HILLGROVE RESOURCES

EPBC-ACT CONTROLLED ACTION EPBC 2013/6965

NATIVE VEGETATION MANAGEMENT PLAN COMPLIANCE REPORT FOR THE

KANMANTOO COPPER MINE EXTENSION 2020/ 2021

Hillgrove Resources 9 December 2021

Cover Picture – Mine Rd SEB-Offset Area: (175 Mine Rd) 9th December 2021; Native grass sward establishment is highlighted in the right side of the photograph and growth of mid-story and canopy species representative of a reconstructed Peppermint Box Grassy Woodland community can be seen on either side of the native grass sward.

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Definitions

Abbreviation	Definition
141 Mine Rd	Hillgrove-owned property & designated SEB-Offset area, 141 Mine Rd Kanmantoo SA 5252
Acacia pycnantha (A. pycnantha)	Open woodland community dominated by *Acacia pycnantha*
DAWE	Australian Department of Agriculture, Water and the Environment
Botanic Gardens	South Australian Seed Conservation Centre, Botanic Gardens of Adelaide
BushRAT	Bushland Rapid Assessment Technique/ DEWNR SA
CD	Compact Disk
CEO	Hillgrove's Chief Executive Officer, Mr Lachlan Wallace
DEM	Department for Energy and Mining SA
DEW	Department for Environment, and Water, SA
DSD	Department of State Development, South Australia
DPC	Department of the Premier and Cabinet, South Australia
EBS Ecology	Fauna and Flora Consultancy division of the EBS Group, Adelaide SA
EBS Restoration	Ecological restoration division of the EBS Group, Adelaide SA
EM	Hillgrove's Environment Manager (Ms Catherine Davis)
EPBC 2013/6965	Approval granted to disturb vegetation under provisions of the EPBC Act
EPBC Act	Environmental Protection and Biodiversity Conservation Act (1999)
Eucalyptus odorata (E. odorata)	Critically endangered grassy woodland community dominated by *Eucalyptus odorata*
Ferguson's	Hillgrove-owned property & designated SEB-Offset area, adjacent to Mine Rd Kanmantoo SA 5252
Hillgrove	Hillgrove Resources Ltd/ Hillgrove Copper Pty Ltd
KCM	Kanmantoo Copper Mine
LFA	Landscape Function Analysis/ Ludwig & Tongway (1997)
Lomandra effusa (L. effusa)	Critically endangered natural temperate grassland vegetation community dominated by *Lomandra effusa*
LOM-Extension	Life of Mine Extension
Lot 25	Hillgrove-owned property & designated SEB-Offset area, adjacent to Mine Rd Kanmantoo SA 5252
ML	Mining Lease 6345
Mulawa	Hillgrove-owned property & designated SEB-Offset area, 175 Mine Rd Kanmantoo SA 5252
NRM Act	Natural Resources Management Act 2004 (SA)
NVMP	Native Vegetation Management Plan
PEPR	Program for Environmental Protection and Rehabilitation
SA	South Australia
SEB x:1	A native vegetation condition rating for SEB-Offset purposes
SEB-Offset	Significant Environmental Benefit - Offset. New vegetation areas established to offset clearance.
SMA	Seed Multiplication Area/ 5ha seed multiplication plot
SPA	Seed Production Area/ 1ha intensive seed farm

1 Executive Summary

This compliance report outlines progress against the approval conditions listed in EPBC 2013/6965 during the 2020-2021 reporting period from 01 September 2020 to 31 August 2021. Please refer to 2014/2015, 2015/2016, 2016/2017, 2017/2018 and 2018/2019 and 2019/2020 EPBC compliance reports for details relating to approval conditions discharged in previous reporting periods. Previous compliance reports can be accessed via the following link:

http://www.hillgroveresources.com.au/environment

Navigate down the page to 'Environmental Protection and Biodiversity Conservation Act (EPBC)', 'Compliance Reports:', and select the report you wish to download. The following historic and current reports are available on the Hillgrove web page:

- ***2015 EPBC Act Compliance Report***
- ***2016 EPBC Act Compliance Report***
- ***2017 EPBC Act Compliance Report***
- ***2018 EPBC Act Compliance Report***
- ***2019 EPBC Act Compliance Report***
- ***2020 EPBC Act Compliance Report***
- ***2021 EPBC Act Compliance Report***

Hillgrove Resources have worked towards complying with the approval granted by EPBC 2013/6965. During the 2020/2021 reporting period Hillgrove have continued to consolidate direct seeding carried out on approximately 20.3ha of land adjacent to Mine Rd commenced in April 2015 and a further 6.7ha of plantings commenced on Ferguson's and Lot 25 in 2018. The total area of EPBC SEB-offset commenced at all sites by the end of the 2020/2021 reporting period was approximately 27ha.

Work during this reporting period has focussed on maintaining existing plantings through a combination of mechanical and chemical weed control including boom and spot spraying, hand weeding, precision brushcutting, cut/swab removal of feral trees and tractor slashing. The program also maintained the Mine's Seed Production area (SPA) and Seed Multiplication area (SMA). Fire risk reduction slashing and weed control were also carried out, both within and surrounding existing plantings. The overall effort invested in maintaining SEB-offsets and related infrastructure and continuing the seed collection, processing and storage programs was 1,658 hours during the 2020/2021 reporting period.

The seed production program and wild-seed seed collection programs yielded approximately 570kg of native seed during this reporting period. 385kg of surplus stored seed was sold to free up seed storage space by relinquishing older seed stock. Approximately 1,134kg of native seed was in storage at the end of the reporting period. The majority of this was a mix of *Austrostipa* and *Rytidosperma* harvested from offset plantings. Good winter rainfall enhanced the overall volume of seed which was harvested in spring 2021.The use of external/commercial seed supplies has not been necessary to date.

During recent years the SEB-offset establishment program has been limited by commercial considerations. The site is currently in care and maintenance as drilling is undertaken to prove up Mineral Resources underneath the open pits on the site with the view to commence an underground mining operation in 2022. This underground operation will not involve removing vegetation from the site.

A revised NVMP may be required to propose a revised SEB-offset program for consideration. A revised program would focus on the topsoil pre-strip method of SEB-offset establishment. Under a revised NVMP to be submitted for approval, Hillgrove may seek approval to move part of the SEB-offset establishment onto equivalent areas of farming land, remnant vegetation or other land owned by Hillgrove, or may seek approval for payment into a fund in lieu of offset establishment if or when such an instrument is developed as part of a review of the Act.

2 Background

The Kanmantoo Copper Mine (ML6345) is located approximately 45km SE of Adelaide, near the townships of Kanmantoo and Callington. The 440ha mining lease (ML) is on the eastern side of the Mt Lofty ranges, within a 425mm rainfall zone. The Kanmantoo Copper Mine (KCM) is operated by Hillgrove Copper Pty Ltd.

The original mine site contained several underground workings from the mid to late 19th century and the original Kanmantoo Copper Mine open pit, which was in operation from 1970 until 1976. Hillgrove undertook exploration work at the site from 2004, which proved up additional mineral resources adjacent to and below the historical Kavanagh open pit. This led to Hillgrove commencing open pit mining and processing ore on the site from 2011. Mining of the main open pit - Giant - was completed in May 2019 with final ore from the depth extensions of the West Kavanagh lode and the processing of stockpiled ore concluded in March 2020. The site is currently in care and maintenance as drilling is undertaken to prove up Mineral Resources underneath the open pits on the site with the view to commence an underground mining operation in 2022. This underground operation will not involve removing vegetation from the site.

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The ML contains a range of remnant native vegetation, including stands of Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia and Iron–grass (Lomandra effusa) Natural Temperate Grassland of South Australia, both of which are listed as critically endangered under the EPBC Act (1999). The ML's vegetation has been significantly altered by more than 150-years of agriculture and mining; however, remnant stands of native vegetation can be found within the ML, varying in condition from SEB-Offset classes of 2:1 to 8:1. The clearance of 1.8ha of Peppermint Box grassy woodland and 3.4ha of Iron-grass natural temperate grassland was required to allow extension of mining activities until 2019 under the Life of Mine Extension proposal, ('the LOM Extension').

The LOM Extension was approved under a revised Program for Environmental Protection and Rehabilitation (PEPR), regulated by the South Australian Department for Energy and Mining, or DEM[1] henceforth the 'Regulator'. Both clearances were deemed 'controlled actions' under the EPBC Act, requiring approval by the Australian Department of the Environment and Energy (ADEE)[2] before the LOM Extension PEPR could be approved by the Regulator. A NVMP was written to encompass the controlled actions associated with the LOM Extension. The NVMP was subsequently approved by the DAWE and permission to proceed with both controlled actions was granted by the DAWE under the conditions outlined in the approval document for this action (Ref: EPBC 2013/6965 dated 6 May 2014). Both controlled actions commenced on 11 September 2014, with due notice provided to the DAWE and the Regulator.

This document is an annual compliance report demonstrating that the controlled actions have been carried out within the 13 conditions attached to EPBC 2013/6965 and that progress has been made against the delivery of SEB-offsets required by EPBC 2013/6965. This report has been published as close as possible to 'within '*3-months of every 12-month anniversary of the commencement of the action*', as required by the approval granted on 6 May 2014.

[1] Formerly Department of Premier & Cabinet SA (DPC) and prior to that Department of State Development (DSD)
[2] Now the Department of Agriculture, Water and the Environment (DAWE)

3 Conditions associated with Controlled Action EPBC 2013/6965

The following table lists the conditions applied to Controlled Action EPBC 2013/6965 and Hillgrove's compliance with each condition. Details associated with Hillgrove's actions relating to each condition during the period from 11 September 2020 to 10 September 2021 are presented in section 3 (below).

Condition No.	Conditions applied to the approval of EPBC 2013/6965	Compliance with condition (✓ or X)
1	The person undertaking the action must not clear more than 1.8ha of the ecological community *Peppermint Box Grassy Woodland* of South Australia within ML 6345	✓ (See 3.1, below)
2	The person undertaking the action must not clear more than 3.4 ha of the ecological community *Iron-grass Natural Temperate Grassland of South Australia* within ML 6345	✓ (See 3.2, below)
3	The person taking the action must prepare and submit a Kanmantoo Copper Mine Native Vegetation Management Plan (NVMP) for the Minister's written approval prior to commencing the action. The NVMP must include the following;	✓
3a	Management actions are undertaken to improve the ecological quality of Peppermint Box and Iron-grass communities within ML6345 and offset lands and protect (them) from degradation for the duration of the action	✓
3b	Regeneration and revegetation strategies implemented for Peppermint Box and Iron-grass communities within the proposed SEB-Offset areas to improve the ecological quality of these areas	✓
3c	An ecological monitoring program is undertaken to monitor success of management actions within the NVMP and define measurable targets of management actions, performance indicators and adaptive management framework for the duration of the action's impact	✓
4	To compensate for the loss of 1.8ha of *Peppermint Box* and 3.4ha of *Iron-grass* communities, the person taking the action must secure the lands identified as the SEB-Offset Areas… as a conservation offset	✓
5	The person taking the action must provide written evidence to the Department of their compliance with Condition 4… to clearly define the location and boundaries of the offset sites prior to the commencement of the action	✓
6	Within 30-days after the commencement of the action, the person taking the action must advise the Department in writing of the actual date of commencement	✓
7	The person taking the action must maintain accurate records substantiating all activities associated with or relevant to these conditions of approval… and make them available upon request to the Department	✓ Agreed/ Ongoing record keeping is undertaken
8	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	**X** 2020/21 report publication delayed by 1 week

9	Upon direction of the Minister, the person taking the action must ensure that an independent audit of compliance is conducted and a report submitted to the Minister	✓ Agreed. No audit yet requested
10	If the person undertaking the action wishes to carry out any activity otherwise than in accordance with the NVMP 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 the NVMP	✓ Agreed.
11	If the Minister believes that it is necessary or convenient for the better protection of listed threatened species and ecological communities to do so, the Minister may request that the person taking the action make specified revisions to the NVMP and submit the revised NVMP for the Minister's written approval	✓ Agreed. No request received as of 11Sep21
12	If at any time after 5-years from the date of this approval, the person taking the action has not substantially commenced the action, then the person taking the action must not substantially commence the action without the written agreement of the Minister	✓ Agreed. The action was commenced on 11 September 2014
13	Unless otherwise agreed to in writing by the Minister, the person taking the action must publish the NVMP referred to in these conditions of approval on their website. The NVMP must be published on the website within 1-month of being approved. The NVMP must remain on their website for the life of the action.	✓ Published on Hillgrove's web page

4 Details of compliance with EPBC 2013/6965 conditions

Details of Hillgrove's compliance with each condition associated with EPBC 2013/6965 is summarised in the following sections.

4.1 Peppermint Box clearance areas

In accordance with the approved NVMP, no more than 1.8ha of Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia has been cleared within ML 6345 since the commencement date of 11 September. Figure 1 below shows the approved clearance limit and Figure 2 shows precise areas of Peppermint Box Grassy Woodland and Iron grass Natural Temperate Grassland of South Australia cleared within ML 6345 after 11 September 2014.

4.2 Iron-grass clearance areas

In accordance with the approved NVMP, no more than 3.4ha of 8:1 Iron grass Natural Temperate Grassland of South Australia and 1.01ha of 6:1 and 4:1 Iron grass Natural Temperate Grassland of South Australia has been cleared within ML 6345 since the commencement date of 11 September 2014.

Figure 1: PEPR-Approved clearance limit

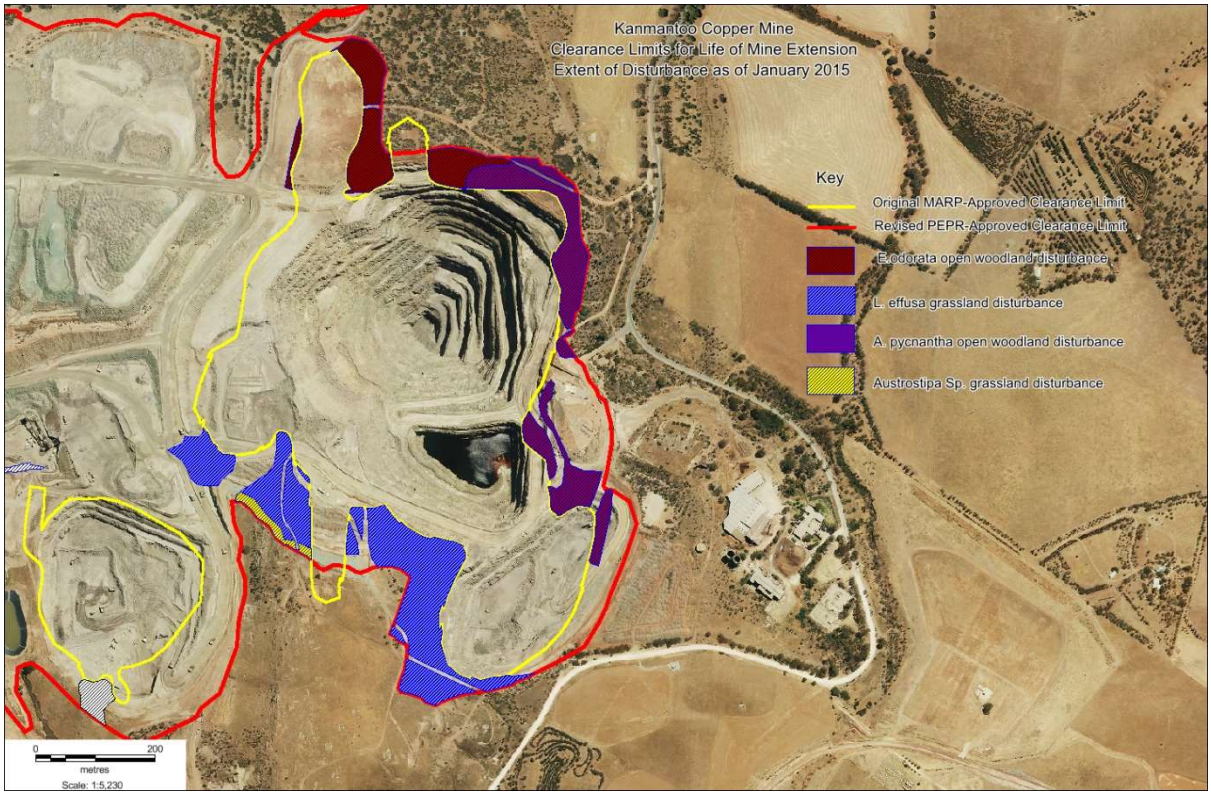


Figure 2: Disturbance of vegetation communities as current date

4.3 Native Vegetation Management Plan Submission

A Native Vegetation Management Plan (NVMP) was written to address the disturbance of vegetation communities and provision of SEB-Offsets associated with the controlled actions approved by EPBC 2013/6965. Hillgrove's NVMP for controlled action EPBC 2013/6965 was approved on 6 of May 2014. It specifically addresses the following approval conditions:

> 3a. Management actions designed to improve the ecological quality of Peppermint Box grassy woodland and Iron-grass natural temperate grassland and offset lands for the duration of the action
>
> 3b. Regeneration and revegetation strategies for Peppermint Box woodland and Iron-grass natural temperate grassland within the proposed 'SEB-Offset areas' to improve the ecological quality of these areas
>
> 3c. An ecological monitoring program to monitor the success of the management actions in the NVMP and define measurable targets of management actions, performance indicators and an adaptive management framework for the duration of the action's impact on Peppermint Box grassy woodland and Iron-grass natural temperate grassland

4.4 Security of SEB-Offset areas

SEB-offsets for the removal of vegetation under the controlled action are shown in Figure 3.

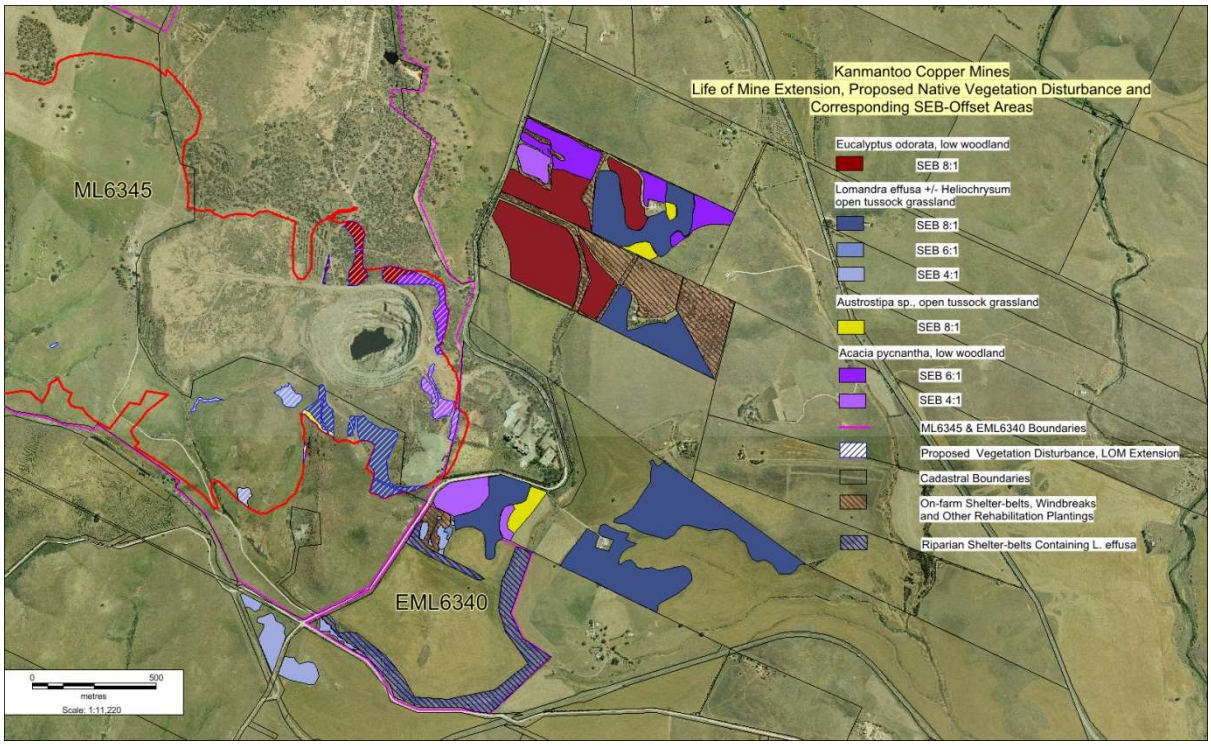


Figure 3: Approved disturbance areas and approved SEB-Offsets associated with action EPBC 2013/6965

All SEB-Offsets are located directly adjacent to the Kanmantoo Copper Mine on Hillgrove-owned properties. Hillgrove has quarantined the SEB-Offset areas from future development and has designated them as 'SEB-Offset blocks' to the exclusion of all other activities. Details of the land titles associated with each land parcel and the SEB-Offsets assigned to each patch are described below and in the NVMP on p30, 'Table 3', and in Figure 4, below.

Property Name	Parcel ID: Title ID (All Owned by Hillgrove)	Allocated Offset Patches (ref NVMP)	Offset Types
141 Mine Rd	F160800 A61: CT5548/435	38, 39, 40, 41, 42, 43, 44, 45, 46, 47	E. odorata (8:1), L. effusa (8:1), Austrostipa (8:1), A. pycnantha (6:1 & 4:1)
Mulawa	F1636 A1: CT5516/79	48, 49, 50	E. odorata (8:1), L. effusa (8:1)
Ferguson	D80644 A21: CT5863/768	51, 55	L. effusa (8:1)
Lot 25	D60948 A25: CT5892/419	52, 53, 54, 56, 57, 58, 62	L. effusa (8:1, 6:1 & 4:1), Austrostipa (8:1)
Back-Callington Rd/ Éclair Mine Rd (Carmen's East)	D4767 A4: CT5552/582 and D30934 Q1: CT5366/650	59, 60, 61	L. effusa (4:1)

Figure 4: Hillgrove-owned properties and their assigned SEB-Offsets

Hillgrove intends to establish the designated SEB-Offset areas as conservation areas protected under Heritage Agreements (or similar), as stated in the NVMP on p3, however this has not yet

occurred. Under a revised NVMP to be submitted for approval, Hillgrove may seek approval to move part of the SEB-offset establishment onto equivalent areas of farming land, remnant vegetation or other land owned by Hillgrove, or may seek approval for payment into a fund in lieu of offset establishment if or when such an instrument is developed as part of a review of the Act.

As of 11 of September 2014 conventional farming operations have been modified or progressively withdrawn from the SEB-Offset areas highlighted above. Note the Google Earth image in Figure 5 (below), dated November 2018, illustrating that SEB-Offset work has commenced on 141 Mine Rd and Mulawa, and the Google Earth image in Figure 6 (below) dated November 2018, illustrating that SEB-Offset works have commenced on the patches labelled Ferguson's/Lot 25 and Lot 25.

4.5 Written evidence of compliance: SEB-Offset area establishment

The Google Earth image in Figure 5, below, illustrates the completion of topsoil pre-stripping and direct seeding in the Mine Rd SEB-Offset areas designated in the NVMP as patches 38, 39, 40,41,48 and 49 on 141 Mine Rd and Mulawa. The combined areas within both blocks (including headlands and a rehabilitated gully erosion feature) total approximately 20.3ha.

Figure 5: SEB-Offset completion of sowing at 141 Mine Rd and Mulawa – November 2018 image

Note the red-brown strips within the yellow highlighted blocks in Figure 5, which demonstrate that topsoil has been pre-stripped and direct-seeded between the adjacent 2015 direct-seeded rows. An erosion gully, previously running through 141 Mine Rd was rehabilitated, formed into a broad gently sloping grassed waterway and direct seeded with native plant species as a component of the topsoil pre-stripping operation in April/May 2018.

Both 141 Mine Rd and Mulawa have been extensively maintained since 2015, with mowing, selective brushcutting, selective weed spraying, hand weeding, tube-stock planting and slashing for fire risk reduction being among the many activities undertaken.

The Google Earth image in Figure 6, also illustrates that SEB-Offset works have commenced on the patches labelled Ferguson's/Lot 25 and Lot 25. The total area of new SEB-offsets commenced on Ferguson's/ Lot 25 in 2018 was approximately 6.68ha or approximately half of the available area of 13.35ha. Section 4.7.2 provides photographs showing the progress of these areas.

All areas have been intensively managed and maintained during the 2020/2021 reporting period, however, further planting of the inter-row strips at Ferguson's, Lot 25 or in other new areas has not yet occurred due to commercial restrictions.

Details of work completed during this reporting period is summarised by the 2021 EBS Progress report (Appendix 1)

Figure 6 GE Image November 2018, SEB Offset Commencement on Ferguson's & Lot 25. Note the red/brown strips, which have been pre-stripped, ripped and direct seeded with native seed mixes.

4.6 Notification of commencement

As reported previously, notification of commencement of the action covered by EPBC 2013/6965 on 11 September 2014 was forwarded to Justin Williams by Catherine Davis on the 9 October 2014 as per the following email:

From: Catherine Davis [mailto:catherine.davis@hillgroveresources.com.au]
Sent: Thursday, 9 October 2014 6:41 PM
To: Williams, Justin
Subject: RE: EPBC 2013/6965 : final approval decision [SEC=UNCLASSIFIED]

Dear Justin,
In accordance with the conditions of referral EPBC 2013/6965

6. Within 30 days after the **commencement of the action**, the person taking the **action** must advise the **Department** in writing of the actual date of commencement.

We wish to notify the department of commencement of the action to clear Native Vegetation for the purpose of expansion of the mine pit occurred 11th September 2014.

Regards,

HILLGROVE RESOURCES

Catherine Davis | Environment Manager | Kanmantoo Copper Mine
Éclair Mine Road (cnr Back Callington Road), Kanmantoo SA 5252
W hillgroveresources.com.au | T 08 8538 6800 | F 08 8538 5255 | M 0408 396 964

Confirmation of notification receipt by Justin was forwarded to Catherine on the 10 October 2014 as per the following email:

From: Williams, Justin [mailto:Justin.Williams@environment.gov.au]
Sent: Friday, 10 October 2014 8:17 AM
To: Catherine Davis
Cc: Strike, Kelly
Subject: FW: EPBC 2013/6965 : final approval decision [SEC=UNCLASSIFIED]

Hi Catherine,

I have forwarded the information to the post approval officer responsible for your project.

Action Officer: Kelly Strike
AWD Section: Approval Monitoring South

Regards,

Justin Williams
Assessment Officer
South West Section
West Assessment Branch
Department of the Environment
GPO Box 787 Canberra, ACT 2601
Phone: 02 6275 9492
justin.williams@environment.gov.au
http://www.environment.gov.au/epbc/index.html

Australian Government
Department of the Environment

4.7 Record keeping: Implementation of the Offset and NVMP

Hillgrove maintains a range of records associated with delivery of the outcomes required by the NVMP and the conditions associated with EPBC 2013/6965. A range of preparatory activities and studies have been undertaken by Hillgrove as previously reported in the 2014/2015, 2015/2016 and 2016/2017, 2017/2018, 2018/2019 and 2019/2020 EPBC compliance reports. Details of activities undertaken, studies completed and records of progress under the NVMP are documented in this compliance report and the reports posted on Hillgrove's Web Page.

Documentary evidence of progress on actions specified by the NVMP for Year 1 to year 7 (11 September 2014 to 11 September 2021) is provided in the following sections.

4.7.1 Item 1: Removal of grazing/cropping pressure

A map highlighting land management limitations for the 2020/2021 reporting period was provided to share farmers in autumn 2021 (see Figure 7, below). Instructions to sharefarmers will be amended in future years as the area of cropping land used to progressively establish SEB-offsets is expanded.

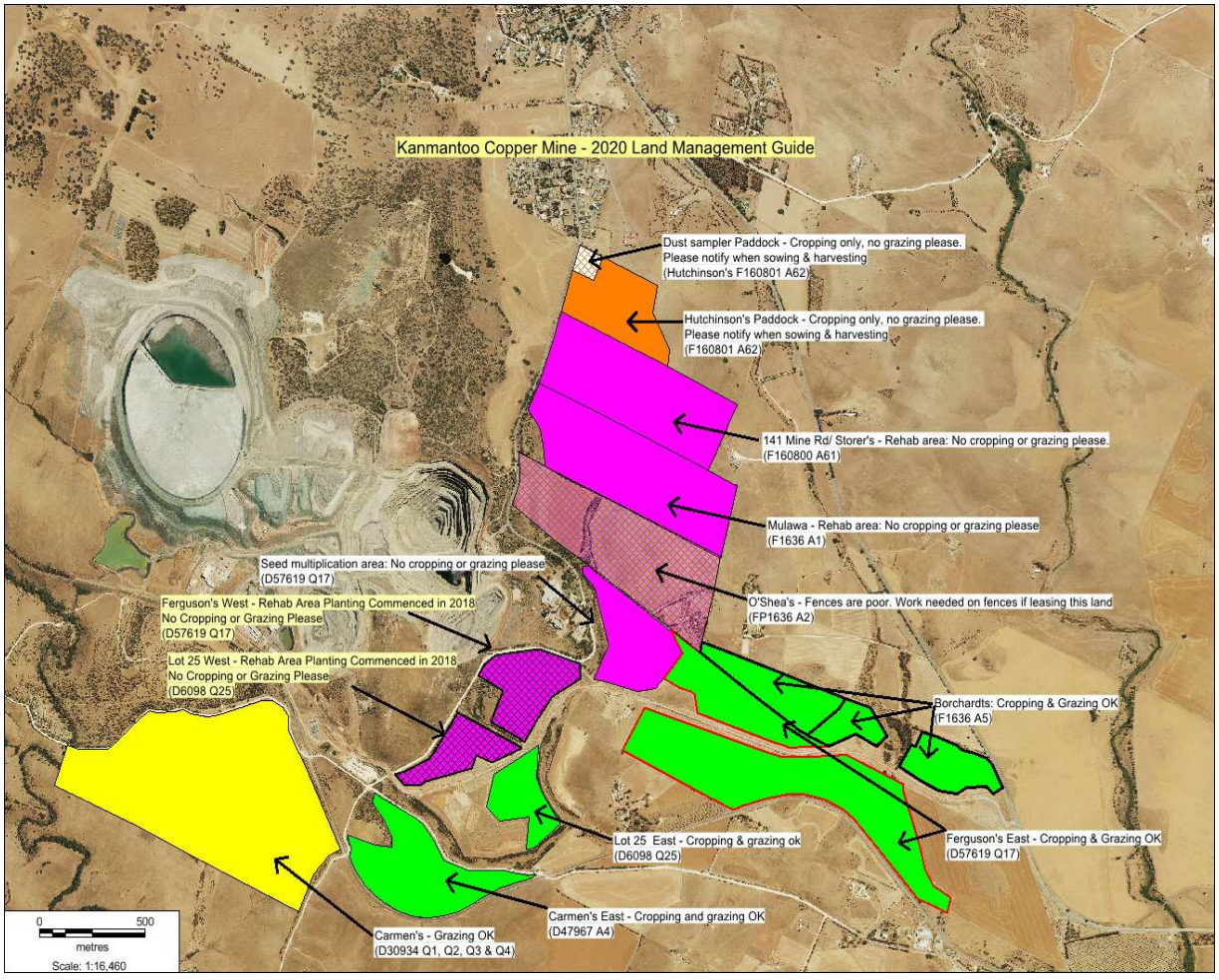


Figure 7: Hillgrove's Land management instructions to sharefarmer, autumn 2020.

4.7.2 Item 2: Schedule offset programs

A program of progressive SEB-Offset commencements associated with initial ML conditions and EPBC 2013/6965, coincides with the scheduled completion of mine landforms in accordance with the Mine Plan and the projected availability of local-provenance native seed for hydroseeding and direct seeding.

The following map illustrates the projected total area of mine landform rehabilitation and SEB-offsets. These areas are collectively associated with initial ML approval and the NVMP approved by EPBC 2013/6965.

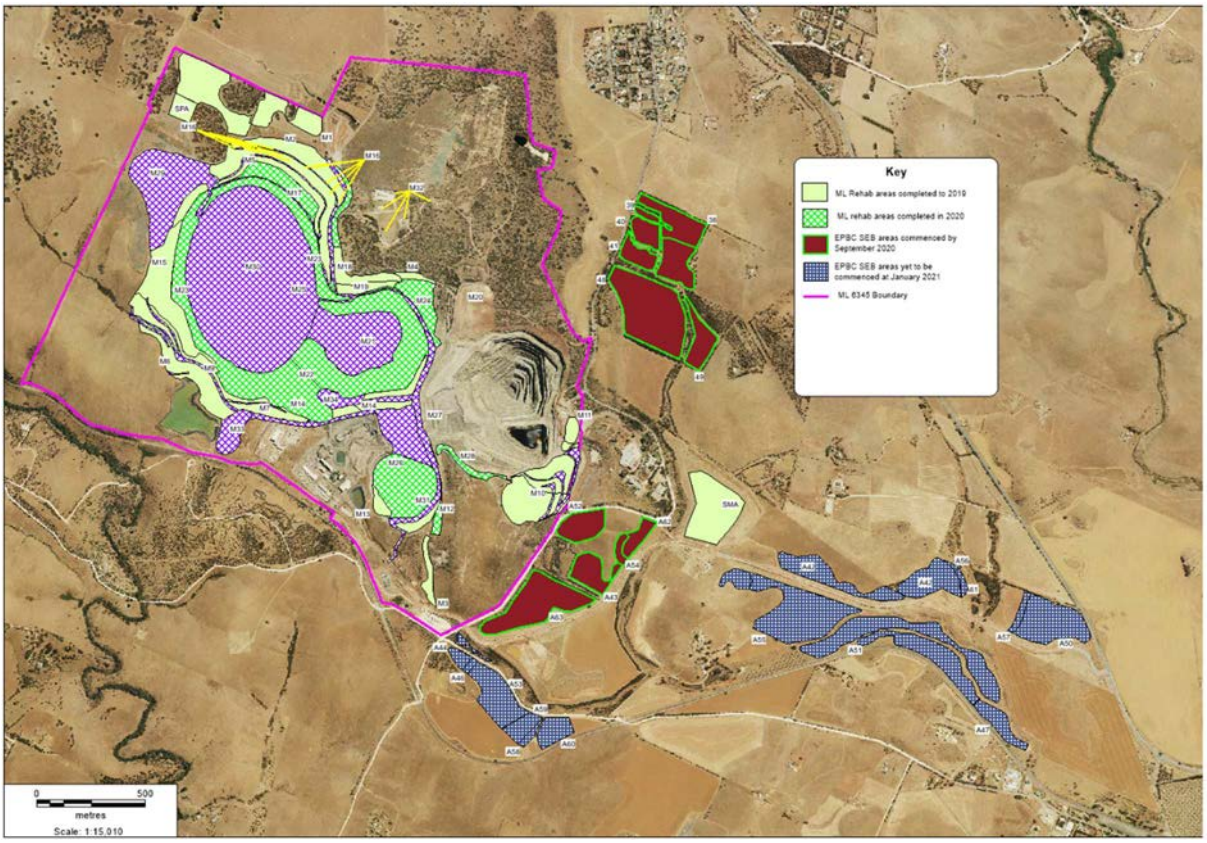


Figure 8: Projected cumulative area of Mine rehabilitation and SEB-Offset program

Figure 10 (below) illustrates the areas within the ML and outside the ML where rehabilitation and delivery of SEB-offsets have commenced.

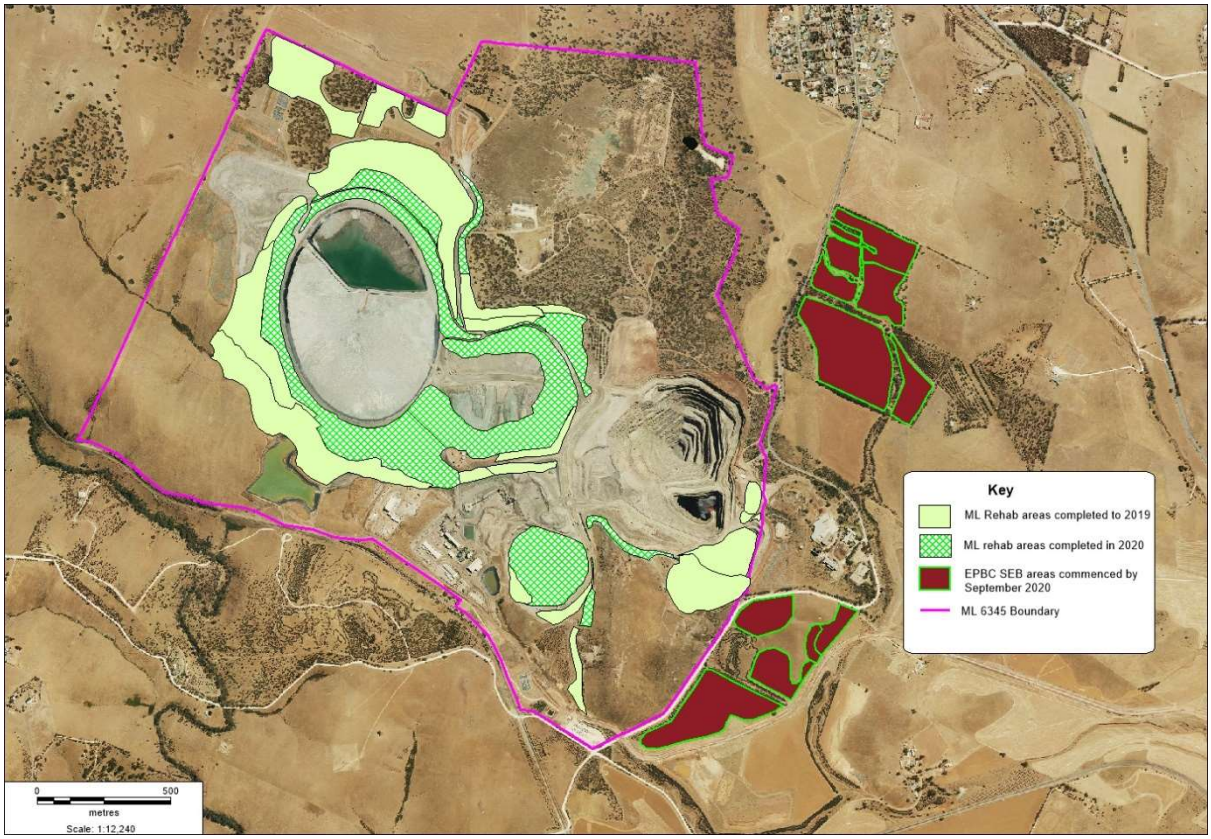


Figure 10: Mine rehabilitation and SEB-Offset program: Summary of Areas Commenced by September 2021

Summary of Progress on delivery of SEB Offsets approved by ***EPBC* 2013/6965**

With the Mine currently in 'care and maintenance' and assessing the potential to develop an underground operation, no additional EPBC SEB-offset planting programs occurred during the reporting period. Progress during this reporting period involved the consolidation of vegetation establishment in the areas of 141 Mine Rd, Mulawa, Ferguson's/Lot 25 & Lot 25. Approximately 27ha of EPBC SEB-offsets have now been commenced under EPBC 2013/6965.

Intensive weed control and land management programs continued for all EPBC SEB-offsets commenced to date. This acted to reduce weed competition and weed seed-set through precision-brushcutting, spot-spraying, hand weeding and selective boom spraying. Careful mowing and selective boom-spraying of the strips sown in 2018 also reduced weed seed set and competition by remnant grassy weeds. Tractor-slashing and selective spraying of the direct-seeded headlands and the rehabilitated erosion channel in the Mine Rd blocks also reduced weed competition and assisted native grass establishment.

Progress towards ensuring seed reserve capacity for future SEB-offset establishment programs continued during this reporting period. Spring/summer 2020-2021 provided significant quantities mixed Rytidosperma and Austrostipa seed from maturing native grass swards at Mine Rd, in addition to seed harvested from the SPA and SMA. Significant quantities of mixed grass seed were also harvested during this reporting period from the areas sown on Ferguson's/ Lot 25. Seed from these areas was collected using hand-propelled 'grass grabbers' and a large ATV-mounted grass grabber. Seed from diverse range of local species was also collected by the wild-seed collection program from the ML and near-mine region.

The following table illustrates work conducted within all aspects of the SEB-offset program by EBS-Restoration staff during the 2020/2021 reporting period. Approximately 1,658 hours or 207 person-days of input was required to execute the 2020/2021 SEB-offset program (note table in Figure 11, below).

Kanmantoo Copper Mine
EBS DAY Sheet Records: 01Sep20 to 31Aug21
SEB-Offset Establishment and Maintenance Activities

	Month & Year x Hours Per Task													
Task and Location	**Sep-20**	**Oct-20**	**Nov-20**	**Dec-20**	**Jan-21**	**Feb-21**	**Mar-21**	**Apr-21**	**May-21**	**Jun-21**	**Jul-21**	**Aug-21**	**Total Hours x Task**	**% Effort x Task**
Brushcut , spot spray, hand weed SMA Vittadinia plot	2	4	2	4	2		4			2			20	1.2%
Brushcut exotic grasses and broadleaf weeds, 141 Mine Rd/Mulawa				20									20	1.2%
Brushcut exotic grasses etc prior to harvest, Mulawa/ 141 Mine Rd, Ferg's/Lot 25		32											32	1.9%
Brushcut exotic grasses within seeded strips Mulawa/ 141 Mine Rd, Ferg's/Lot 25	48												48	2.9%
Brushcut, spot spray SMA Themeda plot	2	4						8					14	0.8%
Brushcut, spot spray, maintenance Lomandra rehab areas				16	12		8		16	24	24	24	124	7.5%
Equipment maintenance & set up			2										2	0.1%
Hand pull, chainsaw, cut/swab feral trees Mulawa/ 141 Mine Rd								24	2	16		2	44	2.7%
Infrastructure maintenance, brushcut, spray, tidy, repair etc.	8		40			1	4		14	8		8	83	5.0%
Rabbit control; fumigate and collapse warrens					8	8				2		2	20	1.2%
Seed cleaning, processing & packaging					88	6	44	12		16			166	10.0%
Seed collection/ Seed harvest			56	28	8	22	16						130	7.8%
SPA Maintenance, hand weed, brushcut & spot spray	32		18	4		12						8	74	4.5%
Spot spray, brushcut SMA plots							12			6		6	24	1.4%
Spot spray, brushcut, hand weed Lot 25/ Ferguson's seeded strips							16		8	32	8	8	72	4.3%
Spot spray, brushcut, hand weed McFarlane Hill												8	8	0.5%
Spot spray, brushcut, hand weed, general maintenance 141 Mine Rd/ Mulawa					8	24	8	36	56	14	48	38	232	14.0%
Tractor slash Access Rd edges and fencelines		16											16	1.0%
Tractor slash Lomandra rehab area					4	7							11	0.7%
Tractor slash Mulawa/ 141 Mine Rd, Lot 25/Ferg's	16		8	20	8							24	76	4.6%
Tractor slash plots, edges & fencelines	26												26	1.6%
Tractor slash SMA plots	8		14		8							16	46	2.8%
Tractor slash SMA, plot edges, Chloris plots, hillsides, tracks, fencelines		8		4									12	0.7%
Tractor slash unseeded midrows and verges Lot 25/Ferg's	16												16	1.0%
Tractor slash, fire risk reduction	8	8	28										44	2.7%
Tractor slash, infrastructure maintenance		16	8	4	8	8							44	2.7%
Tractor spray Lomandra rehab area							8			8			16	1.0%
Tractor spray or spotspray broadleaf weeds and exotic grasses, Mulawa/141 Mine Rd	2	16	16		28	24	32	16					134	8.1%
Tractor spraying general			2		6								8	0.5%
Tractor spraying SMA, Lot 25, Ferguson's						32	16	16	8	16		8	96	5.8%
Total Hours x Month	168	104	194	100	188	144	168	112	104	144	80	152	1658	100.0%
% Effort x Month	10.1%	6.3%	11.7%	6.0%	11.3%	8.7%	10.1%	6.8%	6.3%	8.7%	4.8%	9.2%	100.0%	

Figure 11: Table summarising the 2020/2021 SEB-offset work program by EBS

Detail of progress by EBS during this reporting period is summarised by the EBS annual Report. Please see Appendix 1.

Pictorial record of SEB-Offset establishment on assigned SEB-Offset areas

The following photographs document the progress of SEB-offset establishment on the Mine Rd offset areas since commencement in 2015 and document the development of new SEB-offset areas at Ferguson's and Lot 25 commenced in 2018.

SEB-Offset establishment on assigned SEB-Offset areas: 141 Mine Rd

Figure 12: 141 Mine Rd, SW Corner; April 2015, following crop residue removal by grazing and prior to preparation for direct seeding

Figure 12A: 141 Mine Rd, SW Corner; November 2018

Figure 12B: 141 Mine Rd, SW Corner; November 2019.

Figure 12C: 141 Mine Rd, SW Corner; November 2020

Figure 12D: 141 Mine Rd, SW Corner; December 2021

Mine RD Blocks, (Continued): – 'Mulawa' NE Corner of the 'main block'

Figure 13: 'Mulawa', April 2015. Photograph was taken following removal of cropping residues by grazing and prior to preparation for direct seeding.

Figure 13A: 'Mulawa' NW Corner, November 2018. Photograph was taken following 3-years of managing the initial rows, which were topsoil pre-stripped and direct seeded in 2015 and completion of the remaining topsoil pre-stripping and direct-seeding rows in May 2018.

Figure 13B: 'Mulawa' NW Corner, May 2020.

Figure 13C: ‘Mulawa’ NW Corner, November 2020

Figure 13D: ‘Mulawa’ NW Corner, December 2021

Mine RD Blocks, (Continued): – ‘Mulawa’ SW Corner of the ‘main block’

Figure14: Mulawa SW Corner, main paddock: October 2016, growth of direct seeded strips.

Figure 14A: Mulawa SW Corner, Main Paddock, November 2018

Figure 14B: Mulawa SW Corner, Main Paddock, May 2020

Figure 14C: Mulawa SW Corner, Main Paddock, November 2020

Figure 14D: Mulawa SW Corner, Main Paddock, December 2021

Mine RD Blocks, (Continued): – '141 Mine Rd' Central

Figure 15: 141 Mine Rd Central; Native grass establishment, November 2015

Figure 15A: 141 Mine Rd Central; Canopy and mid-story establishment, November 2018

Figure 15B: 141 Mine Rd Central, May 2020

Figure 15C: 141 Mine Rd Central, November 2020

Figure 15D: 141 Mine Rd Central, December 2021

Mine Rd Blocks, (Continued): – ‘Mulawa’ NW Corner of the ‘main block’

Figure 16: Mulawa, NW Corner; November 2015, Grass establishment following direct seeding

Figure 16A: Mulawa, NW Corner; November 2018, note growth of canopy and mid-story species and completion of topsoil pre-stripping and direct seeding on adjacent rows.

Figure 16B: Mulawa :175 Mine Rd – Spring 2019

Figure 16C: Mulawa: 175 Mine Rd – November 2020

Figure 16D: Mulawa: 175 Mine Rd – December 2021

Commencement of new SEB-offset provision at Ferguson's and Lot 25 during April 2018

Figure 17: Ferguson's, lower block looking SW – November 2018

Figure 17A: Ferguson's, lower block looking SW – May 2020

Figure 17B: Ferguson's, lower block looking SW – November 2020

Figure 17C: Ferguson's, lower block looking SW – December 2021

Figure 18: Ferguson's, upper block looking NE – November 2018

Figure 18A: Ferguson's upper block looking NE – May 2020. Note establishment of native grass and broad-leaved species in the foreground

Figure 18B: Ferguson's upper block looking NE – November 2020.

Figure 18C: Ferguson's upper block looking NE – December 2021.

Figure 19: Ferguson's/Lot 25 - November 2018 (note green seedlings indicating strong native grass establishment in the foreground)

Figure 19A: Ferguson's/Lot 25 in spring 2019 – Note strong native grass establishment

Figure 19B: Ferguson's/Lot 25, May 2020

Figure 19C: Ferguson's/Lot 25, November 2020

Figure 19D: Ferguson's/Lot 25, December 2021

Figure 20: Lot 25 – November 2018

Figure 20A: Lot 25, highlighting native grass sward establishment – spring 2019

Figure 20B: Lot 25, – November 2020

Figure 20C: Lot 25, – December 2021

4.7.3 Item 3: Survey of revegetation plots

As reported previously, landscape function analysis surveys and fauna surveys were conducted on the SEB-Offset patches after commencement of the action covered by EPBC 2013/6965. See previous compliance reports and Appendix 3 for details.

2020/2021 Reporting Period

Fauna Survey

EBS conducted a fauna survey of the ML and Mine Rd SEB-offset areas during late September 2020. The 2020 fauna survey Executive Summary is as follows…

EXECUTIVE SUMMARY

EBS Ecology (EBS) has been engaged by Hillgrove Resources since 2011 to conduct an annual fauna monitoring program over the Kanmantoo Copper (Kanmantoo Mine) Mining Lease (ML). The fauna monitoring program was undertaken in accordance with the conditions and outcomes required in the Program for Environment Protection and Rehabilitation (PEPR) for Kanmantoo Mine. As such, there must be no net adverse impacts on native fauna abundance or diversity in the ML and in adjacent areas.

The fauna monitoring program aimed to determine whether Kanmantoo Mine had met its conditions and outcomes detailed in the PEPR by:

- Conducting roaming transect surveys to record the abundance and diversity of birds;
- Performing targeted spotlighting surveys to record the abundance of the Common Brushtail Possum (*Trichosurus vulpecula*) as well as other nocturnal fauna; and
- Opportunistically recording all other fauna species encountered within the Project area.

The 2020 bird surveys recorded a total of 1035 birds from 58 species over the Project area. This included five State threatened species. In 2020, species richness was the second highest on record at Kanmantoo Mine. The total abundance of birds was slightly higher than that recorded in 2019. Over the lifetime of the fauna monitoring program, the abundance and species richness of birds has shown annual fluctuations, which may be driven by factors such as rainfall, availability of food resources and the presence (or absence) of nomadic and flocking species.

Thirty (30) Common Brushtail Possums were observed within the ML during the 2020 spotlight survey, while no individuals were observed in the Significant Environmental Benefit (SEB) area. To date there have been no observations of Common Brushtail Possums within the SEB area due to an absence of suitable habitat. Over the lifetime of the fauna monitoring program the number of Common Brushtail Possums has remained relatively stable, despite annual fluctuations.

The results from the 2020 fauna monitoring program confirm that there is no significant change in native fauna abundance or diversity within the ML and in adjacent areas. Hence, Hillgrove Resources has satisfied condition (13) and outcome (21) required within the PEPR relating to the conservation of fauna.

EBS recommends the following measures to improve the ongoing management and monitoring of fauna within the Kanmantoo Mine Project area:

- Continue the fauna monitoring program at the same time each year (early spring);
- Reduce spotlighting effort to biennial surveys within the SEB areas due to the low likelihood of Common Brushtail Possums using these areas within the life of mine; and
- Conduct a control program to reduce the numbers of Western Grey Kangaroos (*Macropus fuliginosus*), European Rabbits (*Oryctolagus cuniculus*) and European Brown Hares (*Lepus europaeus*) within the Project area to reduce impacts on remnant and planted native vegetation.

LFA Survey

EBS conducted a landscape function analysis (LFA) survey of the ML and Mine Rd SEB-offset areas during spring 2020. Please see Appendix 3 for details. Results from the 2020 LFA survey suggest that high-quality vegetation swards are progressively being established at the Mine Rd SEB-offset area. LFA parameters for the new vegetation areas continue to be on a trajectory towards the development of vegetation and landscape function attributes which are comparable with analogue sites. The structural diversity of these sites is expected to develop in time, as vegetation matures and succession in mid-story and canopy species delivers fallen timber and other associated niches to the landscape. The following Executive Summary from the 2020 LFA report summarises the results obtained;

EXECUTIVE SUMMARY

A long-term Landscape Function Analysis (LFA) monitoring program is in place to measure the ongoing environmental management, restoration and Significant Environmental Benefit (SEB) offset program components of the Kanmantoo Copper Mine operations in South Australia.

The vegetation monitoring program is now in its ninth year, commencing in 2011 but excluding 2016 when the site was not monitored. Two nationally threatened ecological communities occur within the Project Area: *Eucalyptus odorata* (Peppermint Box) Open Woodland and *Lomandra effusa* (Scented Mat-rush) +/- *Lomandra multiflora* subsp. *dura* (Stiff Mat-rush) Open Tussock Grassland, which are both listed as critically endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Permanent LFA monitoring sites, established in these communities at the beginning of the monitoring program (2011-2013) are used as baselines to guide restoration targets for rehabilitation and SEB areas.

This report provides LFA monitoring results for the 2020 monitoring program and compares these results with those from previous years and with the reference (analogue) sites. The 2020 monitoring included an assessment of 25 existing sites, of which four are analogue sites and 21 are sites to monitor rehabilitation success.

Across the Project Area the restoration sites exist in various states of rehabilitation. However, most rehabilitation sites are indicating successful germination and survival with positive trends toward analogue landscape function indices and restoration goals. In general, the LFA indicators have shown positive rehabilitation trends over the life of the Kanmantoo monitoring program (2011-2020). Rehabilitation plots have typically reached a level of 'self-sustaining communities', relative to analogue sites, after a period of only 3-4 years. Based on the initial success rates of restoration activities across the Kanmantoo Mine Area, it is likely that ongoing works will result in functional trends similar to those observed using LFA to date. This includes initial low values, followed by a rebound period whereby plant cover produces high stability, infiltration and nutrient cycling values before stabilising towards analogue values.

Ecological vegetation attributes such as plant species richness (and whether species are native or exotic) are currently not recorded as part of the LFA monitoring method, limiting the ability of the current program to determine species abundance and diversity or the success of species of interest used in revegetation and seeding mixes. Species composition and germination success should be considered as part of ongoing monitoring to provide information on how species respond to restoration methods, thus informing future rehabilitation activities.

The ongoing monitoring design should continue to adapt to maximise the efficiency and effectiveness of detecting changes in LFA monitoring sites to inform and improve restoration outcomes. Ongoing annual review and adaptation of the monitoring program is recommended, altering factors such as frequency of assessment, indicators measured and sampling locations.

4.7.4 Item 4: Install rabbit-proof fencing

2020/ 2021 Reporting Period

No rabbit proof fencing was installed during this reporting period. Maintenance of existing fences during this reporting period involved minor repairs identified during fence inspections. The removal of livestock from 141 Mine Rd/ Mulawa, Ferguson's/Lot25 and surrounding Hillgrove-owned properties, continues to reduce fence damage and incursion by livestock. Fence damage this season was due to ageing infrastructure, limbs falling from trees during storm events and kangaroos moving to and from the Mine Rd SEB-offset areas.

4.7.5 Item 5: Source equipment and engage contractors

EBS Restoration is the principal contractor responsible for SEB-Offset establishment, weed control and feral animal control on designated SEB areas as outlined in the NVMP. EBS-Ecology is the principal contractor responsible for fauna & flora surveying.

Hunter Brothers Earthmovers were initially engaged as the contractors responsible for 'topsoil pre-stripping' and land preparation process during the initial 2015 program at Mine Rd, and Eichler Earthmovers undertook the works conducted in 2018. Both contractors demonstrated that they had access to the equipment and expertise necessary to effectively carry out topsoil pre-stripping, land ripping, erosion gully rehabilitation and topsoil stockpile construction. All contractors have proven continuing competence within Hillgrove's programs on the ML and SEB-offset areas adjacent to the ML (in particular, EBS Restoration).

4.7.6 Item 6: Weed and feral animal control

Considerable weed control work was completed in the SEB-offsets during this reporting period. Activities including brushcutting, mowing, spot-spraying and selective boom-spraying, are summarised in Figure 11 (above), which highlights overall monthly EBS labour inputs by task for this reporting period.

Rabbit control was carried out during this reporting period at several sites associated with offset plantings.

Kangaroo numbers have steadily increased in recent years, both within the ML and in the surrounding region. Kangaroo populations will be monitored and a culling program may be instigated if they adversely impact the establishment of SEB-offset areas.

An integrated feral animal control program will resume on-site during the 2021/2022 reporting period if warranted.

4.7.7 Item 7: Investigative Studies

Several investigative studies were conducted in preparation for the establishment of SEB-Offset plantings on the designated offset patches. These studies have been discussed in detail in previous compliance reports. Please refer to previous EPBC Compliance Reports for details

No new investigative studies were commenced during this reporting period. Further investigative studies will be scheduled in future reporting periods as required.

4.7.8 Item 8: Enhancement of Native Vegetation Remnants

Vegetation condition assessment suggests there is potential to improve the overall quality of remnant vegetation areas within the ML and on adjacent Hillgrove-owned properties.

Vegetation enhancement works during this reporting period have continued to improve vegetation condition in a section of McFarlane Hill within the ML and in two additional areas outside the ML, either side of the intersection between Mine Rd and Back-Callington Rd, labelled as 'Carmen's East' and 'Lot 25', below. The green highlighted areas (below) will be adjacent to SEB-offsets and will provide linkages to SEB-offsets when they are established.

Figure 21: Vegetation Enhancement commenced during the 2017/ 2018 reporting period

The green highlighted areas contain Iron-grass Natural Temperate Grasslands with moderate species diversity totalling 8.29ha. These areas are degraded by a significant cover of Scabiosa atropurpurea (pincushion daisy), in association with a range of other broad-leaved and grassy weeds. Vegetation enhancement work included tractor-slashing and precision brushcutting to knock down the Scabiosa plants, followed by several rounds of selective spot-spraying to kill the plant crowns and seedlings (see Figure 22, below). Other broad-leaved weeds, including bridal creeper, thistles and cotton bush were targeted during spot-spraying.

Figure 22: Brushcutting *Scabiosa* to improve vegetation condition – Carmen's East

4.7.9 Item 9: Adjustment of boundaries and resurvey

On-ground surveys did not indicate that either the SEB-Offset patch boundaries or the initially mapped property boundaries required adjustment during this reporting period.

4.7.10 Item 10: Build-up seed reserves/ order seeds

Hillgrove has invested considerable effort into the development of seed production, seed collection, broad-acre seed multiplication and seed storage capacity. These programs involve collecting, multiplying and nurturing local-provenance genetic material. Within seed multiplication areas, particular care is taken to support the growth of parent plants with minimal inputs to prevent possible epigenetic creep that could be fostered if seed are allowed to be grown under 'soft' conditions, for example, through fertilising or over-irrigation to drive seed production volume at the expense of seed quality. Hillgrove has not purchased additional seed from external sources to date, with all direct seeded patches being established using locally collected or locally grown seed.

The EBS annual progress report summarises seed production and processing activities during the current reporting period as follows:

1.1 Seed collection, cleaning and management of seed

Throughout the 2020-21 financial year period EBS Restoration undertook the management, collection and storage of native seed collected for Hillgrove Resources. The scope of seed collection was reduced significantly during this period, focusing mainly on native grasses and supplementary understorey species. These were collected between November 2020 and March 2021. The reason for the reduction in native seed collection was due to no scheduled hydroseeding occurring during 2021 and sufficient supplies of seed currently in storage.

As with previous years native grass collection was undertaken using Grass Grabbers both hand and mounted on an ATV. The pre-stripped SEB areas sown in 2018 (Mulawa/141 Mine road, Lot 25 and Fergusons patches) provided the majority of grass seed collected. Approximately 567 kilograms of grass seed (primarily *Austrostipa sp*. and *Rytidospema sp*) were harvested from these areas, underscoring the value of the overall seeding program in terms of providing a valuable seed resource. An additional three kilograms of understorey species were collected from the Seed Production Area (SPA) and the surrounding mine lease and woodlands. Refer Table 1 for 2020-2021 seed collection tally.

Hillgrove Resources commissioned EBS Restoration to investigate options for on selling some of the native grass seed in storage. Native grass seed has a limited shelf life with reduced viability over time. EBS Restoration managed to on sell 204.5kg collected in 2018 and 180.5kg collected in 2019, total of 385kg providing an additional income stream for Hillgrove Resources.

Drying of collected seed was once again carried out in the EBS warehouse, with smaller amounts of seed being dried on site in the shed at Fergusons house, and the relocated container which was previously located at the SPA.

Seed is stored in the EBS warehouse, and the inventory is regularly updated to ensure older collections are used first for seeding programs. Regular turnover of seed stock is easily achieved through these processes.

Refer Appendix 1 for September 2021 Seed Inventory

Hillgrove sold approximately 385kg of surplus native seed during this reporting period to provide storage space for the next seed harvest and to ensure the ongoing viability of seed stocks on-hand.

Details of seed reserves are contained in the EBS annual report, please see Appendix 1

4.7.11 Item 11: Land preparation

During the 2017/2018 reporting period, Eichler Earthmovers provided earthmoving services for SEB-offset establishment. They replaced the Cat 623 Scraper used by Hunter Brothers in 2015, with a land plane towed by a Case IH STX380 tractor to lift topsoil and remove it from the planting bays (see Figure 24, below). While this was an effective equipment combination, higher than expected weed germination in the pre-stripped areas the 2018/2019 reporting period was observed. This was addressed through a combination of mowing to reduce grassy weed seed-set and selective herbicide spraying to remove broadleaved weeds. Ongoing monitoring of weed emergence during autumn 2021 has indicated that weed control and management efforts have effectively suppressed weed emergence, indicating that the land plane is suitable for continued use in future years.

Figure 23: Picking up windrowed topsoil with a Case IH/ Land Plane combination – 141 Mine Rd.

3.7.12 Item 12: Planting programs

As mentioned in previous compliance reports, approximately 10.15ha of topsoil pre-stripping and direct seeding was completed on the remainder of the Mulawa/ 141 Mine Rd blocks during April 2018 and 6.7ha of new SEB-offset area was also commenced on Ferguson's and Lot 25. Collectively, this brings the total area of SEB-offsets 'commenced' to approximately 27ha by the end of this reporting period.

Further expansion of SEB-offset plantings did not proceed during this reporting period. Commercial constraints in previous years have caused the proposed planting program to deviate from that originally associated with the NVMP for EPBC 2013/6965. A proposal to vary the NVMP will be submitted for consideration once the future of the mine is better understood.

3.7.13 Item 13: Assess results and adjust methods

Initial results from topsoil pre-strip trials for SEB-Offset establishment within the NW corner of the ML, Smelter Rd and Mine Rd have proven very promising with strong stands of native vegetation established during the first 7-years of growth. Figures 24 to 24D (below), illustrates the sequence of native vegetation establishment on the 'Smelter Rd' SEB-Offset trail area within the ML.

Preliminary observations from the nearby Mine Rd SEB-Offset patches planted in 2015 indicate they are trending towards the promising result observed on the Smelter Rd trial area. Ongoing observations indicate that an adjustment to planting methodology is not warranted at this stage, though low species diversity emerging from the 2018 plantings will need to be monitored.

Figure 24: Rehabilitation of Smelter Rd April 2012. Smelter Rd provides an analogue site for the Mine Rd plantings. It provides a benchmark to track the development of direct-seeded areas.

Figure 24A: Establishment of native vegetation in the third year following topsoil pre-strip (Smelter Rd, Kanmantoo Copper Mine), October 2015. Note *A. pycnantha* beginning to emerge above grasses.

Figure 24B: Smelter Rd rehabilitation, Year 4 – October 2016, *A. pycnantha* and *Atriplex* spp. emerging from a well-established *Rytidosperma* (Wallaby Grass)/ *Stipa* sward. This patch will mature to form a grassy-woodland vegetation association dominated by an *A. pycnantha*, *E. odorata* and *A. verticillata* overstorey.

Figure 24C: Smelter Rd rehabilitation, Year 5 – July 2017, *A. pycnantha*, *A. verticillata* and *Atriplex* spp. emerging from a maturing *Rytidosperma* (Wallaby Grass)/ *Austrostipa* sward. This patch is developing into an *A. pycnantha* open woodland community.

Figure 24D: Smelter Rd rehabilitation, Year 6 – December 2018, *A. pycnantha*, *A. verticillata* and *Atriplex* spp. emerging from a maturing *Rytidosperma* (Wallaby Grass)/ *Austrostipa* sward. This photograph was taken 5-months later than the photograph in 2017 and in a very dry season, so the density of herbaceous species appears to have reduced due to reduced winter growth and grazing by kangaroos this season. The mid-story and canopy species continue to mature and this area is progressing well towards forming an *A. pycnantha* open woodland community.

Figure 24E: Smelter Rd rehabilitation, Year 8 – November 2020. Weed growth is expanding following the dry season in 2018. Additional weed management input will be required.

4.7.14 Item 14: Replanting program

Initial direct seeding results have been promising and establishment within the new Mine Rd, Ferguson's and Lot 25 plots was assessed during late spring 2021. While strong native grass establishment and good weed management is evident in the 2018 plantings at this stage there is low species diversity. This will continue to be monitored and appropriate actions implemented in the future if required.

4.7.15 Item 15: Establish heritage (or other) agreement

All areas allocated for SEB-Offset establishment are on Hillgrove-owned land. Both Hillgrove's CEO and Environment Manager have undertaken to allow the establishment of Heritage Agreements (or similar instruments) over the SEB-Offset patches, with the Heritage Agreements (or similar) to be lodged against the Land Titles for each property in the future.

Though Heritage Agreements (or similar) are not currently established for the Mine Rd or the Ferguson's/ Lot 25 patches, it is Hillgrove's intention to proceed with establishment at some point in the future

4.7.16 Item 16: Inspect and maintain fences

The removal of livestock from the Mine Rd patches and adjacent Hillgrove-owned land has significantly reduced livestock pressure on the ageing fences surrounding 141 Mine Rd, Mulawa, Ferguson's and Lot 25. Fence inspections were carried out during autumn/ winter 2019. Most fence repairs were related to damage caused by falling trees during winter and kangaroo movement between properties.

4.8 EPBC Act - Compliance Report for EPBC 2013/6965

This report is intended to satisfy Hillgrove's obligation to prove compliance with the conditions associated with EPBC 2013/6965. It is considered that this adequately addresses the NVMP and progress is being made.

This report and previous compliance reports for Controlled Action EPBC 2013/6965 can be found via the link:

http://www.hillgroveresources.com.au/environment

Navigate down the page to 'Environmental Protection and Biodiversity Conservation Act (EPBC)', 'Compliance Reports:', and select the report you wish to download. The following reports are available on the Hillgrove web page;

- ***2015 EPBC Act Compliance Report***
- ***2016 EPBC Act Compliance Report***
- ***2017 EPBC Act Compliance Report***
- ***2018 EPBC Act Compliance Report***
- ***2019 EPBC Act Compliance Report***
- ***2020 EPBC Act Compliance Report***
- ***2021 EPBC Act Compliance Report***

4.9 Participation in audit (if required)

Hillgrove will actively assist with an audit of compliance with EPBC 2013/6965 if requested to do so.

Hillgrove participated in a site inspection by the ADE and DEM (DSD) staff on 18 May 2017. A report of this inspection was returned to Hillgrove on 29 August 2017. A copy of the inspection report can be accessed via Hillgrove's web page via the link:

http://www.hillgroveresources.com.au/environment

Navigate down the page to 'Environmental Protection and Biodiversity Conservation Act (EPBC)', 'Supporting Documents:', and select:

'Mining Inspection Report Kanmantoo Copper Mine May 2017'

Hillgrove received no further requests for audits or inspections from Regulators during the 2020/2021 reporting period.

4.10 Approval for non-approved activities

Non-approved activities have not been undertaken during this reporting period.

4.11 Revision of NVMP (if required by the Minister)

Mine activities have proceeded in accordance with approvals. A formal request for revision of the NVMP has not been received from The Minister at the time of writing this report.

The 'topsoil pre-strip method' of SEB-offset establishment has proven to be successful. A revision of the land areas currently allocated for SEB-offset establishment may be requested in an amended NVMP to provide land suitable to host the topsoil pre-strip method of SEB-offset establishment. This would see a 1 for 1 exchange of Hillgrove-owned land currently under cropping, for the areas currently allocated to SEB-offsets under this approval. This would result in no change to the total area of each category of SEB-offset delivered under the approval granted in EPBC 2013/6965, but it would significantly improve the likelihood of achieving a high-quality outcome for the SEB-offset program overall. If these changes are approved, Hillgrove would seek to operate under a revised NVMP for EPBC 2013/6965..

4.12 5-year sunset date for commencement

Work commenced according to approvals on the 11 September 2014. Subsequently, the 5-year sunset date for commencement will not apply to this approval.

4.13 Publication of Native Vegetation Management Plan

NVMPs are published on the Hillgrove web page. They can be accessed via the following link:

http://www.hillgroveresources.com.au/environment

Navigate down the page to 'Environmental Protection and Biodiversity Conservation Act (EPBC)', 'Supporting Documents:', and select:

NVMP LOM Extension

Or

NVMP Addenda Giant Cutback

5 Conclusions

Hillgrove Resources continue to actively work towards complying with the approval granted by EPBC 2013/6965.

Vegetation disturbance associated with EPBC 2013/6965 was commenced on 11 September 2014 and continued to the approved limit of disturbance during the initial reporting period (11 September 2014 to 11 September 2015). Vegetation disturbance has not extended beyond the limit described by the approved NVMP.

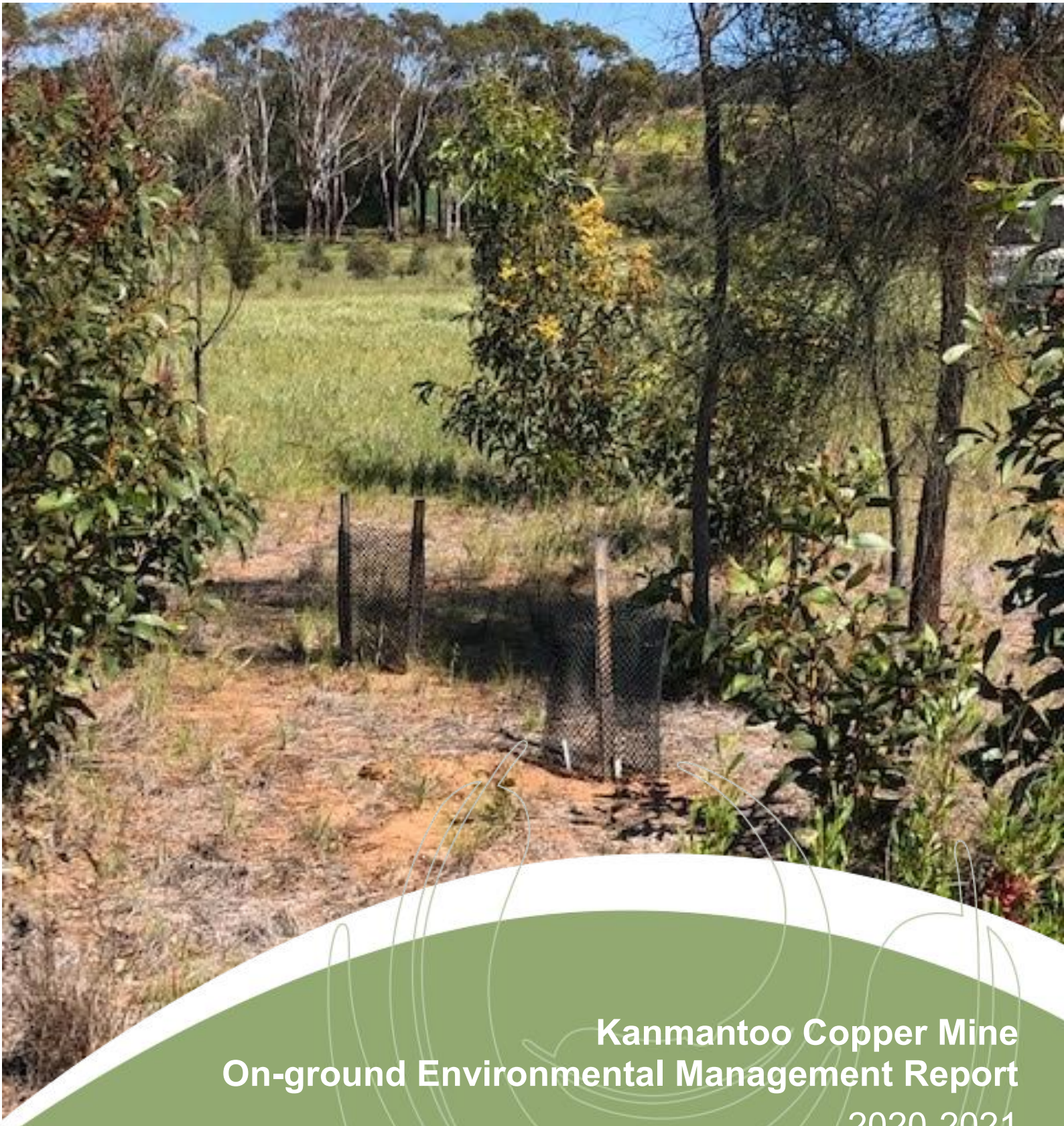
Hillgrove have addressed all of the elements outlined by the Controlled Action. Progress has been made on the establishment of SEB-Offset areas, with approximately 27ha of plantings commenced by the end of the 2020/2021 reporting period. Difficult operating conditions towards the end of mine life deferred further establishment of new offset areas and this may require a revised NVMP once an understanding of the future of the mine is gained.

Seed production programs and wild-seed seed collection programs are continuing. Adequate seed supplies were available for the future SEB-offset plantings and the Mine landform rehabilitation hydroseeding program.

Observations continue to suggest that the topsoil pre-strip technique is well suited to the conversion of farming land to native vegetation with manageable follow-on weed competition. Management programs during 2020/2021 further consolidated the initial plantings and provided an excellent basis for the resumption of topsoil pre-strip and direct seeding in future years. While strong native grass swards have established from the 2018 plantings, species diversity in these areas will need to be monitored.

Hillgrove will continue to work actively towards establishment of assigned SEB-Offsets.

ebs restoration



Kanmantoo Copper Mine
On-ground Environmental Management Report
2020-2021

Kanmantoo Copper Mine
On-ground Environmental Management Report
2020-2021 final

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Prepared by EBS Restoration for Hillgrove Resources

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Front cover photo: *SEB Pre-stripped Revegetation Mine Road*

EXECUTIVE SUMMARY

On behalf of Hillgrove Resources, EBS Restoration has undertaken the majority of rehabilitation activities at the Kanmantoo Mine since 2011. A range of environmental programs have been carried out within the Mine lease and associated properties with the aim of assisting Hillgrove Resources to meet their obligations under the relevant mining act.

Key outcomes from the 2020-2021 (01 Sep 2020 to 31 Aug 2021) reporting period include:

- Annual seed collection program continued into the 2020-2021 period, with approximately 570 kilograms of seed collected, including 567 kilograms of grass seed.
- Provision of seed management services, including sourcing buyers for excess grass seed, storage and handling of collected seed.
- Ongoing management of all areas of existing vegetation, hand seeded and hydroseeded locations through weed control activities such as spraying, tractor slashing and brushcutting and woody weed control where appropriate.
- Maintenance of the Seed Production Area (SPA) at a reduced capacity (caretaker mode) to ensure a continued source of material for future works programs. Tasks include infrastructure maintenance, weeding and slashing.
- Maintenance and enhancement of the Seed Multiplication Area (SMA). Activities undertaken include broad acre slashing, spraying and targeted weed control.
- Fire and risk reduction activities including firebreak boundary slashing, pedestrian access works and infrastructure maintenance.
- Pest control activities including rabbit control, and exclusion of grazing risks to vegetation through fence repairs.

To date, approximately 140 hectares of hydroseeding, hand seeding and pre-strip method seeding have been carried out on areas within the Mine lease and adjacent properties (including re-treatment of recalcitrant areas). These areas are continually maintained where necessary to the point where some locations are already self- sustaining communities of native habitat. The majority of these locations were previously degraded farmland or waste landforms. With proper management these locations will remain a valuable asset to Hillgrove Resources and the local community.

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1 INTRODUCTION

In accordance with requirements under the *Mining Act 1971* a PEPR (Program for Environmental Protection and Rehabilitation) this report outlines on-ground environmental management actions undertaken September 2020 – September 2021. This report has been prepared for the Kanmantoo Copper Mine and Hillgrove Resources.

On-ground environmental action undertaken during the reporting period by EBS Restoration (September 2020 - September 2021) include:

- Provision of project management services
- Seed collection, cleaning, storage, inventory and brokerage
- Ongoing maintenance within rehabilitation locations including: direct seeded pre-strips, hand direct seeding, hydroseeding and existing vegetation
- Management of the Seed Production Area (SPA)
- Management of the Seed Multiplication Area (SMA)
- Ongoing management of declared weeds within the mine lease and associated properties
- General maintenance activities as instructed by Hillgrove resources, including infrastructure maintenance
- Tractor slashing and brushcutting to reduce fire and hazard risk along boundaries and fence lines
- Invasive pest control

1.1 Seed collection, cleaning and management of seed

Throughout the 2020-21 financial year period EBS Restoration undertook the management, collection and storage of native seed collected for Hillgrove Resources. The scope of seed collection was reduced significantly during this period, focusing mainly on native grasses and supplementary understorey species. These were collected between November 2020 and March 2021. The reason for the reduction in native seed collection was due to no scheduled hydroseeding occurring during 2021 and sufficient supplies of seed currently in storage.

As with previous years native grass collection was undertaken using Grass Grabbers both hand and mounted on an ATV. The pre-stripped SEB areas sown in 2018 (Mulawa/141 Mine road, Lot 25 and Fergusons patches) provided the majority of grass seed collected. Approximately 567 kilograms of grass seed (primarily *Austrostipa sp*. and *Rytidospema sp*) were harvested from these areas, underscoring the value of the overall seeding program in terms of providing a valuable seed resource. An additional three kilograms of understorey species were collected from the Seed Production Area (SPA) and the surrounding mine lease and woodlands. Refer Table 1 for 2020-2021 seed collection tally.

Hillgrove Resources commissioned EBS Restoration to investigate options for on selling some of the native grass seed in storage. Native grass seed has a limited shelf life with reduced viability over time. EBS Restoration managed to on sell 204.5kg collected in 2018 and 180.5kg collected in 2019, total of 385kg providing an additional income stream for Hillgrove Resources.

Drying of collected seed was once again carried out in the EBS warehouse, with smaller amounts of seed being dried on site in the shed at Fergusons house, and the relocated container which was previously located at the SPA.

Seed is stored in the EBS warehouse, and the inventory is regularly updated to ensure older collections are used first for seeding programs. Regular turnover of seed stock is easily achieved through these processes.

Refer Appendix 1 for September 2021 Seed Inventory

Table 1. 2020-2021 seed collection tally

Species	Batch number	Collection location	Collection date	Amount March 2021
Austrostipa / Rytidosperma mix	EBSKAN270	Kanmantoo mine site and surrounds	Nov-20	567.000
Cullen australasicum	EBSKAN271	Kanmantoo mine site and surrounds	Nov-20	0.355
Chrysocephalum semipapposum	EBSKAN272	SPA	Nov-20	0.860
Chrysocephalum apiculatum	EBSKAN273	SPA	Nov-20	0.955
Maireana brevifolia	EBSKAN274	Kanmantoo mine site and surrounds	Mar-21	0.840
Maireana rohrlachii	EBSKAN275	SPA	Feb-21	0.031
Kennedia prostrata	EBSKAN276	SPA	Nov-20	0.230
Gonocarpus tetragynus	EBSKAN277	SPA	Nov-20	0.092
Podolepis rugata	EBSKAN278	SPA	Nov-20	0.430
		Total		**570.793**

Figure 1 *Rytidosperma* grass mix collection with Grass grabber

Figure 2 Bales of *Rytidosperma* and *Austrostipa* grass mixes post collection, ready for drying

Figure 3. *Rytidosperma* grass mixes drying in warehouse

Figure 4 *Chrysocephalum semipapposum* , being collected from SPA.

1.2 2020 Revegetation

No further revegetation activities were undertaken during the 2020-2021 reporting period. Ongoing careful hand weeding and spot spraying were carried out around all existing plantings to reduce competition and increase the chances of successful establishment. Ongoing weed control will be performed as necessary to ensure survival of planted species.

Refer Figures 5, 6 and 7 for Diuris photos and previous planting locations.

Figure 5 Diuris sp flowering showing benefits of hand weeding A

Figure 6 Diuris sp flowering showing benefits of hand weeding B

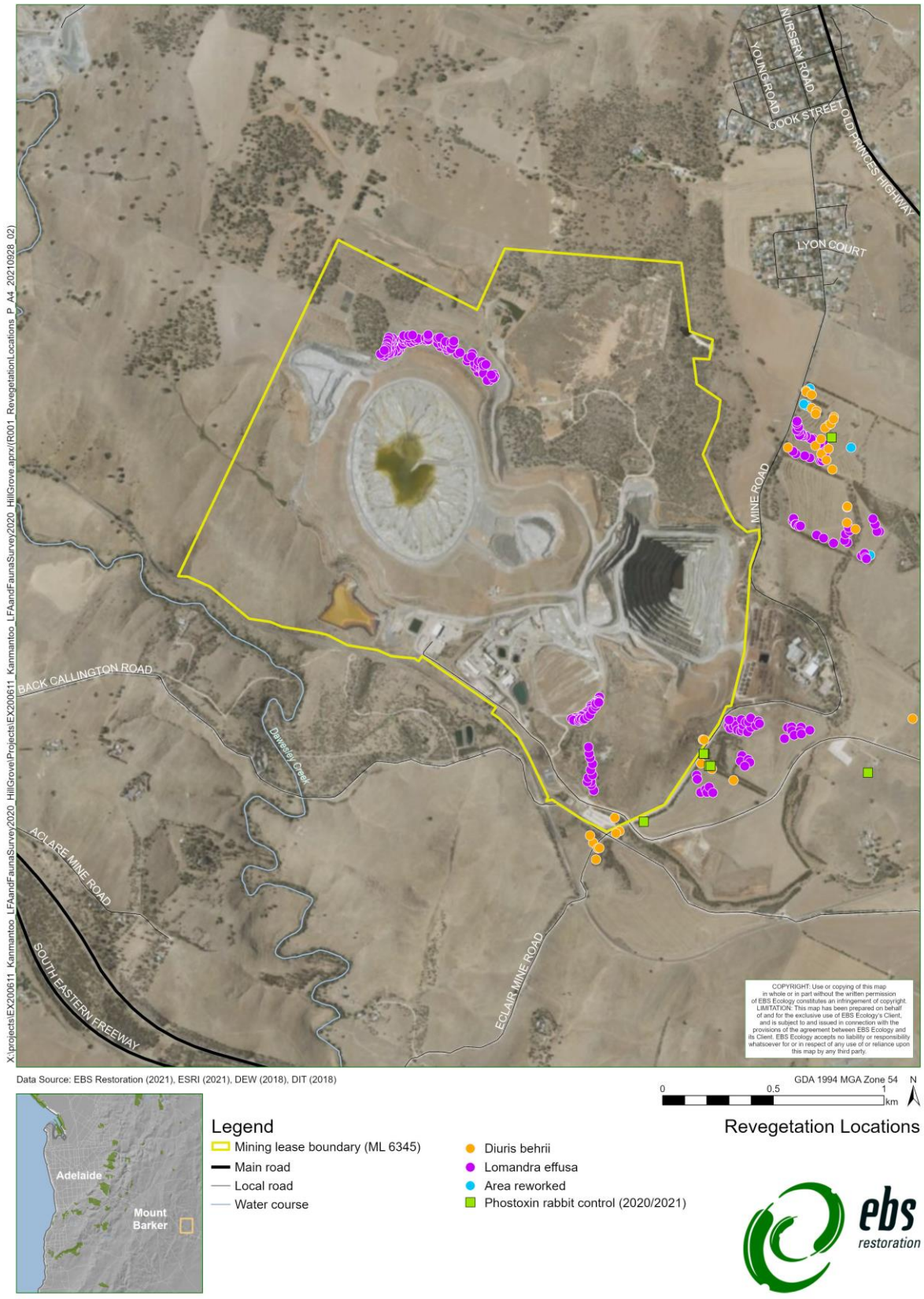

Figure 7 Revegetation locations 2019 and 2020 and Rabbit control 2020-21

1.3 Management of Seed Production Area (SPA)

Due to a reduction in the revegetation program the SPA has been put into caretaker mode with minimal works having been carried out during the reporting period. These works have been carried out with the purpose of maintaining its functionality. In the event of it being needed as a valuable seed resource in the future minor works would be needed to see it return to full capacity.

2020-2021 reporting period tasks included:

- Minor repairs to subsurface irrigation
- Patching repairs to ground weed matting
- Removal of dead and damaged plant material
- Hand weeding, brushcutting and spot spraying to control weeds
- Tractor slashing of broadacre grasses

Figure 8 SPA plantings with irrigation running

1.4 Management of Seed Multiplication Area (SMA)

Works carried out within the SMA during 2020-2021were targeted towards weed control within the existing grass plots.

Although the SMA was once the primary source for native grass seed for the revegetation program, recent years have seen a marked decline in the output of these plots. This is likely due to a combination of factors such as soil depletion, ground compaction and adverse seasonal conditions. The SMA is now managed as a potential SEB offset area as well as a backup seed resource.

As with previous years the grasses at the SMA have been left to discharge their seed naturally in the anticipation of greater recruitment and enhancement of native species.

Regular weed control has been carried out within the grass plots and surrounding verges, including spot spraying, brushcutting, as well as tractor slashing and boom spraying. These works will give any grass seeds a greater chance at establishing among the bare areas between existing plants, without competition from introduced species. This work is also carried out as fuel load reduction.

Figure 9 Tractor slashing of the boundary of the SMA to reduce exotic grass spread and fire reduction

1.5 Direct Seeded Pre-stripped areas

A program of direct seeding has been carried out since 2014 within the Mine lease and associated offset properties. Since this time approximately thirty-four hectares of degraded farm land has been rehabilitated with the aim of establishing a diverse habitat of native vegetation. Although no further seeding works were carried out during the 2020-2021 period, continued maintenance works have been undertaken to enhance and protect the existing areas.

The seeding works are carried out utilising heavy earthmoving equipment to remove the top 100mm of topsoil, which greatly reduces the amount of weed seed and phosphates from the area to be seeded.
The exposed soil is then ripped and cultivated in preparation for hand broadcast of a diverse mix of native species. Overall, this method has proven extremely effective to date, with recruitment of plants from sown seed observed in the majority of the seeded areas.

This method has also proven to be valuable for supplying an easily accessible seed source, especially for native grasses (refer section 1.6. for weed control techniques and activities)

Table 2 Kanmantoo Pre-stripped Seeding Program - dates and locations

Kanmantoo Pre-stripped Seeding Program		
Year	Location	Approximate area (hectares)
2014	North West corner of Mine lease	4
2014	Smelter Road	0.9
2015	North West corner of Mine lease	4
2015	Mine Road / Mulawa	7
2018	Mine Road / Mulawa	8
2018	Mine Road / Mulawa edges (erosion gully and surrounds)	3.7
2018	Access road sites (lot 25 / Ferguson's)	6.6
Total		34.2

1.6 Maintenance and enhancement of existing vegetation and seeded areas.

Areas included within existing vegetation and seeded areas consist of any remnant vegetation or rehabilitation sites within the Mine lease and properties owned or leased by Hillgrove Resources.

These sites include native woodlands, pockets of remnant vegetation, pre-stripped, hand seeded and hydroseeded areas.

Existing vegetation maintenance

Ongoing maintenance and enhancement of existing vegetation has been carried out throughout the 2020-2021 period. Priority works have focused on broadleaf weeds due to the increased rainfall during winter 2021.

In June and July Bridal Creeper was prolific around the edges of Kavanagh woodlands and the North West woodlands. This species was spot sprayed using backpack spray packs with Glyphosate and penetrant herbicide mix. Other species targeted were Artichoke thistle, Salvation Jane and Horehound using the same technique.

Weed control was also carried out on the southern face of McFarlane hill, with species targeted including Artichoke thistle, Horehound (*Marrubium vulgare*) and Scabiosa (*Scabiosa atropurpurea*). McFarlane hill has responded well in previous years to targeted control of these weed species, with a good cover of native *Lomadra effusa* present in the area and also isolated individuals of the rare *Maireana rohrlachii*.

Figure 10 Bridal Creeper along boundary fence

Seeded areas maintenance

Pre-stripped areas

Pre- stripped/ direct seeded sites across the Mine lease and associated properties encompasses a total area of approximately 34 hectares. These locations are easily accessible, and a variety of maintenance activities are performed regularly to conserve and enhance these assets. Activities performed include:

- In previous year's broadacre spraying of selective herbicide was used to control broadleaf weeds within seeded strips. This approach is no longer applicable due to the germination of native species. The approach has now been tailored to more selective methods including, spot spraying, brushcutting and hand weeding detailed below.

- Broadacre spraying of all paths, topsoil stockpiles and bare areas within the boundaries of the seeded properties. This reduces the overall weed load on-site and lessens the likelihood of introduction of new weed species into rehabilitation areas.

- Woody weed control using cut and swab method on feral Eucalyptus species emerging in strips and Acacia iteaphylla within SEB areas.

- Tractor slashing of native grasses immediately post-harvest. Removal of the spent seed heads and top 50 percent of the grass enables the plant to develop a stronger root system, and the mulched material forms a ground layer of cover and nutrients for the topsoil.

- Continued target spraying and selective brushcutting of introduced species throughout all seeded strips. Broadleaf weeds such as Salvation Jane (*Echium plantagineum*) and Capeweed (*Arctotheca calendula*) are sprayed before they reach maturity. Gazania has been recorded for the first time within these areas and has been treated. Spraying is carried out with a combination of backpack units and long line spraying based off a vehicle mounted unit. Selective brushcutting is also carried out on introduced grasses such as Wild oat (*Avena fatua*) prior to seed setting. Follow up spraying is often not necessary on annual species such as these, with the waste material once again adding organic matter to the soil.

Figure 11 Gazania within Pre-stripped areas

Figure 12 Cut and swab of feral Eucalyptus sp.

Hydroseeded and Hand Seeded areas

Maintenance of hydroseeding areas consisted primarily of targeted spraying of Artichoke Thistle using backpack spray unit. This was undertaken prior to flowering to reduce the spread of seed through the area. Locations treated included the North TSF slopes and the South side of McFarlane hill.

The three main hand seeded locations consist of the SAMR (adjacent to Gate 2), Smelter road and the Emily rehab surface. Targeted spraying has occurred in two of these locations throughout 2020-2021, with SAMR area being immediately adjacent the exploration drilling therefor deemed inaccessible. Brushcutting was undertaken on the Smelter road site to reduce exotic grasses and Cape Weed. Broadleaf weeds targeted include Scabiosa, Salvation Jane, Horehound, Bridal Creeper and Cape Weed.

1.7 Hydroseeding

No hydroseeding was undertaken during the 2020-2021 reporting period.

1.8 Fire reduction programs

Annual hazard reduction works were undertaken during October and November of 2020. As with the previous year, the early start to the fire season necessitated an earlier than usual program, consisting primarily of tractor slashing and brushcutting.

Although the bulk of work consisted of cutting firebreaks along boundaries and fence lines, pedestrian areas and active work areas such as infrastructure were also cleared to reduce the risk of snake activity and trip hazards in these areas.

Follow up weed spraying of a complete knockdown herbicide was also carried out where possible to reduce the regrowth of vegetation.

EBS Restoration has invested in suitable equipment for hazard and fire reduction tasks, including a tractor and heavy-duty slashing deck with demountable fire-fighting unit to ensure these activities can be undertaken safely and efficiently.

1.9 Pest management

Control of introduced rabbits (*Orycotolagus cuniculus*) was undertaken during autumn and winter of 2021. Warren fumigation and destruction occurring in several locations across properties outside of the mine lease. Several of these locations have previously been treated with Rabbits returning. Locations treated have been mapped with GPS, Refer Figure 7 and will be once again monitored for activity.

Treatment consists of locating and sealing all escape holes within the warren system, and delivery of Aluminium phosphide into the remaining warren entrance, which is then sealed, Refer Figure 14. This process is undertaken within all relevant safety and pest management licensing requirements.

Kangaroo (*Macropus fuliginosus*) grazing of seeded areas is ongoing throughout many of the rehabilitation areas. Along with destruction of juvenile native seedlings, weed seeds can also be dispersed between areas through faeces.

Minor repairs to boundary fences have been carried out throughout 2020-2021, with the purpose of reducing grazing pressure in seeded and revegetated areas and to prevent unauthorised access of vehicles Refer Figure 14. Unauthorised access had been occurring from the Princess Highway to the access road. Large rocks, tree stumps and star pickets have been placed over the track to discourage entry Refer Figure 16.

Figure 13 Active Rabbit warren complex, North end of Lot 25 where Rabbits have returned

Figure 14 Fumigation of active warren complex, Adjacent Lot 25

Figure 15 Boundary fence repairs to Lot 25

Figure 16 Unauthorised access track being blocked off

APPENDIX

Appendix 1 Seed inventory - September 2021

Species	Batch number	Collection location	Collection date	Amount Sept 2021
Acacia pycnantha	EBSKAN20	Kanmantoo mine site	Dec-11	25.710
Eucalyptus camaldulensis	EBSKAN25	Kanmantoo mine site	2011	0.965
Arthropodium sp.	EBSKAN50	Kanmantoo mine site and surrounds	Dec-12	0.105
Cymbopogon ambiguus	EBSKAN92	SPA	Dec-13	11.000
Acacia argyrophylla	EBSKAN93	Kanmantoo mine site and surrounds	Dec-13	11.920
Eucalyptus phenax	EBSKAN95	Kanmantoo mine site	Feb-14	0.108
Enteropogon acicularis	EBSKAN99	SPA	Dec-13	1.400
Cassinia arcuata	EBSKAN108	Kanmantoo mine site and surrounds	2014	1.400
Callitris canescens	EBSKAN111	Kanmantoo mine site and surrounds	2014	0.080
Goodenia pinnatifida	EBSKAN115	SPA	Dec-14	0.050
Cymbopogon ambiguus	EBSKAN117	SPA	Dec-14	7.500
Helichrysum leucopsideum	EBSKAN128	SPA and surrounds	Dec-14	0.010
Senecio quadridentatus	EBSKAN142	SPA	Feb-15	0.082
Enneapogon nigricans	EBSKAN143	SPA	Feb-15	0.600
Bothriochloa macra	EBSKAN145	SPA	Feb-15	4.000

Species	Batch number	Collection location	Collection date	Amount Sept 2021
Convolvulus erubescens	EBSKAN148	SPA		1.800
Olearia pimeleoides	EBSKAN149	Kanmantoo mine site	Oct-15	0.011
Olearia pannosa	EBSKAN150	Surrounds	Oct-15	0.005
Santalum acuminatum	EBSKAN151	Surrounds	Oct-15	0.013
Eucalyptus calycogona	EBSKAN154	Kanmantoo mine site	Jan-16	0.071
Eucalyptus odorata	EBSKAN155	Kanmantoo mine site	Dec-15	0.757
Vittadinia blackii	EBSKAN157	SMA	Oct-15	1.800
Chrysocephalum semipapposum	EBSKAN158	SPA	Nov-15	0.040
Helichrysum leucopsideum	EBSKAN160	SPA	Nov-15	0.037
Podolepis rugata	EBSKAN161	SPA	Dec-15	0.223
Bothriochloa macra	EBSKAN169	SPA	Nov-15	4.000
Enneapogon nigricans	EBSKAN171	SPA	Nov-15	1.000
Cymbopogon ambiguus	EBSKAN172	SPA	Nov-15	2.500
Enchylaena tomentosa	EBSKAN176	SPA	Feb-16	2.850
Kennedia prostrata	EBSKAN178	SPA	Dec-16	0.055
Enchylaena tomentosa	EBSKAN180	SPA	Apr-17	2.900
Eucalyptus odorata	EBSKAN184	Kanmantoo mine site and surrounds	Jan-17	0.033
Themeda triandra	EBSKAN189	SPA	Jan-17	1.500
Bursaria spinosa	EBSKAN196	Kanmantoo mine site and surrounds	Feb-16	0.038
Themeda triandra (includes stalks)	EBSKAN200	SPA / SMA	Dec-17	56.000
Chloris truncata	EBSKAN201	SMA	Jan-18	7.500
Aristida behriana	EBSKAN202	SMA	Dec-17	0.800

Species	Batch number	Collection location	Collection date	Amount Sept 2021
Austrostipa blackii	EBSKAN204	surrounding area	Nov-17	1.900
Vittadinia sp. Mix	EBSKAN205	surrounding area	Nov-17	0.260
Eucalyptus leucoxylon	EBSKAN207	surrounding area	Feb-18	0.033
Lomandra effusa	EBSKAN210	surrounding area	Nov-17	0.450
Helichrysum leucopsideum	EBSKAN211	surrounding area	Nov-17	0.031
Arthropodium sp.	EBSKAN213	surrounding area	Nov-17	0.013
Eucalyptus socialis	EBSKAN216	surrounding area	Feb-18	0.052
Eucalyptus calycogona	EBSKAN217	surrounding area	Feb-18	0.030
Acacia pycnantha	EBSKAN221	surrounding area	Dec-17	2.650
Bolboschoenus caldwellii	EBSKAN222	surrounding area	Nov-17	0.350
Lomandra effusa	EBSKAN223	surrounding area	Nov-17	0.400
Vittadinia sp. Mix	EBSKAN224	SMA	Feb-18	0.500
Austrostipa / Rytidosperma mix	EBSKAN225	Kanmantoo mine site and surrounds	Nov-18	0.000
Eucalyptus odorata	EBSKAN226	mine lease	Jan-19	1.578
Allocasuarina verticillata	EBSKAN227	Kanmantoo mine site and surrounds	Nov-18	3.785
Callitris gracillis	EBSKAN228	Kanmantoo mine site and surrounds	Jan-19	0.427
Callitris preissii	EBSKAN229	surrounding area	Jan-19	9.580
Convolvulus sp	EBSKAN230	SPA	Feb-19	0.654
Aristida behriana	EBSKAN232	SMA	Feb-19	1.000
Helichrysum leucopsideum	EBSKAN234	Kanmantoo mine site and surrounds	Nov-18	0.060
Ptilotus spathulatus	EBSKAN235	Kanmantoo mine site and surrounds	Nov-18	0.022
Lotus australis	EBSKAN236	Mine rd and SMA	Nov-18	0.013

Species	Batch number	Collection location	Collection date	Amount Sept 2021
Kennedia prostrata	EBSKAN237	SPA	Dec-18	0.220
Hardenbergia violacea	EBSKAN238	SPA	Dec-18	0.068
Podolepis rugata	EBSKAN239	Kanmantoo mine site and surrounds	Nov-18	0.080
Clematis microphylla	EBSKAN240	surrounding area	Dec-18	0.267
Chrysocephalum apiculatum	EBSKAN241	mine lease	Dec-18	0.165
Chloris truncata	EBSKAN244	SMA	Jan-19	1.700
Enneapogon nigricans	EBSKAN245	SMA	Jan-19	2.100
Enchylaena tomentosa	EBSKAN246	SPA	Feb-19	4.000
Maireana brevifolia	EBSKAN247	mine lease and surrounds	Feb-19	4.700
Atriplex semibaccata	EBSKAN248	SPA	Feb-19	1.250
Austrostipa / Rytidosperma mix	EBSKAN249	Kanmantoo mine site and surrounds	Nov-19	349.000
Chrysocephalum semipapposum	EBSKAN251	Kanmantoo mine site and surrounds	Nov-19	1.390
Chrysocephalum apiculatum	EBSKAN252	Kanmantoo mine site and surrounds	Nov-19	0.680
Helichrysum leucopsideum	EBSKAN253	Kanmantoo mine site and surrounds	Nov-19	1.980
Podolepis rugata	EBSKAN254	Kanmantoo mine site and surrounds	Dec-19	0.445
Olearia pannosa	EBSKAN255	Kanmantoo mine site and surrounds	Nov-19	0.390
Ptilotus spathulatus	EBSKAN256	Kanmantoo mine site and surrounds	Nov-19	0.120

Species	Batch number	Collection location	Collection date	Amount Sept 2021
Hardenbergia violacea	EBSKAN257	Kanmantoo mine site and surrounds	Dec-19	0.380
Allocasuarina verticillata	EBSKAN258	Kanmantoo mine site and surrounds	Nov-19	2.650
Acacia acinacea	EBSKAN259	Kanmantoo mine site and surrounds	Nov-19	0.625
Vittadinia sp. Mix	EBSKAN260	Kanmantoo mine site and surrounds	Nov-19	5.800
Maireana brevifolia	EBSKAN261	Kanmantoo mine site and surrounds	Mar-20	2.500
Atriplex semibaccata	EBSKAN262	SPA	Feb-20	6.200
Enchylaena tomentosa	EBSKAN263	SPA	Feb-20	3.000
Convolvulus sp.	EBSKAN264	SPA	Feb-20	0.400
Cullen australasicum	EBSKAN265	Kanmantoo mine site and surrounds	Jan-20	0.520
Dodonaea viscosa	EBSKAN266	Kanmantoo mine site and surrounds	Nov-19	0.150
Einadia nutans	EBSKAN267	SPA	Jan-20	0.021
Maireana rohrlachii	EBSKAN268	SPA	Dec-19	0.030
Gonocarpus tetragynus	EBSKAN269	SPA	Nov-19	0.035
Austrostipa / Rytidosperma mix	EBSKAN270	Kanmantoo mine site and surrounds	Nov-20	567.000
Cullen australasicum	EBSKAN271	Kanmantoo mine site and surrounds	Nov-20	0.355
Chrysocephalum semipapposum	EBSKAN272	SPA	Nov-20	0.860
Chrysocephalum apiculatum	EBSKAN273	SPA	Nov-20	0.955

Species	Batch number	Collection location	Collection date	Amount Sept 2021
Maireana brevifolia	EBSKAN274	Kanmantoo mine site and surrounds	Mar-21	0.840
Maireana rohrlachii	EBSKAN275	SPA	Feb-21	0.031
Kennedia prostrata	EBSKAN276	SPA	Nov-20	0.230
Gonocarpus tetragynus	EBSKAN277	SPA	Nov-20	0.092
Podolepis rugata	EBSKAN278	SPA	Nov-20	0.430
		Total (KG)		**1134.310**

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Kanmantoo

Fauna Survey 2020

Kanmantoo Fauna Survey 2020

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Cover photograph: Open Peppermint Box (*Eucalyptus odorata*) woodland at Kanmantoo Copper Mine in South Australia.

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EXECUTIVE SUMMARY

EBS Ecology (EBS) has been engaged by Hillgrove Resources since 2011 to conduct an annual fauna monitoring program over the Kanmantoo Copper (Kanmantoo Mine) Mining Lease (ML). The fauna monitoring program was undertaken in accordance with the conditions and outcomes required in the Program for Environment Protection and Rehabilitation (PEPR) for Kanmantoo Mine. As such, there must be no net adverse impacts on native fauna abundance or diversity in the ML and in adjacent areas.

The fauna monitoring program aimed to determine whether Kanmantoo Mine had met its conditions and outcomes detailed in the PEPR by:

- Conducting roaming transect surveys to record the abundance and diversity of birds;
- Performing targeted spotlighting surveys to record the abundance of the Common Brushtail Possum (*Trichosurus vulpecula*) as well as other nocturnal fauna; and
- Opportunistically recording all other fauna species encountered within the Project area.

The 2020 bird surveys recorded a total of 1035 birds from 58 species over the Project area. This included five State threatened species. In 2020, species richness was the second highest on record at Kanmantoo Mine. The total abundance of birds was slightly higher than that recorded in 2019. Over the lifetime of the fauna monitoring program, the abundance and species richness of birds has shown annual fluctuations, which may be driven by factors such as rainfall, availability of food resources and the presence (or absence) of nomadic and flocking species.

Thirty (30) Common Brushtail Possums were observed within the ML during the 2020 spotlight survey, while no individuals were observed in the Significant Environmental Benefit (SEB) area. To date there have been no observations of Common Brushtail Possums within the SEB area due to an absence of suitable habitat. Over the lifetime of the fauna monitoring program the number of Common Brushtail Possums has remained relatively stable, despite annual fluctuations.

The results from the 2020 fauna monitoring program confirm that there is no significant change in native fauna abundance or diversity within the ML and in adjacent areas. Hence, Hillgrove Resources has satisfied condition (13) and outcome (21) required within the PEPR relating to the conservation of fauna.

EBS recommends the following measures to improve the ongoing management and monitoring of fauna within the Kanmantoo Mine Project area:

- Continue the fauna monitoring program at the same time each year (early spring);
- Reduce spotlighting effort to biennial surveys within the SEB areas due to the low likelihood of Common Brushtail Possums using these areas within the life of mine; and
- Conduct a control program to reduce the numbers of Western Grey Kangaroos (*Macropus fuliginosus*), European Rabbits (*Oryctolagus cuniculus*) and European Brown Hares (*Lepus europaeus*) within the Project area to reduce impacts on remnant and planted native vegetation.

GLOSSARY AND ABBREVIATION OF TERMS

BOM	Bureau of Meteorology
EBS	EBS Ecology
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
ha	hectares
Kanmantoo (Mine)	Kanmantoo Copper
km	Kilometre(s)
LOM	Life of Mine
ML	Mining Lease
mm	Millimetre(s)
PEPR	Program for Environment Protection and Rehabilitation
Project area	Combined area of the ML and SEB areas
SA	South Australia/South Australian
SEB	Significant Environmental Benefit

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1 INTRODUCTION

EBS Ecology (EBS) has been engaged by Hillgrove Resources since 2011 to conduct an annual fauna monitoring program over the Kanmantoo Copper (Kanmantoo Mine) Mining Lease (ML). The 2020 monitoring program marks the seventh year that EBS has also monitored the Significant Environmental Benefit (SEB) areas, located adjacent to the Kanmantoo ML. The Kanmantoo ML and the Kanmantoo SEB area in combination are named herein as the Project area. The fauna monitoring program was undertaken in accordance with the conditions and outcomes required in the Program for Environment Protection and Rehabilitation (PEPR) for Kanmantoo.

1.1 Objectives

The objective of the fauna monitoring program is to meet the conditions and outcomes as outlined in the PEPR. With regards to fauna (Condition 13), "*the lessee must in constructing and operating the Lease, ensure that there is no adverse impacts from the site operations on the native fauna abundance or diversity in the Lease area and in adjacent areas*". As such, the Outcome (21) required is "*no net adverse impacts from the site operations on native fauna abundance or diversity in the lease area and in adjacent areas*". More specifically, the fauna monitoring program aimed to determine the abundance and diversity of fauna within the Project area by:

- Conducting roaming transect surveys to record the abundance and diversity of birds;
- Performing a targeted spotlighting survey to record the abundance of Common Brushtail Possums (*Trichosurus vulpecula*) as well as other nocturnal fauna species; and
- Opportunistically recording all other fauna species encountered within the Project area.

1.2 Project area

The Project area is located approximately 45 km south-east of Adelaide in the eastern Mount Lofty Ranges of South Australia (SA) and 1.5 km south-west of the Kanmantoo township (Figure 1). The area is representative of a transitional zone on the eastern face of the Mount Lofty Ranges, between the Adelaide Hills woodland regions and the Murray River Plains mallee. It has a long-term average rainfall of 456 mm (Figure 3) (BOM 2020a) and encompasses a variety of soil types and geological structures, conducive to an assortment of vegetation types and habitat niches.

The Project area has a history of mining activity, which started in the mid-nineteenth century and then continued between 1971 and 1976 (Hillgrove Resources 2007). Over the past 150 years, much of the ML has been extensively cleared for cropping, whilst most of the vegetated areas have been grazed by domestic stock. As a result, only small remnant patches of native vegetation in the ML have persisted, including native grasslands and woodland communities.

The SEB offset areas are located adjacent to the Kanmantoo Mine (Figure 2). SEB offset areas associated with the Life of Mine (LOM) extension have been located as near as possible to the ML on suitable Hillgrove Resources owned land parcels. The SEB areas are approximately 109.5 hectares (ha) and comprised of five properties (Figure 2), which have been managed under a mixed cropping / sheep grazing regime for over 100 years. Cropping has been confined to the flats and grazing has been on crop stubble and the higher/rockier areas. Consequently, only small remnant patches of native vegetation remain in the SEB areas, including native grasslands and a mallee community.

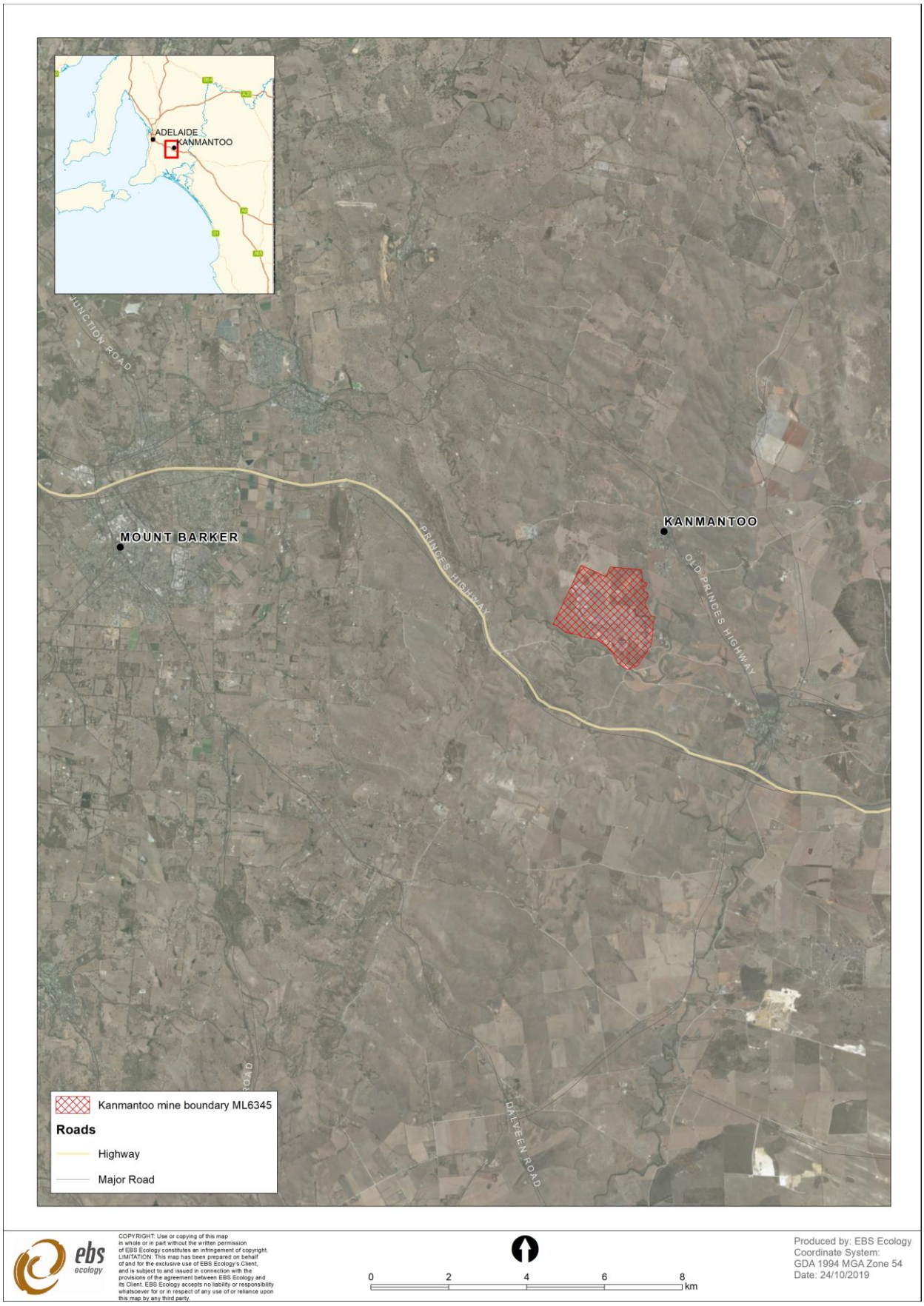

Figure 1. Location of Kanmantoo Mine with respect to local townships and Adelaide, South Australia.

Figure 2. Location of the Kanmantoo ML and SEB areas over the Project area.

2 METHODS

2.1 Field Survey

The field survey was conducted in late September (22nd, 24th, and 25th) to ensure consistency with previous fauna surveys of the Project area. There was some adverse weather during this trip, and not all surveys could be completed during the initial survey. A follow up survey was completed in early October 2020 (6th, 8th, 9th, 12th and 13th).

2.1.1 Weather conditions and rainfall

Weather conditions over the 2020 fauna survey period were characterised by cool to mild mornings and afternoon temperatures (BOM 2020b) with both winds and rainfall varying from light to strong/heavy. Long term rainfall data (1874-2020) was sourced from Kanmantoo weather station (BOM 2020). Rainfall at Kanmantoo shows annual variability, particularly over the 2011 to 2019 timeframe, as annual rainfall ranged from the lowest in 2019 (304.8 mm) to the highest in 2016 (696.8 mm) (BOM 2020). Overall, 2011-13 and 2016-17 had above average rainfall (> 469 mm), while 2014-15 and 2018 were below average rainfall (Figure 3) (BOM 2020). It must be noted that there is missing rainfall data for the years 2012/13, 2017/18 and 2018/19 and therefore their rainfall totals may be greater than the values presented in Figure 3. Furthermore, rainfall data for 2020 is limited to the months Jan-Aug, as at the time of the current report rainfall records for Sept-Dec were not yet available. Therefore, rainfall totals of 2020 are likely to be greater than the values presented in Figure 3.

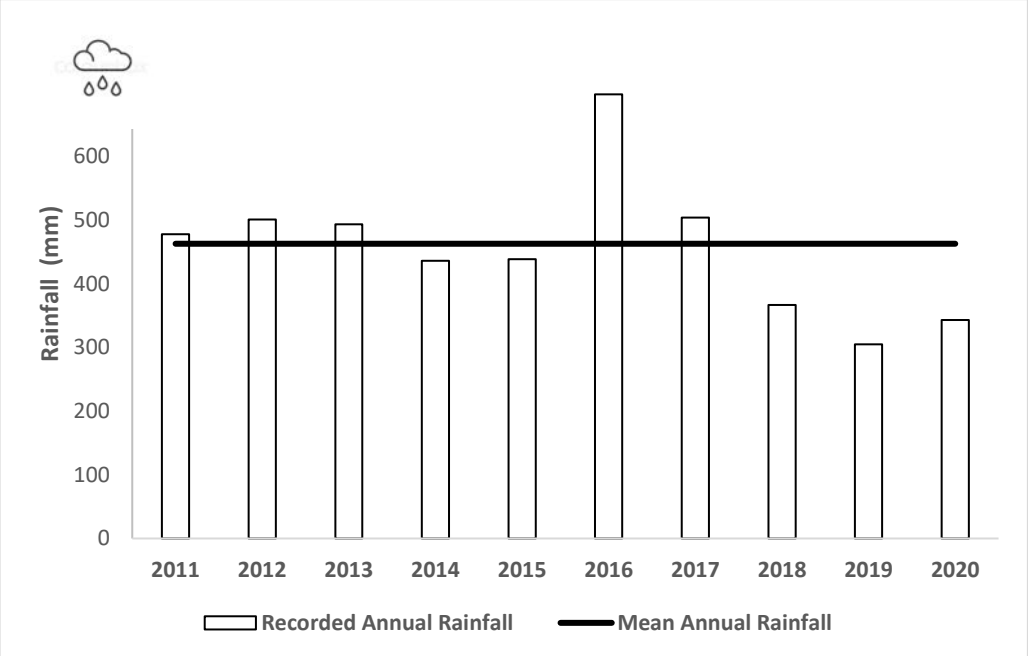

Figure 3. Mean annual rainfall at Kanmantoo weather station (23724) from 2011 to 2020.

Note: There is missing data for Oct 2012, Oct 2017 and Dec 2019 and therefore, the total rainfall for these years may be lower than the true value (BOM 2020). Annual Rainfall data for 2020 is limited to the months Jan-Aug, as at the time of the reporting rainfall records for Sept-Dec were not available. Therefore, the total rainfall for 2020 may be higher than the true value (BOM 2020).

2.1.2 Survey effort per year

Mining Lease

Fauna within the ML has been monitored annually since 2011 (Table 1). Bird monitoring transects within the ML varied in number (11 to 15) before the sites were formalised in 2015, however, the areas within which birds were surveyed were comparable between years. Since 2015, the same bird monitoring transects have been monitored annually.

The spotlighting transect locations have remained consistent since the inaugural year of monitoring in 2011. However, the number of spotlighting nights has reduced from three nights (2011) to one night (2014 to present).

Significant Environmental Benefit Areas

The SEB areas were monitored for the first time in 2014 (Table 1). However, monitoring in 2014 solely focused on spotlighting possums, though, opportune observations of birds were also made. The number of spotlight nights (1) and the transects surveyed have remained consistent since inception in 2014. In 2015, nine bird monitoring transects were established. Each bird monitoring transect is monitored annually.

Table 1. Fauna survey effort per year within the ML and SEB areas of Kanmantoo Mine.

Year	ML		SEB	
	Bird transects	Spotlight nights	Bird sites	Spotlight nights
2011	15*	3	N.M.	N.M.
2012	11*	2	N.M.	N.M.
2013	11*	2	N.M.	N.M.
2014	12*	1	N.M.	1
2015	14	1	9	1
2016	14	1	9	1
2017	14	1	9	1
2018	14	1	9	1
2019	14	1	9	1
2020	14	1	9	1

*sites not formalised
N.M. = not monitored

2.1.3 Birds

Twenty-three (23) bird transects are located over the Project area; 14 in ML and nine in the SEB area (Figure 4). These transects have been strategically positioned to represent the main habitat types and rehabilitation areas across the Project area. Each transect was surveyed by one or two surveyors, who walked the entire length of the transect. Surveys were conducted only during suitable weather conditions (i.e. fine, cool-mild weather with light or no wind). Surveys are not conducted during periods of strong wind or precipitation. The following information was recorded for each bird observed:

- Species;
- Number of individuals per species;

- Behaviour of individuals (foraging, resting, or flying); and
- The substrates individual birds were using (ground, shrub, or tree).

Furthermore, all birds heard were recorded to species and the number of individuals estimated.

2.1.4 Common Brushtail Possum targeted survey

Spotlighting was conducted over repeated routes within the ML and SEB areas to systemically determine the numbers of Common Brushtail Possums in the Project area (Figure 4). The ML and SEB areas were surveyed from a vehicle. The spotlighting routes within the ML and SEB were surveyed over one night for two hours each. All surveys commenced at least one hour after sunset.

The following information was recorded for each possum observed:

- Number of individuals;
- GPS location; and
- Habitat.

Any other fauna species observed opportunistically during spotlighting were also recorded.

2.1.5 Opportunistic observations

Any fauna species recorded within the ML or SEB area outside of systematic surveys were noted as opportune. For each opportune record, the following information was recorded:

- Species;
- Number of individuals;
- GPS location;
- Method, i.e. sight or sound; and
- Habitat.

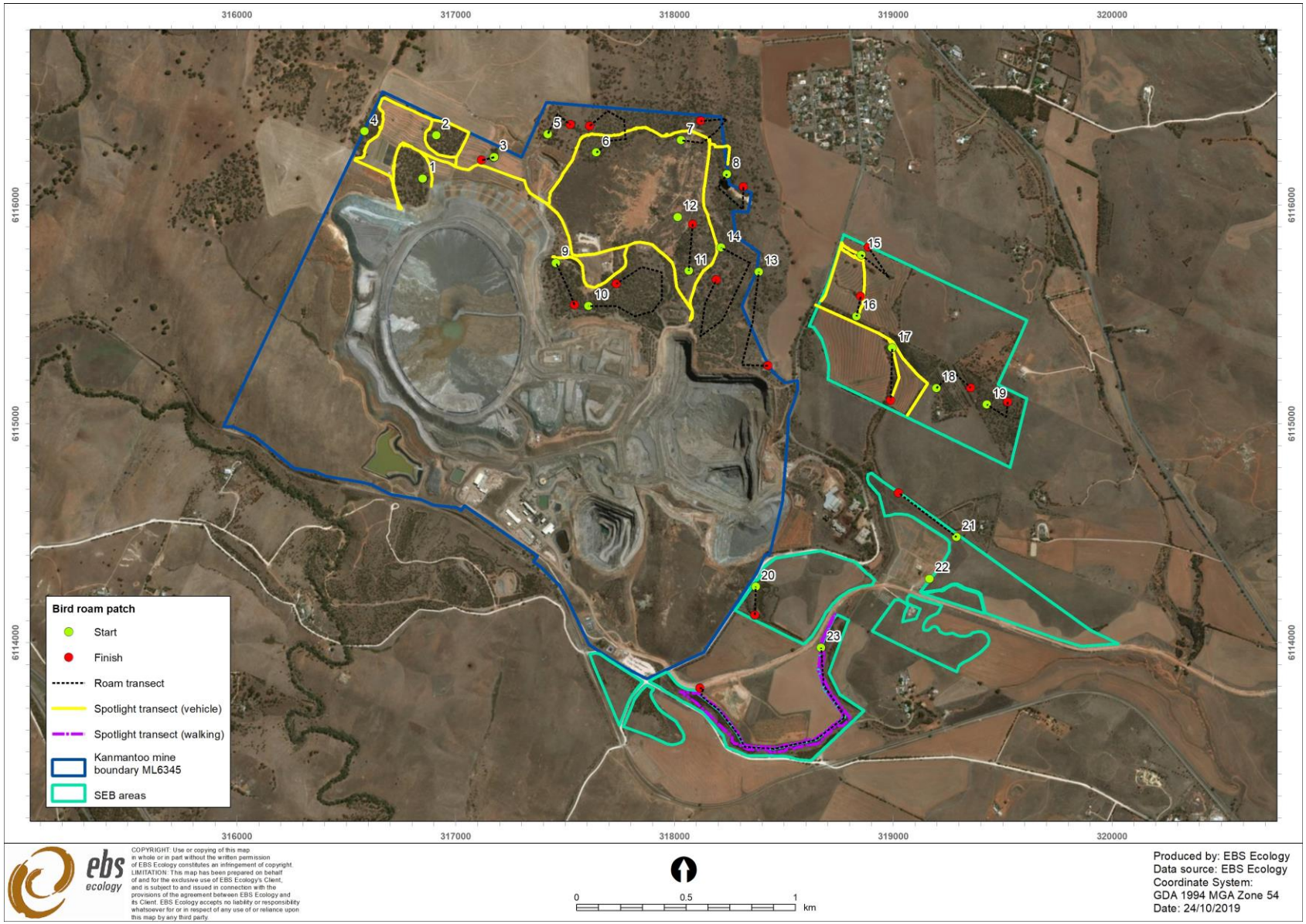

Figure 4. Locations of bird survey transects and spotlight (Common Brushtail Possum targeted survey) transects (vehicle and on foot) over the Project area.

3 RESULTS

3.1 Bird Survey 2020

3.1.1 Species richness

Fifty-eight (58) bird species were recorded over the Project area at survey sites and opportunistically in 2020 (Appendix 1). The families of birds with the greatest representation were:

- Psittaculidae (Parrots) seven species;
- Meliphagidae (Honeyeaters) six species;
- Falconidae (Falcons) four species;
- Acanthizidae (Australian Warblers);
- Artamidae (Woodswallows); and
- Cacatuidae (Cockatoos) three species.

Four species were observed at Kanmantoo Mine for the first time in 2020, which were:

1. Silver Gull (*Chroicocephalus novaehollandiae*);
2. Australian Hobby (*Falco longipennis*);
3. Purple-crowned Lorikeet (*Parvipsitta porphyrocephala*); and
4. Little Lorikeet (*Parvipsitta pusilla*).

3.1.2 Bird abundance

A total of 1035 birds from 58 species were recorded over the Project area at survey sites and opportunistically in 2020 (Appendix 1). The most abundant species over the Project area in 2020 were:

- Galah (*Eolophus roseicapilla*) (112 individuals);
- White-winged Chough (*Corcorax melanorhamphos*) (69 individuals);
- Crimson Rosella (*Platycerus elegans*) (67 individuals); and
- Yellow-rumped Thornbill (*Acanthiza chrysorrhoa*) (64 individuals).

3.1.3 Threatened species

Five bird species that have a threatened status in South Australia were observed in 2020. The State rare White-winged Chough (*Corcorax melanorhamphos*), was abundant, primarily within the ML, but this species was also recorded in the SEB area. The State rare Elegant Parrot (*Neophema elegans*) was widespread over the ML area. The State vulnerable Diamond Firetail (*Stagonopleura guttata*) was found at three locations in the ML and two locations within the SEB area. The State rare Peregrine Falcon (*Falco peregrinus*) was found at one location in the ML. The State endangered Little Lorikeet (*Parvipsitta pusilla*) was observed for the first time throughout the fauna surveys at one location in the SEB (Figure 5).

Figure 5. Locations of State threatened bird species observed during the 2020 fauna monitoring program.

3.2 Bird Survey 2011-2020

3.2.1 Species richness

The species richness of birds at Kanmantoo Mine has fluctuated over the lifetime of the fauna monitoring program (Figure 6). The mean bird species richness recorded per year over the monitoring program is 49.1 μ ± 3.0 S.E. (2011-2020). Fewer bird species were recorded from 2011 to 2014 due to lower search effort, with survey sites confined to the ML only (see Section 2.1.2 above).

In 2020, species richness was the second highest on record at Kanmantoo Mine with a total of 58 bird species observed.

Due to greater consistency in search effort since 2015, species richness is relatively stable between 42 to 58 species after a low species count in 2014 (Figure 6). Variability in species richness does not appear to be correlated with rainfall (Figure 6).

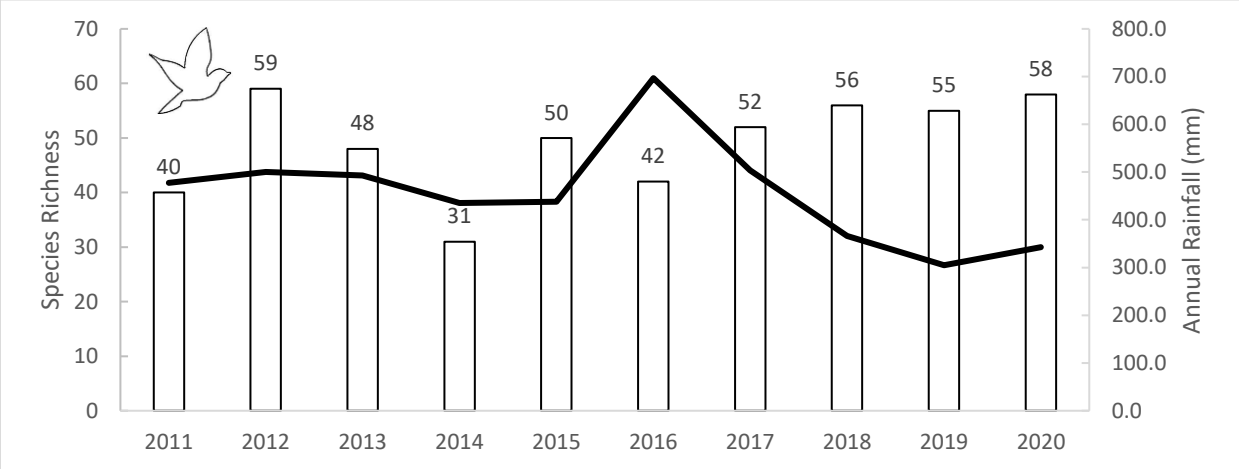

Figure 6. Bird species richness recorded over the fauna monitoring program 2011-2020 in relation to annual rainfall. *Please note that monitoring was confined to the ML from 2011 to 2014 and expanded to include SEB areas from 2015*.

Note: Annual Rainfall data for 2020 is limited to the months Jan-Aug, as at the time of the reporting rainfall records for Sept-Dec were not available. Therefore, the total rainfall for 2020 may be higher than the true value (BOM 2020a).

3.2.2 Bird abundance

The abundance of birds at Kanmantoo Mine has fluctuated over the lifetime of the fauna monitoring program (Figure 7). The average number of birds recorded per year over the monitoring program is 687 μ ± 85.6 S.E. (2011-2020). Fewer birds were recorded from 2011 to 2014 due to lower search effort, with survey sites confined to the ML only.

In 2020, bird abundance was the second highest on record at Kanmantoo Mine with a total of 1035 individuals observed, lower only to 2017, where a large number of nomadic and flocking species were recorded for a total of 1042 individuals. Bird abundance in 2020 was substantially greater compared to the abundances in the past two years, with 700 and 686 individuals observed in 2018 and 2019 respectively (Figure 7).

Despite greater consistency in search effort since 2015, bird abundance has remained variable between years. Variability in bird abundance does not appear to be strongly correlated with rainfall (Figure 7).

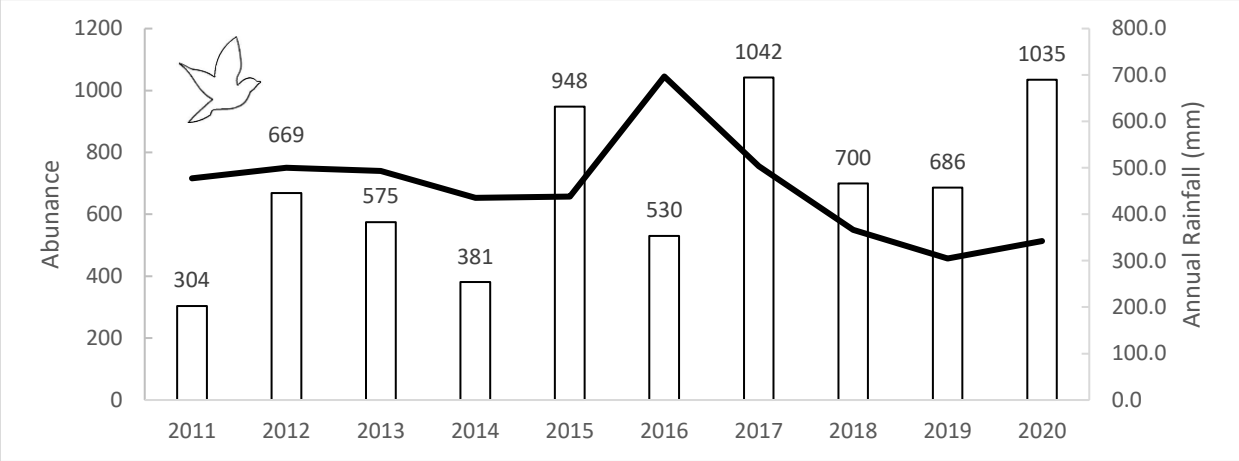

Figure 7. Bird abundance recorded over the fauna monitoring program 2011-2020 in relation to annual rainfall. ***Please note that monitoring was confined to the ML from 2011 to 2014 and expanded to include SEB areas from 2015.***

Note: Annual Rainfall data for 2020 is limited to the months Jan-Aug, as at the time of the reporting rainfall records for Sept-Dec were not available. Therefore, the total rainfall for 2020 may be higher than the true value (BOM 2020a).

3.2.3 Threatened species

A total of nine state threatened bird species have been observed at Kanmantoo Mine over the lifetime of the fauna monitoring program and in 2020 five of these species were observed (

Species name	Common name	EPBC	SA	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Calyptorhynchus funereus	Yellow-tailed Black Cockatoo		V		7			8		65			
Corcorax melanorhamphos	White-winged Chough		R	22	24	16	34	97	36	45	76	58	69
Falco peregrinus	Peregrine Falcon		R	2	2			4	1				1
Myiagra inquieta	Restless Flycatcher		R								1		
Melanodryas cucullata cucullata	Hooded Robin		R	2									
Microeca fascinans fascinans	Jacky Winter		R			1							
Neophema elegans	Elegant Parrot		R	7	16	12	9	19	55	28	27	30	39
Parvipsitta pusilla	Little Lorikeet		E										1
Stagonopleura guttata	Diamond Firetail		V	6	16	4		5		4	13	6	11
Number of threatened species per year				**5**	**5**	**4**	**2**	**5**	**3**	**4**	**4**	**3**	**5**

Table 2).

Three of the eight species of conservation concern have been recorded consistently within the Kanmantoo Mine: The White-winged Chough and Elegant Parrot are the only two threatened species that have been recorded on each annual survey since 2011, while the Diamond Firetail has been observed for eight of the ten survey years. The abundance of White-winged Choughs and Elegant Parrots appears to be stable, if not steadily increasing, while the numbers of Diamond Firetails also appear stable (Figure 8).

Table 2. Bird species of conservation significance recorded at Kanmantoo Mine between 2011 and 2020.

Species name	Common name	EPBC	SA	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Calyptorhynchus funereus	Yellow-tailed Black Cockatoo		V		7			8		65			
Corcorax melanorhamphos	White-winged Chough		R	22	24	16	34	97	36	45	76	58	69
Falco peregrinus	Peregrine Falcon		R	2	2			4	1				1
Myiagra inquieta	Restless Flycatcher		R								1		
Melanodryas cucullata cucullata	Hooded Robin		R	2									
Microeca fascinans fascinans	Jacky Winter		R			1							
Neophema elegans	Elegant Parrot		R	7	16	12	9	19	55	28	27	30	39
Parvipsitta pusilla	Little Lorikeet		E										1
Stagonopleura guttata	Diamond Firetail		V	6	16	4		5		4	13	6	11
Number of threatened species per year				**5**	**5**	**4**	**2**	**5**	**3**	**4**	**4**	**3**	**5**

SA: South Australia (*National Parks and Wildlife Act 1972*). **Conservation Codes:** V: Vulnerable. **R:** Rare. **EPBC:** *Environment Protection and Biodiversity Conservation Act 1999*.

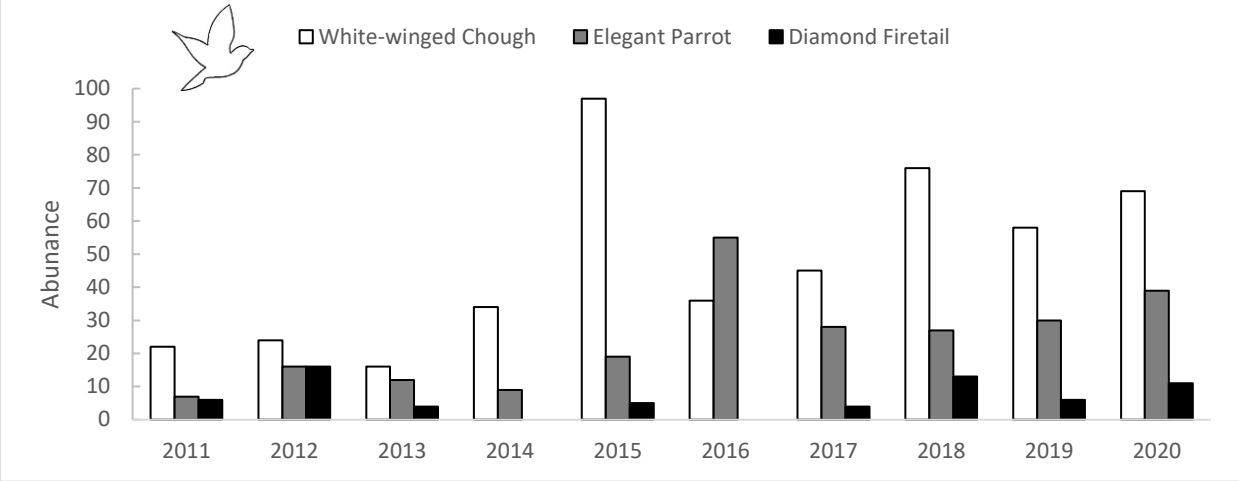

Figure 8. Number of individual White-winged Choughs, Elegant Parrots and Diamond Firetails recorded over the Kanmantoo Mine fauna monitoring program 2011-2020.

The remaining six of the nine species of conservation concern have been recorded inconsistently within the Kanmantoo Mine: The Peregrine Falcon (*Falco peregrinus*) has been observed in five survey years, the Yellow-tailed Black Cockatoo (*Calyptorhynchus funereus*) on three surveys, while the Jacky Winter (*Microeca fascinans fascinans*), Hooded Robin (*Melanodryas cucullata cucullata*), Restless Flycatcher (*Myiagra inquieta*) and Little Lorikeet (*Parvipsitta pusilla*) were observed only on one survey, with the Little Lorikeet observed for the first time in 2020 (

Species name	**Common name**	EPBC	SA	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Calyptorhynchus funereus	Yellow-tailed Black Cockatoo		V		7			8		65			
Corcorax melanorhamphos	White-winged Chough		R	22	24	16	34	97	36	45	76	58	69
Falco peregrinus	Peregrine Falcon		R	2	2			4	1				1
Myiagra inquieta	Restless Flycatcher		R								1		
Melanodryas cucullata cucullata	Hooded Robin		R	2									
Microeca fascinans fascinans	Jacky Winter		R			1							
Neophema elegans	Elegant Parrot		R	7	16	12	9	19	55	28	27	30	39
Parvipsitta pusilla	Little Lorikeet		E										1
Stagonopleura guttata	Diamond Firetail		V	6	16	4		5		4	13	6	11
Number of threatened species per year				**5**	**5**	**4**	**2**	**5**	**3**	**4**	**4**	**3**	**5**

Table 2). Due to the low number of records of these species, trends in the number of individuals that are utilising the Kanmantoo Mine cannot be assessed.

3.3 Possum survey 2020

In 2020 a total of 30 Common Brushtail Possums was observed within the ML, while no observations of the species occurred in the SEB area (Figure 10; Table 3).

3.4 Possum survey 2011-2020

To date there have been no observations of Common Brushtail Possums within the SEB area. In the ML, the number of individuals observed per night has ranged from the lowest of 9 individuals in 2014 to the highest of 44 individuals in 2012.

The average number of possums observed per night is 23.1 μ ± 3.2 S.E. (2011-2020). Over the lifetime of the fauna monitoring program the numbers of Common Brushtail Possums have fluctuated annually (Table 3). Since 2015 numbers of Common Brushtail Possums have been relatively stable ranging from 14 to 30 individuals. The correlation between Common Brushtail Possum abundance and rainfall is shown in Figure 9.

Table 3. Observations of Common Brushtail Possums 2011-2020.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number observed	43	88	53	9	21	14	30	20	22	30
Number of nights surveyed within ML	3	2	2	1	1	1	1	1	1	1
Average number of possums observed per night	14.3	44.0	26.5	9.0	21.0	14.0	30.0	20.0	22.0	30

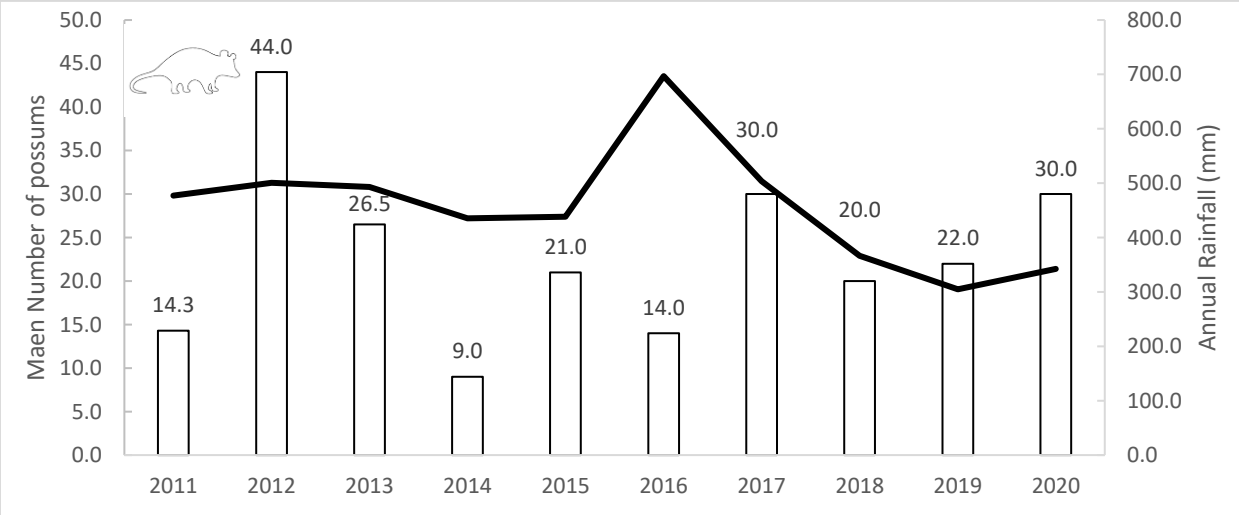

Figure 9. Mean possum abundance recorded over the fauna monitoring program 2011-2020 in relation to annual rainfall. *Please note that monitoring was confined to the ML from 2011 to 2014 and expanded to include SEB areas from 2015*.

Note: Annual Rainfall data for 2020 is limited to the months Jan-Aug, as at the time of the reporting rainfall records for Sept-Dec were not available. Therefore, the total rainfall for 2020 may be higher than the true value (BOM 2020a).

3.5 Opportunistic observations 2020

3.5.1 Frogs

Two species of frogs were heard during the 2020 survey within the ML; *Limnodynastes dumerilii* (Eastern Banjo Frog) and an unidentified frog call.

3.5.2 Mammals

The Western Grey Kangaroo (*Macropus fuliginosus*) was the most abundant mammal species recorded in the Project area, with 30 individuals sighted. In 2020, this species was only sighted within the ML and not within the SEB area. Four Common Wallaroos (*Macropus robustus*) were opportunistically sighted within the ML area. A single Common Ringtail Possum (*Pseudocheirus peregrinus*) was observed during the spotlight surveys in *E. odorata* woodland within the ML area. Two introduced mammal species were recorded in small numbers in 2020; the Rabbit (*Oryctolagus cuniculus*) and the European Brown Hare (*Lepus europaeus*).

Figure 10. Locations and number of Common Brushtail Possums (*Trichosurus vulpecula*) observed during the 2020 fauna survey at Kanmantoo Mine.

4 DISCUSSION

4.1 Birds

The results of the 2020 survey suggest an increase in the species richness and abundance of the bird community within the Project area, compared with the 2019 survey. Variations in the numbers of threatened species is expected, due to changing seasonal conditions, movements and resource availability across the site.

Fluctuations in the number of birds observed at Kanmantoo Mine appear to be in part influenced by the presence of nomadic and flocking species and variations in the numbers of ground foraging species as well as nectivorous species. For example, a flock of 260 Black-faced Woodswallow (*Artamus cinereus*), a nomadic species, and 65 Yellow-tailed Black Cockatoos (*Calyptorhynchus funereus*), a flocking species, were observed in the 2017 survey, greatly increasing the total number of birds recorded for the monitoring program that year. There were no large flocking events during the 2020 survey.

Annual rainfall data does not appear to be correlated with bird abundance or species richness (Figure 6; Figure 7). However, if rainfall data were treated with greater sensitivity, such as looking at the quantity and timing of rainfall within a given year and linking this to the flowering requirements for dominant tree and shrub species, such as Peppermint Box (*Eucalyptus odorata*), then the variability in the number and species richness of nectivorous species may be further explained. Likewise, determining how the rainfall influences soil moisture and the growth of understorey weeds may help explain the variability in the numbers of ground-foraging bird species.

Given the variable nature of the bird community at Kanmantoo Mine, it is imperative that a suite of indicator species is identified to determine whether the mine has impacted on birds. Indicator species should be resident, woodland-dependent species that are not favoured by impaired tree health nor human mediated landscapes (Read *et al.* 2015). The following species found within the Project area meet these criteria:

1. Brown Treecreeper (*Climacteris picumnus*);
2. Diamond Firetail (*Stagonoplerua guttata*);
3. Grey Shrike-thrush (*Colluricincla harmonica*);
4. Rufous Whistler (*Pachycephala rufiventris*);
5. White-winged Chough (*Corcorax melanorhamphos*); and
6. Yellow-rumped Thornbill (*Acanthiza chrysorrhoa*).

The abundance of these species shows variability between years, however, none of the species has been identified to be in decline since the fauna monitoring program commenced in 2011 (Table 4).

It is recommended that future monitoring should focus upon these six indicator species when analysing the impact of the mine for future years in order to determine whether Kanmantoo Mine has satisfied its requirements under the PEPR. It is important to maintain the same level of monitoring effort so that trends for these indicator species can continue to be accurately monitored over time.

Table 4. Observations of the abundance of indicator species 2011-2020.

Species name	Common name	EPBC	SA	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Acanthiza chrysorrhoa	Yellow-rumped Thornbill			33	43	31	21	90	43	38	54	57	64
Climacteris picumnus	Brown Treecreeper			5	12	17	9	8	11	5	10	11	18
Colluricincla harmonica	Grey Shrike-thrush			4	1	3	3	14	13	4	8	15	19
Corcorax melanorhamphos	White-winged Chough		R	22	24	16	34	97	36	45	76	58	69
Pachycephala rufiventris	Rufous Whistler			6	9	6	2	3	6	9	10	2	9
Stagonopleura guttata	Diamond Firetail		V	6	16	4		5		4	13	6	11

Some other notable trends and observations from the dataset more generally include:

- A Little Lorikeet was recorded in 2020 in the Mining Lease area, with no previous records;
- Yellow Thornbills have only been recorded in 2018, 2019 and 2020 with no previous records;
- There were no Varied Sitella records in 2017, 2018, 2019 and 2020 compared with small numbers on the previous seven survey years;
- A general increasing trend for Elegant Parrot and New Holland Honeyeater during the data collection period; and
- Diamond Firetail recorded in an area of the Mining Lease where they have not been observed before in 2020.

Each year that the survey runs, new species continue to be added to the cumulative species for the Project area (four new species in 2020). This can be attributed, in part to natural cycles such as seasonal variation and bird migration. However, the changes can also reflect local-scale changes in the vegetation structure and composition of the vegetation communities at the Project area. In particular, it is expected that as the areas of remnant and restored habitat within and outside the ML area mature and improve, this will provide habitat for an increased number and potentially greater diversity of birds.

4.2 Brushtail Possum

Common Brushtail Possums were restricted to the remnant Peppermint Box (*Eucalyptus odorata*) woodlands of the ML, with no individuals observed within the SEB area. The occurrence of Common Brushtail Possums within the ML is associated with the availability of den sites in the form of hollows within Peppermint Box. Common Brushtail Possums prefer large hollows that are deeper than 1 m (Inions *et al.* 1989). Such hollows take approximately 200 to 400 years to develop in other eucalypt species (Inions *et al.* 1989), and therefore, the habitat within the SEB area may only become suitable after centuries without intervention. Even with the installation of possum boxes, Common Brushtail Possums may not colonise the SEB areas located outside the ML as dispersal is uncommon for adult and even for juvenile possums. Furthermore, crossing a fragmented landscape would make them vulnerable to Red Fox (*Vulpes vulpes*) predation (Byrom *et al.* 2015), which may delay potential colonisation. Additionally, food resources within the SEB areas may be insufficient until the planted Peppermint Box trees reach maturity, which could take over 20 years.

4.3 Pest and over-abundant species

Grazing pressure from over-abundant native and pest herbivore species could be negatively impacting the quality of remnant vegetation in the ML and the success of revegetation. Western Grey Kangaroos, rabbits and hares were all frequently sighted throughout the ML and their control through shooting and baiting may be warranted to ensure that native fauna species are not adversely impacted by reduced habitat quality.

5 CONCLUSION

The results from the 2020 fauna monitoring program confirm that there is no discernible loss of native fauna abundance or diversity in the Mine Lease area and in adjacent SEB areas as demonstrated by the results of the bird and Common Brushtail Possum surveys. As such, Hillgrove Resources has satisfied condition (13) and outcome (21) required for fauna conservation within the PEPR.

6 RECOMMENDATIONS

EBS recommends the following measures to improve the management and monitoring of fauna within the Kanmantoo Mine Project area:

- Continue the fauna monitoring program at the same time each year (early spring) with annual analysis of trajectories for threatened and indicator fauna species;
- Change to biennial spotlighting within the SEB areas due to the low likelihood of Common Brushtail Possums using/colonising these areas in the short-term; and
- Conduct a control program to reduce the numbers of Western Grey Kangaroos, rabbits and hares within the Project area. These are likely to be adversely affecting remnant and planted native vegetation and associated faunal communities.

7 REFERENCES

Bureau of Meteorology (BOM) (2020a). Climate Data Online, Kanmantoo, SA. Station Number: 023724. Accessed at http://www.bom.gov.au/climate/data/ on 26 October 2020.

Bureau of Meteorology (BOM) (2020b). Climate Data Online, Murray Bridge (Pallamana Aerodrome), SA. Station Number: 024584. Accessed at http://www.bom.gov.au/climate/data/ on 26 October 2020.

Byrom, A.E., Anderson, D.P., Coleman, M., Thomson, C., Cross, M.L., Pech, R.P. (2015). Assessing movements of Brushtail Possums (*Trichosurus vulpecula*) in relation to depopulated buffer zones for the management of wildlife tuberculosis in New Zealand. PLOS one. https://doi.org/10.1371/journal.pone.0145636

Hillgrove Resources (2007) *Kanmantoo Copper Project Mining Lease Proposal, Main Report*.

Inions, G.B., Tanton, M.T., Davey, S.M. (1989). Effect of fire on the availability of hollows in trees used by the Common Brushtail Possum, *Trichosurus vulpecula* Kerr, 1792, and the Ringtail Possum, *Pseudocheirus pereginus Boddaerts*, 1785. Australian Wildlife Research 16(4), 449-458.

Read, J.L., Parkhurst, B., Delean, S. (2015). Can Australian bush birds be used as canaries? Detection of pervasive environmental impacts at an arid Australian mine site. Emu 115 (2), 117-125.

8 APPENDIX

Appendix 1. Total bird species observed during the period (2011-2020) spring surveys in both the ML and SEB areas (point counts and opportunistic).

SPECIES NAME	COMMON NAME	EPBC	SA	Exotic	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Acanthagenys rufogularis	Spiny-cheeked Honeyeater									2		2	4	3
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				33	43	31	21	90	43	38	54	57	64
Acanthiza nana	Yellow Thornbill											19	14	8
Accipiter cirrocephalus	Collared Sparrowhawk				3							1		
Aegotheles cristatus	Australian Owlet-nightjar							1	1		1			
Alauda arvensis	Eurasian Skylark			*	1		3		3		1	2		
Anas gracilis	Grey Teal					16				6	10	1		12
Anas superciliosa	Pacific Black Duck					1				10	9			2
Anthochaera carunculata	Red Wattlebird				1	16	5	1	15	1	27	9	15	36
Anthus australis	Australian Pipit					5	4				6		2	2
Aphelocephala leucopsis	Southern Whiteface				6	9					3		2	
Aquila audax	Wedge-tailed Eagle				3	8				1				1
Artamus cinereus	Black-faced Woodswallow				2	3					260			
Artamus cyanopterus	Dusky Woodswallow						8	2	13	5	3	2	2	2
Artamus personatus	Masked Woodswallow						4							
Artamus superciliosus	White-browed Woodswallow						2							2
Aythya australis	Hardhead					1					4	1		
Cacatua galerita	Sulphur-crested Cockatoo									1	3	14	2	4
Cacatua sanguinea	Little Corella				2			1	54	2	9			12

SPECIES NAME	COMMON NAME	EPBC	SA	Exotic	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cacatua tenuirostris	Long-billed Corella												7	
Cacomantis pallidus	Pallid Cuckoo					1			1					1
Caligavis chrysops	Yellow-faced Honeyeater											1		
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo		V			7					65			
Carduelis carduelis	European Goldfinch			*								8	5	4
Chalcites basalis	Horsfield's Bronze-Cuckoo				1						2			
Chalcites osculans	Black-eared Cuckoo					1								
Chenonetta jubata	Australian Wood Duck					3			19		2			
Chroicocephalus novaehollandiae	Silver Gull													2
Cincloramphus crualis	Brown Songlark					2	1							
Climacteris picumnus	Brown Treecreeper				5	12	17	9	8	11	5	10	11	18
Colluricincla harmonica	Grey Shrike-thrush				4	1	3	3	14	13	4	8	15	19
Columba livia	Feral Pigeon [Rock Dove]			*		20	20				2			
Coracina novaehollandiae	Black-faced Cuckoo-shrike				1	2	4	4	3		6	3	1	
Corcorax melanorhamphos	White-winged Chough		R		22	24	16	34	97	36	45	76	58	69
Corvus mellori	Little Raven				5	3	15	12	26	11	65	24	17	45
Dacelo novaeguineae	Laughing Kookaburra								1			1	1	
Daphoenositta chrysoptera	Varied Sittella				7	5	21	4	3	5				
Dicaeum hirundinaceum	Mistletoebird												1	
Egretta novaehollandiae	White-faced Heron					1				1	1			
Elanus axillaris	Black-shouldered Kite				3	2	1							

SPECIES NAME	COMMON NAME	EPBC	SA	Exotic	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Elseyornis melanops	Black-fronted Dotterel					3					5			
Eolophus roseicapilla	Galah				12	17	17	15	60	18	43	30	28	112
Epthianura albifrons	White-fronted Chat					33	18		2			1		
Falco berigora	Brown Falcon				4	6	1	3	4	2	4	4	2	3
Falco cenchroides	Nankeen Kestrel				3	2	1	1		3	1	2	1	4
Falco longipennis	Australian Hobby													1
Falco peregrinus	Peregrine Falcon		R		2	2			4	1				1
Gallina tenebrosa	Dusky Moorhen					3								
Gavicalis virescens	Singing Honeyeater				7	8	6	4	14	12	4	28	13	34
Geopelia placida	Peaceful Dove											1	1	
Glossopsitta concinna	Musk lorikeet					6				2	18	3	19	20
Glossopsitta porphyrocephala	Purple-crowned Lorikeet					20								
Grallina cyanoleuca	Magpie-lark				2	1	1	2	3	1	2		5	8
Gymnorhina tibicen	Australian Magpie				32	16	15	34	57	48	65	22	29	54
Hieraaetus morphnoides	Little Eagle								1					
Hirundo neoxena	Welcome Swallow				2	6	17		1	37	32	13	6	8
Lalage tricolor	White-winged Triller					3						1	13	
Malurus cyaneus	Superb Fairy-wren				4		1		4			4	4	10
Megalurus mathewsi	Rufous Songlark												6	
Melanodryas cucllata cullata	Hooded Robin (South East ssp)		R		2									
Melithreptus brevirostris	Brown-headed Honeyeater					6	18	11	19	3	18	32	29	21

SPECIES NAME	COMMON NAME	EPBC	SA	Exotic	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Melithreptus lunatus	White-naped Honeyeater											2		
Merops ornatus	Rainbow Bee-eater				7	7	1	2	3	1	4			6
Microeca fascinanas	Jacky Winter		R				1							
Milvus migrans	Black Kite						1							
Myiagra inquieta	Restless Flycatcher		R									1		
Neochmia temporalis	Red-browed Finch											1	4	3
Neophema elegans	Elegant Parrot		R		7	16	12	9	19	55	28	27	30	39
Ninox boobook	Southern Boobook												1	
Ocyphaps lophotes	Crested pigeon					9	4			4	2	5	5	11
Pachycephala pectoralis	Golden Whistler												1	
Pachycephala rufiventris	Rufous Whistler				6	9	6	2	3	6	9	10	2	9
Pardalotus punctatus	Spotted Pardalote					3								3
Pardalotus striatus	Striated Pardalote				15	26	32	15	26	9	26	37	38	52
Parvipsitta porphyrocephala	Purple-crowned Lorikeet													4
Parvipsitta pusilla	Little Lorikeet		E											1
Passer domesticus	House Sparrow			*		10	8	1				4	11	14
Petrochelidon nigricans	Tree Martin				12	38	32	50	68	4	41	28	37	25
Petroica goodenovii	Red-capped Robin								1			1		
Phaps chalcoptera	Common Bronzewing						1			2	1	2	2	3
Phylidonyris novaehollandiae	New Holland Honeyeater						2		21	12	13	25	25	45
Platycercus elegans	Adelaide Rosella				33	49	64	42	85	58	65	51	44	67

SPECIES NAME	COMMON NAME	EPBC	SA	Exotic	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Podargus strigoides	Tawny Frogmouth								1		1		1	2
Pomatostomus superciliosus	White-browed Babbler								8	1	5	13	17	22
Psephotus haematonotus	Red-rumped Parrot				10	57	27	56	19	15	25	13	12	23
Ptilotula penicillata	White-plumed Honeyeater				16	18	30	7	13	8	20	28	18	30
Rhipdura albiscapa	Grey Fantail											9	6	
Rhipidura leucophrys	Willie Wagtail				10	11	11	8	22	13	11	19	14	13
Sericornis frontalis	White-browed Scrubwren						1							
Smicrornis brevirostris	Weebill				3		61	20	56	15	8	18	14	11
Stagonopleura guttata	Diamond Firetail		V		6	16	4		5		4	13	6	11
Sturnus vulgaris	Common Starling			*	2	27	11		52	37	11	6	22	37
Tachybaptus novaehollandiae	Australasian Grebe					8	1				4	2		2
Tadorna tadornoides	Australian Shelduck									13				2
Threskiornis spinicollis	Straw-necked Ibis								6					12
Todiramphus sanctus	Sacred Kingfisher					1								
Tribonyx ventralis	Black-tailed Native Hen				6	3								
Trichoglossu haematodus	Rainbow Lorikeet				2	8	11	2					3	4
Turdus merula	Common Blackbird			*				5				1	1	2
Tyto delicatula	Eastern Barn Owl										1	1		
Vanellus miles	Masked Lapwing					3			4	2		1	1	
Zosterops lateralis	Silvereye						4					3	1	
		Total Abundance			**304**	**669**	**575**	**381**	**948**	**530**	**1042**	**700**	**686**	**1035**

SPECIES NAME	COMMON NAME	EPBC	SA	Exotic	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		Total Diversity			40	59	48	31	50	42	52	56	55	58

SA: South Australia (*National Parks and Wildlife Act 1972*). **VU/V: Conservation Codes:** V: Vulnerable. **R:** Rare.

EPBC: *Environment Protection and Biodiversity Conservation Act 1999*.

*Denotes introduced species

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Kanmantoo Copper Mine

Landscape Function Analysis Report

Kanmantoo Copper Mine Landscape Function Analysis Report

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Version 1

Prepared by EBS Ecology for Hillgrove Resources

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Cover photograph: A Landscape Function Analysis monitoring site with transect set out and pins marking out each patch, in the Kanmantoo Copper Mine.

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GLOSSARY AND ABBREVIATION OF TERMS

AN sites	LFA analogue sites
BOM	Bureau of Meteorology
EBS	EBS Ecology
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
Hillgrove	Hillgrove Resources Limited
IWL	Integrated Waste Landform
Kanmantoo	Kanmantoo Copper Mine
LFA	Landscape Function Analysis: an environmental monitoring technique which is internationally recognized as a method of measuring and monitoring ecosystem function and rehabilitation progress.
ML	Mining Lease
m²	square metres
mm	millimetres
NV Act	*Native Vegetation Act 1991*
PEPR	Program for Environmental Protection and Rehabilitation
Project Area	Kanmantoo mine lease (ML) and SEB areas
RH sites	LFA rehabilitation sites
RT	Rehabilitation Transect
SSA	Soil Surface Assessments
SEB	Significant Environmental Benefit
ssp.	sub-species
spp.	species (plural)
SSA	Soil Surface Assessment
TSF	Tailings Storage Facility
WRL	Waste Rock Landform

EXECUTIVE SUMMARY

A long-term Landscape Function Analysis (LFA) monitoring program is in place to measure the ongoing environmental management, restoration and Significant Environmental Benefit (SEB) offset program components of the Kanmantoo Copper Mine operations in South Australia.

The vegetation monitoring program is now in its ninth year, commencing in 2011 but excluding 2016 when the site was not monitored. Two nationally threatened ecological communities occur within the Project Area: *Eucalyptus odorata* (Peppermint Box) Open Woodland and *Lomandra effusa* (Scented Mat-rush) +/- *Lomandra multiflora* subsp. *dura* (Stiff Mat-rush) Open Tussock Grassland, which are both listed as critically endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Permanent LFA monitoring sites, established in these communities at the beginning of the monitoring program (2011-2013) are used as baselines to guide restoration targets for rehabilitation and SEB areas.

This report provides LFA monitoring results for the 2020 monitoring program and compares these results with those from previous years and with the reference (analogue) sites. The 2020 monitoring included an assessment of 25 existing sites, of which four are analogue sites and 21 are sites to monitor rehabilitation success.

Across the Project Area the restoration sites exist in various states of rehabilitation. However, most rehabilitation sites are indicating successful germination and survival with positive trends toward analogue landscape function indices and restoration goals. In general, the LFA indicators have shown positive rehabilitation trends over the life of the Kanmantoo monitoring program (2011-2020). Rehabilitation plots have typically reached a level of 'self-sustaining communities', relative to analogue sites, after a period of only 3-4 years. Based on the initial success rates of restoration activities across the Kanmantoo Mine Area, it is likely that ongoing works will result in functional trends similar to those observed using LFA to date. This includes initial low values, followed by a rebound period whereby plant cover produces high stability, infiltration and nutrient cycling values before stabilising towards analogue values.

Ecological vegetation attributes such as plant species richness (and whether species are native or exotic) are currently not recorded as part of the LFA monitoring method, limiting the ability of the current program to determine species abundance and diversity or the success of species of interest used in revegetation and seeding mixes. Species composition and germination success should be considered as part of ongoing monitoring to provide information on how species respond to restoration methods, thus informing future rehabilitation activities.

The ongoing monitoring design should continue to adapt to maximise the efficiency and effectiveness of detecting changes in LFA monitoring sites to inform and improve restoration outcomes. Ongoing annual review and adaptation of the monitoring program is recommended, altering factors such as frequency of assessment, indicators measured and sampling locations.

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1 INTRODUCTION

A long-term monitoring program using Landscape Function Analysis (LFA) has been implemented by Hillgrove Resources Limited (Hillgrove) to measure the ongoing environmental management, restoration and Significant Environmental Benefit (SEB) offset program components of the Kanmantoo Copper Mine (Kanmantoo) in South Australia.

Hillgrove has an obligation to meet its rehabilitation objectives associated with the Program for Environmental Protection and Rehabilitation (PEPR) for Kanmantoo. Part of the PEPR requires monitoring of nominated areas commissioned to offset clearance of native vegetation associated with mine operations and infrastructure. The monitoring is specifically undertaken to measure the progress of a restoration program over time using the Landscape Function Analysis (LFA) methodology of Tongway and Hindley (2004).

LFA is a tool that brings together a number of different components that, when measured together over time, provide an accurate indication of how a distinct rehabilitation area is performing, and advancing toward a functioning system. The intention of the Kanmantoo LFA monitoring program is to achieve a time series trajectory of land condition across the mine site, enabling critical indicators to be identified, their values analysed and utilised for revision of future management activities (i.e., adaptive management) if required. A comparison with data collected from reference (analogue) sites with similar characteristics, but under ambient conditions, will account for seasonal and external effects beyond the control of the manager and enables a direct comparison of performance. For a system to be developing towards sustainability, it must be accumulating resources faster than they are lost. A functional landscape is one where vital resources such as water, plant litter and topsoil are retained and efficiently used (cycled) within the boundaries of the landscape and released very slowly (Tongway and Ludwig, 2006). LFA provides a rapid assessment of this functionality. When applied over time, results can be analysed to identify trends in the progress of the rehabilitation or remediation.

Within the Kanmantoo Project Area, the target landscape functionality of natural areas (as characterised by reference sites established within native vegetation communities) is compared with rehabilitated opencast mines and rehabilitated slopes of tailings dams. Soil surface quality indicators and landscape indices at Kanmantoo are similar to those observed by van de Walt *et al*. (2012) in platinum mining operations in South Africa. In particular, patches vegetated with grasses and shrubs showed higher functionality than sparsely vegetated interpatch areas.

Since 2011, EBS Ecology has worked with Hillgrove Resources to undertake the ongoing LFA monitoring program across the Kanmantoo Project Area. Details of the monitoring program and associated methodologies and design are detailed in *Kanmantoo Mine Vegetation Monitoring – Landscape Function Analysis* (EBS Ecology, 2011).

1.1 Objectives

The primary objectives of the 2020 LFA monitoring program are to:

- Repeat LFA at a selection of pre-existing sites established since 2011 at Kanmantoo;
- Provide results of ongoing LFA monitoring data assessed in 2020 across the Kanmantoo Project Area and compare with analogue sites and data from previous years;
- Discuss what the program results have revealed to this point and comment on trends observed; and
- Establish and assess new analogue/baseline LFA sites in hillslope grassland areas.

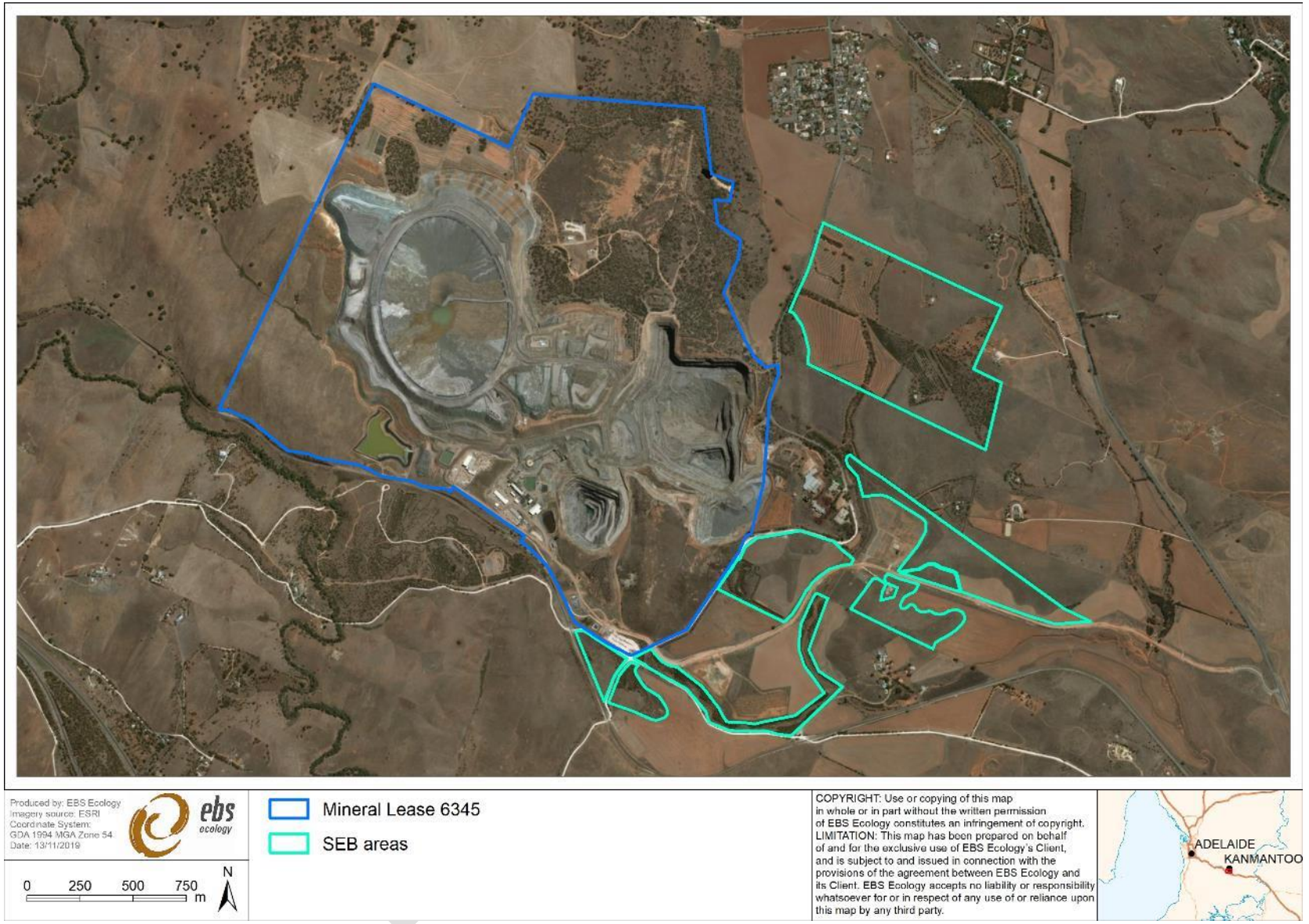


Figure 1. Location of the Mining Lease and Significant Environmental Benefit areas over the Project Area.

2 BACKGROUND

A land condition and restoration monitoring program has been undertaken at the Kanmantoo Mine over a number of years, with the initial baseline surveys commencing in 2011. To date, fifty-one (51) permanent LFA monitoring sites have been established across the Kanmantoo (Mining Lease) ML and SEB areas. These sites comprise a mix of baseline (analogue) and restoration/rehabilitation sites and each site has been monitored at different times and frequencies since 2011, based on changing restoration activities and monitoring priorities over time (Appendix 1). Analogue sites were assessed (using the LFA method) in order to provide baseline data against which to compare future rehabilitation trajectories. These included three *Lomandra effusa* (Scented Mat Rush) Grassland sites, six *Eucalyptus odorata* (Peppermint Box) Woodland sites and three *Austrostipa scabra* ssp. (Spear Grass) Grassland sites.

Initially, the areas set aside for vegetation restoration were highly degraded areas of pastoral land historically utilised for sheep and / or cattle grazing. The soil cover comprised mostly exotic pasture species such as *Avena barbata* (Wild Oat), *Phalaris aquatica* (Phalaris), *Festuca* sp. (Fescue) and *Lolium* spp. (Perennial Rye grass). Remnant woodlands consisted of mature *Eucalyptus odorata* (Peppermint Box) trees devoid of understorey native vegetation. In 2013, a vegetation rehabilitation program commenced with a variety of proven restoration techniques employed, including inter row stripping, tubestock planting and hydroseeding. These methods aim to replicate the compositional, structural and functional characteristics observed in local vegetation communities present in the Pre-European period as closely as possible.

In the Kanmantoo Mine Native Vegetation Management Plan (Coffey 2010), a series of measures associated with achieving a SEB under the NV Act were developed to offset clearance for the Kanmantoo Mine. These measures included protection of quality remnant native vegetation and improving the condition of more degraded remnant native vegetation within the Project Area; and revegetation of pasture and disturbed areas aiming to reduce biomass of exotic species and restore native vegetation communities. Under the existing restoration program, four primary methods are being utilised:

- Direct seeding with native seed (following ripping / soil removal);
- Planting native flora seedlings (tube stock);
- Hydroseeding and hand broadcasting of seed on Tailings Storage Facility (TSF) walls;
- Weed control and bush care; and
- Translocation of significant flora such as *Diuris behrii* (Cowslip Orchid).

Using these methods, approximately 97 hectares have been managed for rehabilitation / restoration since the program commenced (Figure 2). LFA monitoring has been progressively established to assess these restored areas. Monitoring results are compared with analogue sites that were assessed in the initial stages of the monitoring program (i.e., 2011-2013) to measure progress towards a ‘functional’ state (Tongway and Hindley 2004).

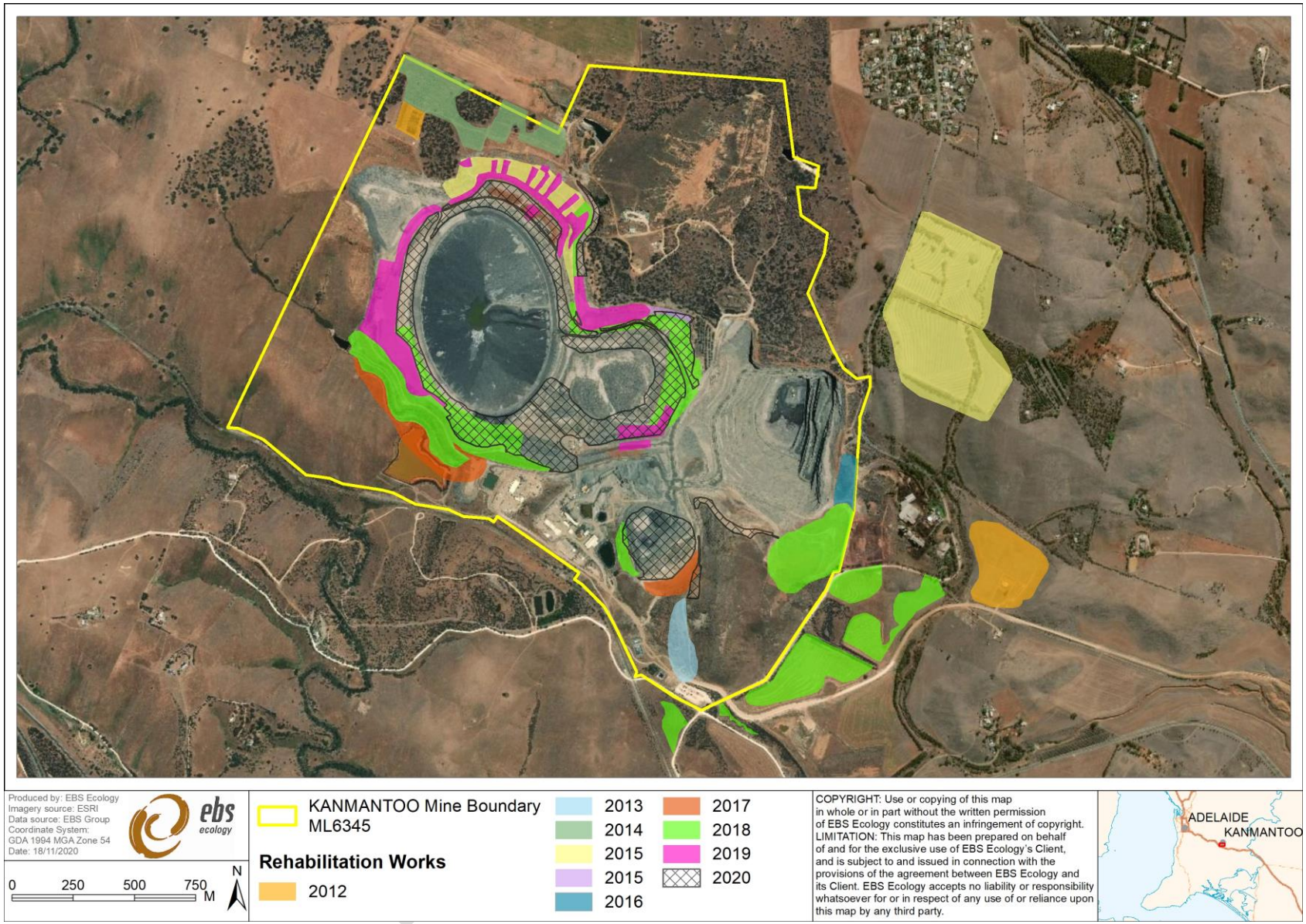


Figure 2. Rehabilitation and restoration activities at Kanmantoo Mine 2012-2020.

3 METHODOLOGY

3.1 Monitoring Program

3.1.1 Vegetation rehabilitation monitoring - Landscape Function Analysis (LFA)

LFA monitoring sites are established in areas that enable Hillgrove to report on its required lease conditions under the current PEPR. LFA sites have been strategically positioned to enable evaluation of the LFA program, the following attributes of rehabilitation areas have been considered:

- Location of monitoring sites;
- representation of vegetation communities; and
- effectiveness of analogue versus rehabilitation sites as comparable data.

LFA rehabilitation (RH) sites

The 2020 LFA Monitoring program included assessment of 25 sites, comprised of nine analogue transects and sixteen rehabilitation transects (Table 1, Figure 3).

Analogue sites were initially established in three different vegetation community types:

1. *Eucalyptus odorata* (Peppermint Box) Woodland (ODO);
2. *Lomandra effusa* (Scented Mat-rush) +/- *Lomandra multiflora* subsp. *dura* (Stiff Mat-rush) Open Tussock Grassland (LOM); and
3. *Austrostipa scabra* ssp. (Spear Grass) Grassland sites (STI).

LFA Analogue (AN) sites

Additional analogue sites have since been established to match restoration priorities in the following two communities:

1. **Derived *Acacia pycnantha* (Golden Wattle) low woodlands (ACA) – established in 2014**

   Examples of this community are located at the north-eastern end of the pit along the degraded edge of the *Eucalyptus odorata* open woodland (Figure 1). The current community is more accurately described as a *Eucalyptus odorata* open woodland with the overstorey removed, where *Acacia pycnantha* is now dominating as an interim climax community. The sites were therefore considered suitable as analogue sites to obtain LFA target reference figures for *Acacia pycnantha* low woodland rehabilitation sites.

2. **Modified hillslope grasslands (GRA) – established in 2019**

   Two of these sites were established within the ML on ‘Carmens’ paddock, west of the dam and two sites were located outside of the ML on the southern side of Back Callington Road near the weather / dust monitoring station (Figure 3).

Table 1. Selection of existing LFA rehabilitation (RH) sites and analogue (AN) sites assessed in 2020, including assessment history from 2011-2020.

	Site type	Site name	2011	2012	2013	2014	2015	2017	2018	2019	2020
1	RH	KANODORT20						✔	✔	✔	✔
2	RH	KANODO RT21							✔	✔	✔
3	RH	KANODO RT19						✔	✔	✔	✔
4	RH	KANODO RT18						✔	✔	✔	✔
5	RH	KANODO RT17					✔	✔	✔	✔	✔
7	RH	KANODO RT15					✔	✔	✔	✔	✔
8	RH	KANODO RT14					✔	✔	✔	✔	✔
10	RH	KANODO RT12					✔	✔	✔	✔	✔
12	RH	KANODO RT10					✔	✔	✔	✔	✔
13	RH	KANODO RT07					✔	✔	✔	✔	✔
14	RH	KANODO 9				✔	✔	✔	✔	✔	✔
15	RH	KANODO 8				✔	✔	✔	✔	✔	✔
16	RH	KANODO 6	✔	✔	✔	✔	✔	✔	✔	✔	✔
17	RH	KANODO 4	✔	✔	✔	✔	✔	✔	✔	✔	✔
18	RH	KANODO 5	✔	✔	✔	✔	✔	✔	✔	✔	✔
19	RH	KANLOM RT02							✔	✔	✔
20	RH	KANLOM RT01						✔	✔	✔	✔
21	RH	KANGRA RT01			✔	✔	✔	✔	✔	✔	✔
22	RH	KANACA RT03							✔	✔	✔
23	RH	KANACA RT02						✔	✔	✔	✔
24	RH	KANACA RT01						✔	✔	✔	✔
25	AN	KANGRA 10								✔	✔
26	AN	KANGRA 11								✔	✔
27	AN	KANGRA 12								✔	✔
28	AN	KANGRA 13								✔	✔

Data collection and analysis were undertaken in accordance with the LFA procedures manual developed by Tongway & Hindley (2004). Details of the rehabilitation monitoring program and associated methodologies are detailed in Kanmantoo Mine Vegetation Monitoring – Landscape Function Analysis (EBS Ecology, 2011). A summary of all sites monitored since 2011 is provided at Appendix 1.

3.1.2 Other monitoring related to rehabilitation

The 2020 fauna monitoring program included monitoring of avifauna (birds) and Possums (primarily Common Brushtail – *Trichosurus vulpecula*). Twenty-three avian transects are located over the Project Area; 14 within the Mining Lease (ML) and nine within the SEB area. Results from the Spring 2020 fauna survey are detailed in EBS Ecology (2020).

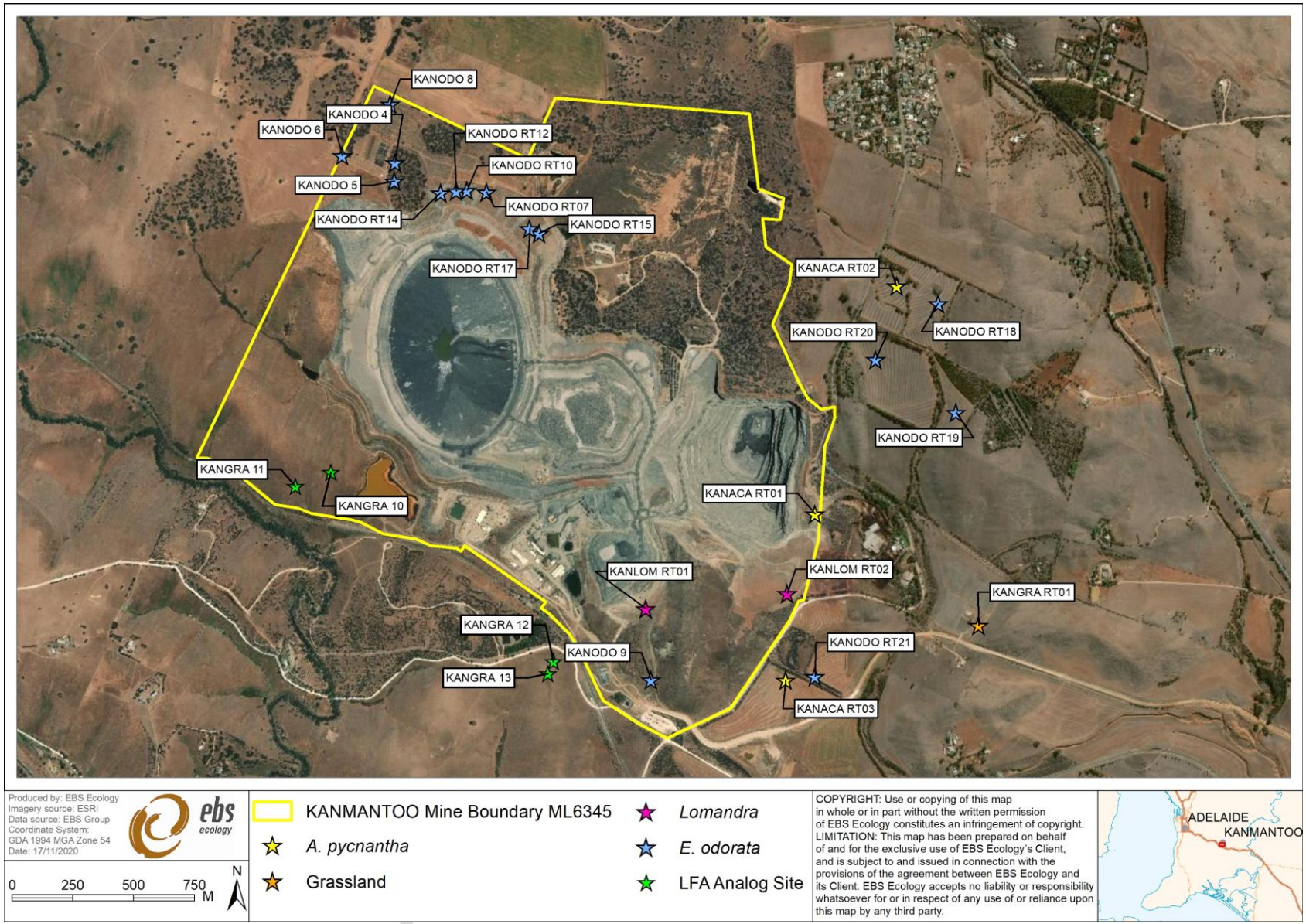


Figure 3. LFA monitoring sites assessed at Kanmantoo Mine in October 2020.

4 LFA RESULTS 2020

4.1 Climate

The nearest reliable long-term climate dataset is located at Kanmantoo (BOM station 23724) for which a long term mean annual rainfall of 462.4 mm has been recorded (Figure 4). The 2019 rainfall total (304.8 mm) was much reduced from the long-term average, even taking into account incomplete data (no data given for December) and was the lowest total recorded since the rehabilitation program inception. This follows on from another low rainfall year (2018) and two years (2016 and 2017) of above average rainfall before then. The 2020 rainfall data is shaping up to be an above average rainfall year with above average rainfall in January, February, April and May this year, with the predicted La Niña phenomenon likely to bring more rain for the rest of the year.

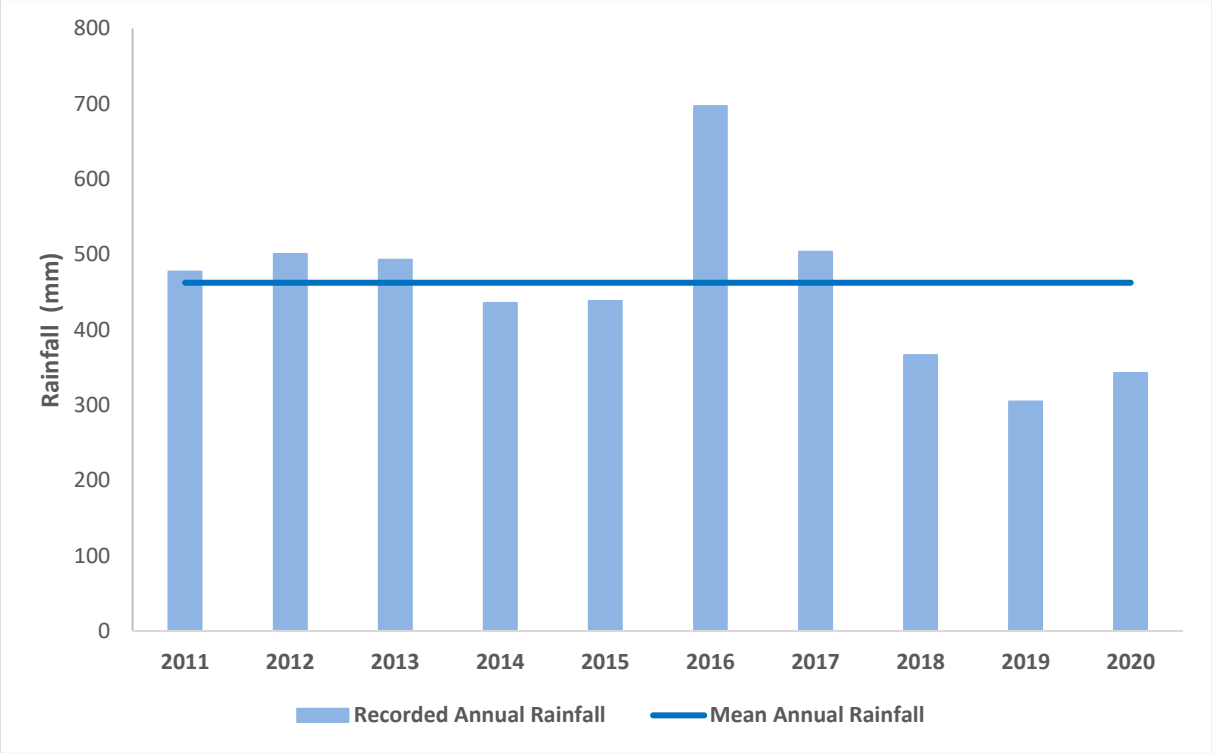


Figure 4. Recorded annual rainfall (2011-2020) and long-term mean annual rainfall (462.4 mm) at Kanmantoo (BOM, 2020).

Note: There is missing data for Oct 2012, Oct 2017 and Dec 2019 and therefore, the total rainfall for these years may be lower than the true value (BOM 2020). Annual Rainfall data for 2020 is limited to the months Jan-Aug, as at the time of the reporting rainfall records for Sept-Dec were not available. Therefore, the total rainfall for 2020 may be higher than the true value (BOM 2020).

4.2 LFA Soil Surface Assessment Results

Results for Soil Surface Assessments (SSA) for individual zones and their contribution to whole of site values are provided in Appendix 2. Baseline data obtained from multiple analogue sites of the same vegetation association were combined to obtain average values (e.g., KANODO 1, 2 and 3) that are used as target values for rehabilitation sites (see chart columns with error bars below).

4.3 *Eucalyptus odorata* (Peppermint Box) Woodland rehabilitation sites

4.3.1 KANODO 04

Site KANODO 04 had soil surface indices approaching analogue values (Figure 5) for stability, infiltration and nutrients after a general reducing trend compared with previous years. Apart from small fluctuations in proportions of Shrub, Tree and Branch Complex patches, the general patch proportions are very similar to 2019 (Figure 6). Landscape organisation was consistent with previous years' observations (Table 2). Visually, this site appears to show little change from previous years (Appendix 2).

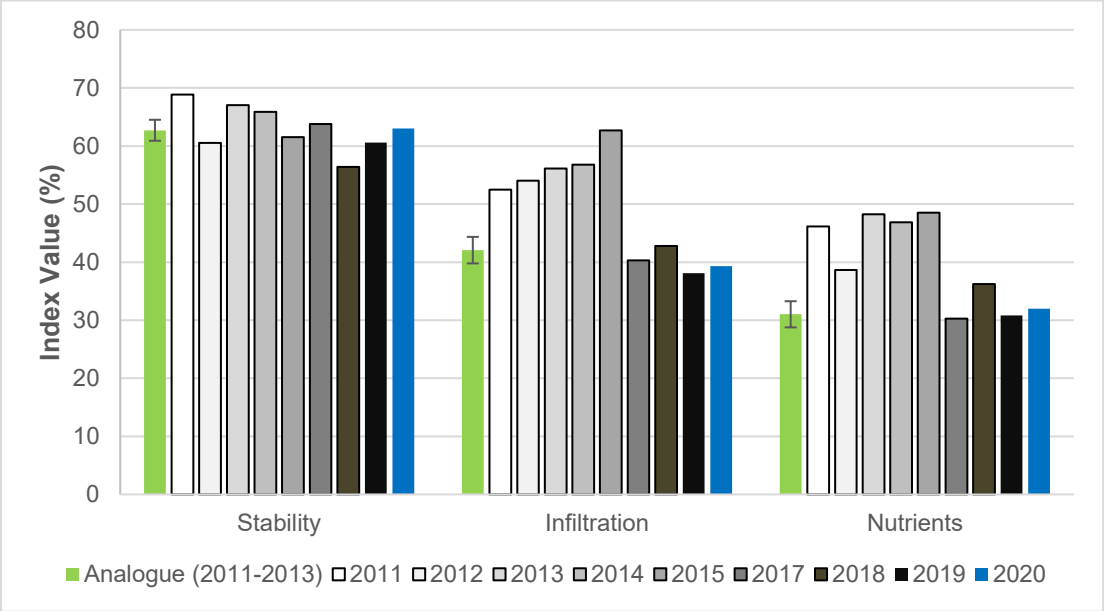


Figure 5. Landscape function indices change (2011-2020) for KANODO 4 with respect to mean analogue site values (2011-2013).

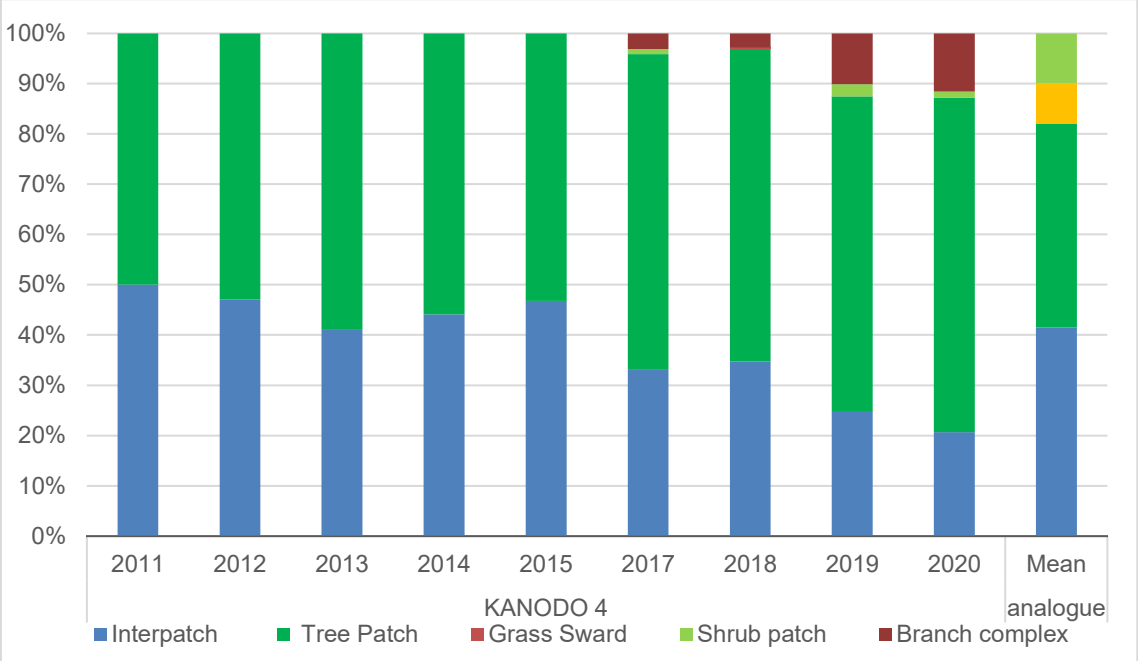


Figure 6. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO 4 2011-2020.

Table 2. Summary of the landscape organisation data for KANODO analogue and KANODO4 rehabilitation site 2011-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.6**
KANODO4 Rehabilitation 2011	0.6	269.1	9	0.5
KANODO4 Rehabilitation 2012	0.6	291.3	6.32	0.529
KANODO4 Rehabilitation 2013	0.7	309.6	5.5	0.6
KANODO4 Rehabilitation 2014	0.6	300.2	7.88	0.6
KANODO4 Rehabilitation 2015	0.6	275.5	5.9	0.5
KANODO4 Rehabilitation 2017	1.3	270.8	2.55	0.67
KANODO4 Rehabilitation 2018	1.3	268.7	2.65	0.65
KANODO4 Rehabilitation 2019	1.5	306.4	1.91	0.75
KANODO4 Rehabilitation 2020	1.3	336.3	1.59	0.79

4.3.2 KANODO 05

KANODO 05 showed all indices with slightly increased values from 2019. This is a contrast to the decreasing trend in the past few years (Figure 7). Transect proportions indicated a slight decrease in complexity compared to 2019, with a smaller proportion of shrub and branch complex patches. However, this may be due to the canopy of the tree patches growing to cover more of the transect, including shrubs and branch complexes that otherwise would have been assessed separately (Figure 8). The landscape organisation summary shows patchiness increasing towards analogue values, which is associated with the shrub and branch complex cover, components that were initially absent in the degraded, unrestored community (Table 3).

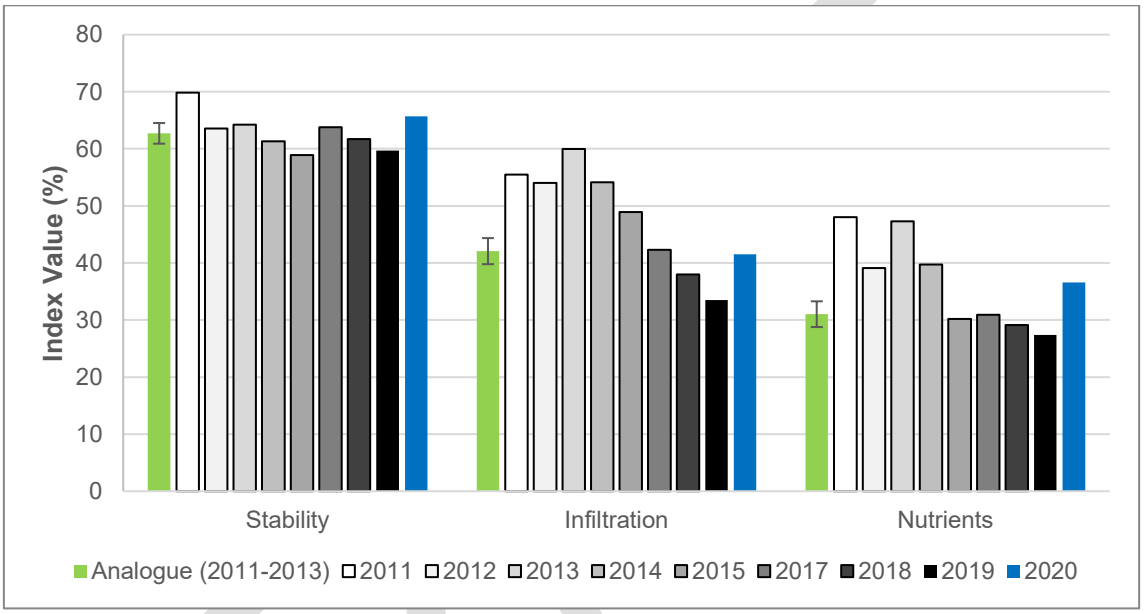


Figure 7. Landscape function indices change (2011-2020) for KANODO5 with respect to mean analogue site values (2011-2013).

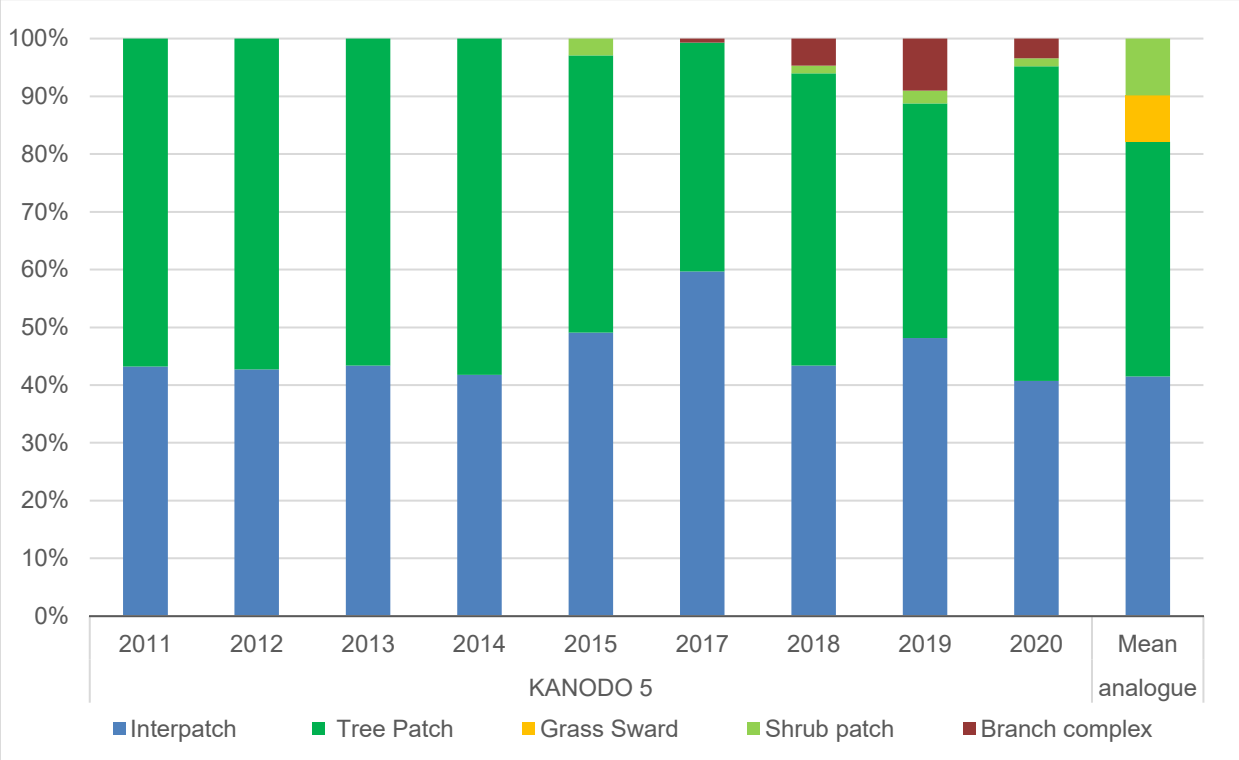


Figure 8. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO05.

Table 3. Summary of the landscape organisation data for KANODO analogue and KANODO5 rehabilitation site 2011-2020.

Site Type	No. of patch zones per 10m	Total patch area (m²)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.6**
KANODO5 Rehabilitation 2011	0.35	324.6	8.21	0.57
KANODO5 Rehabilitation 2012	0.68	252	4.7	0.57
KANODO5 Rehabilitation 2013	0.45	249.50	6.38	0.57
KANODO5 Rehabilitation 2014	0.45	256.60	4.61	0.58
KANODO5 Rehabilitation 2015	1.1	195.99	1.97	0.5
KANODO5 Rehabilitation 2017	0.9	226.0	5.28	0.4
KANODO5 Rehabilitation 2018	1.6	178.9	2.74	0.57
KANODO5 Rehabilitation 2019	2.5	146	1.93	0.52
KANODO5 Rehabilitation 2020	1.1	203.2	2.99	0.59

4.3.3 KANODO 06

Landscape function values for 2020 showed small variability from previous years which demonstrate low rates of change within the remnant communities, and are all very close to analogue values (Figure 9). Transect proportions show slight decreases in both shrub and tree patch areas compared to the previous three years (Figure 10). It is possible that the very high numbers of kangaroos do not allow very rapid recolonisation and establishment of herbaceous species. Qualitatively, the transect appears to have marginally decreased shrub growth from previous years (Table 4).

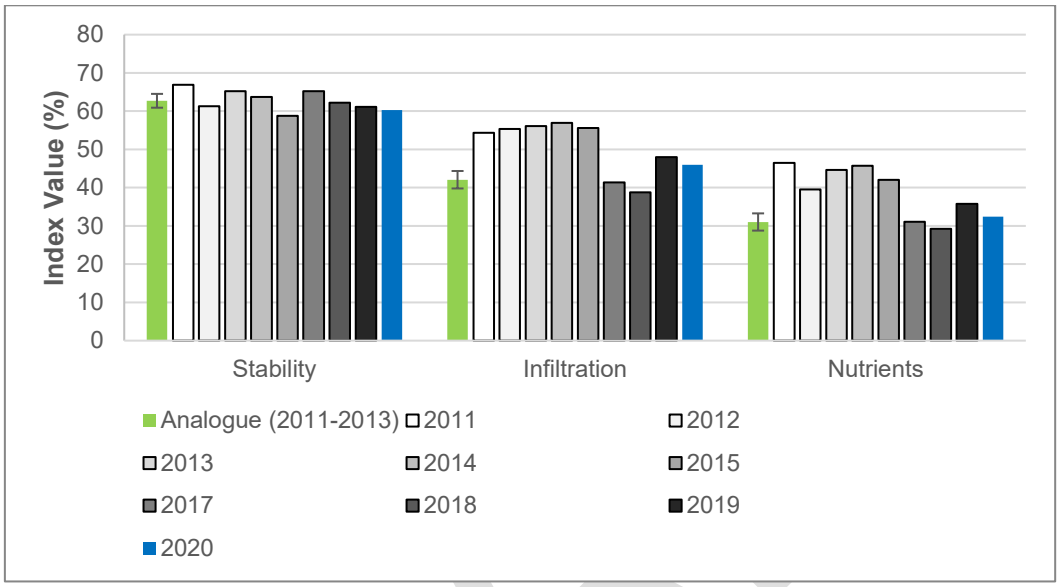


Figure 9. Landscape function indices change (2011-2020) for KANODO6 with respect to mean analogue site values (2011-2013).

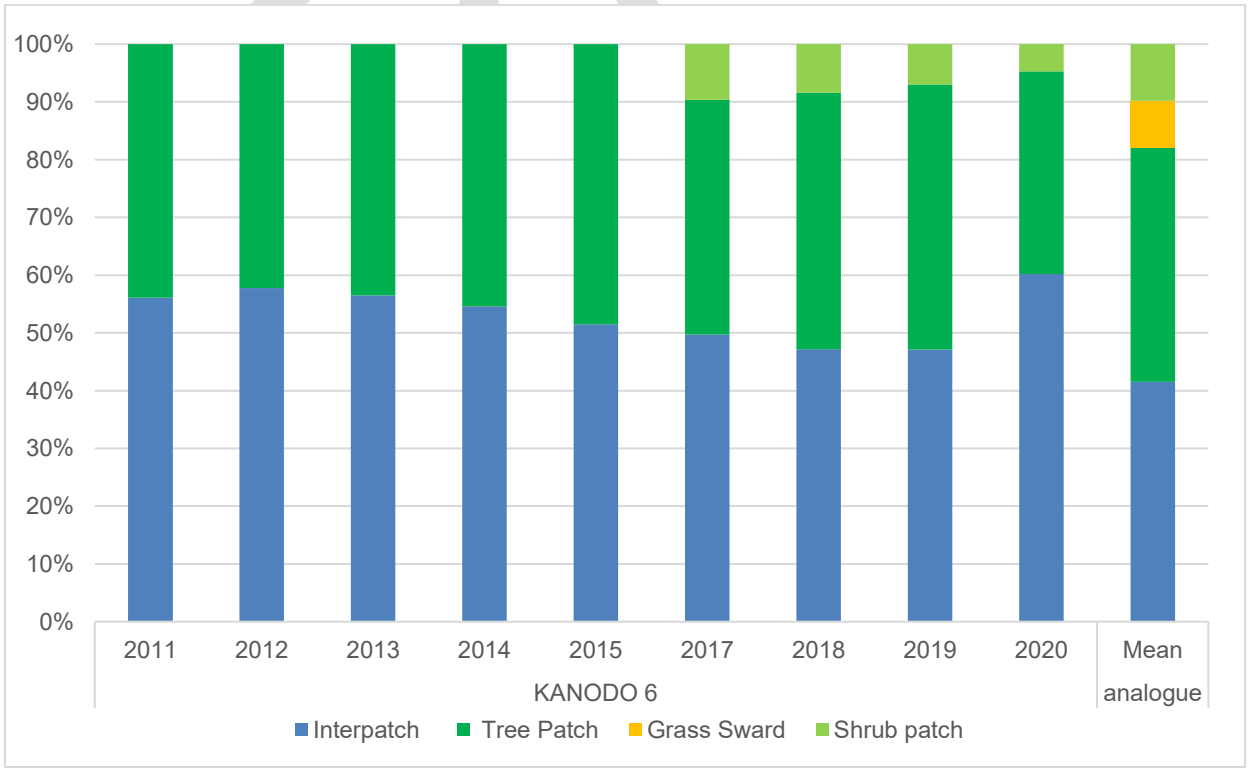


Figure 10. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO06.

Table 4. Summary of the landscape organisation data for KANODO analogue and KANODO6 rehabilitation site 2011-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.6**
KANODO6 Rehabilitation 2011	0.43	194.68	12.9	0.44
KANODO6 Rehabilitation 2012	0.2	194.00	5.92	0.4
KANODO6 Rehabilitation 2013	0.44	196.04	12.97	0.44
KANODO6 Rehabilitation 2014	0.43	208.9	12.56	0.45
KANODO6 Rehabilitation 2015	0.43	215.00	6.1	0.47
KANODO6 Rehabilitation 2017	1.3	171.0	4.59	0.50
KANODO6 Rehabilitation 2018	1.3	168.3	3.1	0.53
KANODO6 Rehabilitation 2019	1.3	174	3.62	0.53
KANODO6 Rehabilitation 2020	1.1	134.5	4.62	0.40

4.3.4 KANODO 08

This site has performed well with a transition from an exotic grassland into a moderately complex restored area. Although the stability and nutrient indices have decreased compared to 2019, the stability index still remains higher than values from 2014 and 2015, and the nutrient index remains higher than all year's bar 2019. Infiltration has increased towards analogue values (Figure 11). Proportions of cover have changed slightly from 2019, with the introduction of Herb Patches and Grass/Shrub Patches for the first time, however, Tree Patches that were recorded in 2018 and 2019 have disappeared (Figure 12). The Landscape Organisational Index has decreased away from analogue values, compared to 2019 (Table 5).

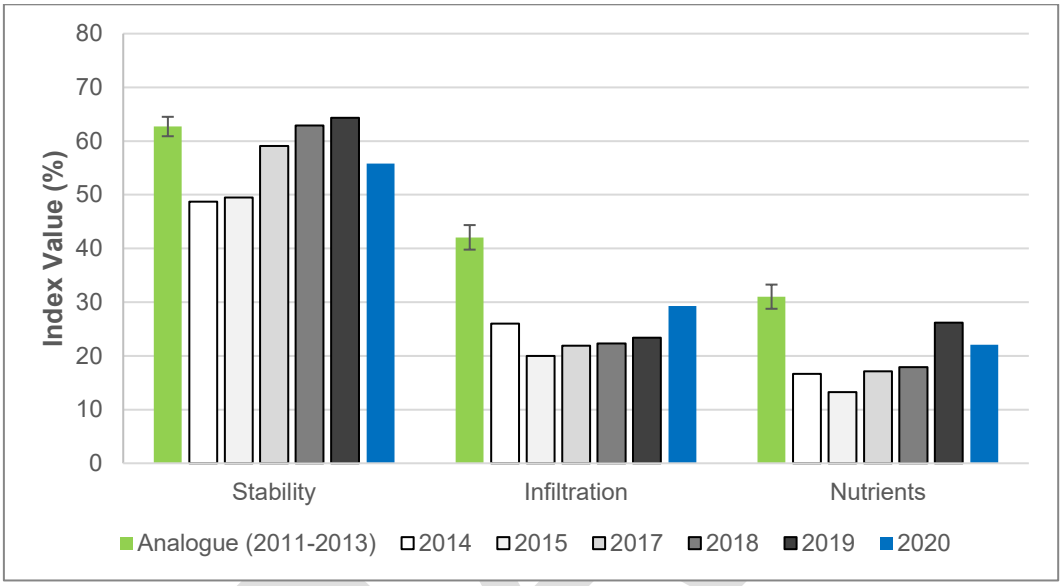


Figure 11. Landscape function indices change (2014-2020) for KANODO 08 with respect to mean analogue site values (2011-2013).

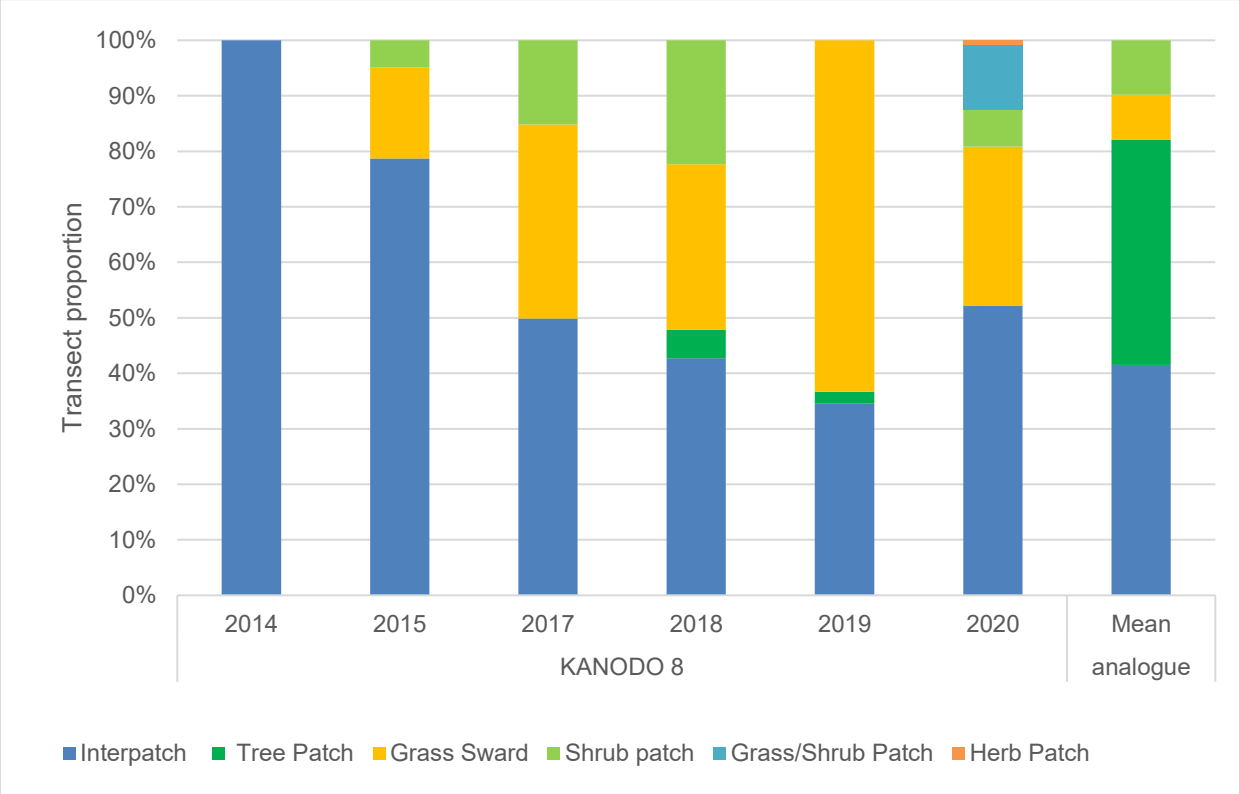


Figure 12. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO 08.

Table 5. Summary of the landscape organisation data for KANODO analogue and KANODO 08 rehabilitation site 2014-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.40**	**1.80**	**0.6**
KANODO8 Rehabilitation 2014	0	0	20	0
KANODO8 Rehabilitation 2015	4.5	20	1.5	0.21
KANODO8 Rehabilitation 2017	1.3	17.1	4.59	0.37
KANODO8 Rehabilitation 2018	10.9	5.3	0.41	0.57
KANODO8 Rehabilitation 2019	11.8	12.4	0.29	0.65
KANODO8 Rehabilitation 2020	14.0	15.1	0.45	0.48

4.3.5 KANODO 09

KANODO 09 showed decreases in all three landscape function indices compared to 2019. Whereas the soil stability index has moved towards analogue values, infiltration and nutrient indices remain lower than analogue values (Figure 13). Proportions of grass swards and shrub patches have decreased compared to 2019 (Figure 14) which is the likely cause for a lower landscape organisational index in 2020 (Table 6).

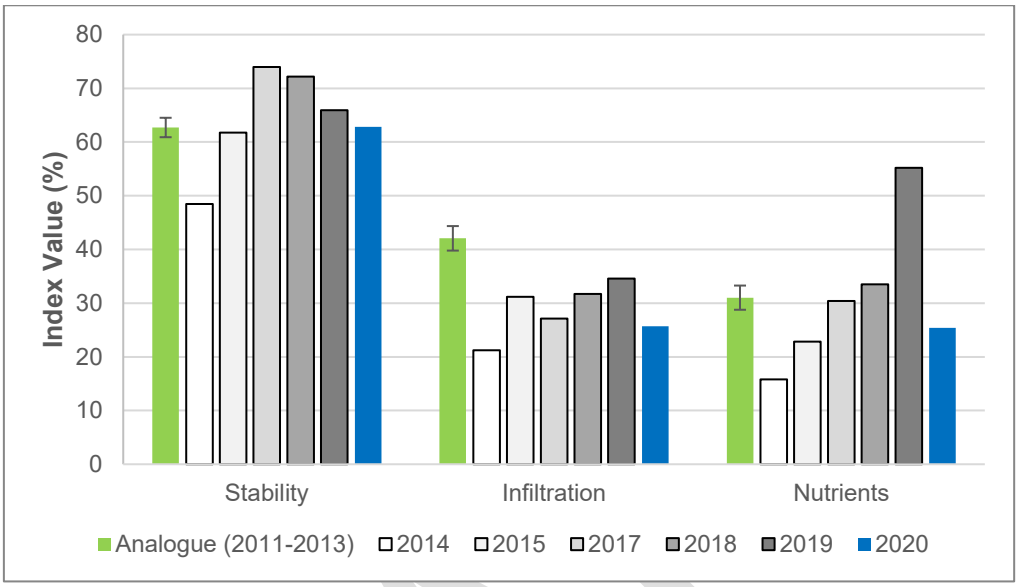


Figure 13. Landscape function indices change (2014-2020) for KANODO 09 with respect to mean analogue site values (2011-2013).

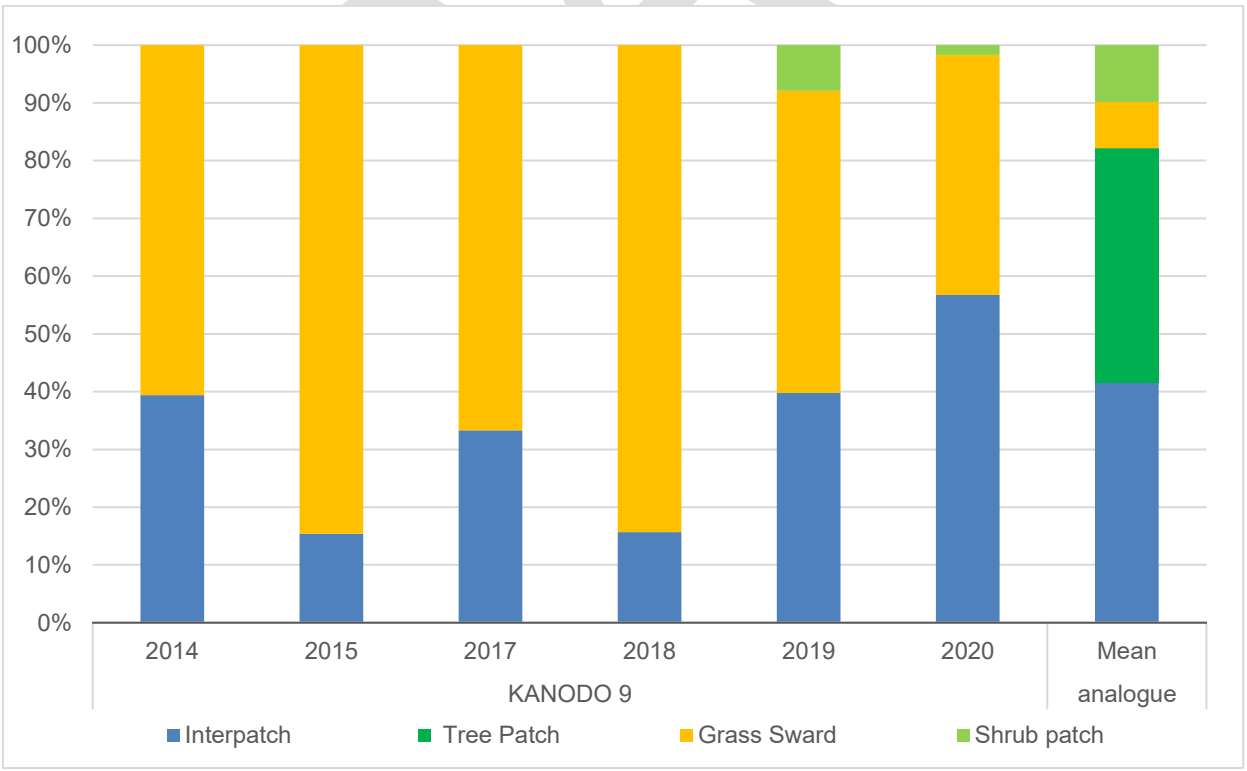


Figure 14. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO 09.

Table 6. Summary of the landscape organisation data for KANODO analogue and KANODO 09 rehabilitation site 2014-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.40**	**1.80**	**0.6**
KANODO9 Rehabilitation 2014	3.6	95.50	1.09	0.61
KANODO9 Rehabilitation 2015	1.9	136.20	0.80	0.90
KANODO9 Rehabilitation 2017	4.8	111.30	0.76	0.70
KANODO9 Rehabilitation 2018	2.0	166.90	0.67	0.84
KANODO9 Rehabilitation 2019	6.0	83	0.71	0.60
KANODO9 Rehabilitation 2020	9.3	28.9	0.61	0.43

4.3.6 KANODO RT 07

KANODO RT 07 showed decreases in soil infiltration and nutrients and a lack of stabilisation towards analogue value for soil stability in 2020 (Figure 15). This may be a result of recent rains flushing organic material out of the survey site. The percentage cover of each of the Surface Soil Assessment zones remain similar to the proportions of 2019 (Figure 16). Patch sizes and inter-patch lengths have increased compared to 2019, leading to a Landscape Organisational Index approaching analogue values (Table 7).

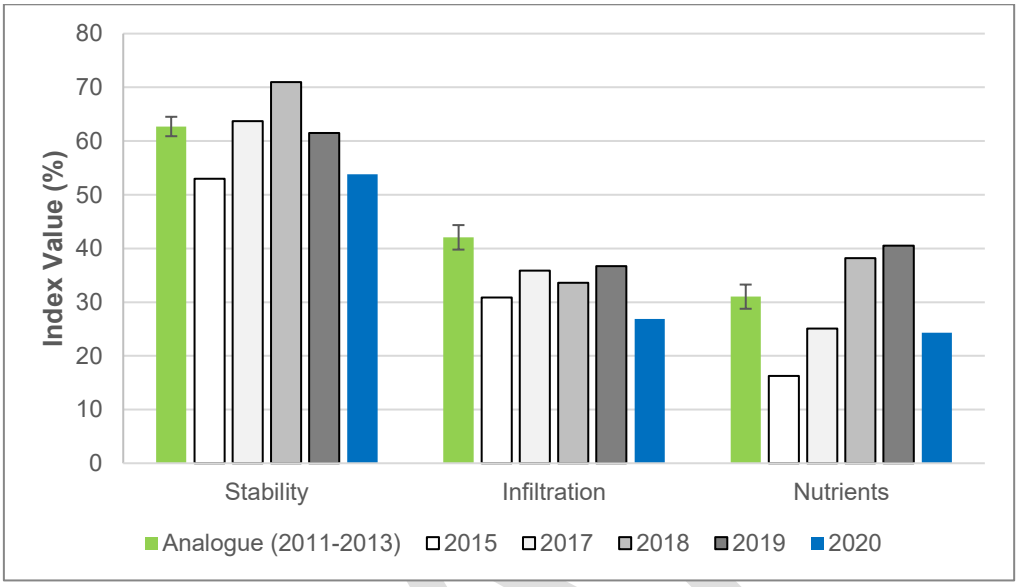


Figure 15. Landscape function indices change (2015-2020) for KANODO RT 07 with respect to mean analogue site values (2011-2013).

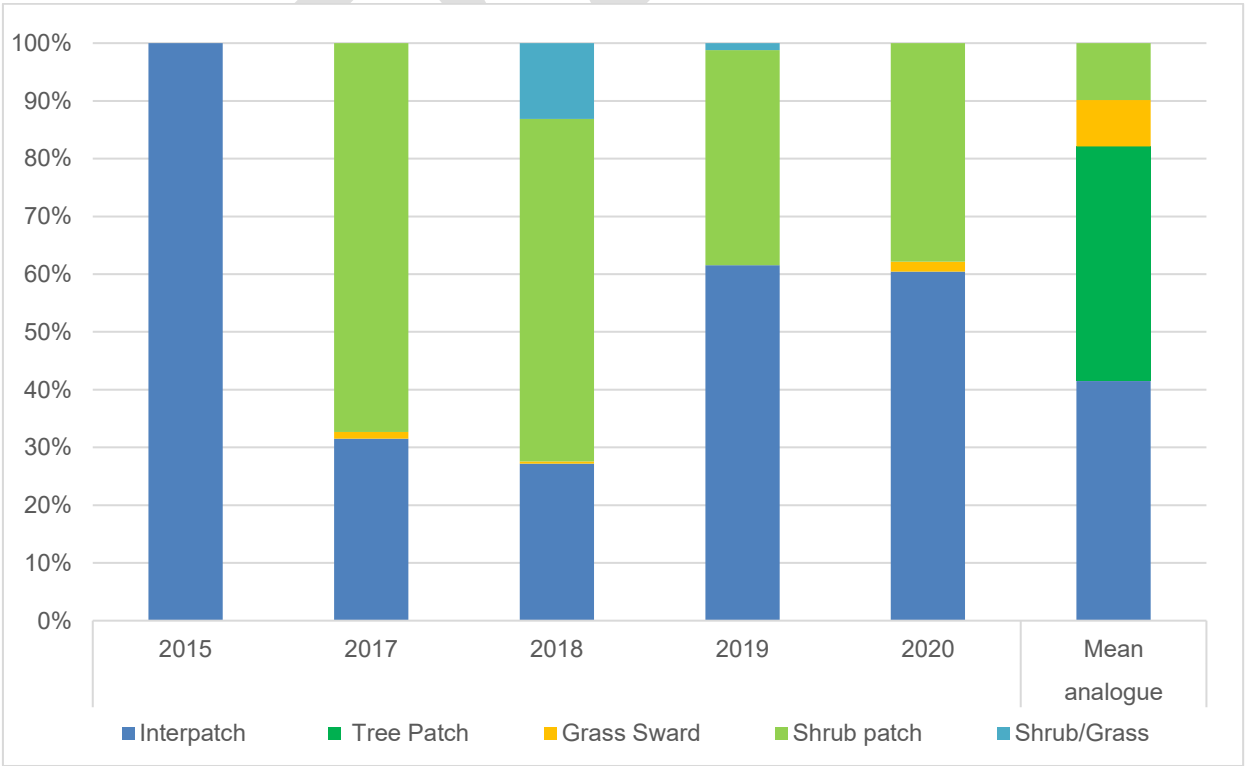


Figure 16. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO RT 07.

Table 7. Summary of the landscape organisation data for KANODO analogue and KANODO RT 07 rehabilitation site 2015-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.4**	**1.80**	**0.6**
KANODO_RT07 Rehabilitation 2015	0	0	1.50	0
KANODO_RT07 Rehabilitation 2017	3.1	79.9	1.28	0.68
KANODO_RT07 Rehabilitation 2018	3.1	83.1	1.10	0.73
KANODO_RT07 Rehabilitation 2019	5.6	8.7	1.10	0.38
KANODO_RT07 Rehabilitation 2020	4.2	26.8	1.44	0.40

4.3.7 KANODO RT 10

KANODO RT 10 remains below mean analogue values, with all three indices decreasing slightly from 2019, although with infiltration and nutrients remaining above index values from 2018 (Figure 17). Proportion of shrub cover increased from 2019, but the tree cover that was evident in 2019 disappeared, and the proportion of grass swards also fell from 2019 (Figure 18). Landscape organisational data continues to trend towards analogue values (Table 8).

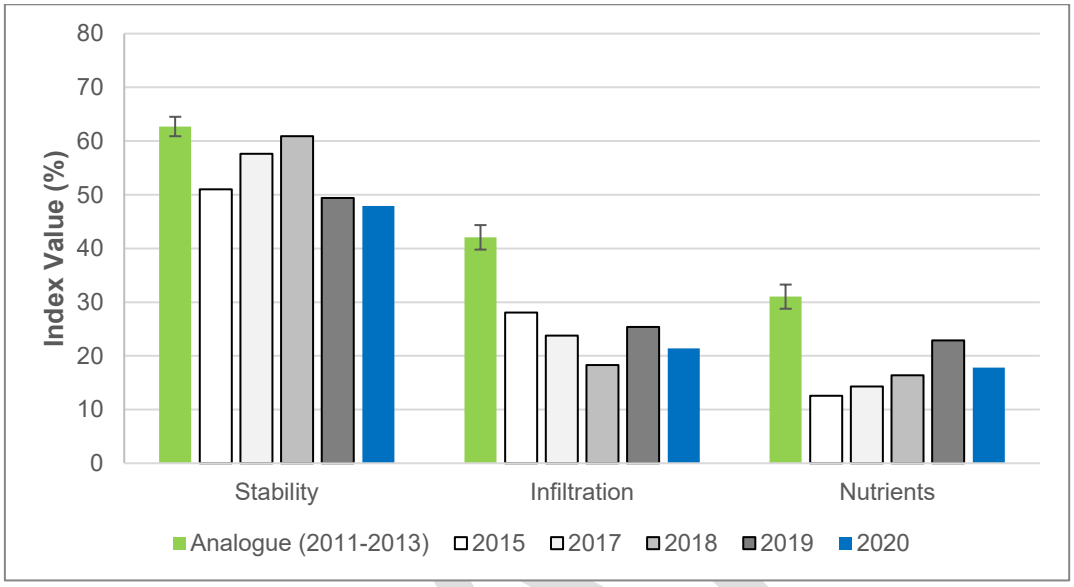


Figure 17. Landscape function indices change (2015-2020) for KANODO RT 10 with respect to mean analogue site values (2011-2013).

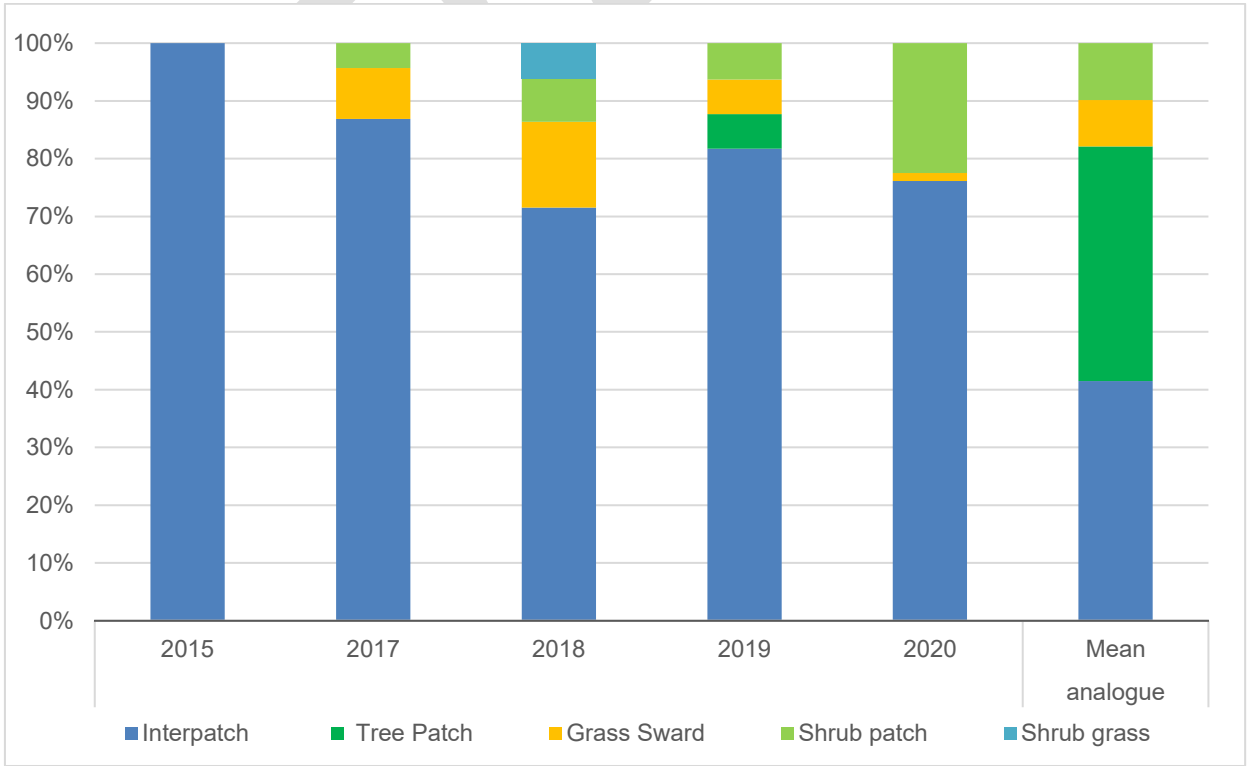


Figure 18. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO RT 10.

Table 8. Summary of the landscape organisation data for KANODO analogue and KANODO RT 10 rehabilitation site 2015-2020.

Site Type	No. of patch zones per 10m	Total patch area (m²)	Average inter-patch length (m)	Landscape Organisational Index
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.6**
KANODO_RT10 Rehabilitation 2015	0	0	20	0
KANODO_RT10 Rehabilitation 2017	5.3	1.7	1.64	0.13
KANODO_RT10 Rehabilitation 2018	5.3	2.3	1.36	0.29
KANODO_RT10 Rehabilitation 2019	6.4	3.3	1.28	0.18
KANODO_RT10 Rehabilitation 2020	3.7	7.0	2.07	0.24

4.3.8 KANODO RT 12

All landscape function indices for KANODO RT 12 have increased compared to 2019, and are either approaching or exceeding analogue values (Figure 19). The shrub patch cover recorded as a smaller element in 2019 has increased to proportions similar to 2017 and 2018 (Figure 20). Landscape organisation was consistent with observations from years 2017 and 2018, with an index much higher than 2019 (Table 9).

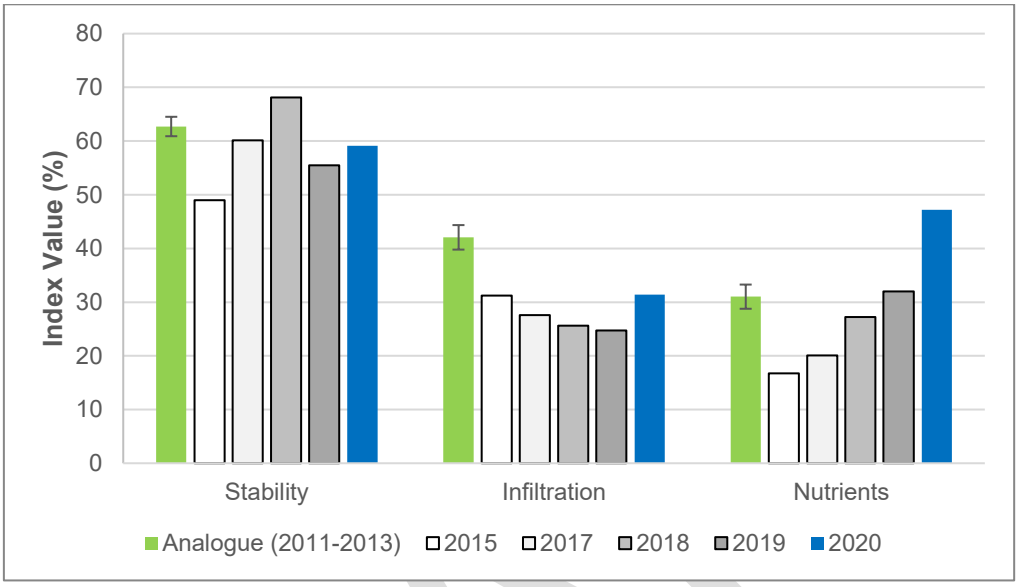


Figure 19 Landscape function indices change (2015-2020) for KANODO RT 12 with respect to mean analogue site values (2011-2013).

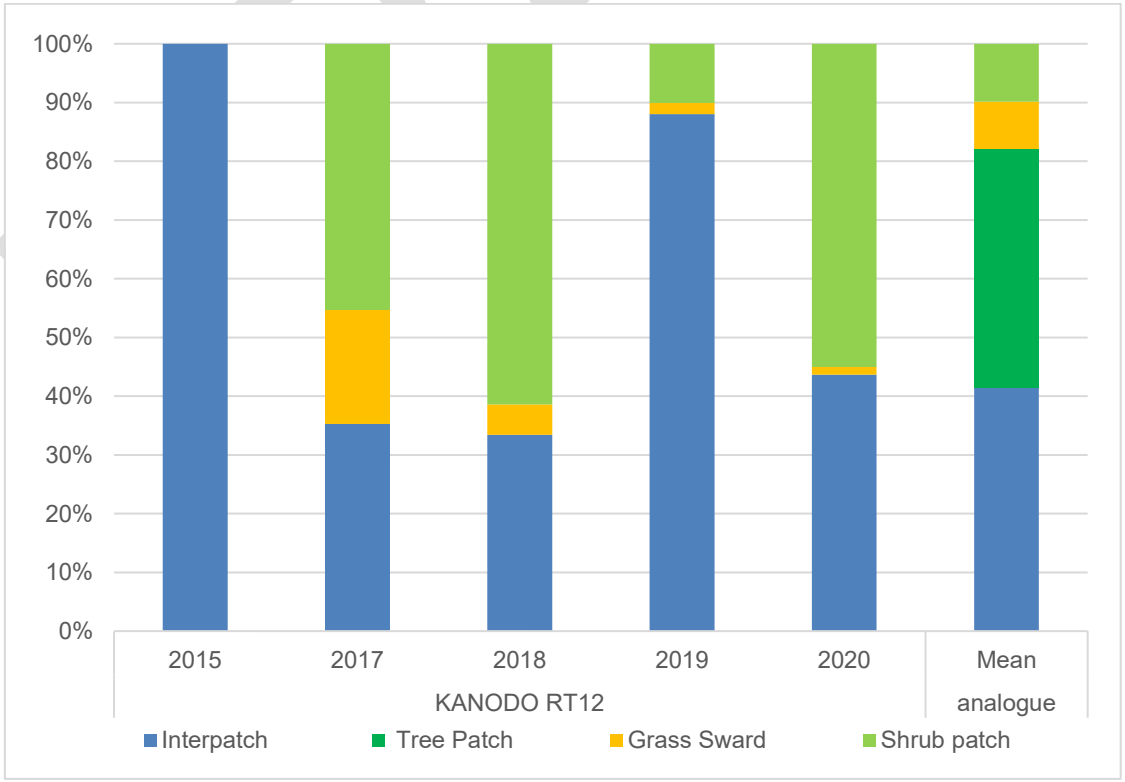


Figure 20. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO RT 12 (2015-2020).

Table 9. Summary of the landscape organisation data for KANODO analogue and KANODO RT 12 rehabilitation site 2015-2020.Table 9

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.6**
KANODO_RT12 Rehabilitation 2015	0	0	20	0
KANODO_RT12 Rehabilitation 2017	4.1	45.9	0.87	0.65
KANODO_RT12 Rehabilitation 2018	4.7	32.2	0.78	0.67
KANODO_RT12 Rehabilitation 2019	4.8	4.6	1.16	0.17
KANODO_RT12 Rehabilitation 2020	4.1	12.6	1.08	0.56

4.3.9 KANODO RT 14

KANODO RT 14 showed very similar infiltration and nutrient index values as the past three years (2017-2019), and a decrease in stability, continuing the decreasing trend since 2017 (Figure 21). This suggests that this site is stabilising below analogue values. The proportion of shrub and grass cover has decreased compared to 2019 (Figure 22). The Landscape Organisational Index for KANODO RT 14 continues to decrease away from analogue values, suggesting that this site may require more intervention to meet target outcomes.

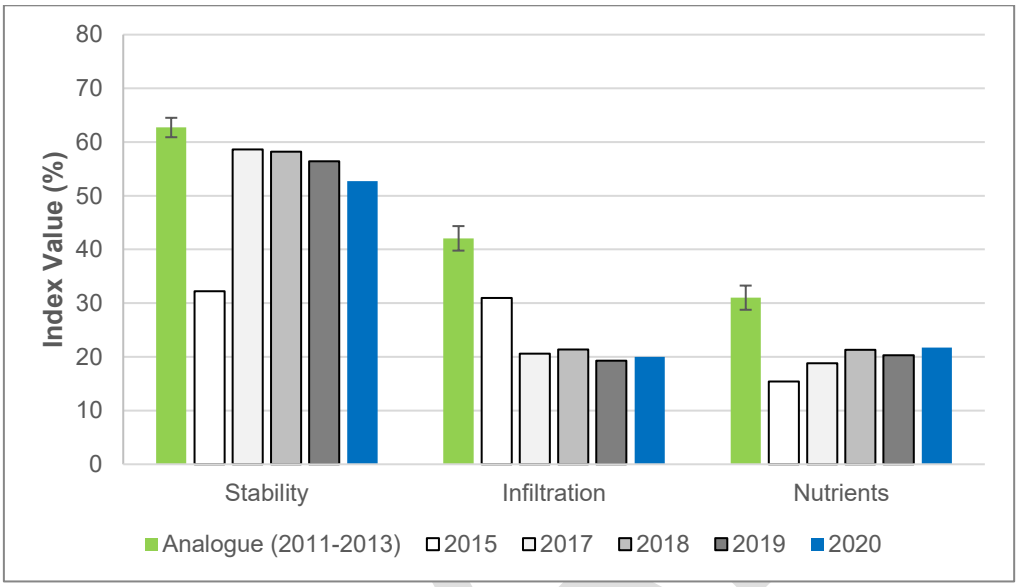


Figure 21. Landscape function indices change (2015-2020) for KANODO RT 14 with respect to mean analogue site values (2011-2013).

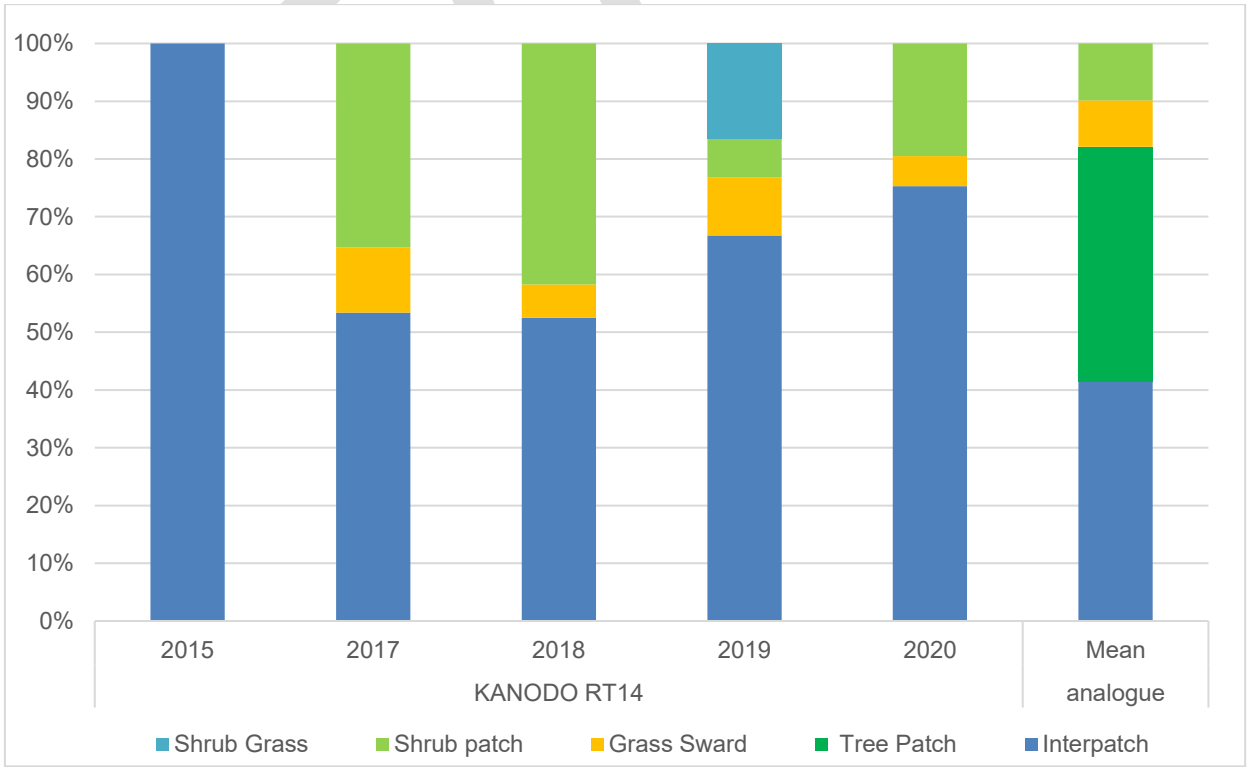


Figure 22. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO RT 14.

Table 10. Summary of the landscape organisation data for KANODO analogue and KANODO RT 14 rehabilitation site 2015-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.6**
KANODO_RT14 Rehabilitation 2015	0	0	15	0
KANODO_RT14 Rehabilitation 2017	5	22.6	1.31	0.47
KANODO_RT14 Rehabilitation 2018	4.5	24.4	1.17	0.47
KANODO_RT14 Rehabilitation 2019	8.1	12.3	0.82	0.33
KANODO_RT14 Rehabilitation 2020	5.4	13.6	1.39	0.25

4.3.10 KANODO RT 15

KANODO RT 15 displayed a decrease across all three soil surface indicators in comparison to 2019 (Figure 23). Trough zone cover reduced in 2020, and with small grass swards appearing, indicating reduced weathering of the surface is occurring (Figure 24). Patchiness has decreased to below analogue values at an average of 2.1 patches observed per 10m, a decrease from 2019 (Table 11).

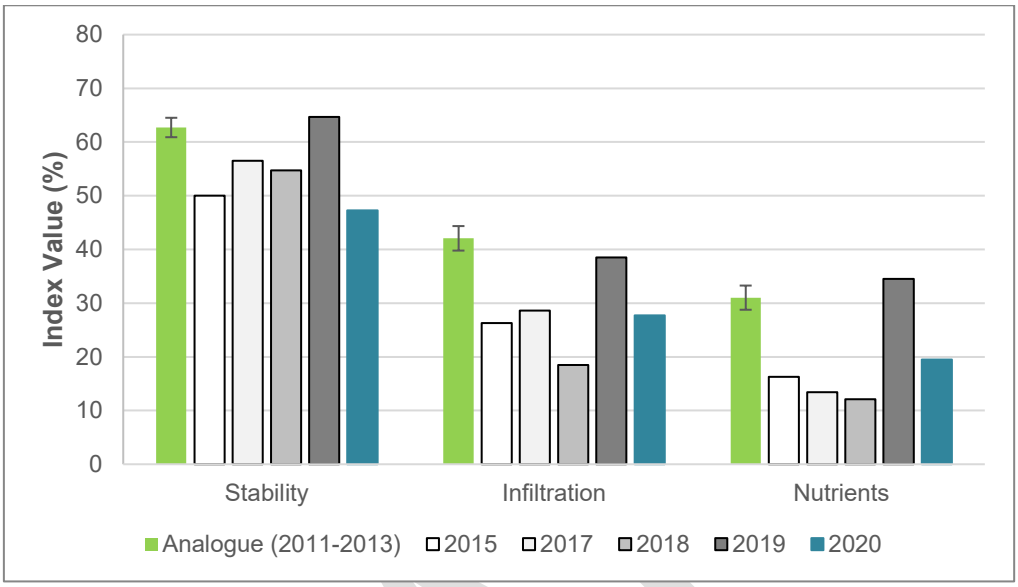


Figure 23. Landscape function indices change (2015-2020)) for KANODO RT 15 with respect to mean analogue site values (2011-2013).

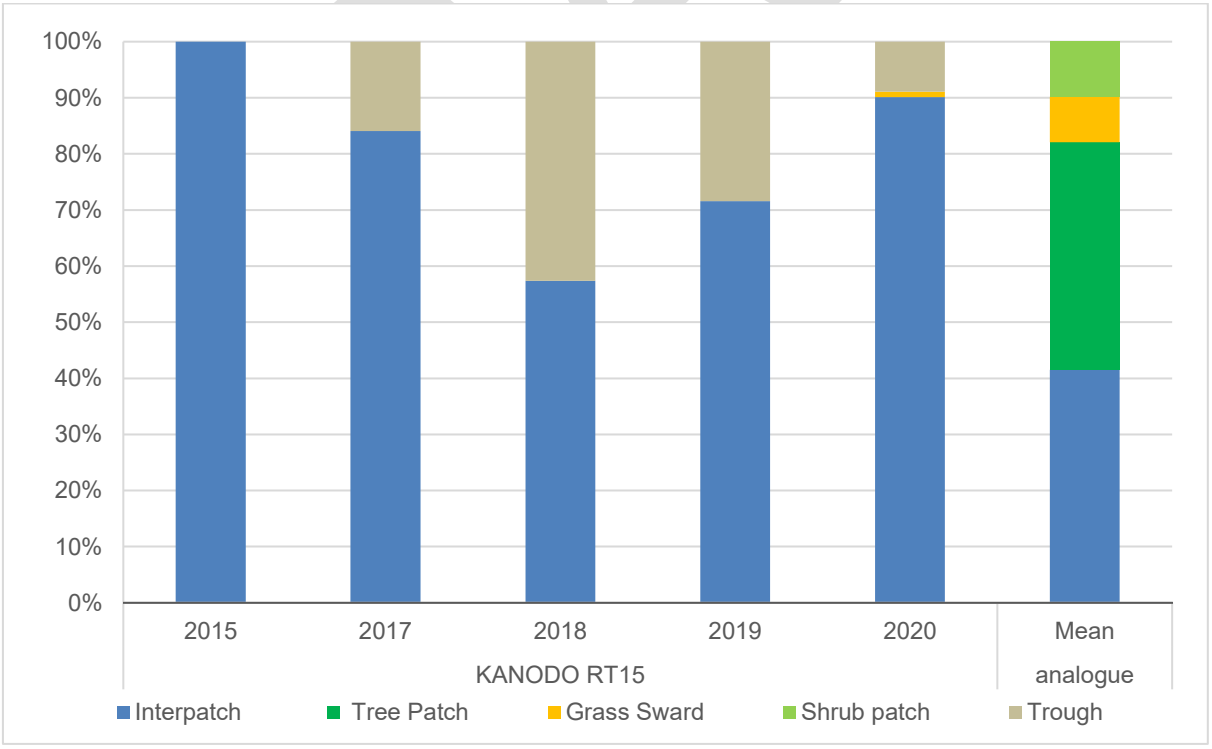


Figure 24. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO RT 15.

Table 11. Summary of the landscape organisation data for KANODO analogue and KANODO RT 15 rehabilitation site 2015-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.6**
KANODO_RT15 Rehabilitation 2015	0	0	20	0
KANODO_RT15 Rehabilitation 2017	10.1	15.1	0.83	0.16
KANODO_RT15 Rehabilitation 2018	12.3	41.6	0.47	0.43
KANODO_RT15 Rehabilitation 2019	9.0	27.8	0.79	0.28
KANODO_RT15 Rehabilitation 2020	2.1	33.8	4.33	0.10

4.3.11 KANODO RT 17

All landscape function indices were lower than 2019, being more similar to those of 2018 (Figure 25). The shrub patch zone which emerged in 2018 and was much reduced in cover in 2019 disappeared in 2020 (Figure 26). Although patch area has increased, the length between patches has increased, leading to a lower Landscape Organisational Index compared to the past two years (Table 12).

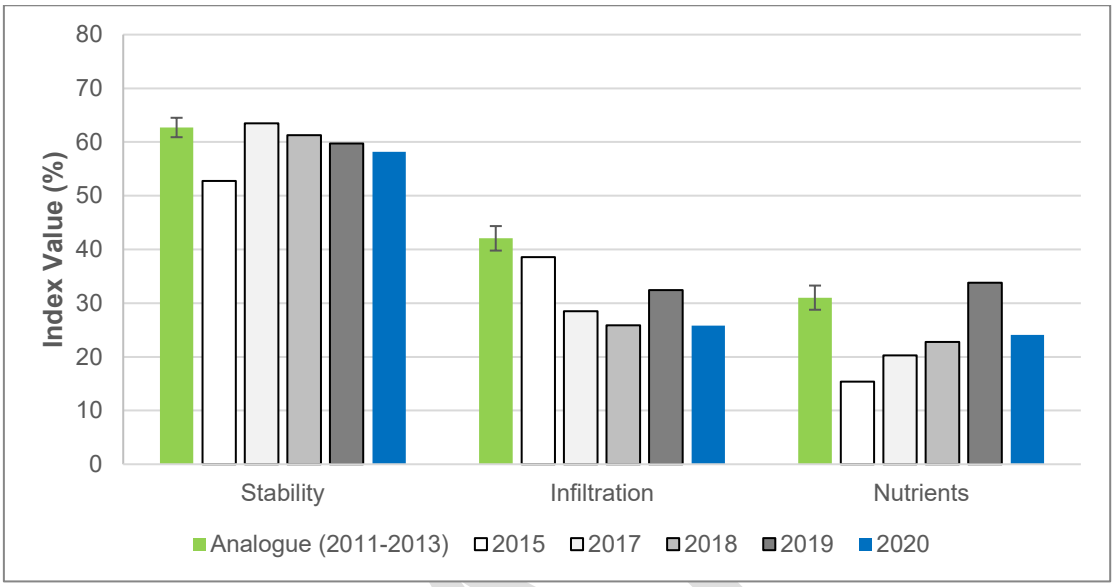


Figure 25. Landscape function indices change (2015-2020) for KANODO RT 17 with respect to mean analogue site values (2011-2013).

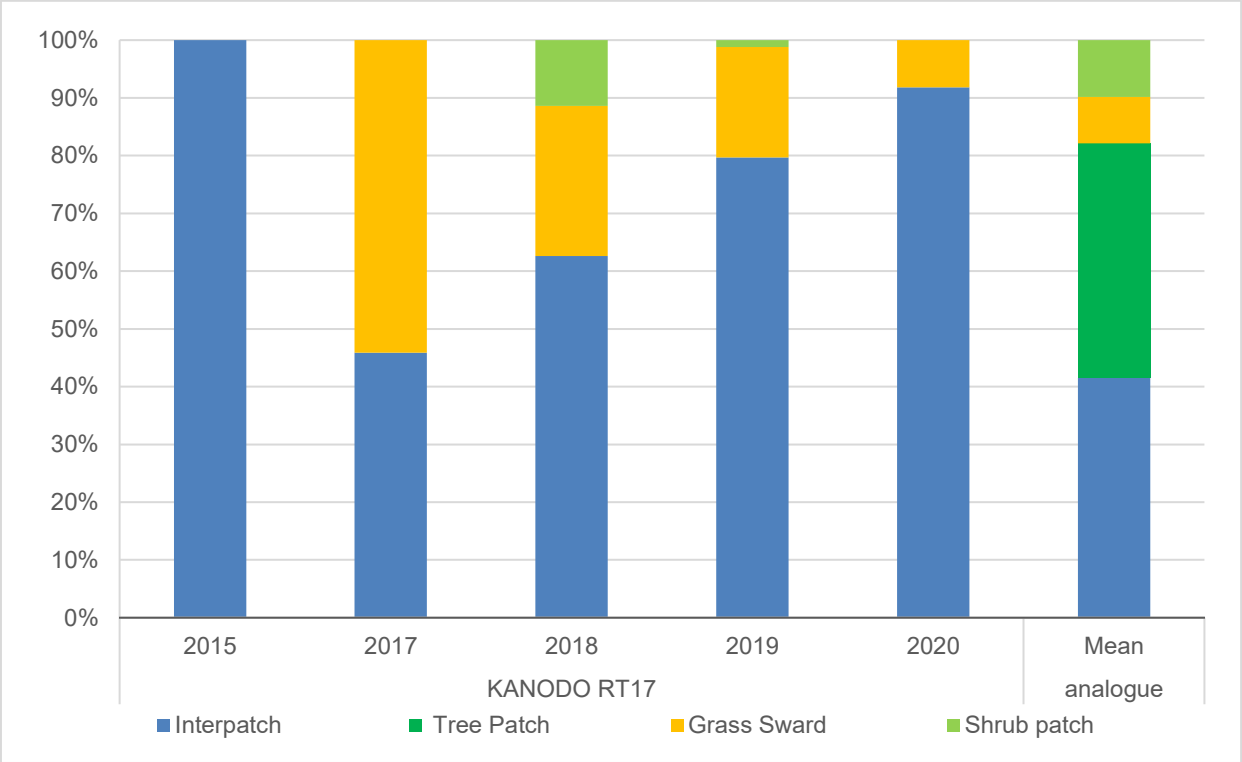


Figure 26. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO RT 17.

Table 12. Summary of the landscape organisation data for KANODO analogue and KANODO RT 17 rehabilitation site 2015-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.6**
KANODO_RT17 Rehabilitation 2015	0	0	20	0
KANODO_RT17 Rehabilitation 2017	4.7	102.9	1.06	0.54
KANODO_RT17 Rehabilitation 2018	6.6	5.2	1.05	0.37
KANODO_RT17 Rehabilitation 2019	9.3	1.1	0.86	0.20
KANODO_RT17 Rehabilitation 2020	6.3	15.3	1.33	0.08

4.3.12 KANODO RT 18, 19, 20, 21

These sites are all similar in terms of their location and restoration histories and as such all display similar trajectories towards analogue values for soil surface values (Figure 27, Figure 29, Figure 31, and Figure 33) as a dense tussock grass sward develops.

The transect proportions for these sites shows a majority covering of grass swards for all sites, with KANODO RT 18, 19 and 20 showing distinct shrub patches for the first time in 2020. All sites also have very low patch length and high patch area values (Table 13, Table 14, Table 15, and Table 16).

From a visual perspective, there is an obvious increase in grass tussock size, spread of chenopod groundcovers and *Acacia* / shrub emergence. A gradual transition is expected within these communities as more overstorey components begin to develop (see photo points at Appendix 3).

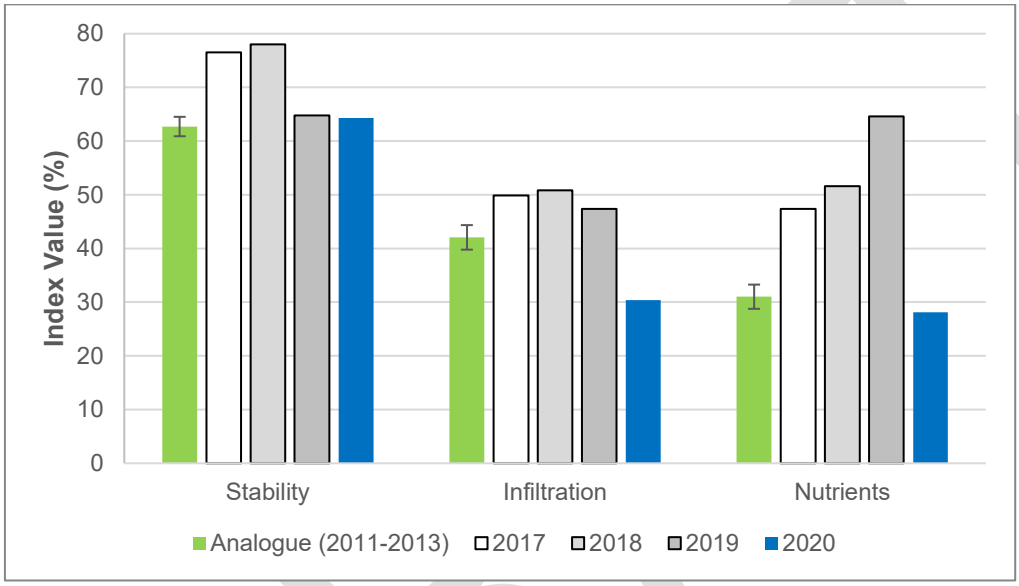


Figure 27. Landscape function indices change (2017-2020) for KANODO RT 18 with respect to mean analogue site values (2011-2013).

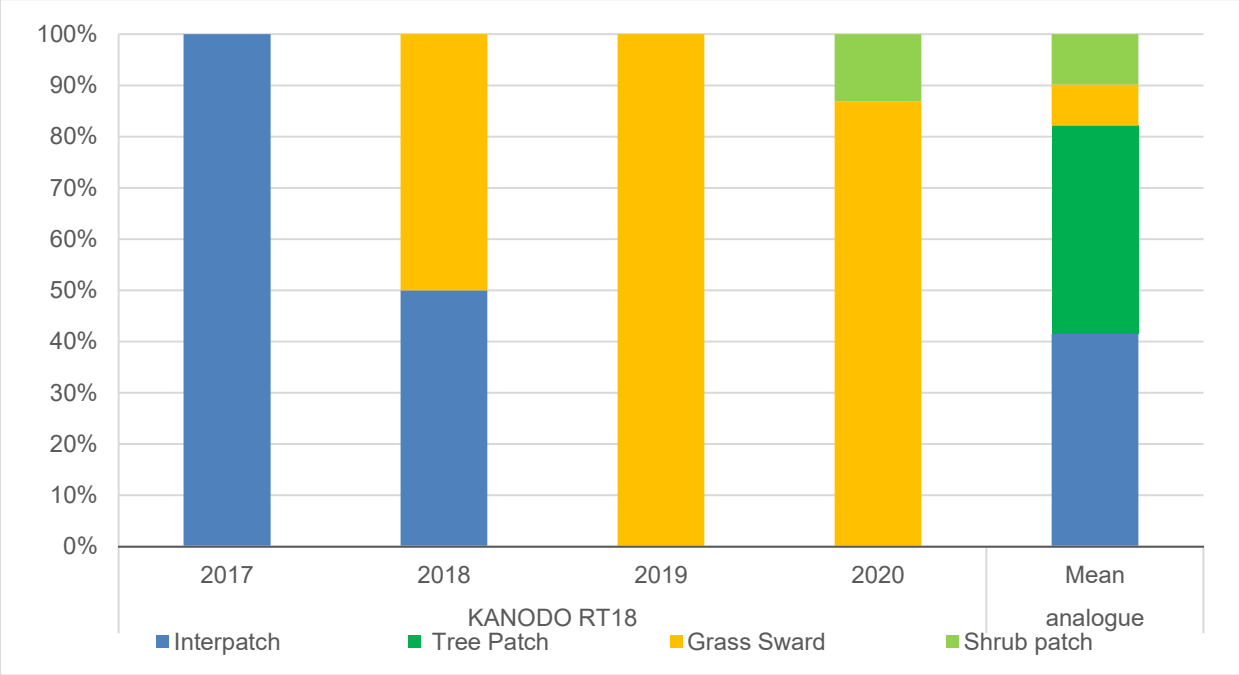


Figure 28. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO RT 18.

Table 13. Summary of the landscape organisation data for KANODO analogue and KANODO RT 18 rehabilitation site 2017-2020.

Site Type	No. of patch zones per 10m	Total patch area (m²)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.60**
KANODO_RT18 Rehabilitation 2017	0.3	125	0	1.00
KANODO_RT18 Rehabilitation 2018	0.4	125	0	1.00
KANODO_RT18 Rehabilitation 2019	0.5	95	0	1.00
KANODO_RT18 Rehabilitation 2020	2.4	116.6	0	1.00

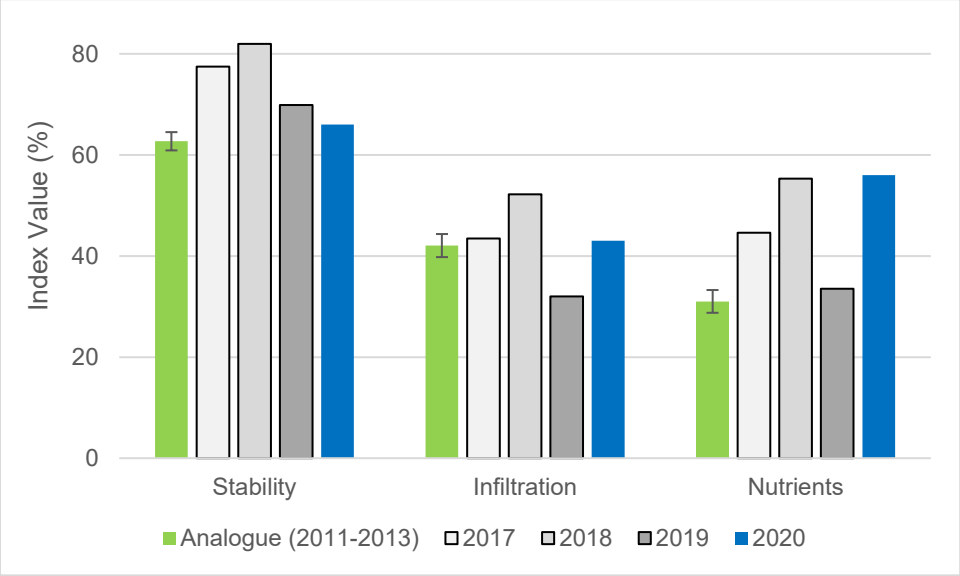


Figure 29. Landscape function indices change (2017-2020) for KANODO RT 19 with respect to mean analogue site values (2011-2013).

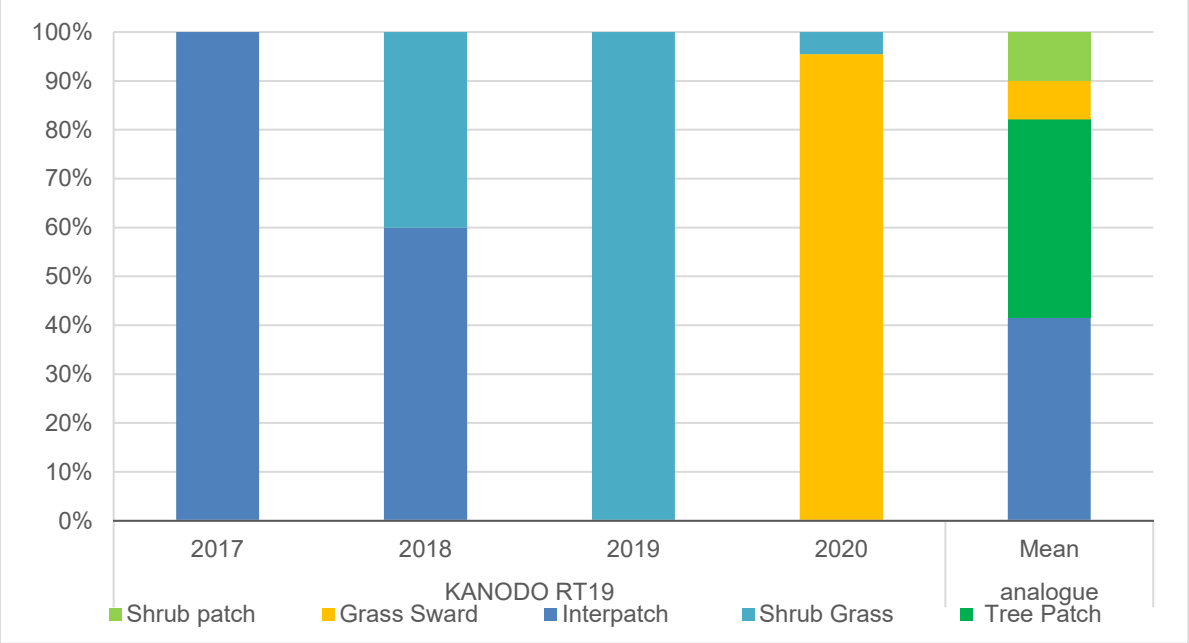


Figure 30. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO RT 19.

Table 14. Summary of the landscape organisation data for KANODO analogue and KANODO RT 19 rehabilitation site 2017-2020.

Site Type	No. of patch zones per 10m	Total patch area (m²)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.6**
KANODO_RT19 Rehabilitation 2017	0.4	125.0	0	1.00
KANODO_RT19 Rehabilitation 2018	0.4	125.0	0	1.00
KANODO_RT19 Rehabilitation 2019	0.4	125.0	0	1.00
KANODO_RT19 Rehabilitation 2020	2.8	120.1	0	1.00

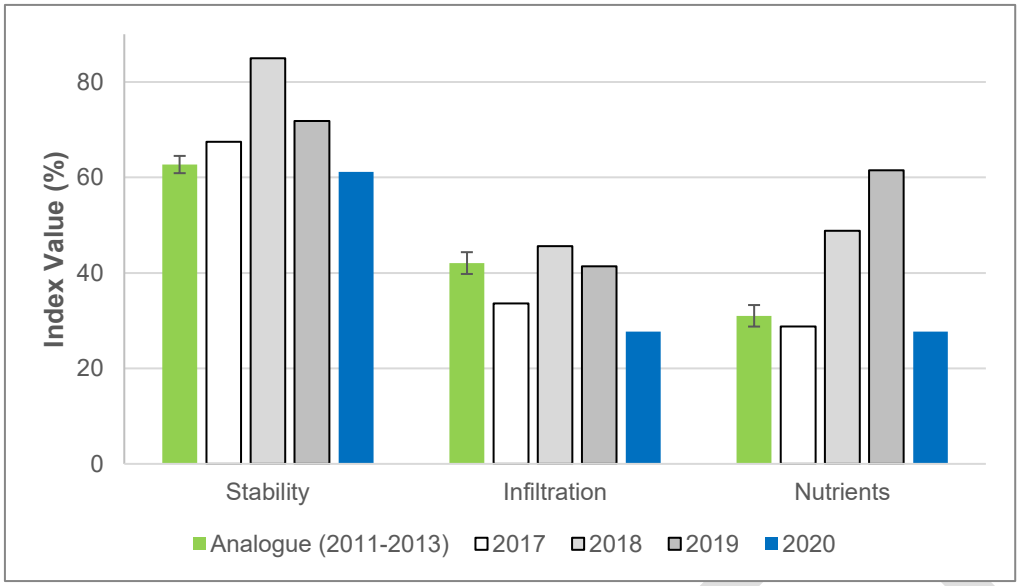


Figure 31. Landscape function indices change (2017-2020) for KANODO RT 20 with respect to mean analogue site values (2011-2013).

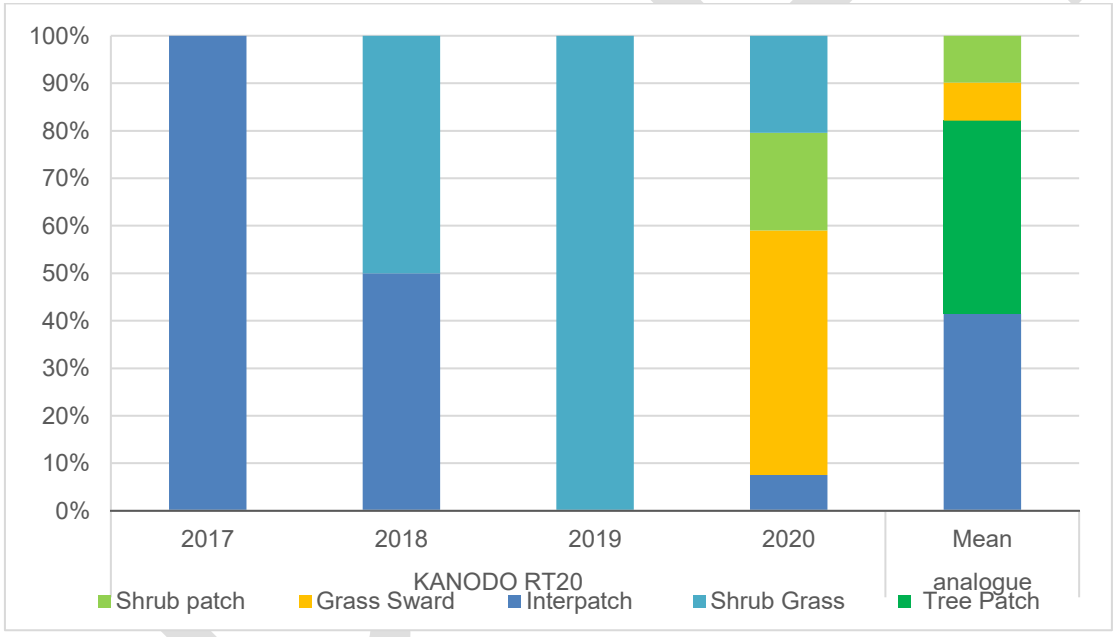


Figure 32. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO RT 20.

Table 15. Summary of the landscape organisation data for KANODO analogue and KANODO RT 20 rehabilitation site 2017-2020.

Site Type	No. of patch zones per 10m	Total patch area (m²)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.6**
KANODO_RT20 Rehabilitation 2017	0.4	125.0	0	1.00
KANODO_RT20 Rehabilitation 2018	0.4	125.0	0	1.00
KANODO_RT20 Rehabilitation 2019	0.4	125.0	0	1.00
KANODO_RT20 Rehabilitation 2020	4.7	106.5	2.25	0.93

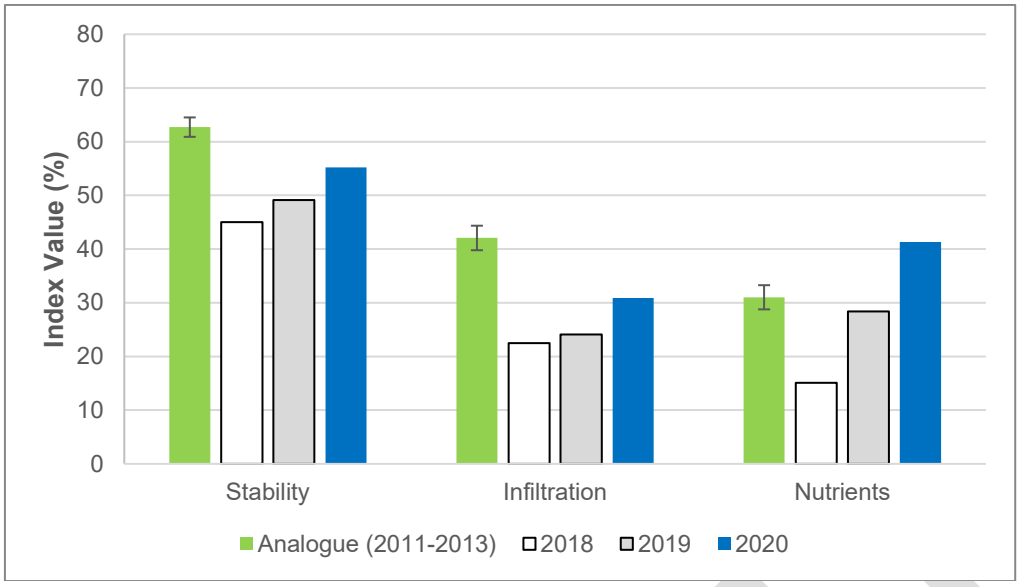


Figure 33. Landscape function indices change (2018-20) for KANODO RT 21 with respect to mean analogue site values (2011-2013).

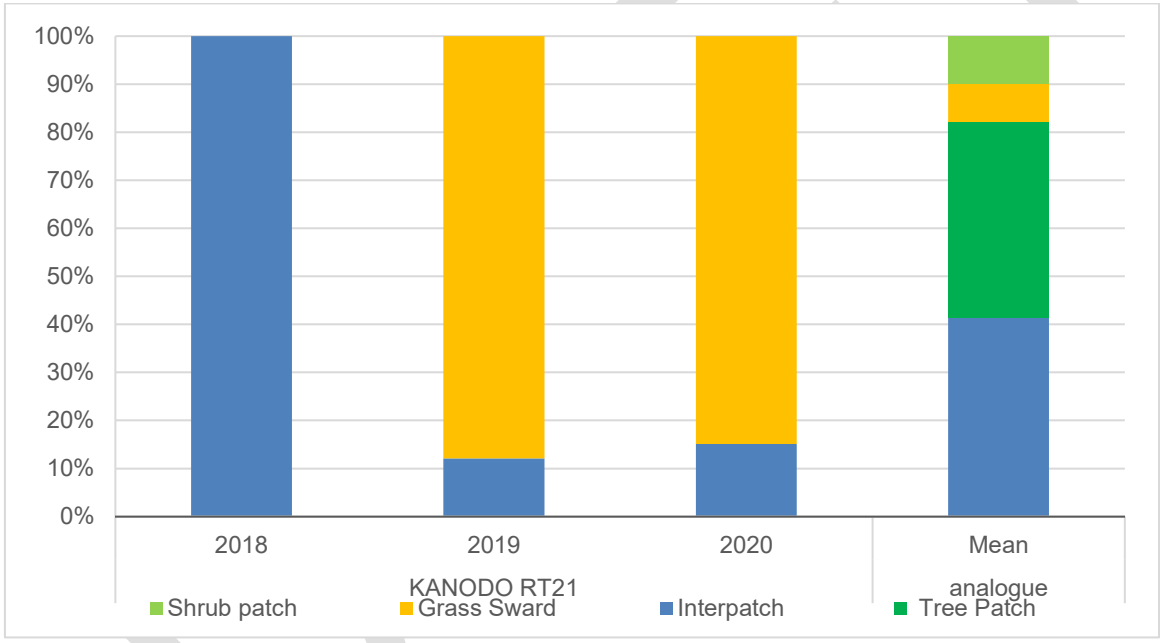


Figure 34. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANODO RT 21.

Table 16. Summary of the landscape organisation data for KANODO analogue and KANODO RT 21 rehabilitation site 2018-20.

Site Type	No. of patch zones per 10m	Total patch area (m²)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**2.8**	**308.4**	**1.8**	**0.6**
KANODO_RT21 Rehabilitation 2018	0.4	125	1	1
KANODO_RT21 Rehabilitation 2019	2.0	124.5	0	1
KANODO_RT21 Rehabilitation 2020	6.1	119.1	0	1

4.4 *Lomandra effusa* (Scented Mat Rush) Grassland rehabilitation transects

4.4.1 KANLOM RT 01

Whilst the stability value of KANLOM RT 01 has slightly increased from 2019, both infiltration and nutrient index values have decreased away from analogue values (Figure 35). The troughs have made a disappearance in 2020 data, and shrub patches have appeared for the first time since the inception of this monitoring site (Figure 36). The Landscape Organisational Index has decreased compared to 2019, there is still much fluctuation as this site is still within early stages of rehabilitation (Table 17).

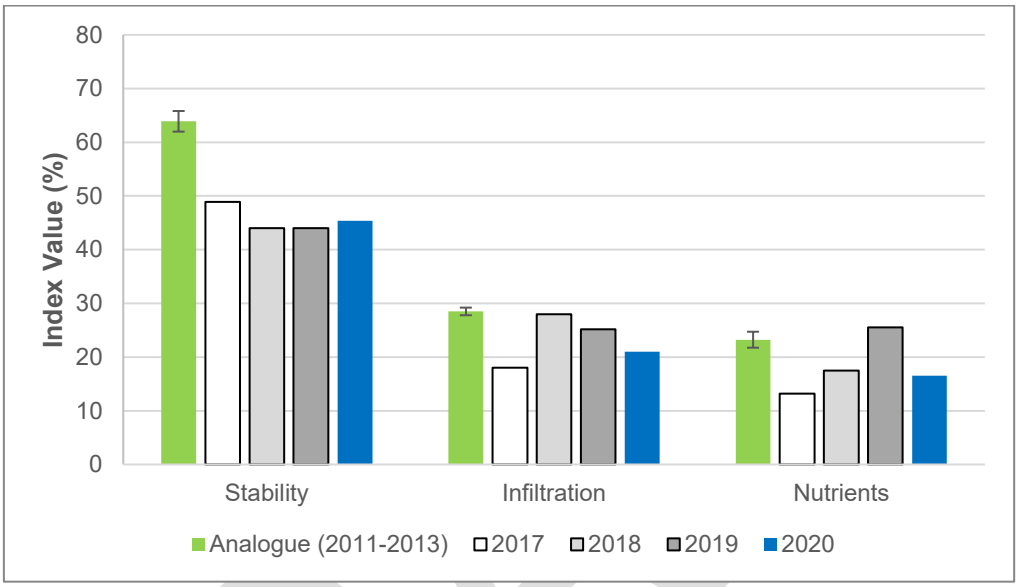


Figure 35. Landscape function indices change (2017-2020) for KANLOM RT 01 with respect to mean analogue site values (2011-2013).

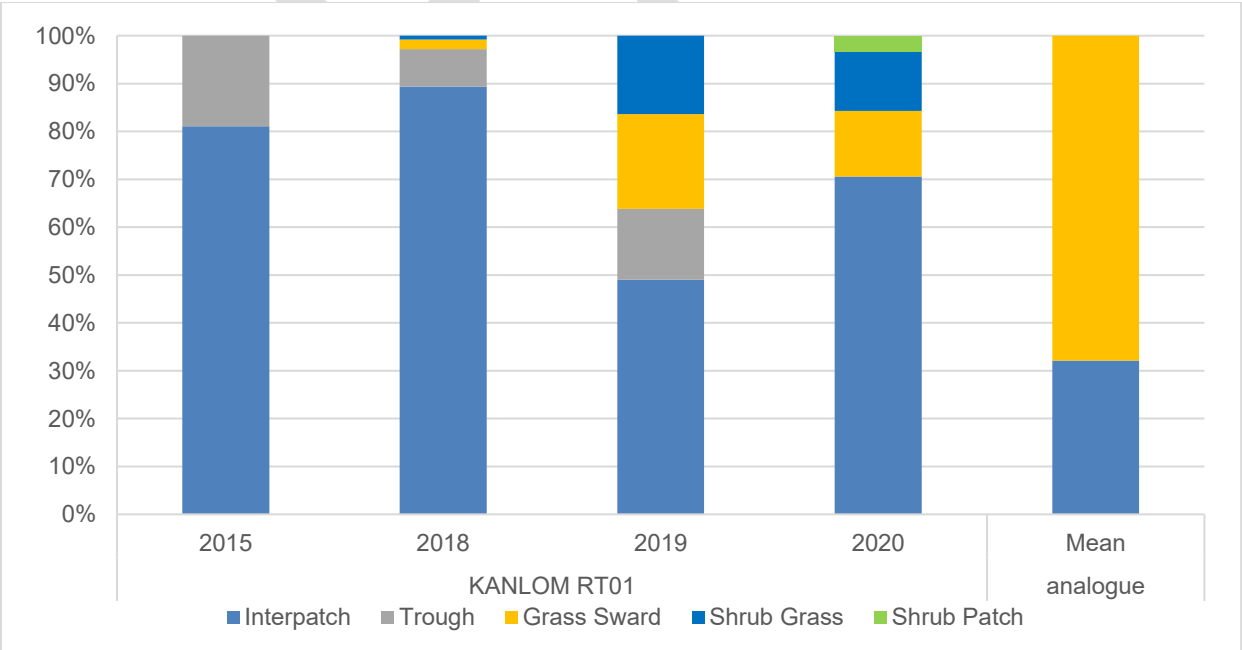


Figure 36. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANLOM RT 01.

Table 17. Summary of the landscape organisation data for KANLOM analogue and KANLOM RT 01 rehabilitation site 2017-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**4.8**	**95.5**	**0.6**	**0.7**
KANLOM_RT01 Rehabilitation 2017	4.3	45.5	1.74	0.19
KANLOM_RT01 Rehabilitation 2018	2.8	19.3	0.81	0.11
KANLOM_RT01 Rehabilitation 2019	7.1	76.8	0.91	0.51
KANLOM_RT01 Rehabilitation 2020	12.4	31.7	0.57	0.29

4.4.2 KANLOM RT 02

The current soil stability value for this site remains below the analogue, likely due to the soil physical properties within this area. The infiltration value, although decreased from 2019, still remains above the analogue value. The nutrient value has decreased form 2019, and now lies below analogue level (Figure 37). Grass swards have established within the troughs, leading to the reduction in proportion of trough compared to grass, approaching analogue proportions (Figure 38). The Landscape Organisational Index continues to fluctuate at this early stage, below analogue values (Table 18).

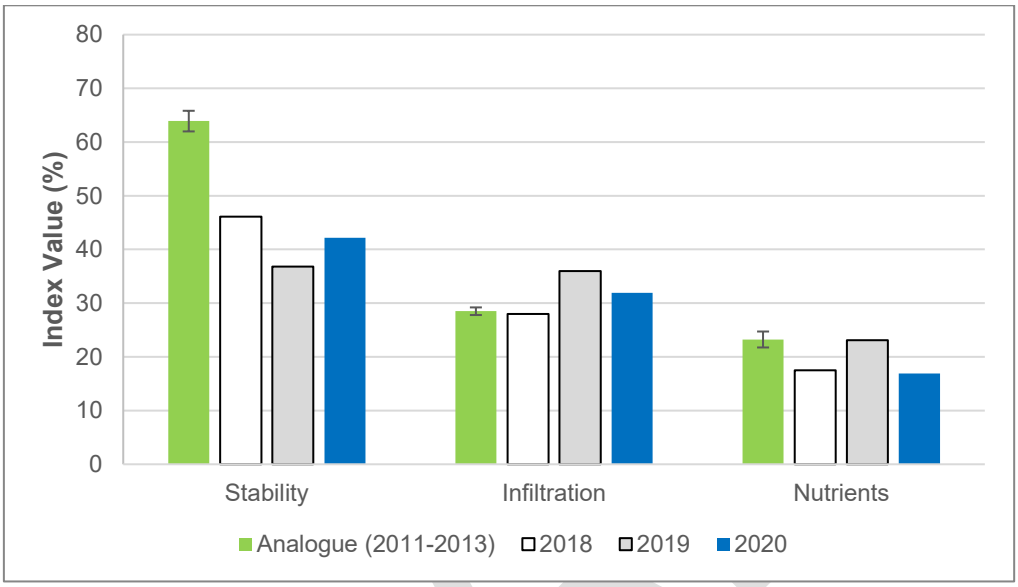


Figure 37. Landscape function indices change (2018-20) for KANLOM RT 02 with respect to mean analogue site values (2011-2013).

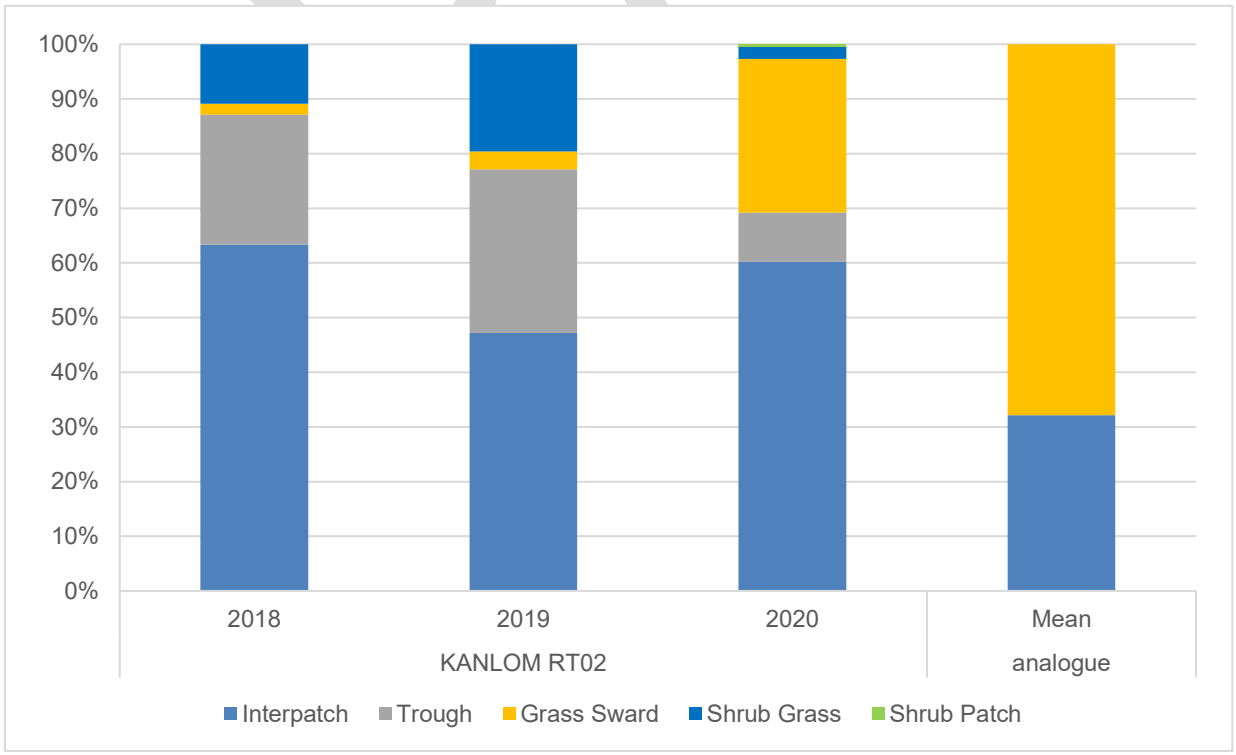


Figure 38. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANLOM RT 02.

Table 18. Summary of the landscape organisation data for KANLOM analogue and KANLOM RT 02 rehabilitation site 2018-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**4.8**	**95.5**	**0.6**	**0.7**
KANLOM_RT01 Rehabilitation 2018	5.5	49.3	1.17	0.35
KANLOM_RT01 Rehabilitation 2019	6.0	85.9	0.99	0.53
KANLOM_RT01 Rehabilitation 2020	9.2	43.9	0.79	0.4

4.5 *Acacia pycnantha* (Golden Wattle) Low Woodland transects

4.5.1 KANACA RT 01

The soil stability value has remained stable for the past four years, slightly below analogue values, whilst infiltration and nutrient indicator values have decreased compared to 2019 (Figure 39). Grass sward cover has increased commensurate with the decrease in shrub cover and the transect is approaching analogue composition and cover values (Figure 40). Patch zones are yet to stabilize as the vegetation continues to develop and transform through early successional stages (Table 19).

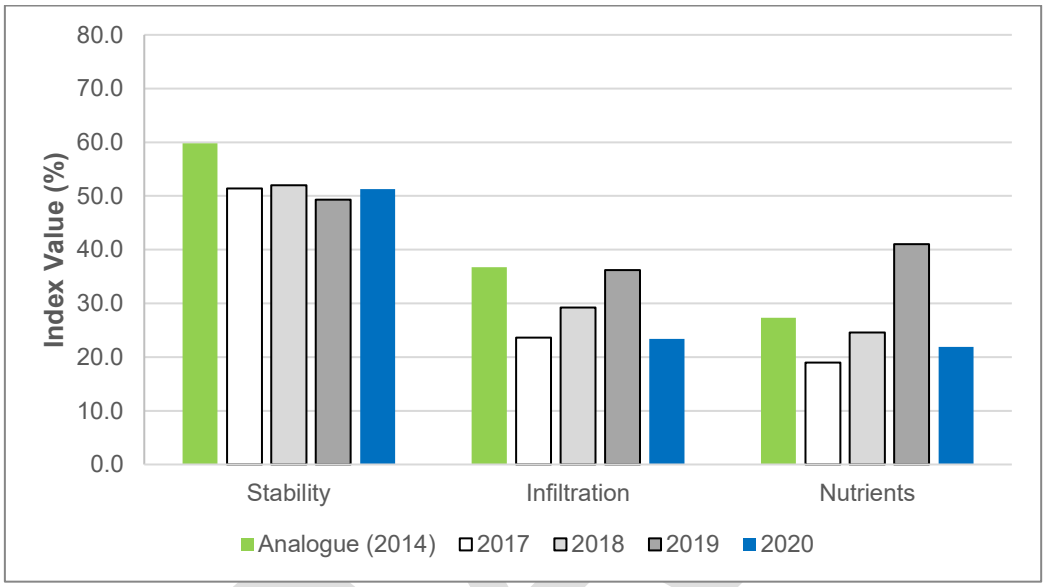


Figure 39. Landscape function indices change (2017-2020) for KANACA RT 01 with respect to mean analogue site values (2014).

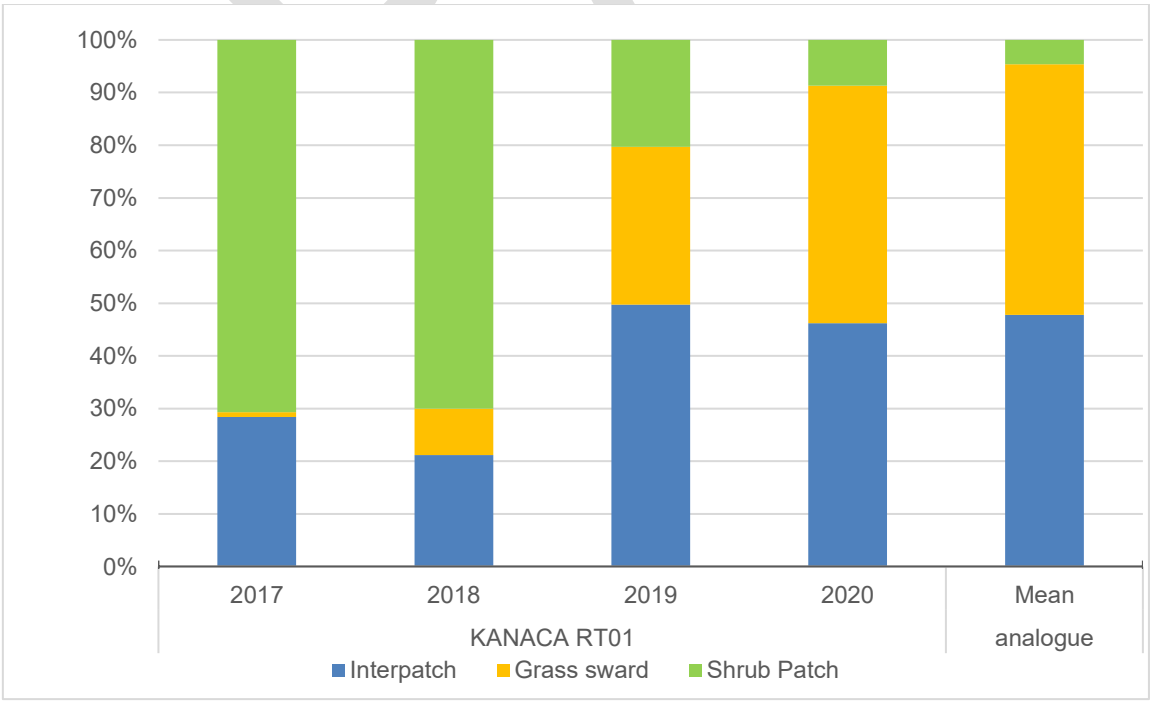


Figure 40. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANACA RT 01.

Table 19. Summary of the landscape organisation data for KANACA analogue and KANACA RT 01 rehabilitation site 2017-2020.

Site Type	No. of patch zones per 10m	Total patch area (m²)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2014	**4.7**	**141.6**	**1**	**0.7**
KANACA_RT01 Rehabilitation 2017	7.7	158.3	2.28	0.32
KANACA_RT01 Rehabilitation 2018	4.3	150.3	0.49	0.79
KANACA_RT01 Rehabilitation 2019	8.7	46.7	0.71	0.50
KANACA_RT01 Rehabilitation 2020	9.9	61	0.48	0.54

4.5.2 KANACA RT 02

The fourth year of monitoring this patch has seen a slight decrease in all three landscape function indices, towards analogue values (Figure 41). Shrub grass patches and inter-patches have appeared for the first time in this transect in 2020, compared to uniform grass swards over the last three years (2017, 2018 and 2019) (Figure 42). The landscape organisation value has decreased to 0.58, from the introduction of inter-patches in 2020 (Table 20).

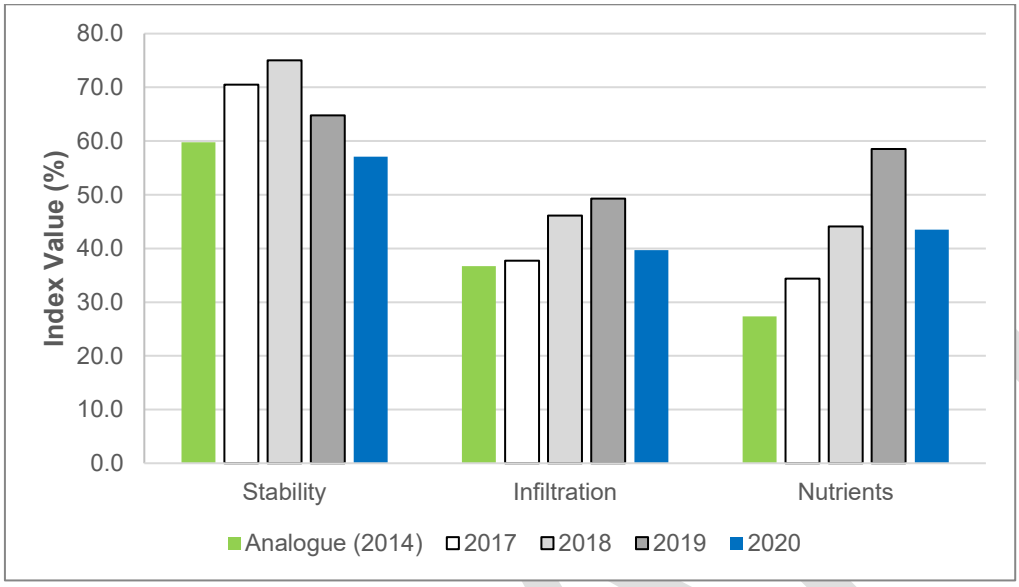


Figure 41. Landscape function indices change (2017-2020) for KANACA RT 02 with respect to mean analogue site values (2014).

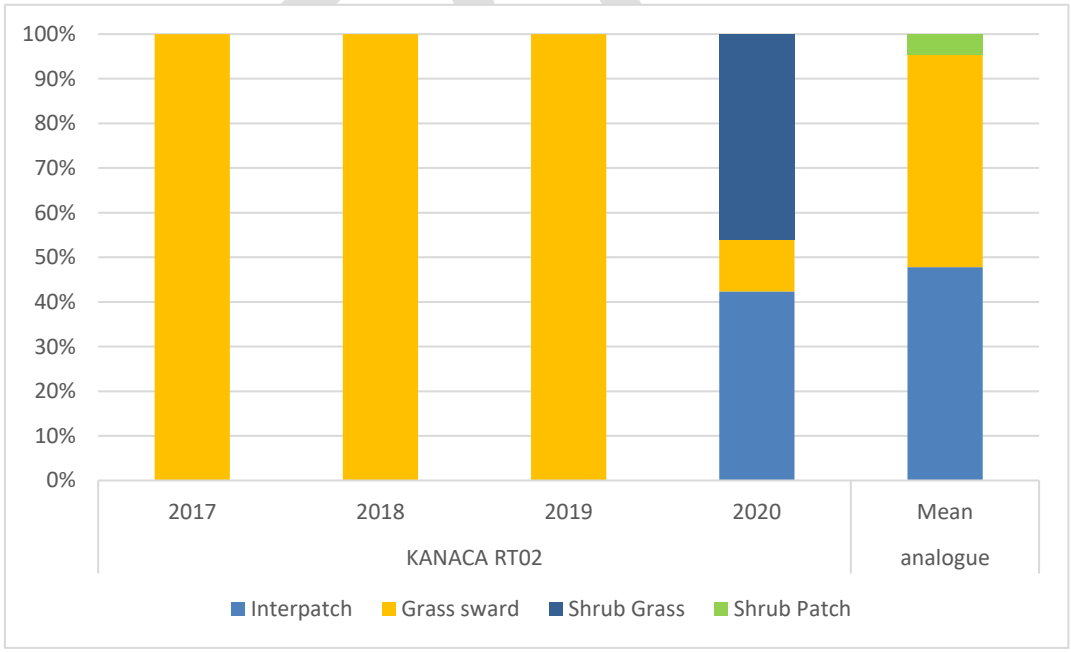


Figure 42. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANACA RT 02.

Table 20. Summary of the landscape organisation data for KANACA analogue and KANACA RT 02 rehabilitation site 2017-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2014	**4.7**	**141.6**	**1**	**0.70**
KANACA_RT02 Rehabilitation 2017	**1**	**125**	**0**	**1.00**
KANACA_RT02 Rehabilitation 2018	**0.4**	**125**	**0**	**1.00**
KANACA_RT02 Rehabilitation 2019	**0.4**	**125**	**0**	**1.00**
KANACA_RT02 Rehabilitation 2020	**4.4**	**35.2**	**0.96**	**0.58**

4.5.3 KANACA RT 03

In the third monitoring year for KANACA RT 03, all three landscape function indices increased towards analogue values (Figure 43). Compared to 2018 and 2019, 2020 proportions showed inter-patch occurring for the first time, suggesting a die-back of grass swards, and the disappearance of the trough (Figure 44). The landscape organisational index dropped to 0.68, closer to analogue values (

Table 21).

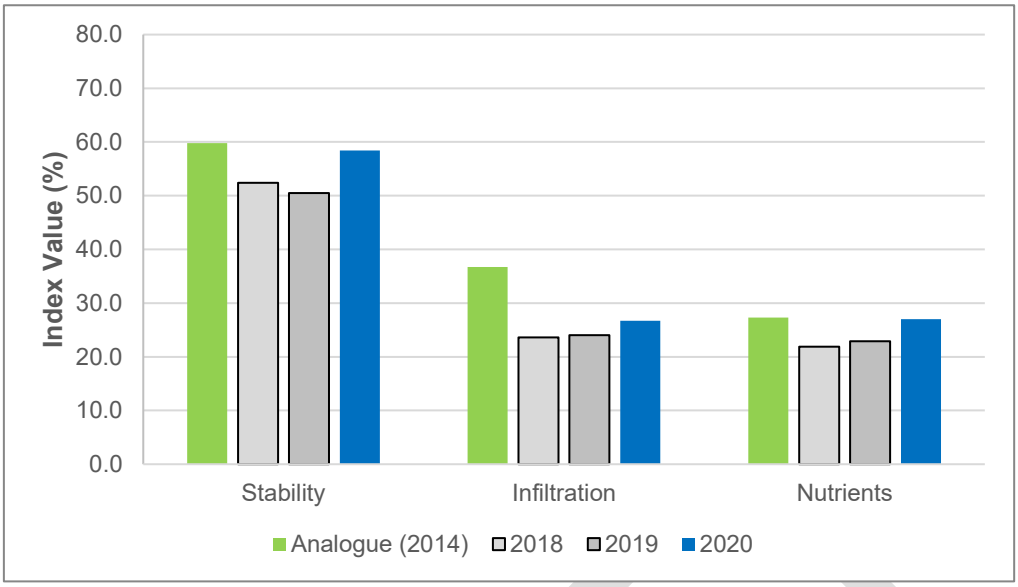


Figure 43. Landscape function indices change (2018-20) for KANACA RT 03 with respect to mean analogue site values (2014).

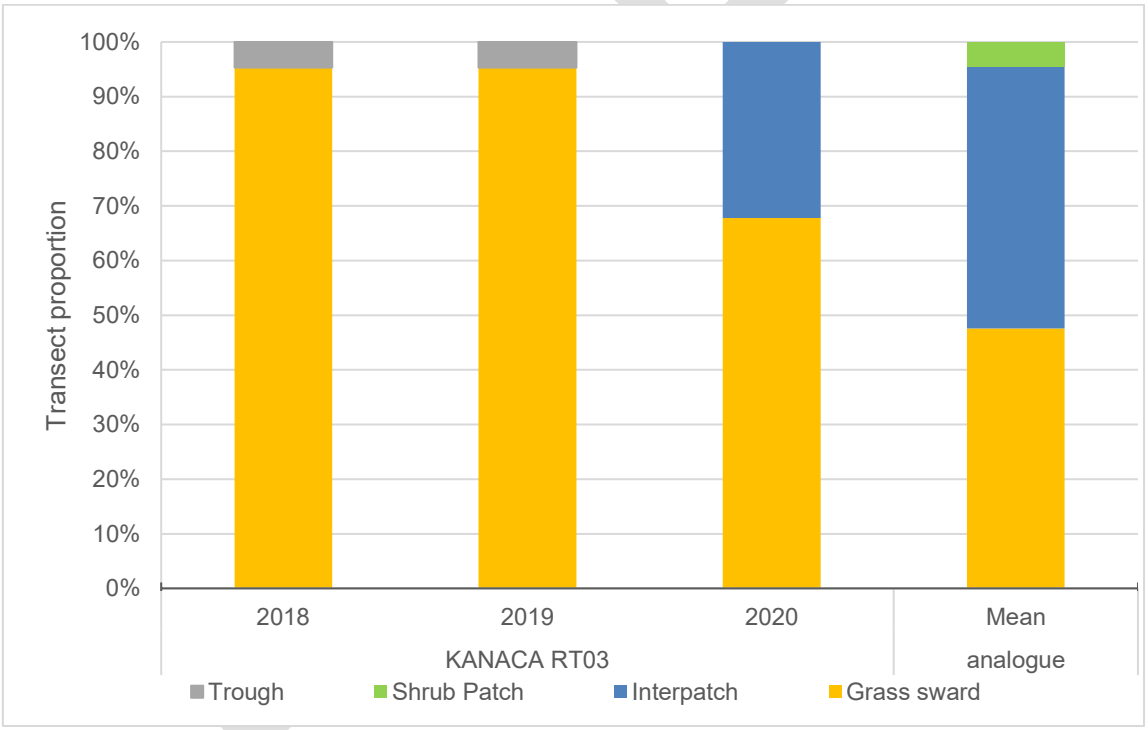


Figure 44. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANACA RT 03.

Table 21. Summary of the landscape organisation data for KANACA analogue and KANACART03 rehabilitation site 2018-20.

Site Type	No. of patch zones per 10m	Total patch area (m²)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2014	**4.7**	**141.6**	**1**	**0.7**
KANACA_RT03 Rehabilitation 2018	**0.3**	**0.48**	**14.3**	**0.05**
KANACA_RT03 Rehabilitation 2019	**1.0**	**173**	**0**	**1**
KANACA_RT03 Rehabilitation 2020	**1.4**	**232.7**	**2.58**	**0.68**

4.6 *Lomandra effusa* (Scented Mat Rush) Grassland rehabilitation transects

4.6.1 KANGRA RT 01

The permanent grass laydown area established in 2012 now has a good cover of *Chloris truncata* (Windmill Grass) which was the original species planted. The trend of increasing functional attributes has continued in 2020 for nutrient cycling, which remains above the mean analogue value, whilst the infiltration value remains similar to that of 2019, and the stability value has decreased further below the analogue value compared to 2018 and 2019 (Figure 45).

The proportion of grass sward which had gradually increased at this site since it was established in 2013 and then decreased slightly in 2019, has further decreased towards analogue site levels in 2020 (Figure 46). Landscape organisation indices remain variable as patch number and area totals move towards a more stable state in the absence of significant disturbance (Table 22)

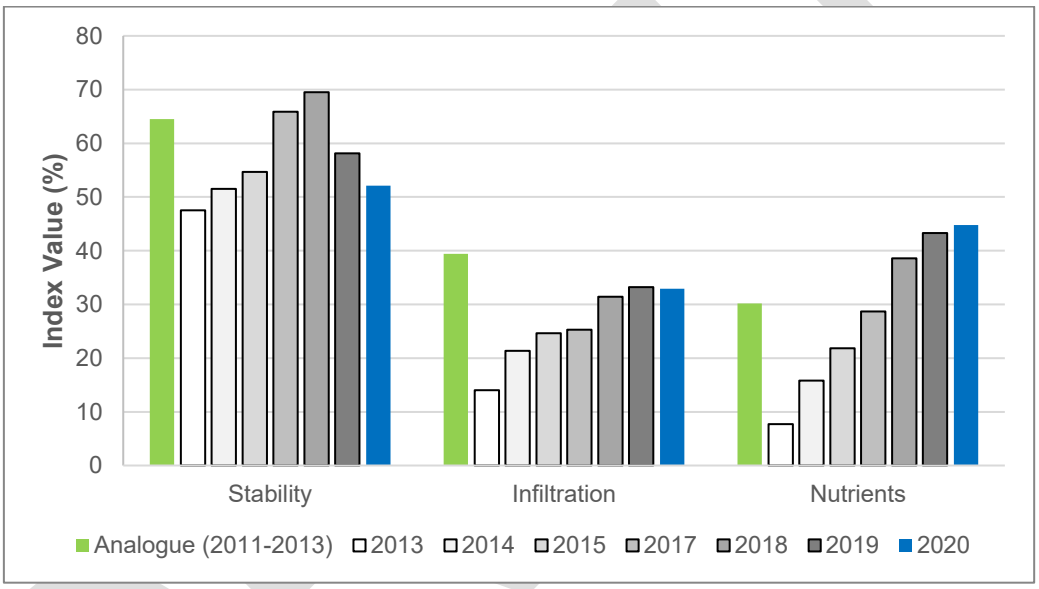


Figure 45. Landscape function indices change (2013-2020) for KANGRA RT 01 with respect to mean analogue site values (2011-2013).

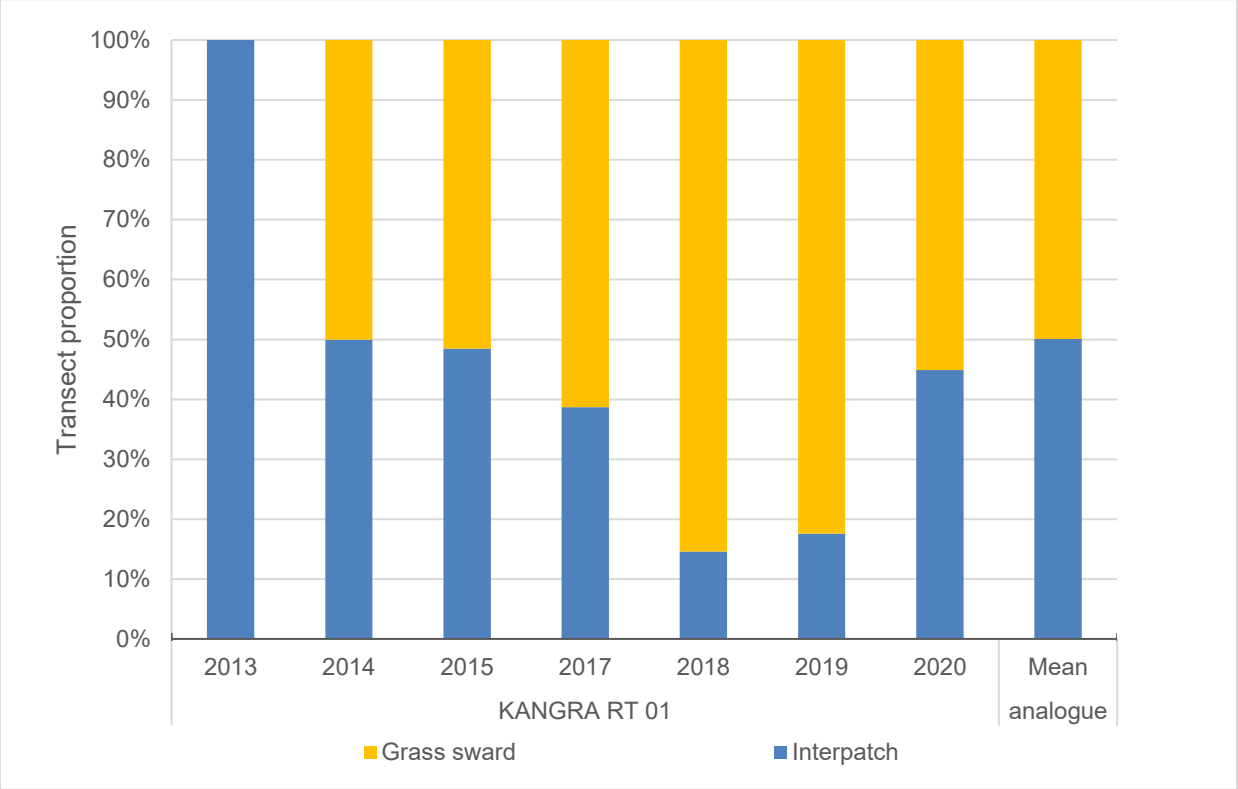


Figure 46. Percentage cover of each of the Surface Soil Assessment zones recorded at site KANGRA RT 01.

Table 22. Summary of the landscape organisation data for KANGRA analogue and KANGRA RT 01 rehabilitation site 2013-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
Analogue 2011 -13	**4.7**	**179.1**	**0.5**	**0.74**
KANGRA1 Rehabilitation 2013	0	100	10	0
KANGRA1 Rehabilitation 2014	5	64.6	1.12	0.53
KANGRA1 Rehabilitation 2015	3	278.4	1.62	0.52
KANGRA1 Rehabilitation 2017	3.3	142.5	1.29	0.61
KANGRA1 Rehabilitation 2018	1.3	211.8	1.51	0.85
KANGRA1 Rehabilitation 2019	2.6	204.3	0.78	0.82
KANGRA1 Rehabilitation 2020	4.7	127.1	0.96	0.55

4.7 Grassy hillslope analogue sites

This section presents results for the four LFA grassland monitoring sites established in 2019, and surveyed in 2020. These sites (KANGRA 10-13) were established as analogue sites on hill slopes with different aspects (see photo points at Appendix 3), representative of hills in the surrounding landscape against which to measure future rehabilitation activities.

4.7.1 KANGRA 10-13

The average soil surface indicators across 2019 and 2020 were generally similar across all four sites with lower stability for KANGRA 13 compared with the other three sites (Figure 47). Average patch type proportions were also similar across sites, with sedge patch still a feature in only KANGRA 11 (Figure 47). Landscape organisational indexes for all four sites have decreased substantially from 2019 values (Table 23, Table 24, Table 25 and Table 26). Compared to the largely uniform native grasslands of 2019, it appears that annual exotic grasses had benefitted greatly with the rains in 2020, leading to much greater inter-patches compared to grass swards. This is why it is important to have multiple years of data for analogue sites, in order to lessen the effects of yearly fluctuations on data from stochastic factors such as weather.

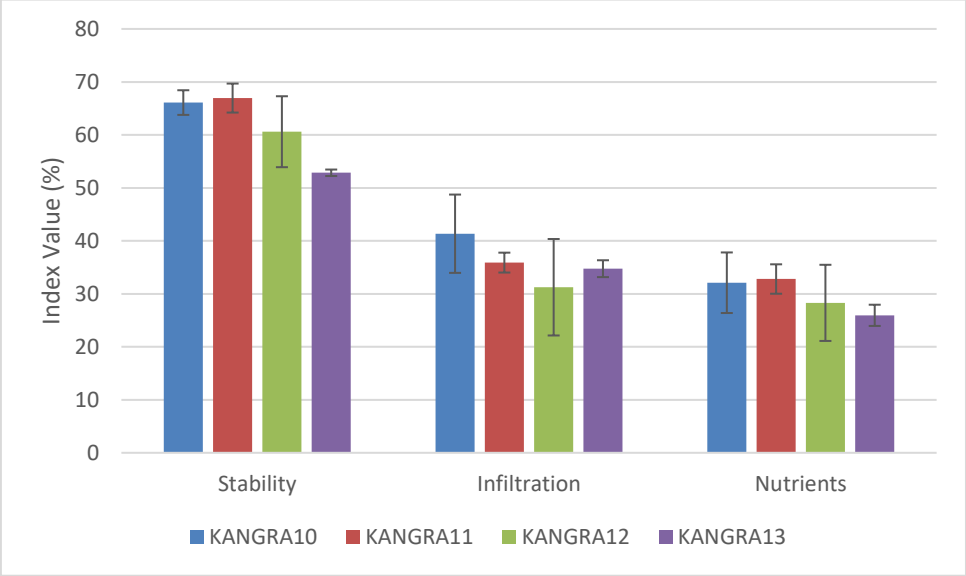


Figure 47. Average landscape function analysis indices for the four analogue grassland sites KANGRA 10-13 over

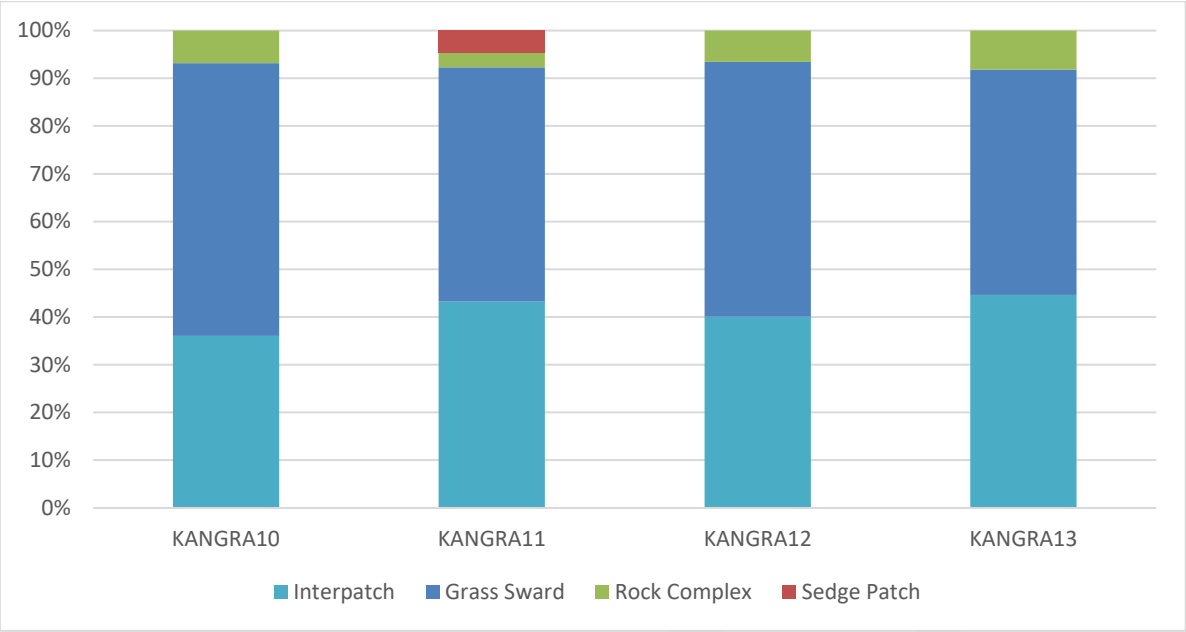


Figure 48. Average percentage cover of each of the Surface Soil Assessment zones recorded at sites KANGRA 10-13 over 2019 and 2020.

Table 23. Summary of the landscape organisation data for the KANGRA 10 analogue site 2019-2020.

Site Type	No. of patch zones per 10m	Total patch area (m²)	Average inter-patch length (m)	Landscape Organisational Index*
KANGRA 10 2019	2.8	190.6	0	1.00
KANGRA 10 2020	8	7.2	0.86	0.28
Average	1.8	98.9	0.43	0.64

Table 24. Summary of the landscape organisation data for the KANGRA 11 analogue site 2019-2020.

Site Type	No. of patch zones per 10m	Total patch area (m²)	Average inter-patch length (m)	Landscape Organisational Index*
KANGRA 11 2019	5.2	183.4	0	1.00
KANGRA 11 2020	3.0	5.9	2.66	0.14
Average	4.1	94.7	1.33	0.57

Table 25. Summary of the landscape organisation data for the KANGRA 12 analogue site 2019-2020.

Site Type	No. of patch zones per 10m	Total patch area (m²)	Average inter-patch length (m)	Landscape Organisational Index*
KANGRA 12 2019	3.0	232.8	0	1.00
KANGRA 12 2020	4.7	15.4	1.72	0.20
Average	3.9	124.1	0.86	0.60

Table 26. Summary of the landscape organisation data for the KANGRA 13 analogue site 2019-2020.

Site Type	No. of patch zones per 10m	Total patch area (m^2)	Average inter-patch length (m)	Landscape Organisational Index*
KANGRA 13 2019	3.0	240	0	1.00
KANGRA 13 2020	1.3	15.1	5.71	0.11
Average	2.2	127.6	2.86	5.56

5 DISCUSSION AND RECOMMENDATIONS

In general, the LFA indicators have shown positive rehabilitation trends over the life of the Kanmantoo monitoring program (2011-2019). Rehabilitation plots have typically reached a level of 'self-sustaining communities', relative to analogue sites, after a period of only 3-4 years.

For areas with the topsoil removed and works undertaken on the WRL which is subjected to bank and trough contour ripping, all indicators show that since inception of rehabilitation works, LFA function indices all achieve or exceed analogue values in the first few years. Sites where no treatment has occurred show below analogue values and downward trends in functional indices.

Based on the initial success rates of restoration activities across the Kanmantoo Mine Area, it is likely that ongoing works will result in similar functional trends as those observed using LFA to date. This includes initial low values, followed by a rebound period whereby plant cover produces high stability, infiltration and nutrient cycling values before stabilising back to analogue values.

The LFA sites monitored at Kanmantoo allow for sufficient data from which to detect trends in functional landscape-based attributes. Qualitative observations of rehabilitation success (i.e., field observations and photopoints) are supported by long-term quantitative LFA results.

Non-functional ecological vegetation attributes such as plant species richness (and whether species are native or exotic) are currently not recorded as part of the LFA monitoring program, limiting the ability of the program to determine the success of species of interest used in revegetation and seeding mixes. Species composition and germination success should be considered as part of ongoing monitoring to provide information on how species respond to specific restoration methods, thus informing future rehabilitation activities. Such information would also be useful for assessing: 1) overall trends in plant species abundance and diversity; and 2) impacts on vegetation from threats such as total grazing pressure.

Ongoing monitoring should continue to adapt in order to maximise the efficiency and effectiveness of detecting changes in LFA monitoring sites. Ongoing annual review and adaptation of the monitoring program is recommended, altering factors such as frequency of assessment, indicators measured and sampling locations.

6 REFERENCES

EBS (2020). Kanmantoo fauna survey 2020. Report prepared for Hillgrove resources by EBS Ecology

Commonwealth of Australia (2019) *Bureau of Meteorology – Climate data, Kanmantoo*.

Coffey Environments (2010). Native Vegetation Management Plan, Hillgrove Copper Pty Ltd, Kanmantoo Copper Project ML 6345.

Coffey Environments (2009). Mining and Rehabilitation Program, Hillgrove Copper Pty LTD, Kanmantoo Copper Project ML 6345.

EBS (2011). Kanmantoo Mine Vegetation Monitoring – Landscape Function Analysis. Report to Hillgrove Resources. EBS Ecology, Adelaide.

Tongway, D.J. and Hindley, N.L. (2004). Landscape Function Analysis: Procedures for monitoring and assessing landscapes (with special reference to Minesites and Rangelands). CSIRO, Canberra. CT, Australia: Sustainable Ecosystems, Commonwealth Scientific and Industrial Research Organisation. (Updated as an "LFA Field Procedures," which is available online: http://members.iinet.net.au/~lfa_procedures/).

Tongway, D. and Ludwig, J. (2006). Assessment of Landscape Function as an Information Source for Mine Closure. Proceedings of the First International Seminar on Mine Closure, Andy Fourie and Mark Tibbett (eds) Australia, Perth, pp. 21-29.

Van der Walt, L, Cilliers, S.S., Kellner, K., Tongway, D. and van Rensburg, L (2012). Landscape functionality of plant communities in the Impala Platinum mining area, Rustenburg. *Journal of Environmental Management* **113**, 103-116.

7 APPENDICES

Appendix 1. Summary of LFA sites monitored and monitoring frequency 2011-2020.

Site name	Site type*	2011	2012	2013	2014	2015	2017	2018	2019	2020	Easting	Northing
KANSTI 4	RH				P	P					319376	6115483
KANODORT20	RH						P	P	P	P	318732	6115394
KANODO RT21	RH							P	P	P	318482	6114090
KANODO RT19	RH						P	P	P	P	319062	6115176
KANODO RT18	RH						P	P	P	P	318988	6115623
KANODO RT17	RH					P	P	P	P	P	317308	6115933
KANODO RT16	RH					P	P	P	P		317324	6115923
KANODO RT15	RH					P	P	P	P	P	317348	6115912
KANODO RT14	RH					P	P	P	P	P	316941	6116079
KANODO RT13	RH					P	P	P	P		316974	6116086
KANODO RT12	RH					P	P	P	P	P	317006	6116086
KANODO RT11	RH					P	P	P	P		317021	6116090
KANODO RT10	RH					P	P	P	P	P	317051	6116090
KANODO RT07	RH					P	P	P	P	P	317131	6116083
KANODO 9	RH				P	P	P	P	P	P	317807	6114076
KANODO 8	RH				P	P	P	P	P	P	316735	6116444
KANODO 7	RH				P	P	P	P			319201	6115552
KANODO 6	RH	P	P	P	P	P	P	P	P	P	316537	6116233
KANODO 4	RH	P	P	P	P	P	P	P	P	P	316754	6116204
KANODO 5	RH	P	P	P	P	P	P	P	P	P	316751	6116127
KANLOM RT02	RH							P	P	P	318368	6114430
KANLOM RT01	RH						P	P	P	P	317786	6114369
KANLOM 8	RH				P	P					319346	6114276
KANLOM 7	RH				P	P					319071	6114078
KANLOM 6	RH				P	P					318438	6114177

Site name	Site type*	2011	2012	2013	2014	2015	2017	2018	2019	2020	Easting	Northing
KANLOM 5	RH				P	P					318697	6114345
KANLOM 4	RH				P	P					319429	6115476
KANGRA RT01	RH			P	P	P	P	P	P	P	319155	6114300
KANACA RT03	RH							P	P	P	318361	6114074
KANACA RT02	RH						P	P	P	P	318818	6115697
KANACA RT01	RH						P	P	P	P	318482	6114758
KANACA 4	AN				P						318536	6114302
KANACA 3	AN				P	P					319538	6115467
KANLOM1	AN	P	P	P							317961	6114064
KANLOM2	AN	P	P	P							317963	6114040
KANLOM3	AN	P	P	P							317931	6114051
KANODO1	AN	P	P	P							317515	6115604
KANODO2	AN	P	P	P							317528	6115551
KANODO3	AN	P	P	P							318229	6115760
KANSTI1	AN	P	P	P							318063	6114321
KANSTI2	AN	P	P	P							318008	6114283
KANSTI3	AN	P	P	P							318130	6115752
KANGRA2	RH			P							319163	6114317
KANGRA3	RH			P							319180	6114339
KANACA1	AN				P						318326	6115281
KANACA2	AN				P						318347	6115328
KANGRA 10	AN								P	P	316490	6114929
KANGRA 11	AN								P	P	316343	6114870
KANGRA 12	AN								P	P	317408	6114149
KANGRA 13	AN								P	P	317382	6114100

Appendix 2. Landscape Function Analysis (LFA) results summary 2011 – 2020.

Zones	Stability (%)									Infiltration (%)									Nutrients (%)								
	2011	2012	2013	2014	2015	2017	2018	2019	2020	2011	2012	2013	2014	2015	2017	2018	2019	2020	2011	2012	2013	2014	2015	2017	2018	2019	2020
KANODO	61.2	60.5	66.3	-	-	-	-	-	-	37.5	44.3	44.4	-	-	-	-	-	-	26.8	31.7	34.5	-	-	-	-	-	-
KANODO4	68.9	60.5	67	65.9	61.5	63.8	56.4	60.6	63	52.5	54.1	56.1	56.8	62.7	40.3	42.8	38.1	39.3	46.2	38.7	48.2	46.9	48.5	30.3	36.2	30.8	32
KANODO5	69.8	63.6	64.2	61.3	58.9	63.8	65.1	59.7	65.7	55.5	54	60	54.2	48.9	42.3	37.9	33.5	41.5	48	39.1	47.3	39.7	30.2	30.9	30.7	27.4	36.6
KANODO6	66.9	61.3	65.2	63.8	58.8	65.2	61.7	61.1	60.3	54.4	55.3	56.1	56.9	55.6	41.4	38	48	46	46.5	39.6	44.6	45.8	42	31.1	29.1	35.8	32.4
KANODO8	-	-	-	48.7	49.5	49.1	62.9	64.3	55.8	-	-	-	26	20	21.9	22.3	23.4	29.3	-	-	-	16.7	13.3	17.1	17.9	26.2	22.1
KANODO9	-	-	-	48.5	61.7	74	72.2	65.9	62.8	-	-	-	21.2	31.2	27.1	31.7	34.6	25.7	-	-	-	15.8	22.8	30.4	33.5	55.2	25.4
KANODO RT_07	-	-	-	-	53	63.7	71	61.5	53.8	-	-	-	-	30.9	35.9	33.6	36.7	26.9	-	-	-	-	16.3	25.1	38.2	40.5	24.3
KANODO RT_10	-	-	-	-	51	57.6	60.9	49.4	47.9	-	-	-	-	28.1	23.8	18.3	25.4	21.4	-	-	-	-	12.6	14.3	16.4	22.9	17.8
KANODO RT_11	-	-	-	-	48.3	59.9	6.9	53.7	-	-	-	-	-	32.3	29.1	24.7	35.4	-	-	-	-	-	16.3	22.5	25.8	37.3	-
KANODO RT_12	-	-	-	-	49	60.1	68.1	55.5	59.1	-	-	-	-	31.2	27.6	25.6	24.7	31.4	-	-	-	-	16.7	20.1	27.2	32	47.2
KANODO RT_13	-	-	-	-	51	6037	63.6	54.2	-	-	-	-	-	31.2	22.3	24.4	19.9	-	-	-	-	-	14	20	25.4	20.5	-
KANODO RT_14	-	-	-	-	32.2	58.6	58.2	56.4	52.7	-	-	-	-	29.1	20.6	21.4	19.3	20	-	-	-	-	15.4	18.8	21.3	20.3	21.7
KANODO RT_15	-	-	-	-	50	56.5	54.7	64.7	47.3	-	-	-	-	30.9	28.6	18.5	38.5	27.7	-	-	-	-	16.3	13.4	12.1	34.5	19.5
KANODO RT_16	-	-	-	-	50	62.6	57.2	54.6	-	-	-	-	-	26.3	25.3	27.3	40.6	-	-	-	-	-	15.4	18.3	22.8	43.7	-
KANODO RT_17	-	-	-	-	52.8	63.5	61.3	59.7	58.2	-	-	-	-	38.6	28.5	25.9	32.4	25.8	-	-	-	-	15.4	20.3	22.8	33.8	24.1
KANODO RT_18	-	-	-	-	-	76.5	78	64.8	64.3	-	-	-	-	38.6	49.9	50.8	47.4	30.4	-	-	-	-	-	47.4	51.6	64.6	28.1
KANODO RT_19	-	-	-	-	-	77.5	82	49.9	66	-	-	-	-	-	43.5	52.2	32	43	-	-	-	-	-	44.6	55.3	33.5	56
KANODO RT_20	-	-	-	-	-	67.5	85	7.8	61.2	-	-	-	-	-	33.6	45.6	41.1	27.7	-	-	-	-	-	28.8	48.8	61.5	27.7
KANODO RT_21	-	-	-	-	-	-	45	49.1	55.2	-	-	-	-	-	-	22.5	24.1	30.9	-	-	-	-	-	-	15.1	28.4	41.3
KANLOM	62.5	61.5	67.7	-	-	-	-	-	-	27.1	29.4	29	-	-	-	-	-	-	21.6	21.9	26.2	-	-	-	-	-	-
KANLOM RT01	-	-	-	-	-	48.9	42.9	44	45.4	-	-	-	-	-	18	30.4	25.2	21	-	-	-	-	-	13.2	16.7	25.5	16.5
KANLOM RT02	-	-	-	-	-	-	46.1	36.8	42.2	-	-	-	-	-	-	28	36	31.9	-	-	-	-	-	-	17.5	23.1	16.9
KANACA_RT01	-	-	-	-	-	51.4	52	49.3	51.3	-	-	-	-	-	23.6	29.2	36.2	23.4	-	-	-	-	-	19	24.6	41	21.9
KANACA_RT02	-	-	-	-	-	70.5	75	64.8	57.1	-	-	-	-	-	37.7	46.1	49.3	39.7	-	-	-	-	-	34.4	44.1	58.5	43.5
KANACA_RT03	-	-	-	-	-	-	52.4	50.5	58.4	-	-	-	-	-	-	23.6	24	26.7	-	-	-	-	-	-	21.9	22.9	27
KANGRA RT01	-	-	47.5	51.5	54.7	65.9	69.5	58.1	52.1	-	-	14	21.4	24.6	25.3	31.4	33.2	32.9	-	-	7.7	15.8	21.8	28.7	38.6	43.3	44.8
KANGRA 10	-	-	-	-	-	-	-	68.7	63.5	-	-	-	-	-	-	-	46.3	36.4	-	-	-	-	-	-	-	39.1	25.1
KANGRA 11	-	-	-	-	-	-	-	70.3	63.6	-	-	-	-	-	-	-	38.2	33.6	-	-	-	-	-	-	-	36.2	29.4
KANGRA 12	-	-	-	-	-	-	-	68.8	52.4	-	-	-	-	-	-	-	42.4	20.1	-	-	-	-	-	-	-	37.1	19.5
KANGRA 13	-	-	-	-	-	-	-	53.6	52.1	-	-	-	-	-	-	-	36.7	32.8	-	-	-	-	-	-	-	28.4	23.5

Appendix 3. Annual LFA monitoring site photographs

Site: KANODO 04


2011

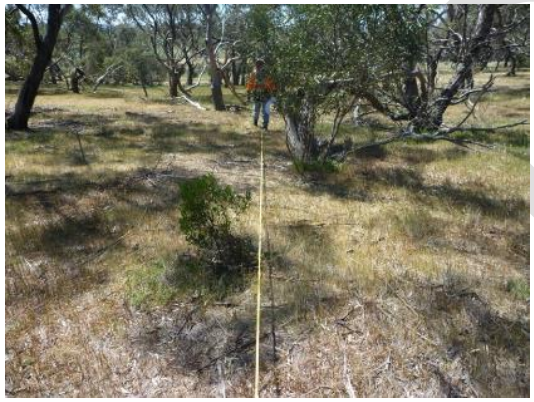

2012


2013


2014


2015


2017


2018


2019


2020

Site: KANODO 06


2011


2012


2013


2014


2015


2017


2018


2019


2020

Site: KANODO 08


2014


2015


2017


2018

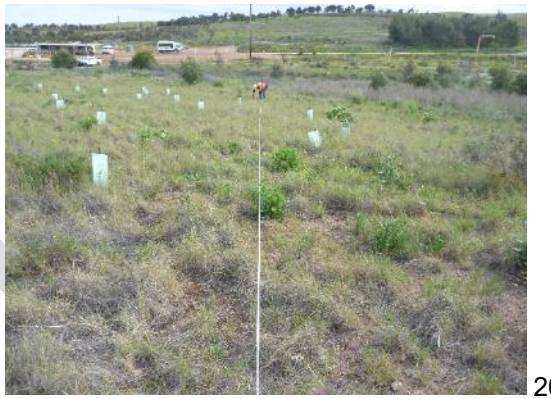

2019


2020

Site: KANODO 09


2014


2015

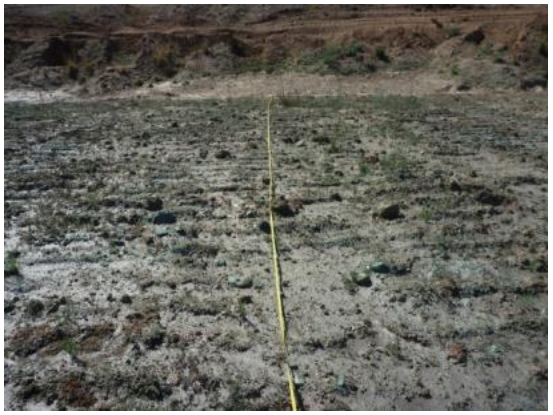

2017


2018


2019


2020

Site: KANODO RT 07



2015

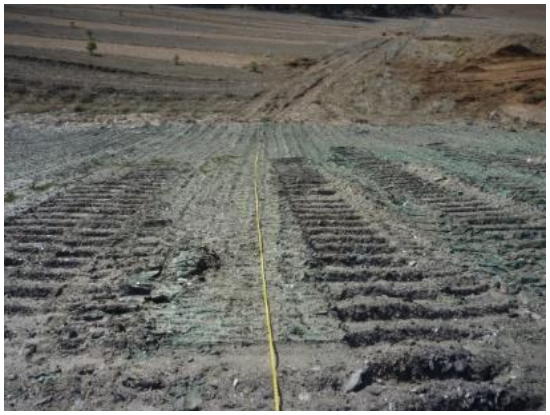
2017

2018

2019

2020

Site: KANODO RT 10



2015

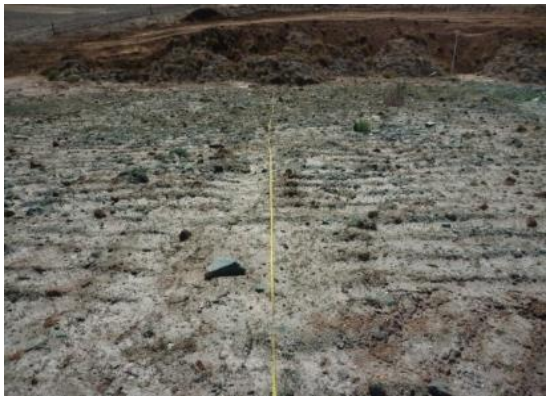
2017

2018

2020 photo not available

2019

Site: KANODO RT 12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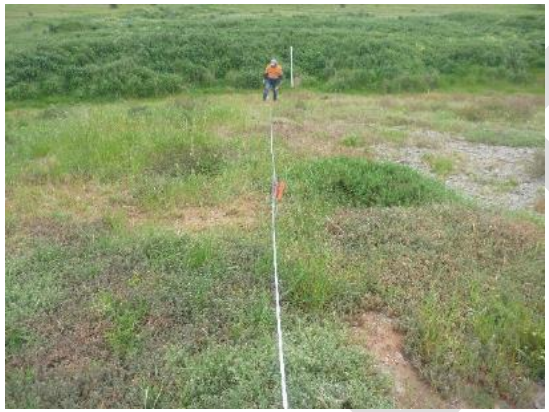
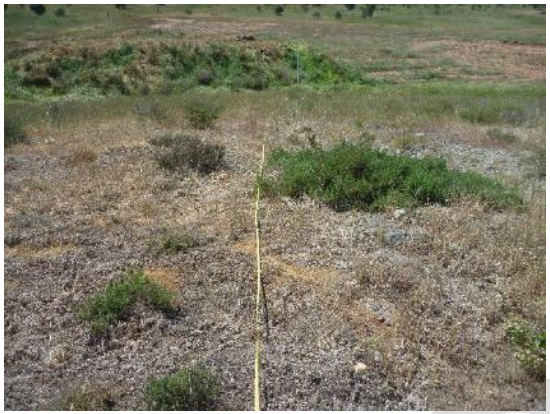
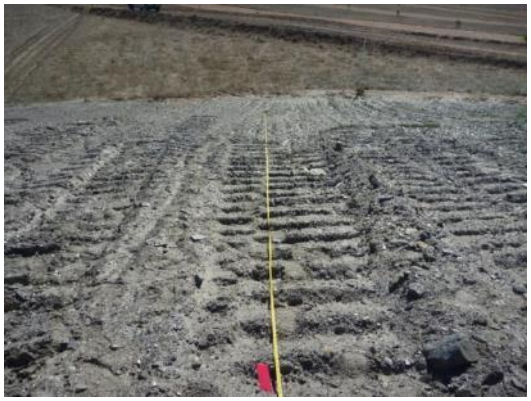

2017


2018


2019


2020

Site: KANODO RT 14


2015


2017


2018


2019

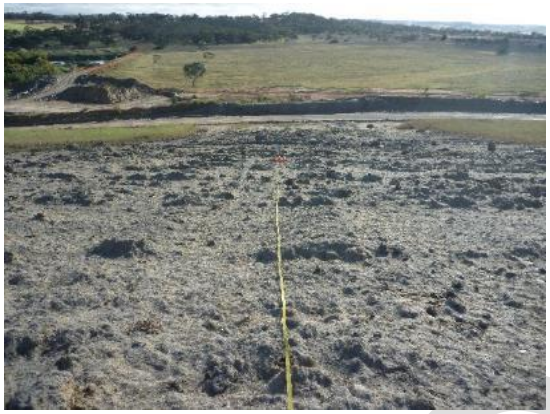

2020

Site: KANODO RT 15


2015


2017


2018


2019


2020

Site: KANODO RT 17


2015


2017


2018


2019


2020

Site: KANODO RT 18

2017

2018

2019

2020

Site: KANODO RT 19

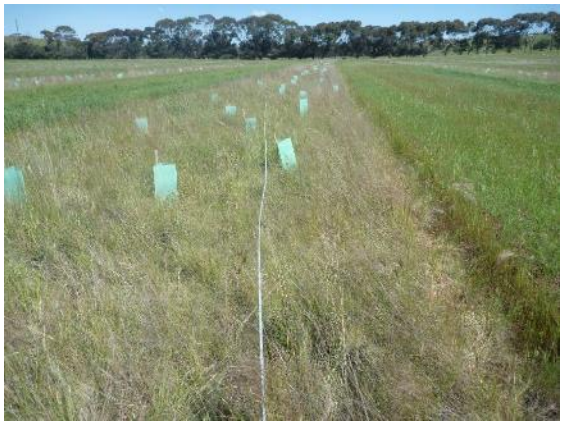
2017

2018

2019

2020

Site: KANODO RT 20


2017


2018


2019

2020 photo not available

Site: KANODO RT 21


2018


2019


2020

Site: KANLOM RT 01

2017

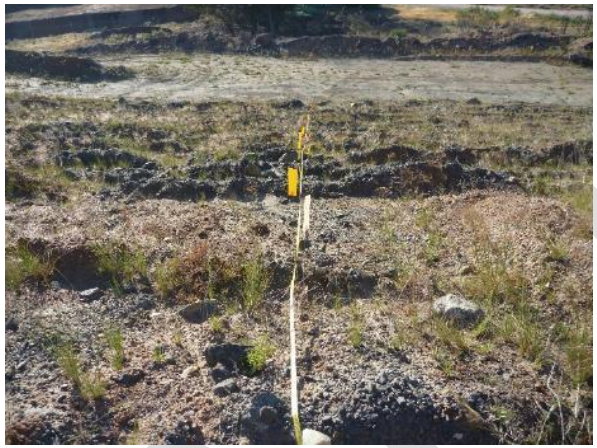
2018

2019

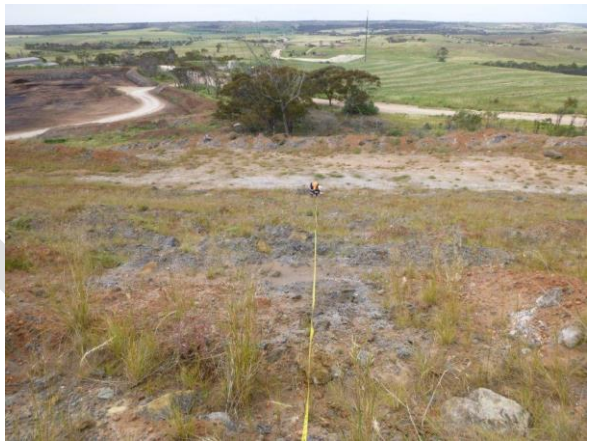
2020

Site: KANLOM RT 02

2018



2019

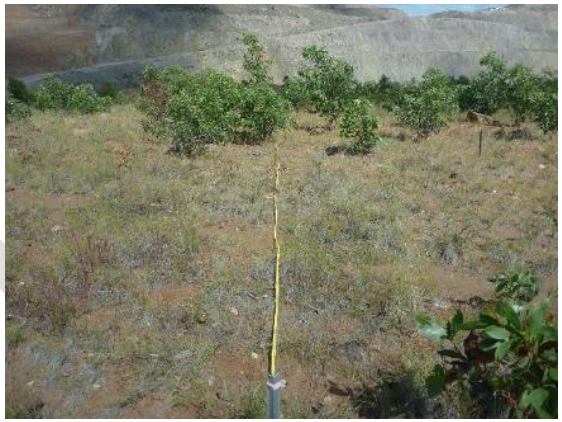


2020

Site: KANACA RT 01


2017


2018


2019


2020

Site: KANACA RT 02


2017


2018


2019


2020

Site: KANACA RT 03

2018

2019

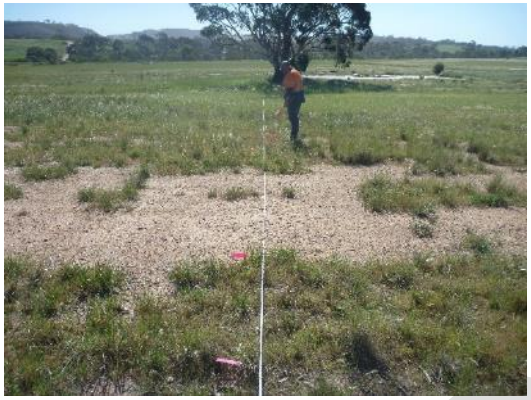
2020

Site: KANGRA RT 01


2013


2014


2015


2017


2018


2019


2020

Site: KANGRA 10


2019


2020

Site: KANGRA 11


2019

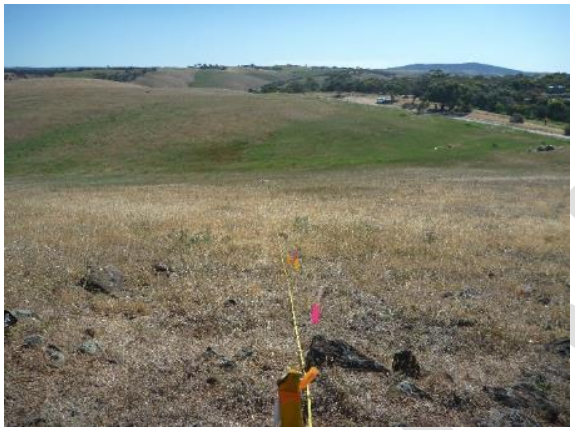

2020

Site: KANGRA 12


2019


2020

Site: KANGRA 13


2019


2020

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