocky Rise Shrubby Woodland

Vegetation Community Mapping - Proposed Kokoda Offset Site

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# Management Plan

# Biodiversity Offset Management Plan

Risk Statement: Low

This Management Plan has been developed to comply with Condition 29 of NSW Project Approval (PA11\_0060) and to comply with the Northparkes Mines Step Change Project Preliminary Documentation as conditioned under the Commonwealth Project Approval (EPBC 2013/6788).

This document will be reviewed on three yearly basis, unless a process change occurs earlier than this period.

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# Revision Summary

First Issue	Issue Date	Implementation Requirements	Approved By
0	30 Nov 14	Biodiversity Management Plan prepared by Umwelt for compliance with NSW Project Condition (PA11_0060)	Environment and Farms Superintendent

Version No.	Revision Date	Clause No.	Revision Details	Approved By
1	22 Sept 2015		Biodiversity Management Plan updated to:  Incorporate comments received from the Department of Planning and Environment  Reformatted into Northparkes document style  Renamed Biodiversity Offset Management Plan (BOMP) rather than Biodiversity Management Plan (BMP)  Removed references to Pine Donkey Orchid management from main document and included in Appendix 3 – Species Management Plan for the Pine Donkey Orchid	Environment and Farms Superintendent
2	26 July 2016		BOMP updated to include comments from OEH. Reformatted document into new Northparkes template.	PSE Manager
3	28 October 2016		BOMP updated to include comments from OEH, following meeting with OEH on 19 October 2016.	Environment and Farms Superintendent
4	24 November 2016		BOMP updated following response from OEH	Environment and Farms Superintendent

Approval Position	Automatic Notifications	

Hard Copy Locations	Associated Documents to be reviewed	

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Glossary of terms

Term	Definition
BOMP	Biodiversity Offset Management Plan
CEEC	Critically Endangered Ecological Community
DNG	Derived Native Grassland
DoE	Commonwealth Department of the Environment
EEC	Endangered Ecological Community
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
ha	Hectares
LFA	Landscape Function Analysis
OEH	NSW Office of Environment and Heritage
DP&E	NSW Department of Planning and Environment
TEC	Threatened Ecological Community
TSC Act	Threatened Species Conservation Act 1995 (NSW)

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# 1. INTRODUCTION

The Northparkes Mines (Northparkes) Biodiversity Offset Management Plan (BOMP) has been prepared to guide the ongoing management of the Kokoda Offset Site for biodiversity conservation and enhancement purposes. The Kokoda Offset Site has been established as a biodiversity offset for the ecological impacts of the Northparkes Mines Step Change Project (the Project). The 350 hectare Kokoda Offset Site is located in the Mandagery locality of the Central West Slopes of NSW (refer to Figure 1.1), approximately 52 kilometres south-east of the Project Area. In addition the BOMP incorporates the existing approved biodiversity offset management plans for the existing Limestone National Forest Offset (refer to Appendix 1) and Estcourt Tailings Storage Facility Offset (refer to Appendix 2) as established in accordance with the previous project approval (PA06\_0026 as modified) at Northparkes.

The BOMP has been prepared in accordance with the NSW Project Approval requirements (PA11\_0060) and Commonwealth Project Approval (EPBC 2013/6788) requirements issued for the Project and provides a framework for the implementation of ecological management actions, regeneration strategies, controls and monitoring programs for the Kokoda Offset Site.

# 1.1 Northparkes Mines Step Change Project

Northparkes is a copper-gold mine located approximately 27 kilometres north-west of Parkes in central New South Wales. Northparkes Step Change Project (the Project) encompasses the continuation of underground block cave mining in two existing ore bodies, the development of underground block cave mining in the E22 resource, additional campaign open cut mining located in existing mining leases and an extended mine life of seven years until 2032.

The Project will result in the removal of 37 hectares of native woodland communities, 15 hectares of derived native grassland communities, 25 hectares of plantation, 39 hectares of exotic grassland, 112 hectares of cultivated land and 11 hectares of disturbed land. Of these communities, two Threatened Ecological Communities (TECs) will be impacted with the removal of:

- 23 hectares of Grey Box Grassy Woodland Endangered Ecological Community (EEC) (Threatened Species Conservation Act 1995 [TSC Act] and Environment Protection and Biodiversity Conservation Act 1999 [EPBC Act]) in woodland form and 15 hectares in Derived Native Grassland (DNG) form;
- 0.28 hectare of White Box Yellow Box Blakely's Red Gum Woodland EEC (TSC Act)/ Critically Endangered Ecological Community (CEEC) (EPBC Act).

The Kokoda Offset Site will conserve 13 hectares of the Grey Box Grassy Woodland EEC (TSC and EPBC Act) and 96 hectares of the Grey Box Grassy Woodland – DNG EEC (TSC and EPBC Act) (to be regenerated into the woodland) as well as 2.2 hectares of the White Box – Yellow Box – Blakely's Red Gum Woodland EEC (TSC Act) and CEEC (EPBC Act).

Pine donkey orchid (*Diuris tricolor*), which is listed as vulnerable under the TSC Act, was recorded within the Project Disturbance Area. Two populations of the pine donkey orchid were recorded near or within the Project Area. One population is located to the north of the Project Area (along Adavale Lane) and the other population is located near the E48 subsidence zone. A total of 1171 plants (234 and 937 respectively) were recorded within the two areas. A total of 14 individual plants and 0.05 hectares of known habitat will be removed by the Project. For further information on the management of the pine donkey orchid, refer to Appendix 3.

Two threatened fauna species were observed within the Project Disturbance Area, being the grey-crowned babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) and the superb parrot (*Polytelis swainsonii*). Both are listed as vulnerable on the TSC Act.

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# 1.2 Overall objectives of the BOMP

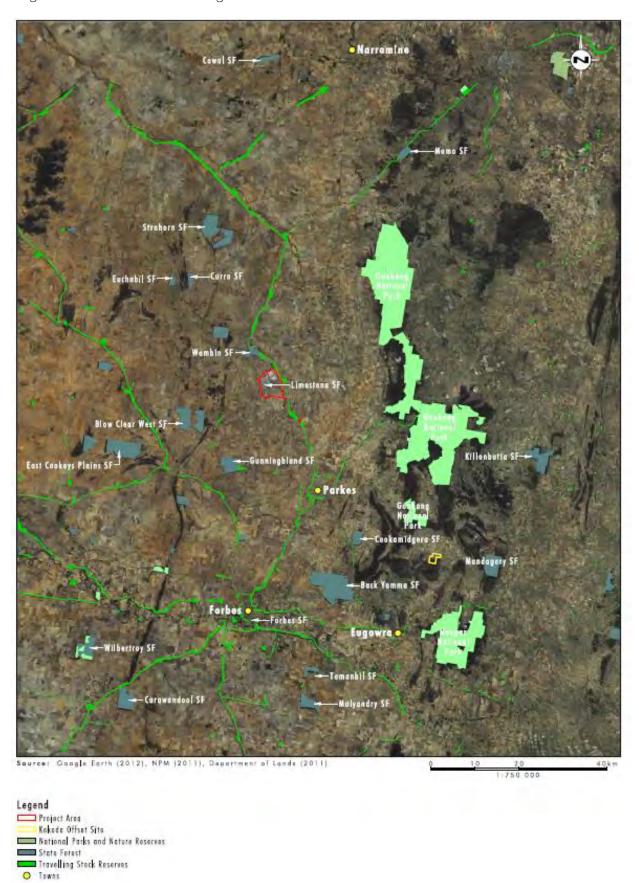
The aim of the BOMP is to facilitate the long term conservation and enhancement of the ecological values of the Kokoda Offset Site. The BOMP broadly focuses on managing woodland for conservation and assisting derived native grassland (DNG) areas to return to woodland form of key targeted vegetation communities. Specific objectives of the BOMP are to:

- identify and describe the area of land that will be required to be managed in accordance with this BOMP;
- provide clear and concise instructions for the management of the Kokoda Offset Site in accordance with the biodiversity management objectives (Section 3);
- provide a working schedule for the implementation of BOMP activities, including:
  - manage remnant vegetation and fauna habitat;
  - o restore the DNG component of the Grey Box Grassy Woodland EEC to woodland community;
  - o integrate the implementation of the biodiversity offset strategies to the greatest extent practicable with the rehabilitation of the site (where relevant); and
- describe monitoring, performance evaluation and reporting procedures that are informative, practical and achievable.

For further information on the management of the Limestone Offset area, Estcourt Offset area and the management and conservation of the pine donkey orchid population's onsite, refer to Appendix 1, Appendix 2 and Appendix 3.

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Figure 1.1 Kokoda offset site regional location



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# 1.3 Regulatory requirements

The Kokoda BOMP addresses the relevant components of conditions 27-32 of the NSW Project Approval (PA11\_0060) and conditions 4 – 9 of the Commonwealth Approval (EPBC 2013/6788) for the Northparkes Mines Step Change Project. The details of the NSW and Commonwealth conditions and reference to where they are addressed in this BOMP are provided in Table 1.1 and Table 1.2.

Table 1.1 NSW Development Consent Conditions - Schedule 3

Condition		Related Section in BOMP
Biodiversity Offsets		
25. The Proponent shall implement the biod summarised in Table 7 below, shown conce and 3 of Appendix 7 and detailed in the ta satisfaction of the Director-General.	Entire BOMP	
Table 7: Summary of Biodiversity Offsets		
Limestone National Forest Offset	Minimum Size Hectares (ha)	
Revegetate land	45.1	
Sub-Total	45.1	
Estcourt Tailings Storage Facility Offset		
Vegetation Community:		
Yellow Box Tall Grassy Woodland	3.3	
Inland Grey Box – White Cypress Pine Tall Woodland	38.8	
Derived Tussock Grasslands	23	
Sub-Total	65.1	
Kokoda Biodiversity Offset		
Grey Box Grassy Woodland EEC	13	
Grey Box Grassy Woodland DNG EEC	96	
White Box Grassy Woodland EEC	2.2	
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest	150	
Rocky Rise Shrubby Woodland	26	
Grey Box – Ironbark Woodland	25	
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine DNG	15	
Dwyer's Red Gum Creek line Woodland	9.4	
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Woodland Low Quality	8.6	
Mugga Ironbark Woodland	1.9	
Farm tracks and dams (disturbed lands)	2.5	
Sub-Total	350.0	
Notes:		
<ul> <li>the Limestone National Forest Biodiversit in blue and labelled "Addition To Limest Figure 1 of Appendix 7;</li> </ul>		

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Condition	Related Section in BOMP
the Estcourt Tailings Storage Facility Biodiversity Offset area is marked with bold black line in Figure 2 of Appendix 7; and	
The Kokoda Biodiversity Offset area is marked with red line in Figure 3 of Appendix 7.	
26. The Proponent shall ensure that the Kokoda Biodiversity Offset provides suitable habitat for all the threatened fauna species confirmed and identified as being present in the disturbance areas.	Section 5.8
Note: The threatened fauna species confirmed and identified as being present in the disturbance areas are listed in Appendix 8.	
Security of Offsets	
27. By the 30 June 2015, unless the Director-General agrees otherwise, the Proponent shall make suitable arrangements to protect the Kokoda Biodiversity Offset in perpetuity in consultation with OEH and to the satisfaction of the Director-General.	Section 2.2
Conservation Bond	
28. By 30 June 2015, unless otherwise agreed by the Director-General, the Proponent shall lodge a Conservation Bond with Planning & Infrastructure to ensure that the biodiversity offset strategies are implemented in accordance with the performance and completion criteria of the Biodiversity Management Plan (refer to Condition 29 below). The sum of the bond shall be determined by:  (a)calculating the full cost of implementing the biodiversity offset strategy (other than land acquisition costs); and  (b) employing a suitably qualified quantity surveyor to verify the calculated costs, to the satisfaction of the Director-General. If the biodiversity offset strategies are completed generally in accordance with the completion criteria in the Biodiversity Management Plan to the satisfaction of the Director-General, the Director-General will release the bond.  If the biodiversity offset strategies are not completed generally in accordance with the completion criteria in the Biodiversity Management Plan, the Director-General will call in all, or part of, the conservation bond, and arrange for the satisfactory completion	Section 8.0
<ul> <li>of the relevant works.</li> <li>Notes:</li> <li>This condition does not apply to the Limestone National Forest Offset;</li> <li>Existing bonds which have been paid for the Estcourt Tailings</li> </ul>	
Storage Facility Biodiversity Offset remain current and are satisfactory to fulfil the requirements of this condition;	
(e) include a seasonally-based program to monitor and report on the effectiveness of these measures, and progress against the detailed performance and completion criteria;	Section 5.0

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Condition	Related Section in BOMP
(f) identify the potential risks to the successful implementation of the biodiversity offsets, and include a description of the contingency measures that would be implemented to mitigate against these risks; and	Section 5.0
(g) include details of who would be responsible for monitoring, reviewing, and implementing the plan.	Section 1.5
Biodiversity Management Plan  29. The Proponent shall prepare and implement a Biodiversity Management Plan for the project to the satisfaction of the Secretary. This plan must:  (a) Be prepared in consultation with OEH, and submitted to the Secretary for approval prior to the commencement of any development on site;	Entire BOMP
<ul> <li>(b) Describe the short, medium, and long term measures that would be implemented to:</li> <li>Management the remnant vegetation on fauna habitat on the biodiversity offset sites;</li> </ul>	Entire BOMP
<ul> <li>Restore the derived native grassland component of the Grey Box Grassy Woodland EEC community within the Kokoda Biodiversity Offset to woodland community;</li> <li>Implement the biodiversity offset strategies; and integrate the implementation of the biodiversity offset strategies to the greatest extent practicable with the rehabilitation of the site (where relevant);</li> </ul>	
(c) Include detailed performance and completion criteria for evaluating the performance of the biodiversity offset strategies, and triggering remedial action (if necessary)	Entire BOMP
<ul> <li>(d) Include a detailed description of the measures that would be implemented for:</li> <li>Enhancing the quality of existing vegetation and fauna habitat in the biodiversity offset areas, including the derived native grasslands component of the Grey Box Grassy Woodland EEC community within the Kokoda Biodiversity Offset;</li> </ul>	Section 5.7
Creating native vegetation and fauna habitat in the biodiversity offset areas and rehabilitation areas through focusing on assisting natural regeneration, targeted vegetation establishment and the introduction of naturally scarce fauna habitat features (where necessary);	Section 5.7
Managing and maintaining the populations of Pine Donkey Orchid located to the north of the project area (near Adavale Lane) and near the E48 subsidence zone;	Appendix 3 (Species Management Plan for the Pine Donkey Orchid)
Collecting and propagating seed	Section 5.9
Managing any potential conflicts between the proposed enhancement works in the biodiversity offset areas and any Aboriginal heritage values (both cultural and archaeological) in these areas;	Section 5.14

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Condition	Related Section in BOMP
Managing salinity;	Section 5.12
Controlling weeds and feral pests;	Sections 5.5 & 5.6
Controlling erosion;	Section 0
Managing grazing and agriculture on site;	Section 5.1& 5.10
Controlling access; and	Sections 5.1 & 5.2
Bushfire management;	Section 5.13
(e) Include a seasonally-based program to monitor and report on the effectiveness of these measures, and progress against the detailed performance and completion criteria;	Section 4
(f) Identify the potential risks to the successful implementation of the biodiversity offsets, and include a description of the contingency measures that would be implemented to mitigate against these risks; and	Section 6, in particular Section 6.4
(g) Include details of who would be responsible for monitoring, reviewing, and implementing the plan.	Section 1.5
Heritage	
Protection of Aboriginal Sites	
30. the Proponent shall ensure that the project does not cause any direct or indirect impact in the Aboriginal sites located outside the approved disturbance area of the project unless otherwise authorised under this approval of the NP&W Act	Section 5.14

Table 1.2 Commonwealth EPBC Act Approval Conditions

Condition	Related Section in BOMP
Offsetting of Residual Impacts	
4. To compensate for the loss of 46 hectares of GBGW and the related and additional loss of habitat for other matters of national environmental significance (Polytelis swainsonii; Lathamus discolour; Anthochaera phrygia) the person taking the action must secure the offset lands identified as the 'Kokoda Offset Site' in Section 2.3 of the Preliminary Documentation. These offset lands must be protected by a legal instrument under relevant legislation on the title prior to commencement of the action	Section 2.2
5. The instrument referred to in Condition 4 must:	Sections 2.2 and 5.0
a) provide for the legal protection of the land for the duration of the impact;	
<ul><li>b) prevent any conflicting future development activities, including mining and mineral extraction;</li><li>c) ensure the active management of the land (in accordance with Condition 9).</li></ul>	

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Condition	Related Section in BOMP
6. The person taking the action must provide evidence to the Department of their compliance with Condition 4, along with offset attributes, shapefiles and textual descriptions and maps to clearly define the location and boundaries of the offset sites, prior to the commencement of the action.	Not applicable to the BOMP.
7. In the event that Conditions 4 and 5 cannot be met, then the person taking the action must secure alternative offset lands to the satisfaction of the Department prior to the commencement of the action.	Not applicable
8. The area of land contained within the offset lands that are secured must include appropriate areas of offset lands (consistent with the Department's EPBC Act offsets policy) for each of the matters of national environmental significance that are impacted by the action, as per Section 2.4.2 and Appendix 6 of the Preliminary Documentation.	Relates to the Preliminary Documentation (Umwelt 2013b)
9. The offset lands ('Kokoda Offset Site') identified in Condition 4 must be managed to improve and maintain the condition of the offset lands to the satisfaction of the Department to achieve the conservation objectives of the offset lands, including:	
a) development of a suitable management plan for the offset lands which specifies conservation objectives and how they are to be achieved. The conservation objectives must be clearly set out, measurable and consistent with the conservation management intent described in Section 2.3 of the preliminary documentation.	The entire BOMP is relevant.
Offsetting of Residual Impacts	
b) implementation of all management actions and conservation measures identified in the Preliminary Documentation, including in Section 2.3 and Appendix 7, such as, weed management, pest management, stock exclusion and ecological monitoring;	Section 5.0
c) active management of derived native grassland areas (GBGW) to allow regeneration and full recovery of these areas of GBGW ecological community over time;	Section 5.7
d) allocation of appropriate funding to achieve the conservation objectives;	Section 8.0.
e) regular monitoring against conservation objectives and adaptive management as appropriate to achieve the conservation objectives.	Sections 4.0 and 5.0

# 1.4 Authority Consultation

Consultation with the relevant authorities including the NSW Office of Environment and Heritage (OEH) and the NSW Department of Planning and Environment (DPE) will occur throughout the implementation of this BOMP and throughout the ongoing management of the Kokoda Offset Site, as required.

Consultation with the Commonwealth Department of the Environment (DoE) has been undertaken as part of the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) project approval process and will continue through the implementation of this BOMP, as required.

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This BOMP was initially submitted to the Department of Planning and Environment (DPE) in November 2014. In September 2015, Northparkes received comments from the Department of Planning and Environment requesting Northparkes to amend additional information in this BOMP. Northparkes amended the BOMP and these comments are detailed in Appendix 4. Northparkes also received recommendations on the BOMP in December 2015 from OEH. These recommendations have been addressed in the current version of the BOMP and are detailed further in Appendix 4.

### 1.5 Roles and responsibilities

Responsibility for the implementation of the Kokoda BOMP lies with CMOC Mining, with input from external specialists and contractors, as required. Table 1.3 lists the key roles and responsibilities of specific Northparkes personnel, concerning the implementation of the Kokoda BOMP.

Table 1.3 Roles and responsibilities

Title	Roles and responsibilities
Managing Director	<ul> <li>ensure that sufficient time and resources are allocated to allow for the implementation of biodiversity management and monitoring strategies as outlined in the BOMP;</li> </ul>
	<ul> <li>authorise internal and external reporting requirements as well as subsequent revisions of this BOMP; and</li> </ul>
	oversee implementation of the BOMP to ensure compliance with approval requirements.
People, Safety and Environment Manager	<ul> <li>co-ordinate the day to day implementation of the BOMP, including the implementation of all management activities;</li> <li>undertake biannual inspections of the Kokoda Offset Site;</li> </ul>
a.rage.	<ul> <li>undertake blannual inspections of the kokoda Onset site,</li> <li>analyse and collate documentation for inclusion in the Annual Review;</li> </ul>
	<ul> <li>assess the effectiveness of the management strategies and instigate the adaptive management process as required;</li> </ul>
	<ul> <li>ensure all internal and external reporting requirements are met;</li> </ul>
	<ul> <li>ensure that all relevant records are effectively maintained on site;</li> </ul>
	<ul> <li>periodically review progress against targets and performance indicators;</li> </ul>
	<ul> <li>ensure that personnel involved in the carrying out and monitoring of the BOMP activities and values are appropriately qualified, licensed and experienced to undertake the task;</li> </ul>
	manage/control access to the Kokoda Offset Site; and
Environment & Farms	<ul> <li>report unauthorised access by stock or vehicles to the Kokoda; and</li> </ul>
Superintendent	report on any fencing or track maintenance works required to prevent stock access to the Kokoda Offset Site.

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Title	Roles and responsibilities	
Other Northparkes Staff and Contractors	<ul> <li>ensure staff and contractors accessing the Kokoda Offset Site are informed and trained where relevant in relation to controls on activities within the Offset Sites;</li> </ul>	
	<ul> <li>receive training regarding controls on activities within the Kokoda Offset Site;</li> </ul>	
	<ul> <li>observe boundaries of the Kokoda Offset Site when undertaking work on site; and</li> </ul>	
	<ul> <li>undertake activities in the Kokoda Offset Site in line with directions from the Operations Manager and People, Safety and Environment Manager.</li> </ul>	

# 1.6 Impact mitigation strategies

Northparkes sought to avoid and minimise potential impacts on the ecological values of the proposed disturbance area throughout the Project planning process. This has included avoidance and minimisation of disturbance of key vegetation communities, particularly the White Box – Yellow Box – Blakely's Red Gum Woodland EEC and Grey Box Grassy Woodland EEC.

Key impact mitigation strategies in the Project Area include weed and feral animal control, general operation controls such as dust, noise, fugitive light and surface water, tree hollow replacement with nest boxes, salvage of ground habitat features (logs, boulders, etc.) for the creation of habitat features in nearby areas, a comprehensive tree felling procedure to limit impacts on hollow-dependent threatened species and the establishment of an annual ecological monitoring program.

These key impact mitigation strategies will be detailed in revision to relevant management strategies and plans. These revised strategies and plans includes the Flora and Fauna Management Plan (FFMP) and will be expanded to include areas to be impacted by the Project.

#### 2. DESCRIPTION OF THE KOKODA OFFSET SITE

The following sections provide a summary of the characteristics and biodiversity values of the Kokoda Offset Site as relevant to this BOMP. Further description of the baseline condition and environment of the Kokoda Offset is provided in the Environmental Assessment and the Preliminary Documentation (Umwelt 2013a and 2013b). In addition, a description of the Limestone National Forest and Estcourt Offset area are provided in Appendix 1 and Appendix 2, respectively.

#### 2.1 Location

The Kokoda Offset Site is strategically located along a north-south potential corridor of remnant woodland and forest vegetation that runs along ridges and hills from north of Eugowra in the south, to east of Narromine in the north (refer to Figure 1.1). The north-south potential corridor includes Goobang National Park, the largest conserved remnant of woodland and forest vegetation in the Central West region of NSW.

The Kokoda Offset Site is located approximately 12 kilometres north-west of Nangar National Park, approximately 8 kilometres south of Goobang National Park, approximately 12 kilometres west of Mandagery State Forest, approximately 17 kilometres east of Cookamidgera State Forest, and approximately 20 kilometres east of Back Yamma State Forest (refer to Figure 1.1).

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The Kokoda Offset Site comprises lower fertility soils in the northern sections, predominately cleared for grazing, and dense woodland covered slopes and ridge lines in the south of the property. Sheep and cattle grazing has been undertaken across the entire property since ecological surveys began in 2013 and is likely to have been the predominant land use for many years. Northparkes removed all stock from the Kokoda Offset Site in early 2015, following purchase of the property.

To the north of the Kokoda Offset Site, the predominant land use is agriculture, primarily cropping but also grazing. This agricultural area is largely confined to the lower and flatter areas, occurring between Goobang National Park and the southern portion of the Kokoda Offset Site.

#### 2.2 Land tenure and conservation mechanism

The Kokoda Offset Site will be secured for in perpetuity conservation. Northparkes has purchased the Kokoda Offset Site is currently undertaking the process of securing a Voluntary Conservation Agreement (VCA) across the Kokoda Offset Site.

#### 2.3 Key ecological values

The Kokoda Offset Site provides conservation of 109 hectares of Grey Box Grassy Woodland EEC (including 96 hectares of DNG that will be returned to woodland form), 2.2 hectares of White Box – Yellow Box – Blakely's Red Gum Woodland EEC/CEEC, known habitat areas for the grey-crowned babbler, little lorikeet and eastern bentwing-bat and potential habitat for a number of threatened fauna species. Further details of the ecological values of the Kokoda Offset Site are provided in the following sections.

### 2.3.1 Vegetation communities and Threatened Ecological Communities

A total of 11 vegetation communities have been recorded in the Kokoda Offset Site, three of which are Threatened Ecological Communities (TECs). Figure 2.1 shows the location of the vegetation communities recorded on the Kokoda Offset Site. These vegetation communities are also listed in Table 2.1 below.

Table 2.1 Vegetation communities of the Kokoda Offset Site

Vegetation Community	TSC Act Status	EPBC Act Status	Vegetation within Kokoda Offset Site (ha)
Grey Box Grassy Woodland	EEC	EEC	13
Grey Box Grassy DNG	EEC	EEC	96
White Box Grassy Woodland	EEC	CEEC	2.2
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest			150
Rocky Rise Shrubby Woodland			26
Grey Box – Ironbark Woodland			25
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine DNG			15
Dwyer's Red Gum Creekline Woodland			9.4
Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Woodland Low Quality			8.6
Mugga Ironbark Woodland			1.9

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Vegetation Community	TSC Act Status	EPBC Act Status	Vegetation within Kokoda Offset Site (ha)
Farm Tracks and Dams – Disturbed Land			2.5
Total			350 <sup>1</sup>

<sup>1 =</sup> Rounding of totals applied (numbers less than 1 – 2 decimal places, numbers between 1 and 10 – 1 decimal place, and greater than 10 - no decimal places)

DNG = Derived Native Grassland

ha = Hectares

The 13 hectares of Grey Box Grassy Woodland and 96 hectares of Grey Box DNG on the Kokoda Offset Site conforms to the TSC Act listed Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions EEC and the EPBC Act listed Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia EEC.

The 2.2 hectares of White Box Grassy Woodland on the Kokoda Offset Site conforms to the TSC Act listed White Box – Yellow Box – Blakely's Red Gum Woodland EEC and the EPBC Act listed White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC.

The 96 hectares of Grey Box Grassy Woodland DNG and 15 hectares of Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine DNG within the Kokoda Offset Site will be managed back to woodland form. The recovery potential of these areas was assessed resulting in the delineation of six vegetation management areas (refer to Figure 2.1). These management areas identify those parts of the DNG predicted to respond well to assisted natural regeneration strategies and those predicted to potentially require active management. Further detail on these vegetation management areas is included in Section 5.7.

CEEC = Critically Endangered Ecological Community

EEC = Endangered Ecological Community

EPBC Act = Commonwealth Environment Protection and Biodiversity Conservation Act 1999

TSC Act = NSW Threatened Species Conservation Act 1995

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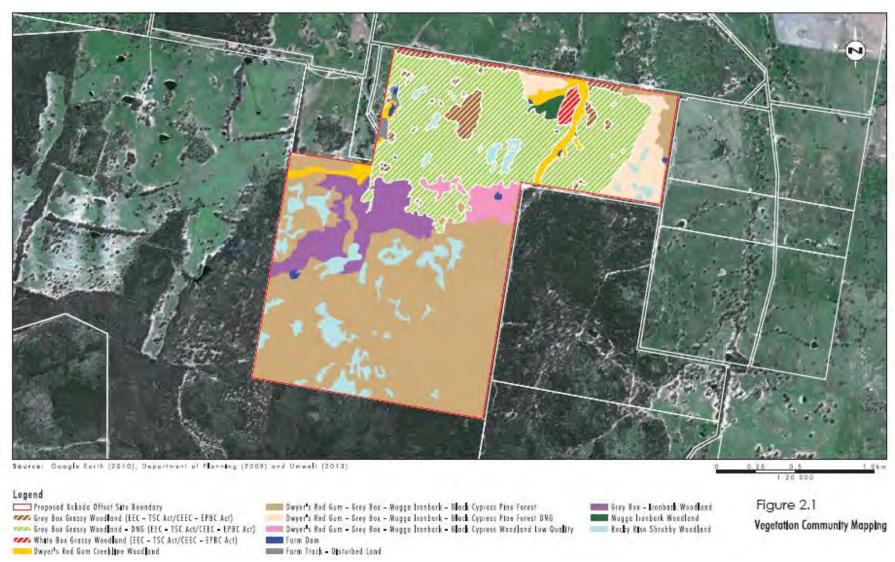


Figure 2.1 Vegetation communities

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Figure 2.3 Conceptual vegetation management area with Landscape Function Analysis monitoring locations





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### 2.3.2 Threatened species

No threatened flora species have been recorded in the Kokoda Offset Site. Twelve threatened fauna species have been recorded in the Kokoda Offset Site and are listed in Table 2.2 below and shown on Figure 2.4.

Table 2.2 Threatened fauna species recorded within the Kokoda offset site

Common Name	Scientific Name	Sta	itus	No. of
		TSC Act	EPBC Act	individuals/ locations
Glossy black- cockatoo	Calyptorhynchus Iathami	V		2/1
Superb parrot	Polytelis swainsonii	V	V	162/23
Little lorikeet	Glossopsitta pusilla	V		25/2
Brown treecreeper (eastern subspecies)	Climacteris picumnus victoriae	V		18/10
Speckled warbler	Chthonicola saggitatus	V		13/9
Hooded robin (south- eastern form)	Melanodryas cucullata cucullata	V		1/1
Grey-crowned babbler (eastern subspecies)	Pomatostomus temporalis temporalis	V		95/20
Varied sittella	Daphoenositta chrysoptera	V		2/2
Diamond firetail	Stagonopleura guttata	V		8/3
Eastern bentwing-bat	Miniopterus schreibersii oceanensis	V		-/2
Little pied bat	Chalinolobus picatus	V		-/2
Yellow-bellied sheathtail-bat	Saccolaimus flaviventris	V		-/2

V = Vulnerable Species

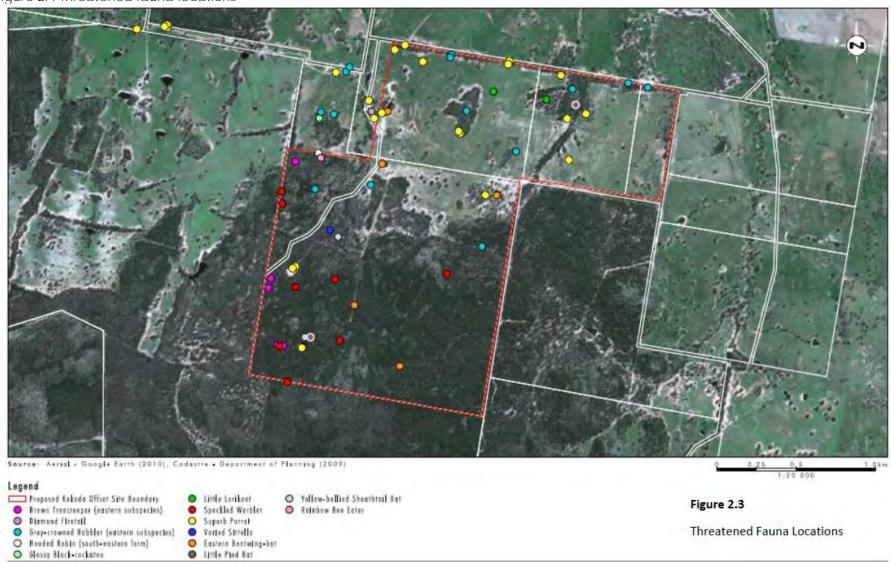
EPBC Act = Environment Protection and Biodiversity Conservation Act 1999

The grey-crowned babbler, brown treecreeper and the superb parrot were the most commonly recorded threatened fauna species across the Kokoda Offset Site. The grey-crowned babbler and the brown treecreeper are both sedentary birds and will utilise the site across all seasons whereas the superb parrot is a seasonally nomadic species which will largely utilise the Kokoda Offset Site for foraging during spring and summer. Given the array of varied habitats within the site, there is a high potential that other threatened fauna species may occur within the Kokoda Offset Site.

TSC Act = Threatened Species Conservation Act 1995

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Figure 2.4 Threatened fauna locations



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# 2.4 Management zone stratification

The Kokoda Offset Site has been stratified into seven management zones based primarily on the condition of the vegetation communities and their recovery potential. Table 2.3 below provides a summary of the management zones identified within the Kokoda Offset Site.

Table 2.3 Management Zones at the Kokoda Offset Site

Management Zone	Vegetation Type	Objective	Total Area
1	Grey Box Grassy Woodland – DNG – Active Revegetation	Restore to woodland	36.3
2	Grey Box Grassy Woodland - DNG - Potential Regeneration	Restore to woodland	21.3
3	Grey Box Grassy Woodland - DNG - Natural Regeneration	Restore to woodland	38.4
4	Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine DNG Active Regeneration	Restore to woodland	1
5	Dwyer's Red Gum - Grey Box - Mugga Ironbark - Black Cypress Pine DNG Natural Regeneration	Restore to woodland	13.8
6	Disturbed – Potential Regeneration	Restore to woodland	1.3
7	All Remnant Woodland and Forest	Conserve and maintain	238
		Total	350

Management zones 1 to 5 are all DNG communities that occur on the lower slopes in the northern section of the property. These areas will each receive varying levels of management, however the long term goal for each of these zones, plus zone 6, is to return them to their former woodland community structure.

#### 3. BIODIVERSITY MANAGEMENT TARGETS

Biodiversity management targets form the basis of the BOMP. The proposed management and improvement strategies (Section 5) will enable the biodiversity management targets and conditions of the approval to be met. Specific performance indicators and completion criteria (Section 5) will be used to track the success of the BOMP in reaching these targets.

The short term (3 year) biodiversity management targets for the management of the Kokoda Offset Site are to:

- establish signage throughout the Kokoda Offset Site;
- remove stock-grazing activities from the Kokoda Offset Site by maintenance of fencing as required;
- establish a monitoring program to assess the success of ongoing management and improvement strategies, in particular focusing on the regeneration potential of Grey Box Grassy Woodland DNG areas; and
- commence establishment of Grey Box Grassy Woodland in areas of DNG through assisted natural regeneration principles;

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- include a range of flora species from each vegetation strata represented in the target community (such as trees, shrubs, and ground cover forbs and grasses), even if only as seedlings/juvenile plants initially, as determined through monitoring of selected reference sites in the target community within the Kokoda Offset Site;
- contain a flora species assemblage trending towards the target communities (i.e. Grey Box Grassy Woodland EEC or Dwyer's Red Gum Grey Box Mugga Ironbark Black Cypress Pine Forest) as determined through monitoring of selected reference sites in the target community within the Kokoda Offset Site;
- support no more than 20 per cent foliage cover of perennial weed species (as a total of all strata, based on monitoring plot data); and
- support no more than 20 per cent bare ground as part of the ground layer.
- effectively manage weed and pest species;
- implement weed monitoring at to assess if weed species are out competing native species once grazing pressure has been removed. Adaptive management practices will be adopted to control weed species as necessary;
- from year two onwards, initiate active revegetation methods to establish Grey Box Grassy Woodland in areas of low recovery potential DNG as required through the results of monitoring in years 1 and 2;
- manage the remnant woodland areas to maintain similar or increasing flora and fauna species diversity;
- establish an appropriate long-term conservation mechanism; and
- demonstrate that accurate records are being maintained substantiating all activities and monitoring associated with the BOMP.

The preliminary medium term (6, 10 and 15 years) biodiversity management targets for the Kokoda Offset Site are to:

- effectively monitor, control and reduce weed and pest species populations;
- monitor and document collective trend towards an increase in native flora and fauna species diversity;
- monitor and document DNG areas trending toward woodland communities, containing natives species commensurate with those of the target woodland communities

The preliminary long term (i.e. 20 years) biodiversity management targets for the Kokoda Offset Site are to:

- effectively control and reduce weed and pest species populations;
- improve the overall native flora and fauna species diversity compared to conditions during baseline assessments;
- improve the habitat value of the remnant woodland communities in the Kokoda Offset Site compared to conditions during baseline assessments;
- successfully establish an additional 96 hectares of Grey Box Grassy Woodland EEC in areas of existing DNG and demonstrate that the regenerated communities are representative of local reference sites in remnant Grey Box Grassy Woodland EEC.
- regenerate/revegetate management areas contain a minimum of 50 per cent of the native flora species diversity recorded from reference sites in the target community within the Kokoda Offset Site;
- regenerate/revegetate management areas support a vegetation structure that is similar to that recorded for reference sites in the target community within the Kokoda Offset Site;

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- demonstrate that second generation trees are present within regeneration/revegetation areas;
- identify that more than 75 per cent of trees are healthy and growing as indicated by long term monitoring;
- ensure that weed species do not dominate any vegetation stratum (i.e. weed species comprise less than 10 per cent of any vegetation stratum);
- ongoing monitoring of soil stability, including implementation of erosion and sediment controls to management significant erosions concerns, as required; and
- regenerate/revegetate areas linked to existing woodland remnants to establish vegetation corridors within the broader landscape and manage excessive edge effects.

#### 4. OFFSET MONITORING PROGRAM

The Kokoda Offset Site will be subject to an ongoing monitoring program to measure the success of management and restoration strategies in meeting the approval conditions (Section 0) and performance indicators as set out in Section 5 in a timely manner. The monitoring program will incorporate annual systematic monitoring as well as biannual (twice yearly) inspections.

# 4.1 Monitoring objectives

The objectives of the Kokoda Offset Site monitoring program will be to:

- identify any potential loss of biodiversity values over the entire Kokoda Offset Site;
- document the ecological characteristics of remnant woodland vegetation to establish a baseline for developing accurate closure criteria for the regeneration of DNG;
- assess the recovery of DNG areas;
- assess and map the presence of threats such as significant populations of pest fauna species or weed infestations; and
- identify the need for additional or corrective management measures to achieve the performance indicators and completion criteria.

#### 4.2 Monitoring timing and schedules

Ecological monitoring will be annual for the first five years (however DNG monitoring will also be undertaken at six months – see Section 5.7.1), then every three years for the following 15 years. The first ecological monitoring survey will be completed within six months of the implementation of the BOMP, and subsequent monitoring events should occur in the same season. It is recommended that the ecological monitoring surveys be undertaken in spring or autumn as there tends to be a lower diversity of species detectable in the more extreme weather conditions of winter and summer seasons (except where specific seasons are required for targeted bird surveys).

# 4.3 Ecological monitoring techniques

The monitoring program incorporates techniques that:

- a) are relatively simple to measure, can be replicated with limited subjectivity, and are reproducible;
- b) adopt the SMART principles (specific, measurable, achievable, realistic and timely);
- c) are targeted towards recording information that provides a good indication of the status of the biodiversity values of the Kokoda Offset Site;

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- d) allow for floristic composition and structure to be monitored over time using basic statistical analysis;
- e) allow for comparison to reference (control) sites; and
- f) are cost effective.

#### 4.3.1 Vegetation monitoring

The ecological monitoring program for the Kokoda Offset Site will include a combination of condition assessments, floristic sampling, sapling survivorship counts and stratified quadrat sampling. Revegetation areas will be monitored by sapling survivorship counts of planted tubestock and condition assessments of surviving tubestock. Regeneration areas (DNG areas where grazing pressure from domestic stock has been removed) will be monitored via stratified and permanent quadrats. Floristic assessments will be undertaken using representative plots and standard botanical survey approaches (e.g. cover-abundance measures) to assess the floristic recovery of the DNG in comparison to the floristic composition of reference sites.

Stratified quadrats will be established in appropriate target communities within the Kokoda Offset Site. The aim of this is to provide reference sites to measure regeneration/revegetation success against. In the event that regeneration/revegetation sites are unsuccessful in trending towards the ecological values of the reference sites, adaptive management will be undertaken, as required. This may include modifying management actions, or supplementing management actions with new or additional techniques to promote the recovery of regeneration/revegetation sites towards the values of reference sites.

Sections 5.6 (weed management) and 5.7 (regeneration of derived native grasslands) detail the individual vegetation monitoring requirements of the Kokoda Offset Site.

#### 4.3.2 Landscape function analysis monitoring

Monitoring will include Landscape Function Analysis (LFA) techniques to assess the soil structure, stability and nutrient cycling within the DNG recovery areas. Landscape function analysis (LFA) is a standardised monitoring procedure that uses rapidly acquired field-assessed indicators to assess the biogeochemical functioning of landscapes (Tongway and Hindley 2004). LFA is based mainly on processes involved in surface hydrology: rainfall, infiltration, runoff, erosion, plant growth and nutrient cycling. The standard LFA methods as described by Tongway and Hindley (2004) will be followed for the survey.

A minimum of eleven LFA sites will be sampled within DNG recovery areas, five within Grey Box – Grassy Woodland EEC, three in Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest, one in Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest low quality, one in White Box Grassy Woodland CEEC and one in Grey-Box – Ironbark woodland non EEC. Suitable reference sites in remnant woodland of the target community within the Kokoda Offset Site will also be sampled. Reference sites will include a minimum of three in Grey Box – Grassy Woodland EEC and three in Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest.

LFA monitoring will also be used as a surrogate indicator for kangaroo grazing. For more information, refer to Appendix 4.

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#### 4.3.3 Threatened bird monitoring

Threatened bird monitoring will be undertaken at the Kokoda Offset Site, focussing on key threatened species. Two threatened bird species were recorded in the project disturbance area, the grey-crowned babbler (*Pomatostomus temporalis temporalis*) and the superb parrot (*Polytelis swainsonii*). Surveys will also be undertaken for the swift parrot (*Lathamus discolor*) and regent honeyeater (*Anthochaera phrygia*). Threatened bird monitoring will comprise bird surveys of existing woodland and recovering DNG areas focusing on the presence of the threatened the grey-crowned babbler, superb parrot, swift parrot and regent honeyeater. Threatened bird monitoring will cover both the existing remnant vegetation areas as well as the recovering DNG areas, once there has been reasonable growth of canopy species (new sites will therefore be added as regeneration/revegetation areas progress). Bird monitoring will be undertaken during winter for the regent honeyeater and swift parrot (during periods when eucalypt trees are flowering) and during early spring for the superb parrot when it is most likely to be utilising the Kokoda Offset Site during local seasonal movements.

Section 5.8 details individual threatened bird monitoring requirements for the Kokoda Offset Site.

#### 4.4 Biannual inspections

Inspections will be undertaken biannually (twice yearly) by Northparkes environment advisors. During these inspections, a broad assessment of the site condition will be made and management strategies will be adapted accordingly if required.

During these inspections no systematic sampling will be undertaken; rather a broad assessment of the site condition will be made from a drive-over of the site. The inspections will aim to identify any visually obvious management concerns that require immediate attention such as new infestations of invasive weeds/pest fauna or track and fence condition. The general progress of regeneration and revegetation efforts will also be assessed during these inspections.

Key Components of Biannual Inspections:

- observe and document any weed and pest fauna infestations requiring management;
- assess the success of completed weed and pest management actions;
- assess the condition of fences, gates and access tracks, identifying areas requiring maintenance;
- document any areas of erosion, sedimentation or salinity requiring management;
- assess the progress of natural regeneration within the DNG areas; and
- inspect the condition of other infrastructure in the Kokoda Offset Site such as sheds, homesteads etc.

# MANAGEMENT STRATEGIES, MONITORING ACTIONS, PERFORMANCE AND COMPLETION CRITERIA

The ability to report on the success of management actions relies on frequent and systematic monitoring of the Kokoda Offset Site. The monitoring program will incorporate annual comprehensive and systematic monitoring as well as biannual (twice yearly) inspections.

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Ecological monitoring will be annual for the first 5 years, then every 3 years for the following 15 years. The first ecological monitoring survey will be completed within 6 months of the implementation of the BOMP, and subsequent monitoring events should occur in the same season. It is recommended that the ecological monitoring surveys be undertaken in spring or autumn as there tends to be a lower diversity of species detectable in the more extreme weather conditions of winter and summer seasons (except where specific seasons are required for targeted bird surveys).

Inspections will be undertaken biannually (twice yearly) by Northparkes environment team. During these inspections, a broad assessment of the site condition will be made, and management strategies will be adapted accordingly if required. During these inspections no systematic sampling will be undertaken; rather a broad assessment of the site condition will be made from a drive-over of the site. The inspections will aim to identify any visually obvious management concerns that require immediate attention such as new infestations of invasive weeds/pest fauna or track and fence condition.

The following management and improvement strategies have been developed for the Kokoda Offset Site to ensure that the BOMP objectives and targets are met. The strategies integrate findings and recommendations from the Northparkes Mines Step Change Project Environmental Assessment, the Preliminary Documentation report (Umwelt 2013a and 2013b) and the Northparkes Step Change Project Response to Submissions Addendum Report (Umwelt 2013c).

#### 5.1 Access management and exclusion of stock

#### 5.1.1 Management actions

All domestic stock were removed from the Kokoda Offset Site in early 2015, within a month of the property being purchased by Northparkes.

#### 5.1.2 Performance and completion criteria

Performance criteria and completion criteria for the access management and stock exclusion are provided in Table 5.1.

Table 5.1 Access management and exclusion of stock performance criteria and completion criteria

Action Performance criteria Year 1 (2015) Year 2 (2016) etion criteria

Exclude stock All stock excluded by 30 June 2015, or earlier. Completed eted

# 5.2 Fencing and signage

Fencing will be used to demarcate the boundaries of the Kokoda Offset Site to exclude stock, as well as to protect from unauthorised access and disturbance. Fences will be suitably signposted to identify the purpose of the Kokoda Offset Site. Fences will be maintained to prevent stock access to the offset area.

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#### 5.2.1 Management actions

#### **Boundary Fencing**

Any new fencing (other than the boundary fences with adjoining neighbours) used within, or on the boundary of, the Kokoda Offset Site will use plain (i.e. non-barbed) wire on the upper strands, and as little barbed wire generally as possible to minimise the impact on native fauna species. As part of the ongoing monitoring program, if a restricted level of barbed wire on fencing is shown to fail to exclude stock, additional measures that pose minimal impact to native fauna will be investigated and implemented.

#### Removal of Redundant Fences

Where possible, redundant internal fences will be removed to allow free movement of fauna throughout the Kokoda Offset Site. Any such works would be appropriately assessed to ensure there is no adverse effect on existing vegetation and habitats.

#### Signage

Signs on access gates and strategic locations on boundary fencing have been erected. The signs will explain that the land is managed for conservation values and that there is restricted access to people, livestock and activities within the area.

#### 5.2.2 Monitoring requirements

#### Maintenance of Fences

Boundary fence inspections will be undertaken as part of the biannual inspections by the Northparkes environment team to ensure that neighbouring stock are not able to enter the Kokoda Offset Site.

# 5.2.1 Performance and completion criteria

Performance and completion criteria for the fencing and signage are provided in Table 5.2. Trigger points for adaptive management of the fencing and signage are provided in Table 5.3

Table 5.2 Fencing and signage performance and completion criteria

Action	Performance criteria Year 1 (2015)	Performance criteria annual actions (2016 <b>-</b> 2034)	Completion criteria
Twice yearly boundary fence inspections by Northparkes environmental advisors	Completed twice per year	Completed twice per year	Completed and results included in annual reporting.
Signage inspection by Northparkes environmental advisors	Completed twice per year	Completed twice per year	Completed and results included in annual reporting.

Table 5.3 Fencing and signage trigger points for adaptive management

Action	Trigger Point for Adaptive Management	Adaptive Management
Boundary fence inspections	Failure of fence allows humans or grazers to enter the site	Repairs undertaken
Signage inspection	Signage removed or damaged	Repair or replace signs

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All adaptive management actions undertaken are to be documented.

#### 5.3 Offset site in-perpetuity conservation

#### 5.3.1 Management actions

The Kokoda Offset Site will be secured for in-perpetuity conservation. Northparkes has purchased the Kokoda Offset Site is currently undertaking the process of securing a Voluntary Conservation Agreement (VCA) across the Kokoda Offset Site.

#### 5.3.2 Performance and completion criteria

Performance and completion criteria for the offset site in perpetuity are provided in Table 5.4.

Table 5.4 Offset site in-perpetuity conservation performance and completion criteria

Action	Performance criteria Year 1 (2015)	Completion criteria
Purchase Kokoda Offset Site	To be completed by 30 June 2015	Completed
Establish an in perpetuity conservation mechanism across the Kokoda Offset Site	Completed by 30 June 2015*	Ongoing

<sup>\*</sup> Extension to establish an in perpetuity conservation mechanism across the Kokoda Offset Site granted from the Department of Planning and Environment until 25 March 2017

#### 5.4 Track maintenance

#### 5.4.1 Management actions

Routine maintenance of tracks within the Kokoda Offset Site will be undertaken as required to make navigation through the property easier when implementing on-ground management and monitoring activities. The tracks also need to be well maintained for firefighting access if required.

# 5.4.2 Monitoring requirements

The condition of tracks will be assessed during biannual (twice yearly) inspections, with maintenance works undertaken as necessary.

#### 5.4.3 Performance and completion criteria

Performance and completion criteria for the maintenance of tracks throughout the Kokoda Offset Site are provided in Table 5.5. Trigger points for adaptive management of the track inspections are provided in Table 5.6.

Table 5.5 Track maintenance performance and completion criteria

Action	Performance criteria Year 1 (2015)	Performance criteria annual actions (2016- 2034)	Completion criteria
Inspections of all tracks by Northparkes environmental officers	To be completed twice per year	To be completed twice per year	Completed

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Table 5.6 Fencing and signage trigger points for adaptive management

Action	Trigger Point for Adaptive Management	Adaptive Management
Inspections of all tracks twice per year by Northparkes environmental advisors	Tracks blocked by fallen trees, excessively eroding or overgrown, preventing safe driving access	Repairs undertaken

# 5.5 Pest and kangaroo management

#### 5.5.1 Management actions

Known feral fauna recorded within the Kokoda Offset Site are fox (Vulpes vulpes), rabbit (Oryctolagus cuniculus) and brown hare (Lepus capensis). These species may impact on the native fauna species through predation and competition for resources such as food, shelter, and breeding sites. Feral animals can also have a detrimental effect on regenerating areas as well as soil stability.

Pest management will comprise baiting control programs for foxes and rabbits, on an as needed basis as determined through monitoring. Where other pest species, such as cats pigs, goats, deer etc., are identified, their numbers will be monitored and control measures appropriate for the species will be included in the pest control program as needed. If monitoring identifies that pest species require control, pest management actions will be implemented in consultation with close neighbours, where possible.

#### 5.5.2 Monitoring requirements

Feral animals (or their sign) will be opportunistically recorded during qualitative bi-annual inspections of the Kokoda Offset Site. If these records indicate the presence of a significant population of feral animals, appropriate adaptive management will be implemented. Bi-annual inspections commenced in April 2015. Data collected from this survey event will be used as the baseline data for ongoing feral animal monitoring. When triggered, pest management will comprise baiting control programs for foxes and rabbits. Where other pest species, such as cats, pigs, goats, deer etc., are identified as requiring control, control measures appropriate for the species will be undertaken. Where possible, Northparkes will seek collaboration with neighbouring land-owners to develop a strategic approach to pest management.

Kangaroo monitoring will also be undertaken bi-annually within the regenerating woodland area. Monitoring is intended to give an indication of relative presence of kangaroo populations within the regenerating area over time. If a significant increase in the kangaroo population is recorded over two consecutive monitoring periods adaptive management will be investigated. Kangaroo monitoring will commence in 2017, at which point a suitable, repeatable survey methodology will be developed and documented in the AEMR. All adaptive management actions undertaken are to be documented in the AEMR.

All adaptive management actions undertaken are to be documented in the AEMR.

# 5.5.3 Performance and completion criteria

Performance and completion criteria for pest management are provided in Table 5.7. Trigger points for adaptive management of the pest controls are provided in Table 5.8.

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Table 5.7 Pest management criteria and completion criteria

Action	Performance criteria years 1 -5 (2015- 2019)	Performance criteria years 8, 11, 14, 17 & 20	Performance criteria annual actions (2015– 2034)	Completion criteria
Annual opportunistic monitoring of feral animal presence during annual ecological monitoring surveys	Completed annually for the first 5 years	To be completed every 3 years after year 5	N/A	Completed
Six monthly opportunistic monitoring of feral animal presence during site inspections by Northparkes environment officers	Completed every 6 months	N/A	Completed every 6 months	Completed

Table 5.8 Pest control trigger points for adaptive management

Action	Trigger Point for Adaptive Management	Adaptive Management
Annual or 6 monthly surveys of the Kokoda Offset Site	Feral fauna species or signs of their presence are identified during 2 or more surveys. Or any feral species is identified during a single survey at a level (species specific) that may be impacting on biodiversity values of the Kokoda Offset Site.	Species specific management program will be developed and implemented. In the event that a species management program may increase the numbers of another pest species (e.g. fox control leading to an increase in cat numbers), both species will be targeted in the management program.

# 5.6 Weed management

#### 5.6.1 Management action

Introduced species recorded in the Kokoda Offset Site that are considered environmental weeds include Capeweed (Arctotheca calendula), Paterson's curse (Echium plantagineum), black-berry nightshade (Solanum nigrum), tree-of-heaven (Ailanthus altissima) and blackberry (Rubus fruticosus sp. agg.). Blackberry (Rubus fruticosus sp. agg.) is the only noxious weed species recorded on the Kokoda Offset Site listed in the Cabonne Local Government Area control area.

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#### 5.6.2 Monitoring requirements

Weeds will be opportunistically recorded during qualitative bi-annual inspections of the Kokoda Offset Site. If the opportunistic records indicate the presence of a significant population of weed species, appropriate adaptive management will be implemented. Bi-annual inspections commenced in April 2015. Data collected during this survey event will form the baseline data for ongoing weed monitoring. The weed control program aims to eradicate Blackberry and Tree of Heaven from the previously mapped locations on the property.

# 5.6.3 Performance and completion criteria

Performance and completion criteria for weed management are provided in Table 5.9. Trigger points for adaptive management of the weed controls are provided in Table 5.10.

Table 5.9 Weed management performance and completion criteria

Table 5.9 Weed Mallag	Списти репонна І			
Action	Performance criteria year 1 (2015)	Performance criteria years 2 & 3 (2016 & 2017)	Annual actions until Year 20	Completion criteria
Baseline weed inspection	Competed	NA	NA	Completed
Initial weed control program	Completed	NA	NA	Completed
Six monthly ecological monitoring of mapped weeds by Northparkes environmental advisors	Completed	Completed twice per year	Completed twice per year	Completed
Weed management as required by monitoring	Undertaken as identified by monitoring	Undertaken as identified by monitoring	Undertaken as determined by review in year 3	Completed

Table 5.10 Weed control trigger points for adaptive management

Action	Trigger Point for Adaptive Management	Adaptive Management
Annual ecological monitoring or 6 monthly surveys	Continued presence of weed plants at next survey period after treatment (e.g. 6 months after spraying).	The species specific management controls will be reviewed. The frequency of the controls may be increased or alternative control measures may be implemented
	Weed plants are identified in areas where they have not been previously identified	The weed management program will be extended to include these areas
	Patches of perennial/annual grass weeds occurring in DNG regeneration or revegetation areas (see Section 5.7)	Spot spray or dig out small clumps Investigate potential suitability of strategic conservation grazing periodically for weed suppression Monitor and maintain weed control.

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# 5.7 Regeneration of Derived Native Grasslands

Areas of DNG across the Kokoda Offset Site will be managed back to areas of Grey Box Grassy Woodland EEC or Dwyer's Red Gum – Grey Box – Mugga Ironbark – black Cypress Pine Forest, consistent with the surrounding remnant vegetation.

Grey Box grassy woodlands and derived native grasslands of south-eastern Australia occurs in two forms (SEWPaC, 2012). The most common form is as a grassy woodland comprising a tree layer and an understory that must have native grasses but has a varying proportion of shrubs and herbs (SEWPaC, 2012). The derived native grassland form can occur in patches where the tree canopy and mid layer have been almost entirely removed but the native ground later remains largely intact with high flora diversity (SEWPaC, 2012). Key features of grey box grassy woodland communities include the following:

- Woodland with >50% grey box in the overstorey;
- A shrub layer that is moderately dense to absent and includes species such as Dodonaea viscosa ssp. Spatulata
- A ground layer that includes grasses, flowering plants, chenopods, leaf litter and/ or soil crusts. Common species in this layer include Rhodanthe diffusa, Goodenia pinnatifida, Einadia nutans and Crytogram soil crusts.

An initial assessment of the recovery potential for the DNG areas of the Kokoda Offset Site identified six vegetation management areas which are shown on and summarised in Table 5.11.

Table 5.11 Perliminary vegetation management areas

Vegetation Management Area	Area (ha¹)
Grey Box Grassy Woodland - DNG: Active Revegetation Areas	36
Grey Box Grassy Woodland - DNG: Natural Regeneration Areas	38
Grey Box Grassy Woodland - DNG: Potential Recovery Areas	21
Dwyer's Red Gum - Grey Box - Mugga Ironbark - Black Cypress Pine Forest DNG: Natural Regeneration Areas	14
Dwyer's Red Gum - Grey Box - Mugga Ironbark - Black Cypress Pine Forest DNG: Active Revegetation Areas	1.0
Farm Track - Disturbed Land: Potential Recovery Areas	
Total	111

<sup>1 =</sup> Rounding of totals applied (numbers less than 1 – 2 decimal places, numbers between 1 and 10 – 1 decimal place, and greater than 10 - no decimal places)
DNG = Derived Native Grassland

Three types of vegetation management areas were identified:

- Natural regeneration areas which contained existing signs of regeneration and are expected to regenerate naturally once stock is removed and weeds are controlled.
- Potential regeneration areas which contained limited existing signs of regeneration or occur close to a potential seed source and may regenerate naturally once stock have been removed and weeds are controlled. After 24 months of management the level of regeneration occurring in potential regeneration areas will be assessed and such areas

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Active revegetation areas contained no signs of natural regeneration and had little
potential to regenerate naturally. After 24 months of management the level of
regeneration occurring in active regeneration areas will be assessed and those
identified with poor or no regeneration potential will be identified for active
revegetation measures. Planting of tree and shrub species will be undertaken in
active revegetation areas with poor or no regeneration potential.

### 5.7.1 Monitoring of regeneration areas

### Management actions

Following the removal of domestic stock, natural regeneration management areas will be allowed to regenerate naturally for a period of 24 months. Weed monitoring will be undertaken to ensure that weed species do not out-compete native species once the grazing pressure has been removed.

At 24 months detailed monitoring of the recovery of the natural regeneration management areas will be undertaken to precisely map the recovery potential of the DNG areas to inform further detailed management actions. Those areas with high recovery potential will be allowed to continue regenerating naturally and management of high recovery potential areas will be limited to weed and pest control measures.

The key actions proposed to facilitate natural regeneration of DNG areas are:

- Stock removal: the removal of all stock grazing activities from the Kokoda Offset Site is likely to be the most important step in encouraging native species to reestablish in areas of DNG.
- Weed monitoring: in years one to three monitoring will be important in identifying key areas for weed control to ensure that native species are given the best chance of regenerating naturally. Weed monitoring will be undertaken through biannual (twice yearly) inspections and annual ecological monitoring to ensure that weed species do not out compete native species once the grazing pressure has been removed.
- Weed control: The removal of stock is likely to initially cause an influx of introduced species to establish and this will need to be managed appropriately to allow native tree and shrub species to naturally regenerate. It may be necessary to initially liberate naturally regenerating native trees and shrubs from introduced or invasive plants that are smothering their growth until they are large enough to out-compete and shade-out the invasive species.
- Pest fauna management: introduced and native fauna species have potential to threaten natural regeneration through overgrazing of new plant growth and soil disturbance. More intensive pest management may be required in assisted natural regeneration areas until a stable and resilient ecosystem is established. If it becomes a major threat to the success of natural regeneration, consideration may need to be given to other controls such as erecting temporary fencing around selected regeneration areas
- Other techniques to be implemented to trial for the regeneration of DNG areas include the use of crash grazing, slashing or controlled burning.

# Monitoring requirements

As described above, for the first two years, all areas of DNG will be managed through assisted natural regeneration. After two years, detailed monitoring of the recovery of the DNG areas will be undertaken to precisely map the recovery potential of the DNG areas to inform further detailed management actions (using the vegetation management areas delineated in

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and Table 5.11 as a guide). Those areas with high recovery potential will continue regenerating naturally and management will be limited to weed and pest control measures. Areas with low to moderate recovery potential will be managed using active revegetation techniques. Preliminary estimates of recovery potential indicate 37 hectares are likely to require active revegetation management.

DNG areas with moderate recovery potential will be targeted for low intensity revegetation works. This may include supplementary planting of canopy species (using tubestock) to supplement naturally occurring eucalypt saplings and/or other species as per recommendations of a consultant botanist and consistent with key species of Grey Box Grassy Woodland EEC or the Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest.

DNG areas with low recovery potential will be targeted for moderate to high intensity revegetation works. This may include ripping of soil and planting of tubestock species as per recommendations of a consultant botanist and consistent with the key species of the Grey Box Grassy Woodland EEC or the Dwyer's Red Gum – Grey Box – Mugga Ironbark – Black Cypress Pine Forest. Tubestock will be planted at an approximate density of 400 individuals per hectare.

The selection of plant species used in the revegetation strategy is vital to the process of creating a vegetation community that is consistent both structurally and floristically with the target community, particularly in areas where the Grey Box Grassy Woodland EEC is the target. Selection of plant species used in revegetation activities should draw on the floristic results of monitoring in good condition reference sites, in consultation with a qualified and experienced botanist.

The ecological monitoring program for the Kokoda Offset Site DNG regeneration/revegetation areas will include a combination of condition assessments, floristic sampling, sapling survivorship counts and stratified quadrat sampling. Revegetation areas will be monitored by sapling survivorship counts of planted tubestock and condition assessments of surviving tubestock. Regeneration areas (DNG areas where grazing pressure from domestic stock has been removed) will be monitored via stratified and permanent quadrats. Floristic assessments will be undertaken using representative plots and standard botanical survey approaches (e.g. cover-abundance measures) to assess the floristic recovery of the DNG in comparison to the floristic composition of reference sites.

Stratified quadrats will be established in appropriate target communities within the Kokoda Offset Site to provide reference sites to which the success of regeneration/revegetation works can be compared. In the event that regeneration/revegetation sites fail to trend towards the ecological values of the reference sites, adaptive management will be undertaken and management actions will be modified or supplemented with new or additional techniques to promote the recovery of regeneration/revegetation sites towards the values of reference sites.

Monitoring will include Landscape Function Analysis (LFA) techniques to assess the soil structure, stability and nutrient cycling within the DNG recovery areas. Landscape function analysis (LFA) is a standardised monitoring procedure that uses rapidly acquired field-assessed indicators to assess the biogeochemical functioning of landscapes (Tongway and Hindley 2004). LFA is based mainly on processes involved in surface hydrology, rainfall, infiltration, runoff, erosion, plant growth and nutrient cycling. The standard LFA methods as described by Tongway and Hindley (2004) will be followed for the survey.

The proposed annual monitoring surveys comprise:

• six permanent flora plots will be established in existing remnant target woodland communities (reference sites), comprising:

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- o three in Grey Box Grassy Woodland EEC; and
- o three in **Dwyer's Red Gum** Grey Box Mugga Ironbark black Cypress Pine Forest.

Data on floristics and structure, habitat features and ecological condition will be recorded;

- Eleven plots in DNG regeneration/revegetation areas, comprising:
  - five in Grey Box Grassy woodland DNG (EEC) probable active rehabilitation areas;
  - o three in Dwyer's Red Gum Grey Box Mugga Ironbark Black Cypress Pine DNG probable active rehabilitation areas;
  - o one in Dwyer's Red Gum Grey Box Mugga Ironbark Black Cypress Pine Forest low quality;
  - o one in White Box Grassy Woodland CEEC; and
  - o one in Grey Box Ironbark woodland non EEC.

Data on floristics and structure, habitat features and ecological condition will be recorded;

- sapling survivorship counts of planted tubestock and condition assessments of surviving tubestock in regeneration and revegetation areas (to start in 2015);
- permanent photo point monitoring at each monitoring site;
- a replicable stem count assessment in suitable reference (remnant woodland in target communities) and regeneration (DNG) sites for use in developing completion criteria and tracking future progress (to start in 2015); and
- LFA monitoring surveys in DNG recovery areas and reference sites in remnant woodland in target communities. A minimum of 11 LFA sites will be undertaken.

Performance and completion criteria

Performance and completion criteria for active and natural regeneration management areas are provided in Table 5.12. Trigger points for adaptive management of the active and natural regeneration management area methods are provided in Table 5.13.

For performance and completion criteria for stock exclusion, weed management and pest management that apply to the regeneration and revegetation of derived native grassland areas see Section 5.1(exclusion of stock), Section 5.5(pest management) and Section 5.6(weed management).

Table 5.12 Regeneration of derived native grasslands performance and completion criteria

Action	Baseline Surveys (2014)	Performance criteria years 1-5 (2015 to 2019)	Performance criteria years 8, 11, 14, 17 & 20	Completion criteria
Annual ecological monitoring	Baseline ecological monitoring to be undertaken during 2014	To be completed annually for the first 5 years	To be completed every 3 years after year 5	Completed
Landscape Function Analysis monitoring	Baseline LFA monitoring to be undertaken during 2014	To be completed annually for the first 5 years	To be completed every 3 years after year 5	Completed

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Table 5.13 Natural regeneration trigger points for adaptive management

Action	Trigger Point for Adaptive Management	Adaptive Management
Monitoring of DNG recovery potential at 2 years	DNG areas identified with high recovery potential	Those areas with high recovery potential will be allowed to continue regenerating naturally and management will be limited to weed and pest control measures.
	DNG areas identified with moderate recovery potential	DNG areas with moderate recovery potential will be targeted for low intensity revegetation works. This may include supplementary planting of canopy species tubestock to supplement naturally occurring eucalypt saplings and/or other species as per recommendations of a consultant botanist and consistent with the key species of the final target community.
	DNG areas identified with low recovery potential	DNG areas with low recovery potential will be targeted for moderate to high intensity revegetation works. This may include ripping of soil and planting of tubestock species as per recommendations of a consultant botanist and consistent with the key species of final target community.
Annual LFA monitoring	LFA results show a decrease of greater than 25% in soil stability, infiltration or nutrient cycling in successive years	Review current soil management practices and initiate specific control measures.
	Soil stability, infiltration and/or nutrient cycling scores of 1 or more DNG treatment types are not trending towards the values of the relevant reference sites.	Review current soil management practices and initiate specific control measures.
Ecological monitoring of DNG areas	Less than 50% success of plantings in any management area after 1 year	Investigate potential climatic or environmental reasons that may have contributed to the low success rate. Where possible develop strategies to address the climatic or environmental drivers for poor survival rates.  Review current planting management practices and initiate specific management measures.  Following the above investigations and development of management strategies to maximise future survival rates, replace the lost plants.

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Action	Trigger Point for Adaptive Management	Adaptive Management
	Vertebrate pest species identified as limiting regeneration potential through grazing	Identify species specific pest management controls and implement specific control measures. Refer to Table 5.7 above (pest management).
	Native vertebrate species limit regeneration through grazing	Identify species specific management controls and implement species specific control measures.
		Consider exclusion fencing and other plant protection measures if other controls are not identified.
	Low species diversity or species diversity not consistent with target	Investigate presence of weed species and undertake targeted weed control where necessary (see Section 5.6).
	community.	Undertake active revegetation techniques including direct seeding or tubestock planting, following appropriate ground preparation such as weed control, ripping and/or auguring.
	Low or no tree cover appearing	Plant or direct seed trees at an appropriate density using minimal disturbance.
	Tree dieback (from insect pressure, herbicide drift, water stress)	revegetate with dense shrubs to increase diversity and attract insectivorous birds.  avoid using defoliants near
	Dense stands of colonising tree or shrub species dominate regeneration or revegetation areas	woodlands when windy.  assess whether thinning is necessary thin manually if appropriate leave if patches are small and plants are native

#### 5.7.1 Habitat augmentation

Habitat augmentation may be required if the regeneration areas do not meet the habitat structure benchmarks of the reference woodlands at the appropriate maturity stage. If required, nest boxes can be added to trees once that have reached a sufficient size, to accommodate a suite of fauna species that occur in the reference woodlands. No habitat features salvaged from the impact area will be moved to the offset site as there is a risk that unknown diseases or pathogens could be transferred the approximate 50 kilometres between the sites during that process. Any fallen timber located during the track maintenance works within the offset site will be moved into the DNG regeneration areas, where practical.

#### Monitoring requirements

If applicable, any habitat augmentation will be monitored for its effectiveness during the annual ecological monitoring program. In the event that nest boxes are installed, an annual monitoring program will be developed which will include monitoring of occupancy rate and box condition.

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Performance and completion criteria

Performance and completion criteria and trigger points for adaptive management of any habitat augmentation will be developed if required.

### 5.8 Threatened bird species monitoring

### 5.8.1 Monitoring requirements

Threatened bird monitoring will be undertaken at the Kokoda Offset Site, focussing on key threatened bird species. Two threatened fauna species were recorded in the project disturbance area, the grey-crowned babbler (*Pomatostomus temporalis temporalis*) and the superb parrot (*Polytelis swainsonii*). Specific assessments of the potential for the Kokoda Offset Site to offset potential impacts on the swift parrot and regent honeyeater were a focus of the Preliminary Documentation report for the Referral to the Commonwealth Department of the Environment. Annual monitoring surveys of the Kokoda Offset Site will also include surveys for the swift parrot (*Lathamus discolor*) and regent honeyeater (*Anthochaera phrygia*).

Threatened bird monitoring will comprise bird surveys of existing woodland and recovering DNG areas focusing on the presence of the threatened grey-crowned babbler, superb parrot, swift parrot and regent honeyeater. Threatened bird monitoring will cover both the existing remnant vegetation areas as well as the recovering DNG areas, once there has been reasonable growth of canopy species (new sites will therefore be added as regeneration/ revegetation areas progress). Monitoring should be undertaken during winter for the regent honeyeater and swift parrot (during periods when eucalypt trees are flowering) and during early spring for the superb parrot when it is most likely to be utilising the Kokoda Offset Site during local seasonal movements. Monitoring will be undertaken for the grey-crowned babbler during both winter and spring survey periods.

The proposed monitoring surveys will comprise:

- Plot-based diurnal spring woodland bird surveys. As a minimum, two x 20 minute bird surveys will be undertaken at six reference sites (in target woodland community remnants) and five DNG regeneration sites (consistent with flora monitoring sites where possible). Each survey will cover an approximate two hectare area around the flora monitoring plots. Spring woodland bird surveys will be undertaken in DNG regeneration sites during all growth stages as grey-crowned babblers may occur in both DNG and woodland areas, and superb parrots may forage in DNG areas.
- Plot-based diurnal winter bird surveys for the regent honeyeater and swift parrot. Winter bird surveys should be undertaken in areas of flowering eucalypts across the Kokoda Offset Site. Each year a minimum of six eucalypt flowering sites should be surveyed. If no flowering eucalypts are identified during the winter survey period, the winter bird surveys will be undertaken at the six flora reference sites (in target woodland community remnants). Two 20 minute bird surveys will be undertaken at each site and cover approximately a two hectare area around the flora monitoring plots. Once DNG regeneration areas provide a four metre high canopy, winter bird surveys will also be undertaken across each of the five DNG regeneration areas.;

Opportunistic observations of the four targeted threatened bird species will be recorded during all other monitoring survey activities.

# 5.8.2 Performance and completion criteria

Performance and completion criteria for threatened bird surveys are provided in Table 5.14. Trigger points for adaptive management of the threatened bird surveys are provided in Table 5.15.

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Table 5.14 Threatened bird survey performance and completion criteria

Action	2014 Baseline Surveys	Years 1 to 5 performance criteria 2015 to 2019	Years 8, 11, 14, 17 & 20 performance criteria	Completion criteria
Annual winter bird surveys	Completed	To be completed annually for the first 5 years	To be completed every 3 years after year 5	Completed and results included in annual reporting.
Annual spring bird surveys	Completed	To be completed annually	To be completed every 3 years after year 5	Completed and results included in annual reporting.

Table 5.15 Threatened bird survey trigger points for adaptive management

Action	Trigger Point for Adaptive Management	Adaptive Management
Annual winter bird surveys	No flowering eucalypts are identified during winter months.	Consider undertaking additional winter bird surveys during May or October if a large proportion of the eucalypt trees present at the Kokoda Offset Site flower during May or October.

#### 5.9 Seed collection

The existing woodland vegetation of the Kokoda Offset Site provides a valuable source of native seed. If active revegetation activities are required, this seed resource will be utilised where practical. The use of local provenance seed can improve the success of revegetation, while also preserving the genetic integrity of the local vegetation.

Sustainable seed collection from the Kokoda Offset Site will also be considered for use in the rehabilitation of Northparkes Areas where suitable.

# 5.10 Appropriate management of adjacent agricultural land

There will be ongoing consultation with adjacent land owners and/or managers to ensure they are aware of the biodiversity conservation objectives of the Kokoda Offset Site.

#### 5.11 Erosion and sedimentation

Owing to a high vegetation cover across most of the Kokoda Offset Site, erosion is not currently a significant management issue. Inspections of any areas of erosion concerns should be included in routine biannual inspections, targeting riparian areas and sites with limited vegetation cover.

If an area of significant erosion concern is identified, appropriate short term erosion and sediment controls will be implemented and longer term stabilisation actions such as vegetation establishment will be investigated.

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# 5.12 Salinity

Salinity has not been identified as an issue of concern within the Kokoda Offset Site to date. Given that the site has a high vegetation cover it is not likely to become a management issue. However, any evidence suggesting the land is affected by salinity should be documented and the appropriate management and remediation strategies implemented.

# 5.13 Bushfire management

A Bush Fire Management Plan for the Kokoda Offset Site (BFMP) has been prepared (refer Appendix 5). The vegetation of the Kokoda Offset Site requires appropriate bushfire management to protect life and property while providing the necessary protection to the significant ecological features of the area.

The BFMP plans for the exclusion of fire from regeneration and revegetation areas, where possible. This allows young vegetation communities to mature to a stage where they are able to withstand bushfire and regenerate naturally following a fire event. This is nominally at least 15 years, but is dependent on the success of plant establishment and the vegetation community present. The Bushfire Management Plan also considers the locations of known records of threatened species and TECs. Fire should be excluded from these areas, where possible, so that planned burn frequency and intensity does not threaten the persistence of threatened species and TECs.

The use of low intensity controlled burns to facilitate natural regeneration from the soil seed bank may need to be considered later in the project if natural recruitment levels are not sufficient. If required, an appropriate strategy will be developed in close consultation with the Rural Fire Service.

# 5.14 Management of cultural heritage values

The Kokoda Offset Site is not subject to an Aboriginal Cultural Heritage Management Plan, however there is potential that it may contain sites of Cultural Heritage Value. As such, appropriate consideration to Cultural Heritage values will be made in regards to activities undertaken within the Kokoda Offset Site.

### ADAPTIVE MANAGEMENT

### 6.1 Adaptive management process

Adaptive management of the BOMP will be responsive to any new and relevant data that may arise through the monitoring described in Section 4, legislative change or any other studies completed at the site. This will enable a flexible approach to management commitments, allowing ongoing feedback and refinement of the BOMP. Adaptive management will be a key mechanism to address the risks to the successful implementation of the BOMP. Adaptive management steps include regular review of the BOMP, including adaptation of targets and performance indicators, recognising potential risks to the successful implementation of the BOMP and having a frame work in place for corrective actions.

#### 6.2 Review of BOMP

The BOMP is to undergo an internal review and revision every three years to refine and make improvements to the management strategies and to assess their performance against preliminary performance indicators and completion criteria. The three year review will look for opportunities to improve the management strategies and further develop and forecast the longer term performance indicators and completion criteria.

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Amendments to the BOMP in response to adaptive management and continual improvement requirements that are consistent with the conditions of approval do not need to be submitted to relevant authorities for approval.

# 6.3 Assess targets and performance indicators

The performance indicators and completion criteria outlined in Section 5 are preliminary and apply to the first three years of the BOMP implementation. As this current version of the BOMP was updated in 2016, the BOMP will be reassessed in 2019, unless a process changes earlier than this date that requires consideration. This three yearly review will reassess the targets and performance indicators and will be:

- adapted and changed as targets are met and new challenges arise;
- will be assessed and redeveloped as appropriate in response to monitoring outcomes; and
- Will be assessed for the success of the management and improvement strategies.

Modifications to the targets and performance indicators will be recorded in a revised BOMP for the Kokoda Offset Site.

#### 6.4 Potential risks and corrective actions

There are a number of potential risks, or situations where preliminary performance indicators and completion criteria might not be achieved. The key risk of the Kokoda BOMP not succeeding relates to the return of DNG communities to woodland communities, and to the management of threats such as weeds and pests. The use of reference sites will assist in identifying whether observations from monitoring are able to be addressed by modifying management actions, or if they are due to broader conditions that can't be controlled such as climatic and seasonal factors (e.g. drought).

A list of potential situations where biodiversity conservation objectives of this BOMP may not be met is provided in Table 6.1, along with potential corrective actions. This list is adapted from Rawlings et al. (2010).

Table 6.1 Risks and recommended corrective action measures<sup>1</sup>

Potential Risks	Recommended Corrective Actions			
General Management Risks				
Unauthorised stock access	identify access points and repair fences appropriately; and			
	communicate with adjacent landholders to emphasise that no stock are to have access to the Kokoda Offset Site.			
Infestations of noxious and environmental weeds are increasing or new species detected.	adapt weed management program and modify strategies accordingly.			
Infestations of pest animals are increasing or new species detected.	adapt pest management program and modify strategies accordingly.			
Risk to Success of Regeneration	n/Revegetation of DNG Areas			
No regeneration of plants, or indicator species missing	<ul> <li>assess fencing and ensure there is no unauthorised stock access;</li> </ul>			
	control exotic weeds and pest animals to reduce competition; and			

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Potential Risks	Recommended Corrective Actions
	<ul> <li>if deemed necessary, instigate active regeneration techniques including direct seeding or tubestock planting, following appropriate ground preparation.</li> </ul>
Low species diversity or species diversity not consistent with target community.	<ul> <li>targeted weed control; and</li> <li>instigate active revegetation techniques including direct seeding or tubestock planting, following appropriate ground preparation such as weed control, ripping and auguring.</li> </ul>
Low or no tree cover	<ul> <li>plant/ direct seed trees at appropriate rate using minimal disturbance.</li> </ul>
Tree dieback (from insect pressure, herbicide drift, water stress)	<ul> <li>revegetate with dense shrubs to increase diversity and attract insectivorous birds;</li> <li>avoid using defoliants near woodlands when windy; and</li> <li>increase patch size through revegetation.</li> </ul>
Patches of perennial/annual grass weeds occurring	<ul> <li>spot spray or dig out small clumps;</li> <li>investigate suitability of strategic conservation grazing periodically for weed suppression and to stimulate native pasture; and</li> <li>monitor and maintain control.</li> </ul>
Dense stands of colonising tree or shrub species dominate regeneration or revegetation areas	<ul> <li>assess whether thinning is necessary;</li> <li>leave if patches are small and plants are native; and</li> <li>thin manually if appropriate.</li> </ul>
Scarcity of key habitat features present in relation to reference sites	<ul> <li>add habitat features such as logs or branches;</li> <li>control feral predators;</li> <li>increase the number of vegetation layers in the patch; and</li> <li>establish nest boxes for target species.</li> </ul>

<sup>1 =</sup> Adapted from Rawlings et al. (2010)

# 7. REPORTING AND DOCUMENTATION REQUIREMENTS

# 7.1 Record keeping

Northparkes will maintain accurate records substantiating all activities associated with measures taken to implement the BOMP. These records may be subject to audit by the DoE, the DPE or an independent auditor.

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# 7.2 Annual reporting

Condition 12 of the Commonwealth Project Approval states that:

'Within three months of every 12 month anniversary of the commencement of the action, the person taking the action must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any plans as specified in the conditions. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the Department at the same time as the compliance report is published. The person taking the action must also notify any non-compliance with this approval to the Department in writing within two business days of becoming aware of the non-compliance'.

Further to this, Condition 8 of the NSW Project Approval states that:

'the Proponent shall provide regular reporting on the environmental performance of the project on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this approval'.

In accordance with these conditions, within 3 months of every 12 month anniversary of the commencement of the Project, Northparkes will prepare an Annual Review which will be published on their website. In relation to the BOMP, the Annual Review will contain the following information:

- 1. compliance with each of the conditions of approval;
- 2. description of implementation of the BOMP as specified in the conditions of approval;
- 3. rehabilitation and management activities undertaken within the reporting period, including estimated costs;
- 4. results of monitoring events for the reporting period; and
- 5. required amendments to the management or monitoring processes as identified by the adaptive management mechanism.

Utilising the adaptive management mechanism outlined in Section 6, the results of monitoring will be utilised to inform updates to the management actions to be undertaken in the Kokoda Offset Site.

# 7.3 Ecological monitoring reporting

An ecological monitoring report will be prepared on completion of each monitoring survey. The report will include:

- a detailed description of the monitoring methods employed;
- a discussion of the results;
- an assessment as to whether the preliminary performance indicators have been met, and how the project is tracking towards the completion criteria;
- a revision of the management and improvement strategies as appropriate; and
- a revision of the preliminary performance indicators and completion criteria (if required).

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# 8. CONSERVATION BOND AND IMPLEMENTATION COSTS

A Conservation Bond for the Kokoda Offset Site is required by DPE in accordance with Condition 31. The purpose of this bond is to cover the cost of the management of land required to be set aside as an offset area, should the mine consent holder be unable or unwilling to continue management of the land. The Conservation Bond value is based on all the activities identified in the approved BOMP and is the full cost of implementing the biodiversity offset strategy. The Conservation Bond estimate has been prepared in accordance with relevant guidelines and accepted practice to inform this process.

# 9. BOMP CHECKLIST AND IMPLEMENTATION SCHEDULE

A checklist summarising the Kokoda Offset Site BOMP actions required, and their schedule for implementation for the first three years is provided in Table 9.1. This is a snapshot of the key actions required in the first three years of implementation of the BOMP. Reference to the relevant sections of this BOMP should be made for more detail of the actions required.

Table 9.1 Checklist and implementation schedule for the Kokoda offset site BOMP

Actions/Targets	Timeframe
Management and Improvement Actions	
Install necessary boundary fencing and signage for the Kokoda Offset Site.	Complete.
Remove stock grazing activities from the Kokoda Offset Site.	Complete Authorised strategic conservation grazing may be adopted for ecological restoration purposes (Section 5.6).
Establish an appropriate long-term conservation mechanism for the Kokoda Offset Site.	To be agreed upon before 25 March 2017.
Lodge a conservation bond.	Complete
Routine inspection and maintenance of tracks and fences by Northparkes environmental officers.	Biannual (twice yearly) inspections.  Maintenance is required throughout the life of the BOMP.
Establish an effective annual weed and pest control programs.	To be established in Year 1. Annually review and revise.
Undertake weed and pest control activities.	Commencing Year 1, concentrate efforts in DNG areas in Years 1 – 3 to assist natural regeneration.
Establish woodland vegetation in areas of derived native grassland (DNG) through assisted natural regeneration.	Implement assisted natural regeneration activities (weed and pest control, stock removal etc.) in Years 1-5.
	Assess progress towards performance indicators and completion criteria during the Year 3 review of the BOMP (incorporating results of inspections and monitoring).
	Commence active revegetation methods after Year 2 if natural regeneration is not progressing appropriately.

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Actions/Targets	Timeframe
Active revegetation activities	Will only commence if necessary after a minimum of 2 years trial with assisted natural regeneration. The need for active revegetation will be assessed at each 3 year revision of the BOMP.
Monitoring Actions	
Establish a suitable monitoring program to assess the success of ongoing management and improvement strategies	Complete
Ecological Monitoring	Commence surveys in autumn or spring in Year 1 (baseline survey), and undertaken annually for first 5 years. Winter migratory bird monitoring to commence in winter of Year 1 (baseline survey).
General inspections across the Kokoda Offset Site by Northparkes environmental officers.	Biannually from Year 1.
Reporting and Documentation Actions	
Accurate records are being maintained substantiating all activities and monitoring relating to implementation of the BOMP.	Ongoing from Year 1.
Collate data on actions implemented and results of inspections and monitoring into the Annual Review.	Annually from Year 1.
Ecological Monitoring Report	Following completion of each monitoring period, within 3 months of each monitoring survey event, commencing Year 1 (baseline survey).
Update BOMP, including a revision of management actions, performance indicators and completion criteria.	Every 3 years from commencement (earlier if deemed necessary).

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# 10. REFERENCES

North Mining Limited, 2006. Management Plan – Site Wide – Land use. North Mining Limited.

North Mining Limited, 2008. Management Plan – Site Wide – Flora and Fauna. North Mining Limited.

Rawlings, K., Freudenberger, D. and Carr, D. (2010) A Guide to Managing Box Gum Grassy Woodlands, Department of the Environment, Water, Heritage and the Arts, Canberra.

Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC) (2012). Grey Box (Eucalyptus macrocarpa) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia: A guide to the identification, assessment and management of a nationally threatened ecological community. Commonwealth of Australia. Canberra.

Tongway, D J and Hindley, N L 2004. Landscape Function Analysis: Procedures for monitoring and assessing landscapes with special reference to mine sites and rangelands. CSIRO Sustainable Ecosystems, Canberra.

Umwelt (2013a) Environmental Assessment Northparkes Step Change Project. Prepared by Umwelt on behalf of Northparkes Mines.

Umwelt (2013b) Northparkes Mines Step Change Project Preliminary Documentation EPBC Act Referral 2013/6788. Prepared by Umwelt on behalf of Northparkes Mines.

Umwelt (2013c) Northparkes Mines Step Change Project Response to Submissions Addendum Report. Prepared by Umwelt on behalf of Northparkes Mines, November 2013.

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Appendix 1 Limestone National Forest Offset Area Revegetation Plan

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Appendix 2 Vegetation Management Plan (for the Estcourt Offset area)

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Appendix 3 Species Management Plan for the Pine Donkey Orchid

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# Appendix 4 Regulatory Comments

# Biodiversity Management Plan – Updates to BOMP based on Department of Planning and Environment comments received in September 2015

DoP comment	Comments	Status
Still appears in draft from	Document reformatted to Northparkes style for consistency with of Management Plan. Draft removed.	Complete
Appendices 1 & 2 missing	Attached Limestone National Forest Offset Area Revegetation Plan (Appendix 1) and Vegetation Management Plan (for the Estcourt Offset area) (Appendix 2)	Complete
Figures 2.3 and 2.4 missing	Figures updated to reflect the table of contents	Complete
Section 6.3 requires updating	Section 6.3 has been updated. As we are currently only in the first year on the BOMPs implementation, no results can be reported at this stage.	Complete Section 6.3
Objectives to include mention of Donkey Orchid conservation and management.	All information relating to the management of the pine donkey orchid (PDO) has been moved to Appendix 3 – Species Management Plan for the Pine Donkey Orchid (SMP for the PDO). Northparkes was requested to draft a SMP for the PDO following the submission of the BOMP to provide additional information about this particular threatened species and its management. As such, having all the information regarding the PDO in the one place provides clarity and increases readability, so that the BOMP only applies to the Kokoda offset site and all information relating to the PDO is centralised in one location.	Complete Refer Species Management Plan (Appendix 3)
Table 1. To include consent conditions for Donkey Orchid	Consent conditions relating to PDO have been included with a cross reference to Appendix 3 (SMP for the PDO).	Complete

Biodiversity Offset Management Plan- Additionally changes made to BOMP based on recommendations from the Office of Environment & Heritage in December 2015

OEH comment	Comments	Status
1.1 Update the preliminary long term biodiversity	Acknowledged, change made to BOMP in Section 3.	Complete
management targets (section 3) to state:		
(a) "Increase the overall native flora and fauna species		
diversity compared to the baseline		
condition" (or something similar)		
(b) "Improve the habitat values of the remnant woodland		
communities in the Kokoda Offset		
Site compared to the baseline condition" (or something		
similar).		
2.1 Remove reference to the establishment of 300 metres	Acknowledged, changes made to BOMP in Section 3 and	Complete
of new fencing in section 3	Section 5.2 to reflect that establishment/maintenance of	

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OEH comment	Comments	Status
	fencing will be conducted as required to exclude stock from the offset area. Section 5.2 states that no new fencing is required.	
2.2 The in-perpetuity conservation mechanism has not yet been finalised. Amend the status to "ongoing" or another similar description within Table 5.4.	Acknowledged, change made to BOMP in Table 5.4.	Complete
2.3 Develop an ecological burn strategy for the Kokoda offset site.	A Bush Fire Management Plan has been developed for the Kokoda Offset Site and has been included in this document (refer Appendix 5). The ecological burn strategy is included in Section 5.	Complete
2.4 Collect and document baseline information on feral fauna and kangaroo populations.  2.5 Implement targeted monitoring of feral fauna and kangaroo numbers.	Kangaroos and feral fauna species (including foxes, hares and rabbits) occur at Kokoda. However, the number of kangaroos and feral fauna are not considered to be at a level that is detrimental to the biodiversity conservation values at the offset site. Additionally, as Kokoda is located within a predominately agricultural landscape and the boundary fences at the offset site are not kangaroo or feral proof, movement of these species, in particular kangaroos, occurs freely across property boundaries and the broader landscape.  Vegetation surveys, using a Landscape Function Analysis (LFA) methodology, were undertaken across the property in 2014 and 2015. Baseline surveys conducting in 2014 were undertaken prior to the purchase of the property, while low intensity sheep grazing was still being undertaken across the property. In 2015, LFA monitoring surveys were undertaken across the property, approximately 6 months after stock had been removed. As such, both of these assessments provide baseline information on the level of grazing impacts on ground cover across the property, both with low intensity livestock grazing and after livestock grazing was removed. As stock have been excluded from the property since early 2015, the majority of ongoing grazing at the property will be from kangaroos.	Complete

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OEH comment	Comments	Status
	As Kokoda contains several ground cover species of interest, including several (not listed) orchid species, low level grazing provides an important service in terms of regulating the density of the ground cover so small herbs and forbes are able to compete and persist. However, it is acknowledged that left unregulated, kangaroo numbers, in particular, could increase over time.	
	As such, the baseline vegetation surveys undertaken in 2014 and 2015 will be used as surrogate indictor of grazing intensity at the property. If ongoing LFA surveys indicate that ground cover has declined to levels similar to the baseline vegetation surveys, adaptive management will be initiated and an investigation into kangaroo numbers will be commenced.	
	Additionally, feral fauna will be monitored during biannual inspections. Where feral animals are recorded, pest management options will be discussed with the near neighbours and implemented as required. Northparkes is in regular communication with the near neighbours around Kokoda, and will continue to discuss and collaborate with these neighbours on issues including kangaroo and feral animal management for the offset site.	
2.6 Consider the potential for updating the weed management actions (Table 5.9) to have a goal to eradicate tree-of-heaven and blackberry.	Northparkes internal Weed Control Program for the Kokoda Offset Site includes provisions to spray and actively manage tree-of-heaven and blackberry at the Kokoda Offset Site. However, as Kokoda occurs within an agricultural landscape with different land management practices, even if these weed species are eradiated from the property, it will be extremely difficult to ensure that these species are not reintroduced.	Complete

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OEH comment	Comments	Status
2.7 Amend the current trigger points for weed control	Acknowledged, change made to BOMP in Table Table 5.10.	Complete
(Table 5.10) so that they are quantifiable.		
2.8 Information regarding the benchmark woodland sites	Acknowledged, change made to BOMP. Refer to Figure 2.2	Complete
for the derived native grassland vegetation communities	for benchmark woodland sites for the derived native	
should be included.	grassland vegetation communities.	
2.9 Overlay locations of the LFA monitoring sites and the	Acknowledged, change made to BOMP. Figure 2.2 updated	Complete
ecological monitoring sites on the vegetation	with LFA monitoring sites.	
management zone diagram.		
2.10 Northparkes Mines should meet with OEH after the	Northparkes has open communication with the OEH.	Complete
detailed monitoring of the derived native grasslands has	Northparkes has an annual meeting regarding environmental	
been completed and before the next stage of	monitoring (AEMR), which OEH is invited to attend.	
revegetation commences.	Additionally, OEH is welcome to contact Northparkes at any	
	time to arrange a meeting.	

Biodiversity Offset Management Plan- Additionally changes made to BOMP based on recommendations from the Office of Environment & Heritage in August 2016

OEH comment	Comments	Status
Targeted baseline surveys and ongoing monitoring of feral pests and kangaroo populations	Northparkes and OEH staff met on 19 <sup>th</sup> October 2016 to discuss outstanding comments on the BOMP. The changes included in version 3 of the BOMP were discussed and agreed upon during this meeting.	Complete
Trigger points for weed control and eradication goals for specific weed species	Northparkes and OEH staff met on 19 <sup>th</sup> October 2016 to discuss outstanding comments on the BOMP. The changes included in version 3 of the BOMP were discussed and agreed upon during this meeting.	Complete

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Appendix 5 Bush Fire Management Plan for the Kokoda Offset Site



DOC18/43022

Mr Dahui Zhang Secretary CMOC Mining Pty Limited Suite 24.06, Level 24, Governor Macquarie Tower 1 Farrer Place SYDNEY NSW 2000

# Dear Mr Zhang

I am pleased to advise I have signed the Kokoda Biodiversity Offset Conservation Agreement as the Minister's delegate under section 21(1) of the National Parks and Wildlife Act 1974.

By entering into this agreement, you are part of a wide network of people in NSW who have taken this path to protect our unique natural and cultural heritage for the benefit and enjoyment of current and future generations.

I understand that the conservation area contains habitat for a number of threatened species and protects three ecological communities including: the Western Grey Box - Cypress Pine shrubby woodland on stony footslopes in the NSW South Western Slopes Bioregion and Riverina Bioregion, the White Box - White Cypress Pine - Western Grey Box shrub/grass/forb woodland in the NSW South Western Slopes Bioregion, and the Mugga Ironbark - Black Cypress Pine woodland on hillslopes and ridges of the Central Lachlan region of the NSW South Western Slopes Bioregion.

The NSW Biodiversity Conservation Trust (BCT) will register the conservation agreement on the property title. Once this is complete, the BCT will inform local council of the agreement and return a copy of the signed registered documents to you.

Thank you for entering into this partnership to secure the biodiversity values of this area in perpetuity.

If you have any questions about the agreement, please contact Mr Stuart Gold, Team Leader Landscape Conservation, Programs Branch, BCT, on 9995 6529 or at stuart.gold@bct.nsw.gov.au.

Yours sincerely

Anthony Lean

9 FEBRUARY ZOIF





Mr Dahui Zhang Secretary CMOC Mining Pty Limited Suite 24.06, Level 24, Governor Macquarie Tower 1 Farrer Place SYDNEY NSW 2000 Our ref: DOC18/383819

posted 12.6.18

Sender to keep 605 34992045 098

Dear Mr Zhang

# Re: Registration of Kokoda Biodiversity Offset Conservation Agreement

I am pleased to advise you that the registration of your Conservation Agreement is now complete. A copy of the signed Agreement lodged at Land Registry Services (LRS) is enclosed for your records. Also, if you have not been sent or arranged for a Conservation Area identification sign for your property, please advise us as soon as practicable and we will arrange for a sign to be sent to you.

With regard to eligibility for proportional rate exemptions under s555 of the *Local Government Act 1993*, a courtesy letter has been sent to your local Council notifying them of details relating to your Conservation Agreement. A copy of the letter is enclosed for your information.

I would like to thank you for your cooperation in working with us to finalise the Conservation Agreement.

12 June 2018

Yours singerely

Marita Valent

**Branch Support Officer** 

Programs Branch, Biodiversity Conservation Trust