umwelt
Environmental & Social Consultants



ENGIE

WILLOGOLECHE WIND FARM

Offset Area Monitoring Report 2024

FINAL

July 2025

WILLOGOLECHE WIND FARM

Offset Area Monitoring Report 2024

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
ENGIE

Project Director: Marina Louter
Project Manager: Emma Tremain
Author: C.J. Panozzo
Report No. R03/31500
Date: July 2025

Environmental & Social Consultants

Adelaide office:
1/112 Hayward Ave
Torrensville SA 5031

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

Disclaimer

This document has been prepared for the sole use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that for which it was supplied by Umwelt (Australia) Pty Ltd (Umwelt). No other party should rely on this document without the prior written consent of Umwelt.

Umwelt undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. Umwelt assumes no liability to a third party for any inaccuracies in or omissions to that information. Where this document indicates that information has been provided by third parties, Umwelt has made no independent verification of this information except as expressly stated.

©Umwelt (Australia) Pty Ltd

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
V1	Dr M. Louter	15/05/2025	E. Tremain	8/07/2025
V2	E. Tremain	28/07/2025	E. Tremain	28/07/2025

Abbreviations

Abbreviation	Description
%	Percent / Percentage
±	Standard error of mean
BOM	Bureau of Meteorology
DSE	Dry Sheep Equivalent
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
Declared weed	A weed that is regulated under the *Landscape South Australia Act 2019* due to its threat to primary industry, the natural environment and public safety.
DEW	Department for Environment and Water (South Australian)
EBS	EBS Ecology Pty Ltd (which is now Umwelt)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
Ha	Hectare/s
INTG	Iron-grass Natural Temperate Grassland of South Australia
LSA Act	*Landscape South Australia Act 2019*
NPW Act	*National Parks and Wildlife Act 1972*
NRMDB	Natural Resources Murray-Darling Basin
NY NRM	Northern and Yorke Natural Resources Management
OMP	Offset Management Plan
PCQM	Point-centred Quarter Method
PPH	Perennial plants per hectare
Project	the Willogoleche Wind Farm
SA	South Australia
sp.	Species
spp.	Species (plural)
ssp.	Subspecies
TEC	Threatened Ecological Community
Umwelt	Umwelt (Australia) Pty Ltd
Weed	A plant species which does not naturally occur in an area.
WTG	Wind turbine Generator
WWF	Willogoleche Wind Farm

Executive Summary

ENGIE have established an on-ground Offset Area to meet the conditions associated with the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) approval (EPBC 2011/5850) for the Willogoleche Wind Farm (WWF; the Project). As the WWF impacted patches of the nationally Critically Endangered *Iron-grass Natural Temperate Grassland of South Australia* (INTG) *Threatened Ecological Community* (TEC), which is protected by the EPBC Act, an environmental offset is required to compensate for the impact and will be achieved via implementation of the on-ground Offset Area. The main aim of the on-ground Offset Area is to protect and restore a representative patch of INTG TEC to provide an overall biodiversity gain that adequately compensates for the impacts to INTG TEC associated with development of the WWF.

The on-ground Offset Area is being implemented in accordance with the *Willogoleche Wind Farm Offset Management Plan EPBC 2011/5850* (OMP) (EBS Ecology 2017), which outlines minimum targets and management actions required to meet the targets, as well as monitoring and reporting requirements. In accordance with the OMP, an annual monitoring program will be implemented to assess whether the targets are being met and/or whether management actions require adapting. As such, an Offset Area monitoring program commenced in 2018 to collect baseline data prior to implementation of management actions and continued on an annual basis since then.

Umwelt was engaged by ENGIE to undertake the annual Offset Area monitoring in 2024. This report presents the results of the 2024 Offset Area monitoring and provides a comparison with previous Offset Area monitoring undertaken to date.

The 2024 Offset Area monitoring was undertaken on 21 to 23 October 2024 and involved the same methodology used in previous monitoring events, including the Point-Centred Quarter Method (PCQM), quadrat sampling and ramble survey at two previously established Offset Area Assessment Sites, to assess whether the OMP targets are being met and/or whether management actions require adapting. This included determining the condition class of the INTG within the Offset Area, in accordance with *EPBC Act Policy Statement 3.7. Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia and Iron-grass Natural Temperate Grassland of South Australia* (DEWR 2007).

In 2024, the Offset Area was found to have generally improved in condition since baseline survey in 2018 and compared to the previous survey in 2023. An increase in the number of perennial plants per ha and number of rare species with a decrease of dead material in 2024, shows a positive change in condition since 2023 and the baseline survey. A positive change can also be seen in cryptogam and litter cover compared to the previous year, while there has been a positive change in species diversity, plant height, bare ground cover and condition class since the baseline survey.

Despite the desirable trend of the average dead material decreasing, it is still above what is considered to be indicative of a healthy native grassland such as INTG, but this reflects die-off of the weeds observed in the previous year and not a decline in INTG condition. Following the previous monitoring event, the corresponding report advised that periodic, intensive grazing (maximum of 7 days followed by 4 weeks rest) between May and November should be resumed. Although it is presumed that grazing occurred following the recommendation, evidenced by the reduction in plant height and the scats present, the intensity of grazing was not enough to suppress the influx of weeds before they began to die-off. Weeds were still present in 2024 and weed cover in 2024 has significantly increased, compared to 2023. If an adaptive grazing regime is not implemented in the Offset Area, observed improvements in the health of the INTG grassland since 2018 are at risk of being lost in future years.

A total of 20 native flora species were observed within the Offset Area in 2024, which is an increase from the nine species found in the baseline survey. However, there was a decrease in total native flora species observed in 2024 compared to 2023 as both Assessment Sites decreased by one species. Despite the decrease, both Assessment Sites still qualified as INTG Condition Class B.

Of the grassland health indicator attributes assessed, only 'Lomandra presence' achieved the benchmark goal range for both sites, while the bare ground cover benchmark was only achieved for Site 2. However, both litter and cryptogam cover have improved compared to 2023, with this being the only year that the cryptogram cover has increased since this data was first collected in 2019 survey.

A high annual rainfall in 2020, followed by above average rainfall in the two months prior to the 2022 survey enabled a proliferation of weed species across the Offset Area, which is likely to have resulted in the high litter cover observed across 2020 to 2023. However, the below average annual rainfall in 2023 and 2024 is likely to have contributed to the reduction of litter cover as the weeds observed in the previous years have now died-off and were yet to rejuvenate. Impacts of climatic variability have been exacerbated by an inappropriate grazing regime, where the inter-tussock space between Lomandra and native grasses was not ideal for promoting the regeneration of native grass or herbaceous species and weed species were able to dominate.

In summary, the following actions are recommended:

- Resume periodic grazing in the Offset Area between May and November, allowing a maximum of 7 days grazing (or possibly less depending on the number and type of sheep grazing) followed by at least 4 weeks rest.
- Grazing should be timed to coincide with the elongation of annual weedy grass stems, prior to development of seed heads, to reduce seed set of annual weedy grasses.
- No grazing is to occur during late spring / early summer to allow native seed set (i.e., between November and May).
- Manage grazing according to seasonal conditions by:
    - Reducing grazing duration and frequency in dry conditions and do not enable grasses to be grazed to less than 5 cm in height
    - Increase grazing duration and frequency in wet conditions / after above average rainfall
    - Start grazing later in winter and stop earlier in spring.

- Weed control should focus on removal of isolated patches of Declared weeds identified in the 2024 survey.
- Grazing and weed management actions undertaken by the landholder in the Offset Area, **must be reported annually** (for example via the *Activity Record Datasheet*, and *Paddock Monitoring Sheet* provided in the Appendices of this report) to enable monitoring results to be assessed and linked to management actions, including:
    - Timing, duration and intensity (stocking rate and type of sheep) of grazing
    - Targeted weed control (i.e., spot spraying, hand removal).
- An annual review of the status of the Offset Area is recommended as part of the annual monitoring and reporting program, including liaison between the landholder, ENGIE and ecological consultant. It is recommended that following finalisation of this report, a meeting between involved parties be arranged to discuss the findings of this monitoring report and management actions going forward.

Refer to **Section 6.0** Recommendations for further detail on the above recommendations.

Table of Contents

Abbreviations i

Executive Summary ii

1.0 Introduction 1

1.1 Objectives 1

2.0 Background 3

2.1 Willogoleche Wind Farm 3

2.2 EPBC Act Approval Conditions (EPBC 2011/5850) 3

2.3 Offset Area and Offset Management Plan 3

2.3.1 Offset Area Aims, Objectives and Targets 4

3.0 Methodology 6

3.1 Assessment Sites 6

3.2 Point-centred Quarter Method (PCQM) 8

3.3 Quadrat Sampling 12

3.3.1 Grassland Health Indicators 12

3.3.2 Weed Survey 15

3.4 Ramble Survey 15

3.5 Opportunistic Observations 15

3.6 Data Analysis 16

3.6.1 PCQM 16

3.6.2 Quadrat Sampling for Weeds and Grassland Health Indicators 17

3.6.3 EPBC Condition Ramble Survey 17

3.7 Limitations 17

4.0 Results 19

4.1 Climate 19

4.2 2024 Offset Area Monitoring Summary 20

4.3 PCQM 21

4.3.1 Spacing of Perennial Plants 22

4.3.2 Perennial Plants Per Hectare (PPH) 23

4.3.3 Basal Width and Cover 24

4.3.4 Plant Height 25

4.3.5 Plant Health 26

4.3.6 Species Composition 27

4.4 Quadrat Sampling 28
4.4.1 Grassland Health Indicators 28
4.4.2 Weeds 29
4.5 Ramble Survey 33
4.5.1 Native Species Diversity 33
4.5.2 INTG TEC Condition Class 33
4.5.3 Rare Flora 34
4.5.4 Grazing and Erosion 35
5.0 Discussion 36
5.1 Summary of Condition Within the Offset Area 36
5.2 PCQM 37
5.2.1 Perennial Plants Per Hectare 37
5.2.2 Spacing of Perennial Plants 37
5.2.3 Basal Cover 38
5.2.4 Plant Height 38
5.2.5 Plant Health 39
5.2.6 Species Composition 39
5.3 Condition Class 39
5.4 Grassland Health Attributes 40
5.5 Weeds 40
5.5.1 Weed Cover 40
5.5.2 Declared species 41
5.6 OMP Targets 42
6.0 Recommendations 44
6.1.1 Grazing Management 44
6.1.2 Weed Management 45
7.0 References 46

Figures

Figure 3.1	Overview of Willogoleche Wind Farm, Including the Offset Area and Assessment Sites	7
Figure 3.2	The Point-Centred Quarter Method Involves Collecting Data on the Closest Native Perennial Plant (Indicated by a Green Star) in Four Quarters at Each Sample Point	8
Figure 3.3	Schematic of a 50 m Long Transect with Ten 1 m^2 Quadrats, Surveyed at 5 m Intervals (Not to Scale)	13
Figure 4.1	Monthly Rainfall Data for November 2016 to October 2024 (with Offset Area Monitoring Survey Periods Highlighted in Red)	19
Figure 4.2	Declared Weed *Cynara Cardunculus* (Artichoke Thistle) Observed at Site 1 via Ramble Survey	32
Figure 4.3	Declared Weed *Echium Plantagineum* (Salvation Jane)	32
Figure 4.4	Declared Weed *Marrubium vulgare* (Horehound) Observed at Site 1	32
Figure 4.5	A Heavily Grazed *Cryptandra campanulata* Specimen	35
Figure 4.6	Close-up of a *Rumex dumosus* Specimen	35

Graphs

Graph 4.1	Average Distance (cm) of Grass Tussocks from PCQM Centre Point (2018-2024)	22
Graph 4.2	PPH at Each Assessment Site via PCQM (2018–2024)	23
Graph 4.3	Percent Basal Cover, Representing the Percent of Each Hectare Covered by a Perennial Plant Species, Measured Using PCQM (2018-2024)	24
Graph 4.4	Average Plant Height at Each Assessment Site (2018-2024)	25
Graph 4.5	Average Height of the Four Most Common Perennial Grass Species Recorded (2018–2024)	26
Graph 4.6	Average Percentage of Dead Material Observed per Tussock (2018–2024)	26
Graph 4.7	Frequency (%) of Perennial Grasses at Sample Points (2018–2014)	27
Graph 4.8	Relative Importance of Perennial Native Grasses (2018–2024)	28

Tables

Table 1.1	Previous Offset Area Monitoring Completed at WWF	1
Table 2.1	Ecological Indicators, Desired Outcomes and Targets for the Offset Area	5
Table 3.1	Assessment Site and Monitoring Transect Location Details	6
Table 3.2	Data Collected via PCQM, Analysis Approaches, Purpose of Data Collection, Desired and Undesired Trends, Comments and Recommendations	10
Table 3.3	Grassland Health Indicator Attributes, Desired and Undesired Trends, Comments and Recommendations	14
Table 3.4	EPBC INTG TEC Condition Class Criteria (DEWR 2007)	15

Table 4.1	Summary of 2024 Monitoring Results Based on PCQM and Ramble Survey	20
Table 4.2	Number of Species of Each Life form (via Ramble Survey in 2024)	20
Table 4.3	Summary of Grassland Health Indicators for 2024 Compared With Mean and Benchmarks	20
Table 4.4	Summary of Monitoring Results Based on PCQM for 2018–2024	21
Table 4.5	Summary of Grassland Health Indicator Results 2019-2024 and Compared to Benchmark	29
Table 4.6	Average Coverage (%) of Weed Species at Each Assessment Site in 2024	30
Table 4.7	Management Requirements for Declared Weeds Observed in 2024	30
Table 4.8	Native Species Recorded at Each Assessment Site in 2024	33
Table 4.9	INTG TEC Condition Class Data for Each Site for 2018-2024 (With Criteria in Green)	34
Table 5.1	Summary of Monitoring Results Based on the PCQM and Ramble Surveys Averaged Across Site 1 and Site 2 (2018–2024)	37
Table 5.2	Status of Offset Area Management Objectives and INTG TEC Condition (2024)	43

Appendices

Appendix 1	Important Dates, Monitoring and Offset Area Milestones
Appendix 2	Offset Area Site Photographs (2018-2024)
Appendix 3	Weed Cover Percentage (%) (2019-2024)
Appendix 4	Activity Record Datasheet
Appendix 5	Paddock Monitoring Sheet
Appendix 6	Threatened Species and Declared Weeds Observed in 2024

1.0 Introduction

ENGIE have established an on-ground Offset Area to meet conditions associated with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approval (EPBC 2011/5850) for the Willogoleche Wind Farm (WWF; the Project). As construction of the WWF impacted patches of the nationally Critically Endangered *Iron-grass Natural Temperate Grassland of South Australia* (INTG) *Threatened Ecological Community* (TEC), which is protected by the EPBC Act, an environmental offset is required to compensate for the impact and will be achieved via implementation of the on-ground Offset Area. The main aim of the on-ground Offset Area is to protect and restore a representative patch of INTG TEC to provide an overall biodiversity gain that adequately compensates for the impacts to INTG TEC associated with development of the WWF.

The on-ground Offset Area is being implemented in accordance with the *Willogoleche Wind Farm Offset Management Plan EPBC 2011/5850* (OMP), (EBS Ecology 2017). The OMP was reviewed in 2024 and the *Willogoleche Wind Farm Offset Management Plan – 5 Year Review* (EBS Ecology 2024a) should be read in conjunction with the OMP. The OMP outlines minimum targets and management actions required to meet the targets, as well as monitoring and reporting requirements. In accordance with the OMP, an annual monitoring program will be implemented to assess whether the targets are being met and/or whether management actions require adapting.

This report presents the results of the annual Offset Area monitoring undertaken in 2024, which is the sixth monitoring event since the baseline survey was conducted in 2018. The baseline survey collected data on the Offset Area prior to implementation of management actions. Refer to the reports listed in **Table 1.1** for more information on previous Offset Area monitoring events. Note that EBS Ecology became Umwelt (Australia) Pty Ltd in July 2024.

Table 1.1 Previous Offset Area Monitoring Completed at WWF

Year	Report	Reference
2018	*Willogoleche Wind Farm Offset Area Monitoring Report 2018* (This report contains baseline data for the Offset Area prior to implementation of management actions.)	EBS Ecology 2018
2019	*Willogoleche Wind Farm Offset Area Monitoring Report 2019*	EBS Ecology 2020
2020	*Willogoleche Wind Farm Offset Area Monitoring Report 2020*	EBS Ecology 2021
2021	*Willogoleche Wind Farm Offset Area Monitoring Report 2021*	EBS Ecology 2022
2022	*Willogoleche Wind Farm Offset Area Monitoring Report 2022*	EBS Ecology 2023
2023	*Willogoleche Wind Farm Offset Area Monitoring Report 2023*	EBS Ecology 2024b

1.1 Objectives

The objectives of this report are to:

- Describe the methodology used for the 2024 monitoring event.

- Present the results of the 2024 monitoring event and compare to baseline and subsequent annual monitoring event results.
- Assess the condition of the Offset Area against the core management objectives and targets set out in the OMP.
- Provide discussion and recommendations regarding management of the Offset Area.
- Provide discussion and recommendations regarding the annual monitoring program.

2.0 Background

2.1 Willogoleche Wind Farm

The WWF is located approximately 6 km west of the township of Hallett in the Mid North of SA. The Project is comprised of 32 wind turbine generators (WTGs), an electrical substation, an operation and maintenance facility and associated access tracks and infrastructure. Construction works for the WWF commenced on 9 September 2017 and sectional completion was achieved on 12 November 2019. However, the WWF had been generating and exporting electricity to the grid during the commissioning and optimisation process for several months prior to the date of sectional completion. The WWF is expected to be operational for approximately 25 years.

2.2 EPBC Act Approval Conditions (EPBC 2011/5850)

WWF received EPBC Act approval, with associated conditions, on 28 January 2014, and a variation to conditions attached to the approval on 12 December 2016. To offset impacts on INTG, the approval conditions require an offset site 4 ha in size to be secured under a Heritage Agreement under the South Australian *Native Vegetation Act 1991* and implementation of an Offset Management Plan approved by the Minister. A Heritage Agreement (HA 1602) was registered on 9 August 2019 and formally protects the Offset Area in perpetuity, preventing current and future landowners to develop or significantly change the site. The *Willogoleche Wind Farm Offset Management Plan EPBC 2011/5850* (EBS Ecology 2017) (OMP) was approved by the Minister on 3 February 2017. The OMP was reviewed and revised in 2024 to the *Willogoleche Wind Farm Offset Management Plan – 5 Year Review* (EBS Ecology 2024a) (OMP).

2.3 Offset Area and Offset Management Plan

As outlined previously, an on-ground Offset Area has been established to compensate for the Project's impact on INTG TEC and is being implemented in accordance with the OMP, which outlines minimum targets and management actions required to meet the targets, as well as monitoring and reporting requirements. The Offset Area is located on Woodman Road, just beyond the western boundary of the southern extent of the WWF. It is approximately four hectares in size and located within a larger area of *Lomandra multiflora* subsp. *dura* Open Tussock Grassland that was historically utilised for livestock grazing (EBS Ecology 2017).

An initial assessment of the Offset Area was undertaken in 2013 (EBS Ecology 2013) to inform development of the OMP. At the time of writing the OMP (initial version; EBS Ecology 2017), the Offset Area was in poor to moderate condition, meeting the criteria for INTG TEC condition class C, in accordance with the condition classes outlined in the *Commonwealth Listing Advice on Iron-grass Natural Temperate Grassland of South Australia* (TSSC 2007). However, as permanent monitoring sites were not established in 2013, quantitative baseline data was collected for the first time in 2018 (year 0) (EBS Ecology 2018) and is used to compare data from subsequent annual monitoring events against, to determine if targets are being met or if management actions need to be adapted. A summary of important dates and annual monitoring completed to date is provided in **Appendix 1**.

2.3.1 Offset Area Aims, Objectives and Targets

As stated previously, the main aim of the on-ground Offset Area is to protect and restore a representative patch of INTG TEC to provide an overall biodiversity gain that adequately compensates for the impacts to INTG TEC associated with development of the WWF.

As such, the core management objective for the Offset Area, via the OMP, is to improve the quality of the INTG TEC within it such that it meets the criteria for INTG TEC Condition Class B (or higher), in accordance with the condition classes outlined in the *Commonwealth Listing Advice on Iron-grass Natural Temperate Grassland of South Australia* (TSSC 2007) and *EPBC Act Policy Statement 3.7 – Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia and Iron-grass Natural Temperate Grassland of South Australia* (DEWR 2007). To achieve this, the OMP states that the following targets will need to be achieved:

- Increase diversity of native flora species[1] by a least 6 species (from nine to 15 or more).
- Increase the number of broad-leaved herbaceous flora species[1] (in addition to identified disturbance resistant species[2]) by two (to be three or more).
- Increase the number of perennial native grass species[1] (excluding Lomandra spp.) by at least two species (to be four or more).
- Increase the density of native perennial grass species (i.e. tussock count[3]) (including *Lomandra* spp.) to one per metre (or more).

Additional management objectives for the Offset Area as listed in the OMP include:

- Manage feral herbivore populations if required.
- Establish long-term scientific monitoring sites to demonstrate attainment of condition class targets.

Furthermore, as outlined in the OMP, management of the Offset aims to address the following key Recovery Actions from the *National Recovery Plan for the Iron-grass Natural Temperate Grassland of South ecological community, 2012* (Turner, 2012):

- Strategy 3: Increase the area of the EPBC listed INTG secured and managed for conservation.
- Strategy 4: Maintain or improve the condition and integrity of the EPBC listed INTG remnants using 'best practice' strategies.
- Strategy 5: Increase the area of occupancy of the EPBC listed INTG ecological community across its natural range.

[1] As measured in a 50 m x 50 m quadrat
[2] The following species are identified as disturbance resistant species: *Ptilotus spathulatus* forma *spathulatus*; *Sida corrugata*; *Oxalis perennans*; *Convolvulus erubescens*; *Euphorbia drummondii*; and *Maireana enchylaenoides*.
[3] As measured along a 50 m transect

2.3.1.1 Ecological Indicators

The OMP outlines four ecological indicators and associated desired outcomes, along with targets at five years, ten years and 16 years, which are presented in **Table 2.1**. The four ecological indicators align with the four targets outlined above and the criteria for INTG TEC Condition Class B (or higher), in accordance with the condition classes outlined in the *Commonwealth Listing Advice on Iron-grass Natural Temperate Grassland of South Australia* (TSSC 2007) and *EPBC Act Policy Statement 3.7 – Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia and Iron-grass Natural Temperate Grassland of South Australia* (DEWR 2007).

As outlined in the OMP, the EPBC Offsets Assessment Guide (DSEWPC 2012) was used when planning the Offset. This included identifying the start quality/condition of the offset area (prior to management actions) and nominating a future quality of the offset area (with implementation of management actions) after a certain timeframe. The start quality was rated '2' (out of 10) and the future quality was nominated as a '7' (out of 10), with the timeframe nominated as 16 years. This means that the quality of the INTG within the Offset Area needs to improve from a '2' to a '7' within 16 years.

Table 2.1 Ecological Indicators, Desired Outcomes and Targets for the Offset Area

Ecological Indicator	Suggested Method	Desired Outcome	Interim 5 Year Target	Interim 10 Year Target	Target (16 years)
Plant species diversity	Two 50 m x 50 m quadrats (ramble survey)	Increase in native species diversity from 9 (observed in 2017) to more than 15.	11	13	>15
Perennial native grass species diversity	Two 50 m x 50 m quadrats (ramble survey)	Increase native grass species from two to four or more species.	3	4	≥ 4
Broad-leaf native herbaceous species diversity	Two 50 m x 50 m quadrats (ramble survey)	Increase the broad-leaf native herbaceous species from one to three or more (excluding disturbance resistant species).	1	2	≥ 3
Density of Tussock Grassland Species (including native grass and Iron-grass)	Two 50 m point count transects.	Increase density of tussock species to one per metre.	1 per 10 m	1 per 5 m	≥ 1 per m

3.0 Methodology

The 2024 Offset Area Monitoring involved data collection along a 50 m monitoring transect, together with a ramble survey, within two previously established Assessment Sites in the Offset Area, as explained below. The field survey work was undertaken from 21 to 23 October 2024 by Umwelt Ecologist N. Piscioneri and Senior Environment Officer E. Tremain.

3.1 Assessment Sites

Each Assessment Site consists of a 50 m long monitoring transect running approximately north-south and 25 m either side of the monitoring transect, creating a 50 m x 50 m (0.25 ha) 'Assessment Site' (**Table 3.1**; **Figure 3.1**).

Table 3.1 Assessment Site and Monitoring Transect Location Details

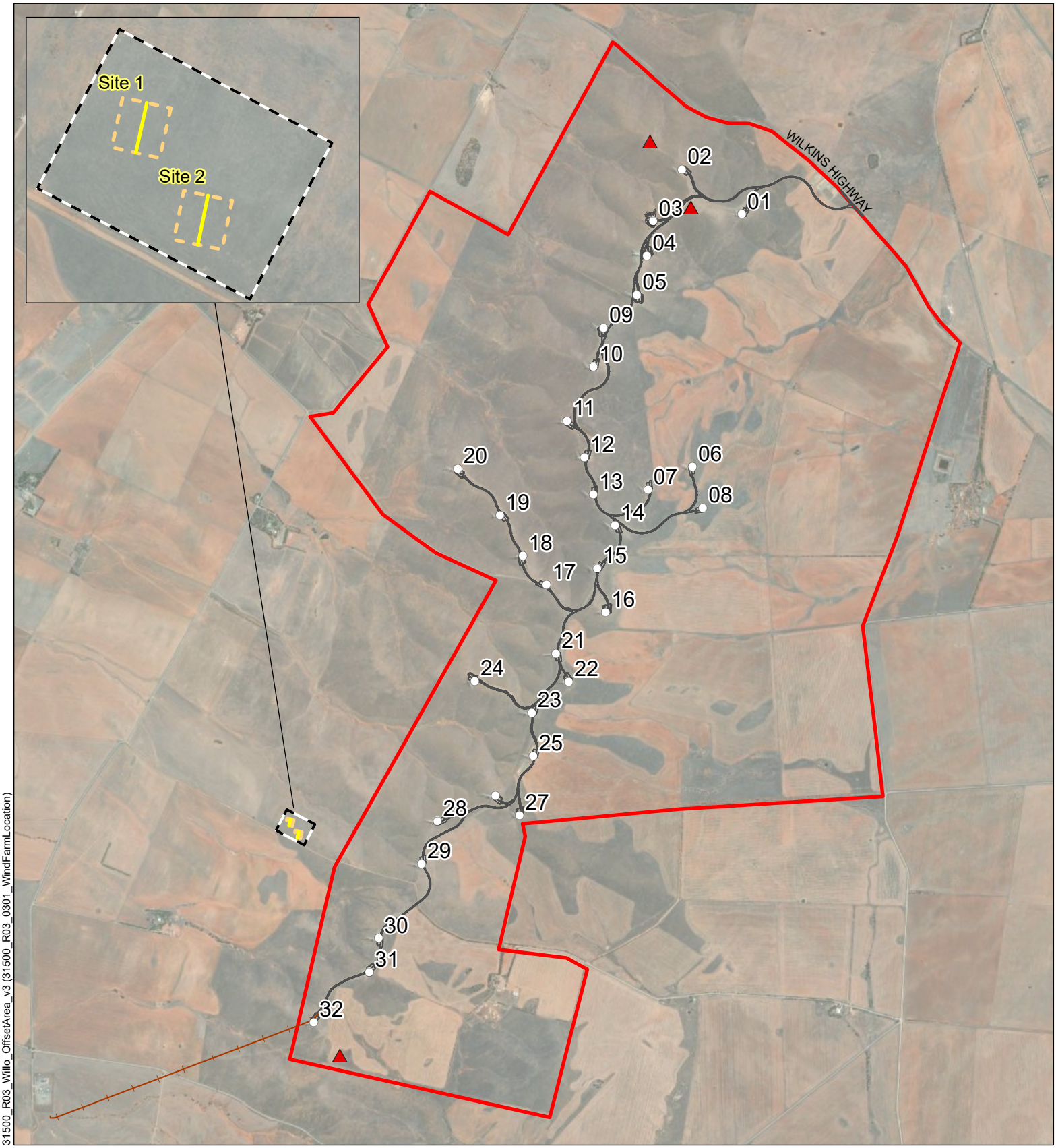
Assessment Site	Location	Monitoring Transect Location Details				INTG TEC Condition Class (2019)
		End of Transect	Zone	Easting	Northing	
1	North-west vicinity of the offset	Northern	54H	297168	6298716	Class B
		Southern		297156	6298666	
2	South-east vicinity of the offset	Northern	54H	297230	6298623	Class B
		Southern		297219	6298572	

In 2019, additional methods including a 50 m x 50 m ramble survey were incorporated into the Offset Area monitoring program to allow for a more rigorous assessment of vegetation and to enable assessment of the sites against the condition class criteria for INTG TEC listing.

In 2021, the ramble search was refined and reduced to 25 m either side of each existing monitoring transect and should remain like this for future surveys for repeatability and simplicity.

Photographs looking along each monitoring transect are provided in **Appendix 2**, including the start point (at 0 m) and end point (at 50 m) for monitoring events in 2019 to 2024. However, photographs were only taken at the start (north) point in 2018.

Figure 3.1: Overview of Willogoleche Wind Farm, Including the Offset Area and Assessment Sites



Willogoleche Wind Farm project boundary
Offset Area
Offset Area Assessment Site
Monitoring Transect
Wind turbine
Met mast
Electranet Interconnect
Windfarm infrastructure



31500_R03_Willo_OffsetArea_v3 (31500_R03_0301_WindFarmLocation)

Data Source: Umwelt (2025), ESRI (2025), DEW (2022), DIT (2022)

Date Exported: 8/07/2025 10:29 AM
Created by: sophie.haswell

COPYRIGHT: Use or copying of this map in whole or in part without the written permission of Umwelt constitutes an infringement of copyright. LIMITATION: This map has been prepared on behalf of and for the exclusive use of Umwelt's Client, and is subject to and issued in connection with the provisions of the agreement between Umwelt and its Client. Umwelt accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this map by any third party.

GDA2020 MGA Zone 54

N

0 0.5 1 km

3.2 Point-centred Quarter Method (PCQM)

In 2024, the PCQM methodology used in previous monitoring events was repeated. Methodology was slightly altered in 2021 based on feedback from the 2020 survey results. PCQM involves surveying ten sample points along a 50 m transect, assessing perennial plant parameters at 5 m intervals (starting at 0 m). Each sample point is further divided into four quarters by placing a range pole (or similar) perpendicular to the transect line, then the distance from the sample point to the nearest native perennial plant in each of the four quarters is measured and recorded (**Figure 3.2**), resulting in assessment of 40 perennial plants per transect (Tongway & Hindley 2004). The PCQM is used instead of other methods, for example tussock counts in 1 m^2 x 1 m^2 quadrats, due to the number of small grasses (i.e. *Rytidosperma* spp.) making counts very time consuming.

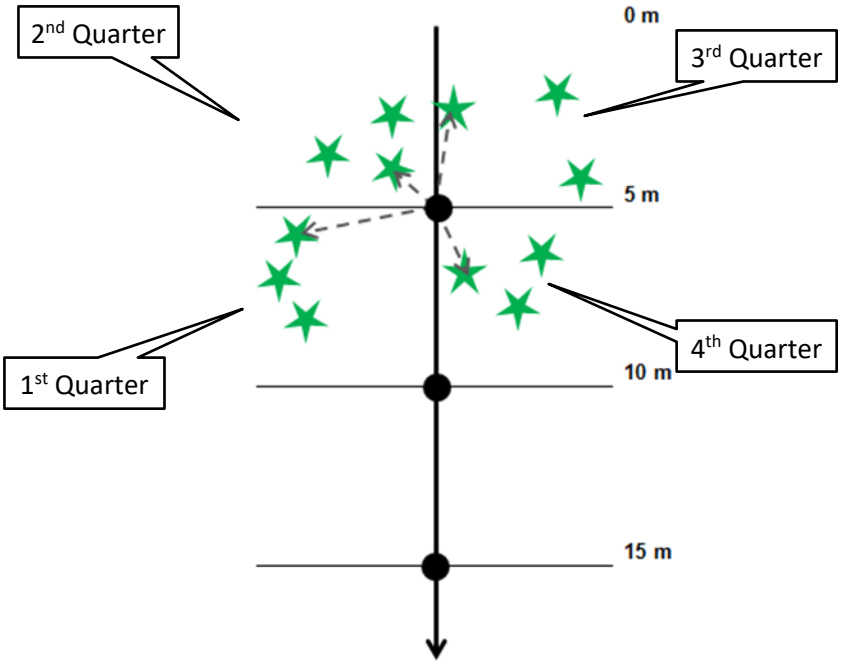


Figure 3.2 The Point-Centred Quarter Method Involves Collecting Data on the Closest Native Perennial Plant (Indicated by a Green Star) in Four Quarters at Each Sample Point

(Image Adjusted From Tongway & Hindley 2005)

Consistent with measurements taken since 2021, measurements in 2024 were limited to the four most dominant perennial grass species to enable more robust analysis.

At each sample point along the transect, the four distance measures are averaged to represent the distance (d) at each sample point, and then these distances are averaged to calculate the average distance of all sample points on a transect.

In addition to the species, the canopy width (spread) in cm, plant height (cm) (to the top of the leaves) and basal width (cm) (rootstock width of tussock at the ground) of each of the 40 perennial plants is recorded (Tongway & Hindley 2005).

Previously, the PCQM data has been used to calculate percentage cover and volume of perennial plants in metres cubed (m^3). However, given that canopy width is highly variable dependent on seasonal conditions and is sensitive to grazing, it is considered that trends may be more evident and meaningful if basal area (m^2) is used, which also provides an indication of land function, and influences the relative importance of a species within an ecosystem. A summary of data collected via PCQM in 2024 and how the data was then analysed, along with the purpose of data collection, desired and undesired data trends for grassland health, potential data limitations and recommendations for future monitoring, is provided in **Table 3.2.**

From the data collected the following indices can be derived:

1. The density of plants per unit area for each species.
2. Basal cover per unit area (m^2/ha).
3. Importance value of each species, where:
    a. *Relative density*: percentage of points a species is recorded at (maximum n = 40 per site).
    b. *Relative cover*: basal area as a percentage of all species recorded at the site.
    c. *Relative frequency*: normalised absolute frequency which is the percentage of sample points at which a species occurs (maximum n = 10) (may total over 100 given that up to four species may be present at each sample point for an absolute frequency of 400).
    d. *Relative importance*: Gives weight to three factors of relative density, cover, and frequency. This means that plants with a small basal area can be dominant only if there are enough of them widely distributed across the transect.

Table 3.2 Data Collected via PCQM, Analysis Approaches, Purpose of Data Collection, Desired and Undesired Trends, Comments and Recommendations

Parameter	Data Collected	Analysis	Purpose	Desired trend	Undesirable Trend	Comment	Recommendations
Cover (m^2)	Basal width	PCQM	Determine basal cover (m^2) of perennial plants.	Stable or slight increase.	Significant increase or decrease.	Based on several years of monitoring, it was deemed that PCQM had some limitations. Therefore in 2019, the method was supplemented with additional data collection methods. In 2020 these PCQM measures were reviewed again to determine a more appropriate and indicative method moving forward, and in the 2021 survey basal width and PPH were used as the primary indicator of plant health for this survey method.	Continue to monitor using PCQM. However, supplement with collecting total percentage native cover data (as undertaken in 2019). E.g., measure using % native cover in 1 m x 1 m quadrats.
Volume (m^3)	Canopy width breadth, height and canopy density (%)	PCQM	Determine volume of vegetation in metres cubed (m^3).	Ideally stable or increase, but data is not meaningful.	Ideally stable or increase.		No longer analysed as part of this report.
Density of Perennial Plants per ha (PPH)	Distance from PCQM centre point	PCQM	Determine the number of perennial plants per hectare.	Stable or slight increase.	Significant increase or decrease.		Continue to monitor using PCQM. Only the four most dominant or important indicator species to measure were included in the PCQM in 2021 and 2022 (*Lomandra, Aristida, Austrostipa* spp., *Rytidosperma* spp.)
% dead material	Percentage of green material on tussocks (canopy density)	Average % dead material	Determine tussock dieback, a useful indicator in grassland health.	Stable or decreasing	Increasing	Potentially useful indicator of plant health.	Continue to measure percentage dead material of 40 plants per transect.
Canopy size of tussock (in cm)	Canopy width	Average canopy width	Aims to changes on the canopy size of tussocks (will detect grazing pressure and seasonal conditions).	Stable or increasing size	Decreasing	Potentially useful indicator of plant size.	No longer analysed as part of this report. Height is deemed a more robust and suitable indicator of grazing pressure. Basal width is deemed a more suitable indicator of cover.

Parameter	Data Collected	Analysis	Purpose	Desired trend	Undesirable Trend	Comment	Recommendations
Height of plant (in cm)	Height of plant	Average height	Aims to detect changes in height – useful for determining grazing pressure.	Stable or increasing height	Decreasing	Height is deemed a more robust and suitable indicator of grazing pressure. Basal width is deemed a more suitable indicator of cover.	**Continue** to measure plant height of 40 plants per transect (from ground to tip of leaves, not seed/flower head).

3.3 Quadrat Sampling

3.3.1 Grassland Health Indicators

Following on from the methods introduced in 2019 and 2021, the 2024 survey measured the following five grassland health indicator attributes (life forms) as well as the presence or absence of *Lomandra* spp., in each of the ten 1 x 1 m quadrats indicated in **Figure 3.3**, at the two Assessment Sites, to further inform trends in grassland condition and health within the Offset Area:

- Percentage (%) cryptogams (including on rock surfaces)
- % litter (an estimation of all annual exotic plant material (dead or alive) and dry debris as a measure of residual dry biomass)
- % bare ground
- % total native cover
- % rock
- *Lomandra* spp. presence or absence (added to methodology in 2021).

Lomandra is a long-lived tussock with deep roots which hold soils together, also acting as a seed trap and providing protection from heavy grazing due to their unpalatability (NRMDB 2019). Based on recommendations of the 2020 report, the 2021 survey added a frequency score for *Lomandra* ssp. to the 1 x 1 m quadrat sampling method to gain a better understanding of its distribution across each site and provide a comparison for the PCQM.

The following three grassland health indicator attributes are compared to the unofficial benchmark values for Grasslands in the Northern Lofty botanical region, which are set out within the *Bushland condition monitoring manual: Northern Agricultural & Yorke Peninsula Regions* (Pedler et al. 2007):

- (%) cryptogams (benchmark of ~50%)
- % litter (benchmark of <25%)
- % bare ground (benchmark of <5%).

An overview of the purpose of the data collected, the desired and undesired trends, comments and recommendations for future monitoring within the Offset Area are provided in **Table 3.3.**

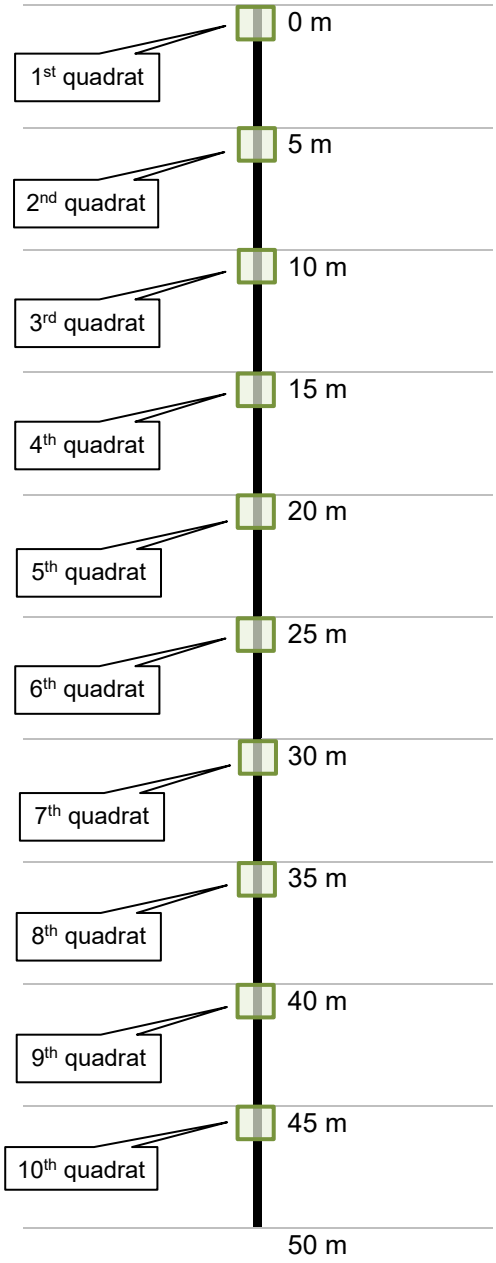


Figure 3.3 **Schematic of a 50 m Long Transect with Ten 1 m² Quadrats, Surveyed at 5 m Intervals (Not to Scale)**

Table 3.3 Grassland Health Indicator Attributes, Desired and Undesired Trends, Comments and Recommendations

Attribute	Purpose	Desired trend	Undesirable trend	Comments / Recommendations
% cryptogams	Presence of cryptogams indicates soil health, stability and nutrient cycling.	Increasing/ benchmark.	Decreasing The unofficial benchmark values for cryptogams (with moss and lichen cover) comprises up to 50 % for Grasslands in the Northern Lofty botanical region (Pedler, Croft & Milne, 2007).	Continue to monitor.
% litter including exotic annual grass (the majority of litter)	Will monitor percentage of the site covered in dead annual grass material which indicates a high % of weeds, some loss of patchiness and may inhibit germination of native species.	Decreasing.	Increasing (generally indicates increased weeds in the grassland system).	Continue to monitor.
% bare ground (meaning exposed dirt free of litter, moss, plants (dead or alive), rock or cryptogams)	Will monitor soil disturbance and potential for soil loss or erosion. Can increase due to dry conditions, increased livestock or weed invasion.	Decreasing/ benchmark (native species often germinate in bare ground so some may be desirable).	Increasing. The unofficial benchmark values for % bare ground in Grasslands in the Northern Lofty botanical region is approximately <5 % (Pedler, Croft & Milne, 2007).	Continue to monitor.
% total native cover (all perennial and annual species)	Will determine trends in the total native cover and determine if site becomes overgrown or experiences significant losses of vegetation.	Stable or slight increase.	Significant increase (loss of patchiness) or significant decrease.	Consider also collecting percentage cover of various life forms (forbs, grasses, shrubs etc.) to better inform cover of different components.
% rock	Data collected to obtain full picture of structural attributes. Rock cover does not need to be collected in future years.	Stable.	Significant change.	Monitor annually as an indicator of observer variability.
Frequency of Lomandra (% of quadrats)	Data collected to supplement PCQM when prevalence of perennial tussock grasses limit recording of Lomandra tussocks.	Stable or increasing.	Decreasing frequency.	First data collected in 2021. Continue to monitor.

3.3.2 Weed Survey

At each Assessment Site, weed species and coverage (as a percentage of area covered) were assessed within a 1 m^2 quadrat placed at 5 m intervals along the 50 m monitoring transect, starting at 0 m and finishing at 45 m, resulting in a total of ten quadrats being assessed (**Figure 3.3**).

General notes on weed cover were also made whilst traversing the Offset Area and during the ramble survey (explained below). It is of note that the total percentage litter was also determined as part of the grassland health data, where dry material largely represents dead exotic species.

3.4 Ramble Survey

In addition to the PCQM sampling, grassland health indicator and weed survey methods outlined above, a ramble survey was undertaken at each Assessment Site to record any native species present, particularly those that may not have been recorded by the PCQM or Quadrat Sampling (as they were not present within the ten quadrats along the monitoring transect). The ramble survey was undertaken within a 25 m buffer either side of the monitoring transect (a total of 0.25 ha).

The data collected is used to determine the condition class of the INTG within the Offset Area, in accordance with *EPBC Act Policy Statement 3.7. Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia and Iron-grass Natural Temperate Grassland of South Australia* (DEWR 2007) (**Table 3.4**). Subsequently it was also determined if the condition of INTG has changed or remained stable since the baseline assessment was undertaken in 2018.

Table 3.4 EPBC INTG TEC Condition Class Criteria (DEWR 2007)

Condition Class	Minimum Size	Diversity of Native Species[1]	No. of Broad-leaved Herbaceous Species[1] in Addition to Identified Disturbance Resistant Species[2]	No. of Perennial Grass Species[1] (Excluding Lomandra)	Tussock Count[3] (Including Lomandra)
Listed ecological community					
A	0.1 ha	>30	≥10	>5	1/m
B	0.25 ha	>15	≥3	>4	1/m
Degraded patches amenable to rehabilitation					
C	No minimum	>5	No minimum	>1	No minimum

1: As measured in a 50 m x 50 m quadrat.

2: Disturbance resistant species: *Ptilotus spathulatus* forma *spathulatus, Sida corrugata*, *Oxalis perennans*, *Convolvulus angustissimus*, *Euphorbia drummondii*, and *Maireana enchylaenoides.*

3: As measured along a 50 m transect.

3.5 Opportunistic Observations

In addition to the PCQM, quadrat sampling and ramble survey outlined above, any opportunistic observations, for example of Declared weeds, grazing and erosion, within the Offset Area were also recorded.

3.6 Data Analysis

As the Offset Area monitoring commenced in 2018 and new methods were added in 2019 and in 2021, it is too early in the monitoring program to undertake any meaningful statistical analysis. Descriptive data and any observations of changes or constants between 2018 and 2024 are reported in **Section 4.0** (Results) and **Section 5.0** (Discussion). Statistical analysis will be conducted in future years when there is enough data to ascertain if any changes within the Offset Area are occurring over the period of the monitoring program. Analysis tools used for each survey methodology are detailed below.

3.6.1 PCQM

At each of the two Assessment Sites within the Offset Area, PCQM data was used to calculate the following parameters.

Density (Plants/Ha) – Perennial Plants Per Hectare (PPH)

Absolute density of perennial plants is defined as the number of plants per unit area. The distances measured using the PCQM method are used to calculate density without having to count every perennial plant in an area. The estimate works by calculating the mean distance from the centre-point (sum of the nearest point-to-perennial distances in the quarters surveyed, divided by the number of quarters), for each site, and for all sites combined in any given year.

Using this calculation, density per m^2 is calculated using the formula $1/mean\ density^2$. This number can then be extrapolated to calculate the average number of perennial plants per hectare by multiplying the result by 10,000 (as there are 10,000 m^2 in a ha).

Ground Cover (m^2/ha) (Basal Width)

Basal cover or basal area is determined by considering the cross-sectional area of plants near the ground, where the diameter at ground level of a perennial plant (such as a grass tussock) is measured and then converted to calculate an approximate area (m^2) or 'footprint' of the individual plant.

In a dry year you might expect to have a higher average basal width, but lower density due to greater distance from the centre point to the nearest plant. Whereas in good seasons, you might expect the opposite, due to a denser coverage of emergent grasses. Plants such as *Lomandra* sp., which are long lived and slow growing, should remain relatively stable in basal width, but may be variable in their relative frequency, appearing less in good years due to the presence of numerous other grasses filling in the space close to the PCQM point.

Plant Height Based on Averages of Plants Measured

Plant height can be used as a 'grazing coefficient' within grasslands, where grasses typically reach a standard range in foliage height (note, measure is of foliage height *not* flowering stalks) regardless of seasonal conditions. When compared with other measures such as basal width, average height of plants can be used to determine if plants are juvenile, mature and / or heavily grazed, and to what extent. Additionally, plant height can be correlated to dominance of species, with the average height of grasses at a site likely to be correlated with a higher abundance of 'tall grasses' or mature Lomandra.

Dead Material (%) Based on Averages of Plants Assessed

The percentage of dead material can be used in combination with other variables to determine the health of plants. For example, where basal width has reduced but spacing of plants has not, a high amount of dead material may represent a decline in health of perennial native grasses. Where basal width is reduced and spacing of plants *has* reduced too, it may be indicative of grass recruitment (i.e., young plants).

Relative Importance

Data from the PCQM can be used to calculate an 'importance value', which provides an indication of distribution of species across the site. The measure weighs up factors of relative density (percentage of sample points species identified at), relative cover (basal area as a percentage of all species recorded at the site) and relative frequency (a measure of distribution along the transect). The relative importance value can have a maximum of 100 which would represent for example, a single species found at every sample point. The data is analysed using the methods described by K. Mitchell (2015) using data analysis tool 'R', in addition to using standard averages to determine trends.

Relative importance is shown for the four most dominant species found across sites, *Rytidosperma* spp. (Wallaby Grass), *Austrostipa* spp. (Spear-grass), *Aristida behriana* (Brush-wire Grass) and *Lomandra multiflora* ssp. *dura* (Hard Mat-rush).

3.6.2 Quadrat Sampling for Weeds and Grassland Health Indicators

Percentage cover data is collected for each weed species occurring within each quadrat and for grassland health indicators including litter, bare ground, cryptogams, and rock. Results for each were calculated across each site and the Offset Area based on average values using Microsoft Excel. In 2021 an additional measure was added to supplement PCQM methodology to determine frequency of Lomandra tussocks within the 10 quadrats.

3.6.3 EPBC Condition Ramble Survey

Species recorded during the EPBC condition ramble survey were combined with those recorded during the quadrat survey to create a species list for each site. Total species diversity and numbers of species from each life form (non-disturbance resistant broad-leaved herb and native grasses) are tallied and compared with EPBC condition class criteria for INTG (described in **Section 3.4**).

3.7 Limitations

The PCQM is typically used in woodland ecosystems, where trees and shrubs remain relatively stable over time, and as such, the same individuals are measured repeatedly. In grassland environments, perennial plants are subject to considerable seasonal variation, with grass regeneration likely to strongly influence the composition and density estimates, which may not be reflective of a healthy or otherwise ecosystem, but rather of a fluctuating one. The PCQM can be influenced by aggregated (clumped) species and estimates of PPH could vary significantly if the transect is not placed in the same location each year, or if seasonal variation resulted in a proliferation of regenerating species. For example, species such as *Lomandra multiflora* ssp. *dura* may not be recorded at all in years where high regeneration of other perennial grasses (such as *Rytidosperma*) fill the inter-tussock space. This does not suggest it is not present, rather that methods failed to detect it, either by the placement of the transect, or various seasonal factors.

Starting in 2021 additional presence / absence data was collected for Lomandra tussocks in each of the ten 1 m x 1 m quadrats to help counteract this issue.

Similarly, grassland ecosystems are highly variable according to seasonal conditions and therefore visual estimates of cover, which can already be subjective due to observer experience, can cause variation and error in the data which may not necessarily be caused by the effects of management measures. Measures that should remain relatively stable over time (such as rock cover), can be used as indicators of this kind of observer variation, and cover of more permanent and or slow growing features, such as cryptogamic crust and *Lomandra* spp. could be used with more confidence in the long term.

4.0 Results

4.1 Climate

Climate in the Mid North region where the WWF and offset area are located, consists of mild winters and hot summers, with rain occurring predominantly in the winter months (NY NRM 2018).

Monthly rainfall data for the period of November 2016 (approximately two years prior to the baseline Offset Area monitoring survey in November 2018) through to the end of October 2024, is presented in **Figure 4.1.** Rainfall data from November 2016 until January 2024 has been obtained from the Bureau of Meteorology (BOM) Hallett (Lorraine) weather station (#21024), which is located approximately 7 km west-south-west of the southern extent of the WWF and offset area (BOM 2025a). However, as climate data for the Hallett (Lorraine) weather station is not yet available past January 2024, rainfall data for February to October 2024 has been sourced from the BOM Yongala (#019062) weather station (BOM 2025b).

Average annual rainfall at the Hallett (Lorraine) weather station is 467.2 mm (BOM 2025a). Below average annual rainfall occurred in 2017, 2018 (when the baseline assessment was undertaken) and 2019. Above average annual rainfall occurred in 2020, 2021 and 2022, while 2023 and 2024 (until the time of the Offset Area monitoring survey) had below average rainfall.

Rainfall in the 12 months preceding the 2024 monitoring survey totalled 228 mm. The months of November 2023 to January 2024 experienced slightly higher than average monthly rainfall. However, each month from February 2024 up to the monitoring survey in October 2024 experienced rainfall much lower than average.

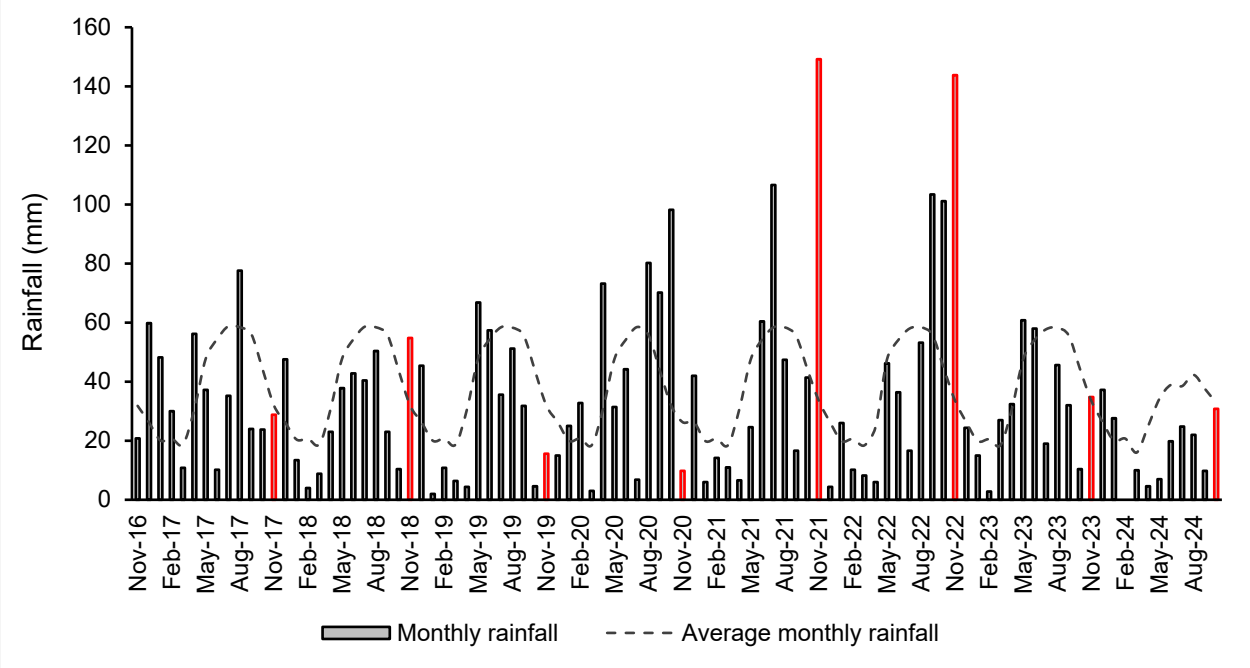


Figure 4.1 Monthly Rainfall Data for November 2016 to October 2024 (with Offset Area Monitoring Survey Periods Highlighted in Red)

Source: BOM Hallett (Lorraine) weather station (#21024) and Yongala (#019062) weather station (BOM 2025a; 2025b)

4.2 2024 Offset Area Monitoring Summary

The results of the 2024 Offset Area Monitoring are summarised in **Table 4.1** to **Table 4.3** and explained and discussed in relation to monitoring results of previous years in the relevant sections below.

Table 4.1 Summary of 2024 Monitoring Results Based on PCQM and Ramble Survey

Assessment Site	Perennial Plants Per Hectare (PPH)	Spacing of Perennial Plants (cm)	Basal Width (cm)	Plant Height (cm)	% Dead Material	Rare Flora (# of Species)	Species Diversity
1	225,528	21.06	4.06	8.4	51.57	1	19
2	97,656	32	11.13	11.45	32.29	1	17

Table 4.2 Number of Species of Each Life form (via Ramble Survey in 2024)

*Life Form	Number of Species of Each Life Form at Each Assessment Site (via Ramble Survey)	
	Assessment Site 1	Assessment Site 2
Broad-leaf Herb	4	5
Disturbance Resistant Broad-leaf Herb	6	6
Grass / Sedge	8	6
Shrub	1	0
Total	**19**	**17**
Tussock Density	**~20.21/ m^2**	**~8.78/ m^2**
***INTG Condition Class**	**B**	**B**

*Refer to Section 3.4 for condition classes and life form descriptions.

Table 4.3 Summary of Grassland Health Indicators for 2024 Compared With Mean and Benchmarks

Assessment Site	% Cryptogams	% Litter	% Bare Ground	% Rock	% Native Cover	% Lomandra Presence
1	23.6	74.5	12.3	4.7	10.9	0.2
2	31	53	3	9.9	6	0.1
Offset Area Mean	**27.3**	**63.75**	**7.65**	**7.3**	**16.9**	**0.15**
***Benchmark (goal)**	**~50%**	**<25%**	**<5%**	**N/A**	**N/A**	**N/A**

*Unofficial benchmark values for Grasslands in the Northern Lofty botanical region (Pedler et al. 2007). Green indicates where benchmark goal has been met.

4.3 PCQM

The findings of the PCQM survey in 2024, together with an annual comparison of results since the initial survey in 2018, are summarised in **Table 4.4**. Results of each attribute are discussed further in **Section 4.3.1** to **Section 4.3.6.**

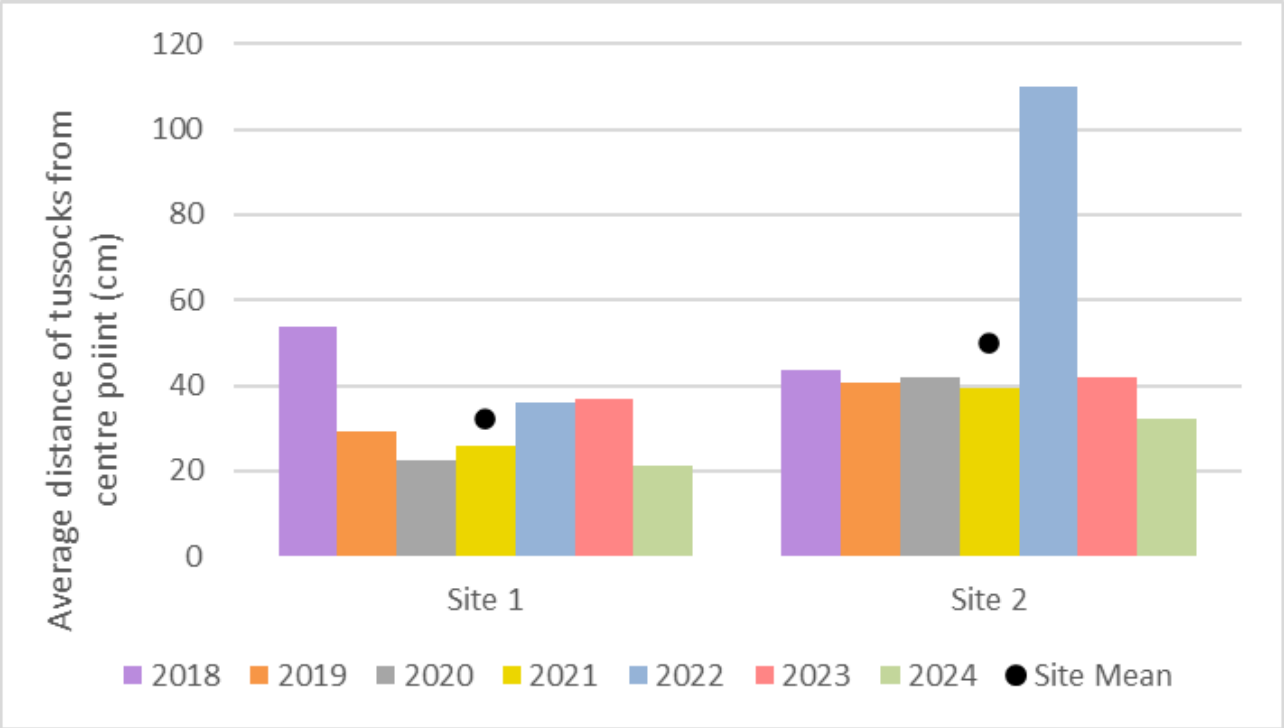
Table 4.4 Summary of Monitoring Results Based on PCQM for 2018–2024

Assessment Site	Perennial Plants Per Hectare (PPH)	Average Spacing of Perennial Plants (cm)	Average Basal Width (cm)	Average Plant Height (cm)	Average Dead Material (%)	Rare Flora (# of Species)	Species Diversity
2024							
1	225,528	21.06	4.06	8.4	51.57	1	18
2	97,656	32.0	11.13	11.45	32.29	1	16
2023							
1	73,542	36.88	8.87	22.1	73.5	1	19
2	57,507	41.7	13.81	15.39	66.63	1	17
2022							
1	76,521	36.15	7.05	19.73	47.50	1	17
2	8,261	110.03	9.64	30.23	42.88	1	14
2021							
1	149,074	25.90	3.85	20.88	46.63	1	20
2	64,870	39.26	6.3	23.98	30.48	1	14
2020							
1	194,708	22.70	16.15	16.74	23.78	1	20
2	56,892	41.90	18.03	21.53	48.74	0	21
2019							
1	118,497	29.05	8.30	9.60	49.80	1	17
2	60,221	40.75	11.60	11.10	50.40	1	19
2018							
1	33,916	54.30	8.90	2.75	53.50	0	9
2	52,485	43.65	8.60	2.40	53.75	0	9
Mean	**81,544**	**44.31**	**9.84**	**15.88**	**44.56**		

4.3.1 Spacing of Perennial Plants

The average perennial plant distance from the centre point in 2024 was 21.06 cm (mean) ± 11.28 cm (Standard error of the mean) at Site 1 and 32.0 cm ± 26.78 cm at Site 2 (**Graph 4.1**). The spacing between plants in 2024 is the lowest to date for both sites. Plant spacing at Assessment Site 1 has decreased since the baseline survey in 2018 (53.70 cm) and since 2023 (36.88 cm). Plant spacing at Assessment Site 2 decreased since the baseline survey in 2018 (43.65 cm) and since 2023 (41.7 cm).

The average perennial plant distance from the centre point since the baseline survey is 32.20 ± 11.28 cm at Site 1, and 49.90 ± 26.78 cm at Site 2. The difference of the average perennial plant distance from the centre point between the two Sites in 2024 was 10.94 cm, with the difference between the two sites for the duration of the monitoring being 17.70 cm.

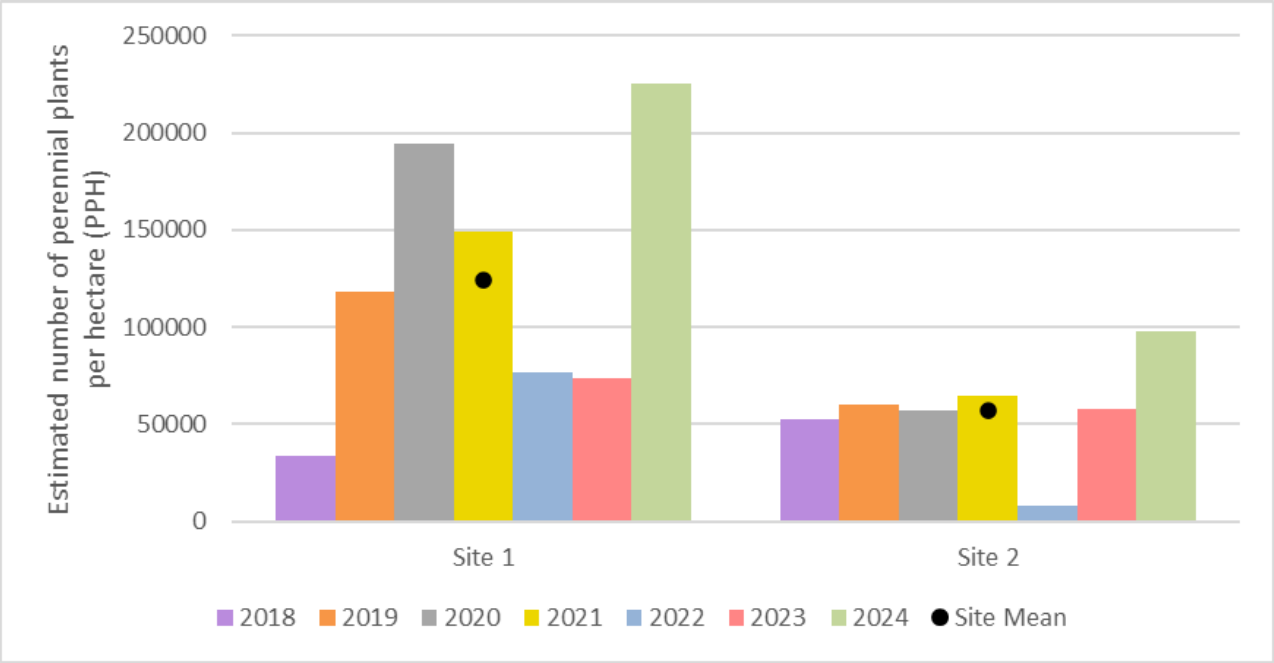


Graph 4.1 Average Distance (cm) of Grass Tussocks from PCQM Centre Point (2018-2024)

4.3.2 Perennial Plants Per Hectare (PPH)

The PPH in 2024 was 225,528 at Site 1 and 97,656 at Site 2, which is the highest recorded to date (**Graph 4.2**). The PPH at Assessment Site 1 has drastically increased by 191,612.67 since the baseline survey and 151,986.25 from 2023. Whereas the PPH at Assessment Site 2 has increased by 45,171.70 since the baseline survey and 40,148.3 from 2023.

The average PPH since the baseline survey is 124,540.9 ± 69,378.16 at Site 1, and 56,841.77 ± 26,208.28 at Site 2 (**Graph 4.2**). Site 1 had a much higher PPH compared to Site 2 with the difference between the two Sites in 2024 being 127,872. The PPH of Site 1 has historically been larger than Site two with the difference between the average PPH of the two sites for the duration of the monitoring being 67,699 (**Graph 4.2**).



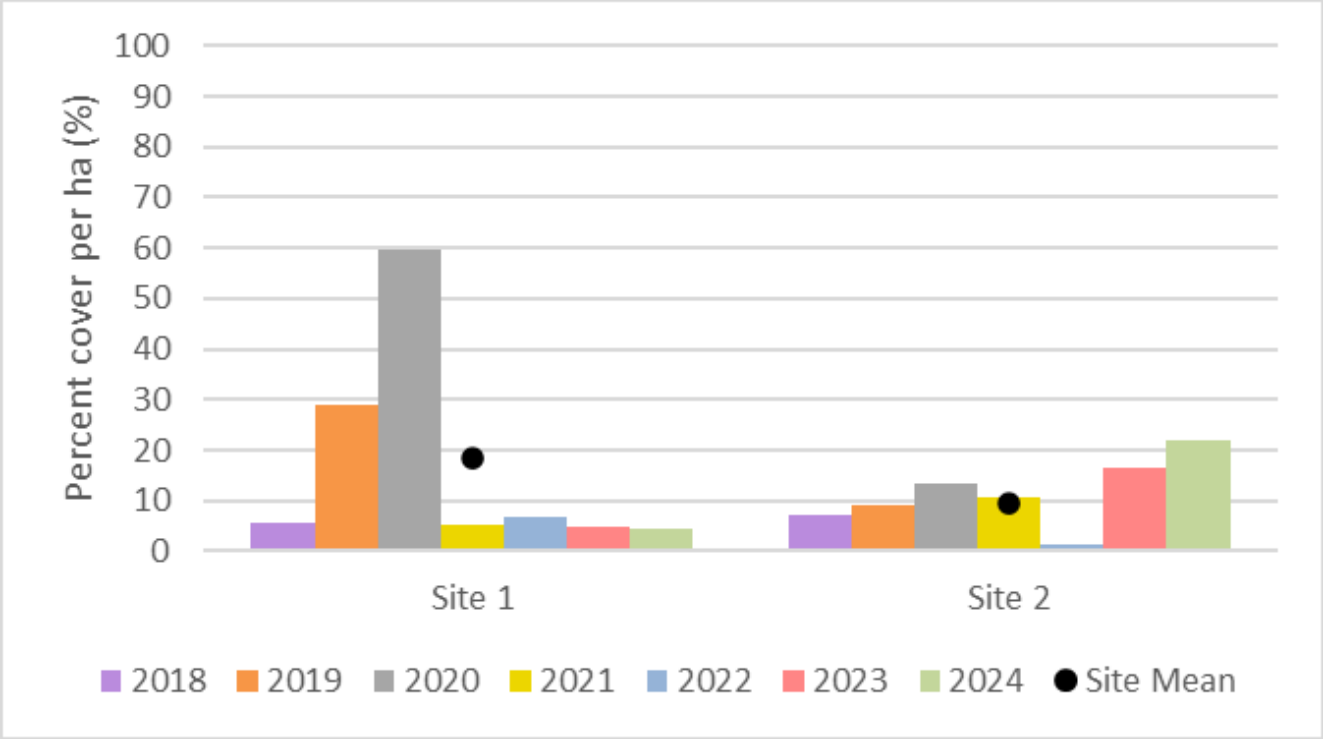
Graph 4.2 PPH at Each Assessment Site via PCQM (2018–2024)

4.3.3 Basal Width and Cover

The average basal width in 2024 was 7.38 cm, with Site 1 averaging 4.06 cm and Site 2 averaging 11.13 cm. The 2024 basal width average was lower than the average basal width in the baseline survey of 8.8 cm but higher than the 2023 average of 7.02 cm.

In 2024, Site 1 had an average basal cover of 4.63 % while Site 2 had an average of 21.76 % which is the highest the site has recorded to date (**Graph 4.3**). In 2024, the average basal cover for Site 1 was found to be similar to the previous year (2023) with a small decrease of 0.34 %, while the average basal cover for Site 2 had an increased by 5.08 %. Similarly, the average basal cover for Site 1 has only slightly decreased by 1.04 % while Site 2 has increased by 14.77 % since the baseline survey.

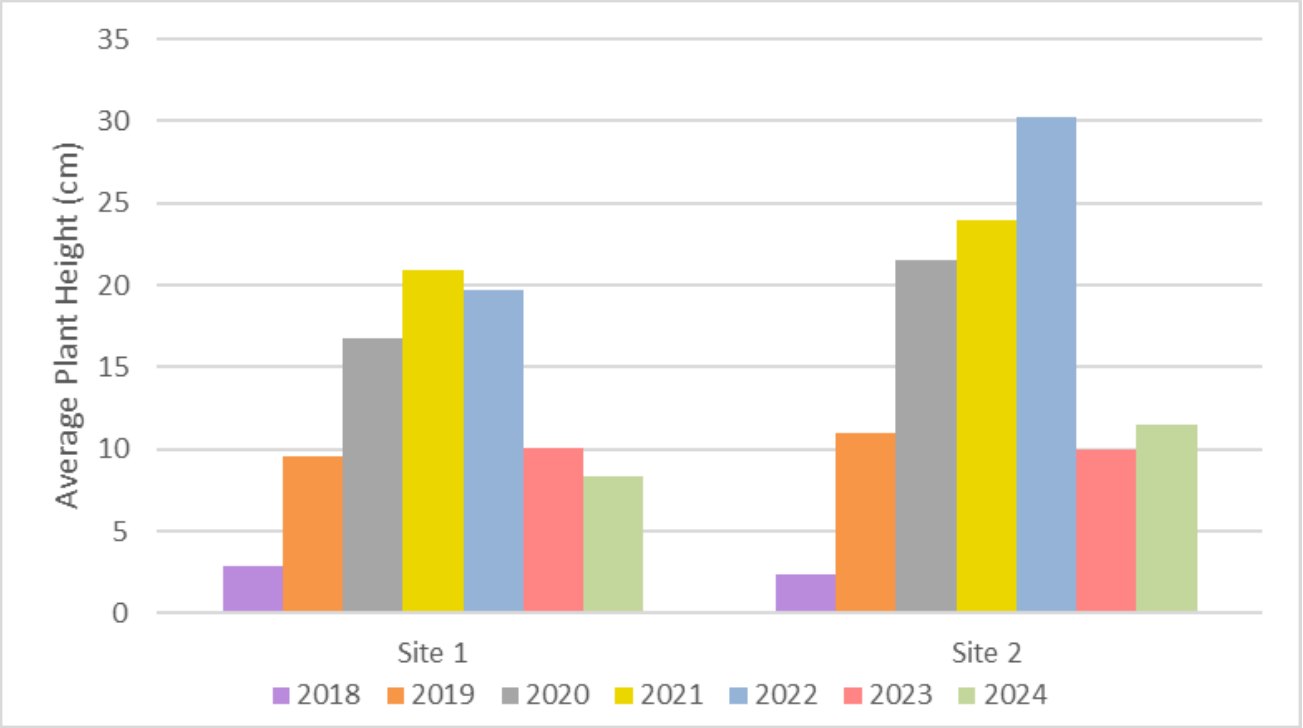
The average basal cover since the baseline survey is 18.61 ± 21.02 % at Site 1 and 9.66 ± 6.68 % at Site 2 (**Graph 4.3**). The high variability of the average basal cover is due to the high average recorded in 2019 and 2020 for Site 1 and low average recorded in 2022 for Site 2. These high and low years for the sites, has caused Site 1 to have a higher average basal cover than Site 2 by 8.95 %. However, Site 2 has had a higher average than Site 1 in majority of the years (**Graph 4.3**).



Graph 4.3 **Percent Basal Cover, Representing the Percent of Each Hectare Covered by a Perennial Plant Species, Measured Using PCQM (2018-2024)**

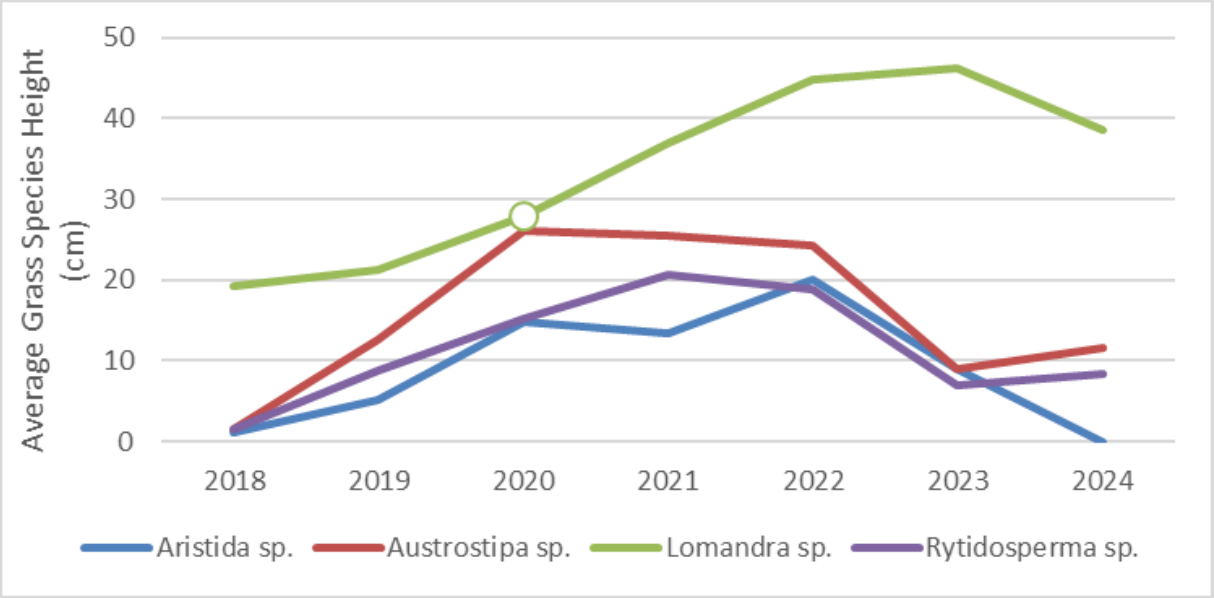
4.3.4 Plant Height

The average perennial plant height in 2024 was 8.4 cm at Site 1 and 11.45 at Site 2 (**Graph 4.4**). Site 1 had an average decrease of 1.68 cm and Site 2 had an average increase of 1.45 cm since 2023. Compared to the baseline survey both sites have had an increase: 5.56 cm at Site 1 and 9.05 cm at Site 2. The 2024 average perennial plant height at each site is below the average since the baseline survey of 12.61 ± 6.64 cm for Site 1 and 15.79 ± 9.69 cm for Site 2. Both sites recorded their highest average height in 2020, 2021, and 2022, but on average the average plant height for Site 2 is greater than Site 1 by 3.19 cm (**Graph 4.4**).



Graph 4.4 Average Plant Height at Each Assessment Site (2018-2024)

The average height of the four most common perennial grass species recorded is presented in **Graph 4.5**. This data indicates that *Aristida*, *Austrostipa* and *Rytidosperma* species are no longer at their typical expected growth height, as although they have increased in height after 2018, they plateaued and then decreased again since 2022. In 2024, the average height of the long-lived and slow growing *Lomandra* species was 38.5 cm, which is more than double the average height of 19.2 cm at the baseline survey. However, the average height of *Lomandra* species in 2024 has declined slightly since 2023, when the average height was 46.25 cm.

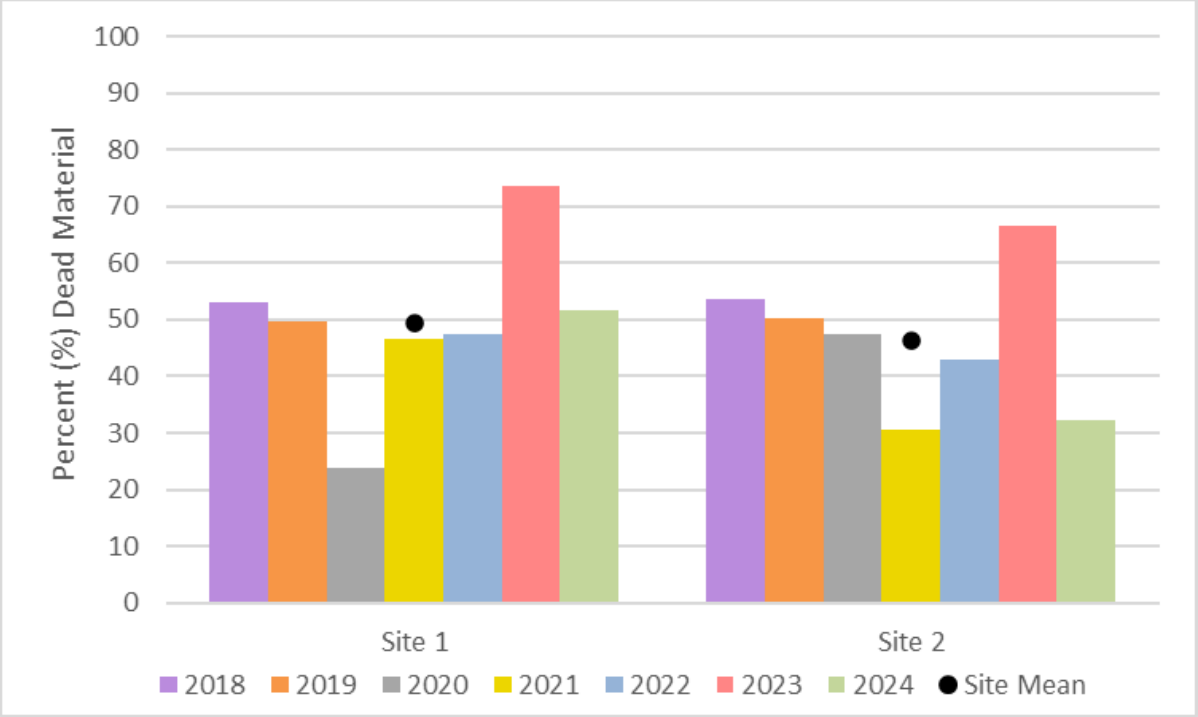


Graph 4.5 Average Height of the Four Most Common Perennial Grass Species Recorded (2018–2024)

White circle indicating an estimated height as the genus wasn't recorded in the PCQM during that year.

4.3.5 Plant Health

In 2024, the percentage of dead plant material estimated per tussock was 41.91 ± 11.59 %, with an average of 51.57 % at Site 1 and 32.26 % at Site 2 (**Graph 4.6**). After 2023 recorded the highest percentage of dead plant material for the duration of the monitoring program of 70.06 %, the dead material percentage dropped by 28.15 % in 2024. On average over the duration of the monitoring program, both sites have a similar percentage of dead material with 49.38 ± 14.53 % at Site 1 and 46.27 ± 12.56% at Site 2 (**Graph 4.6**).

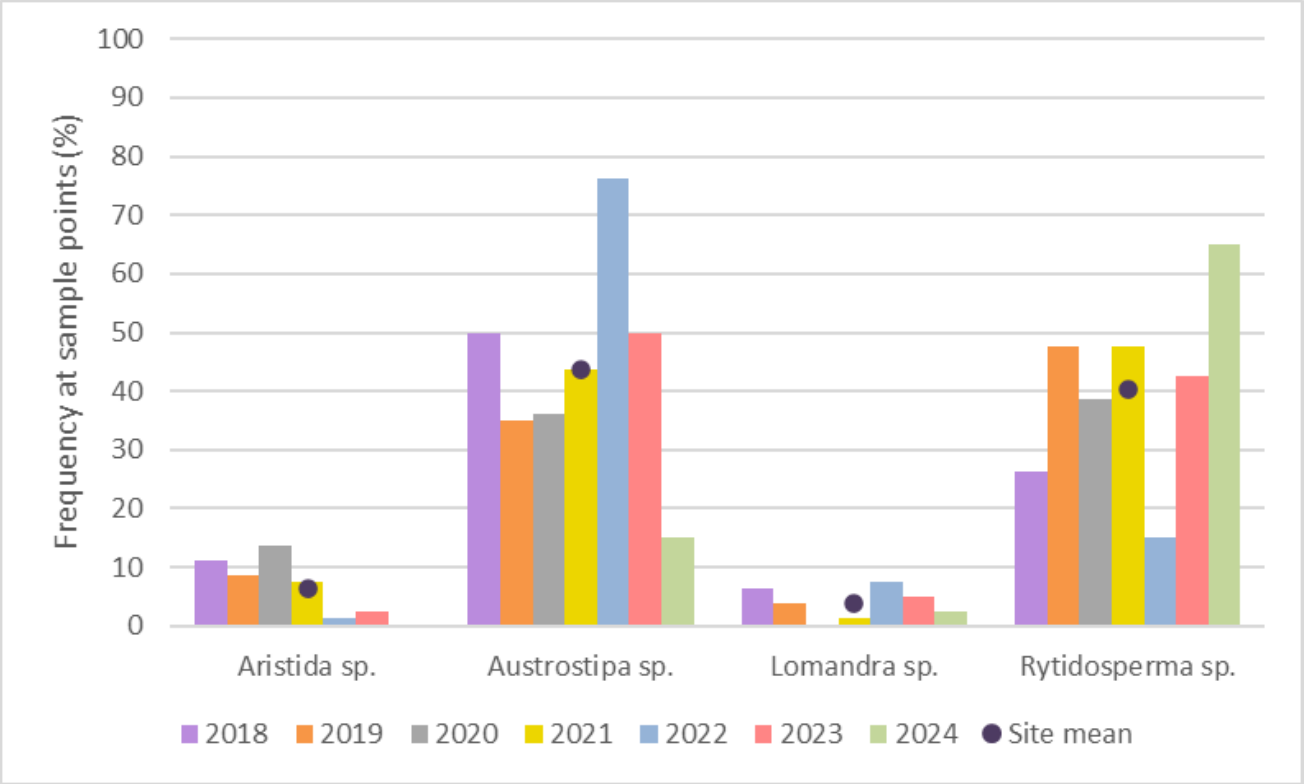


Graph 4.6 Average Percentage of Dead Material Observed per Tussock (2018–2024)

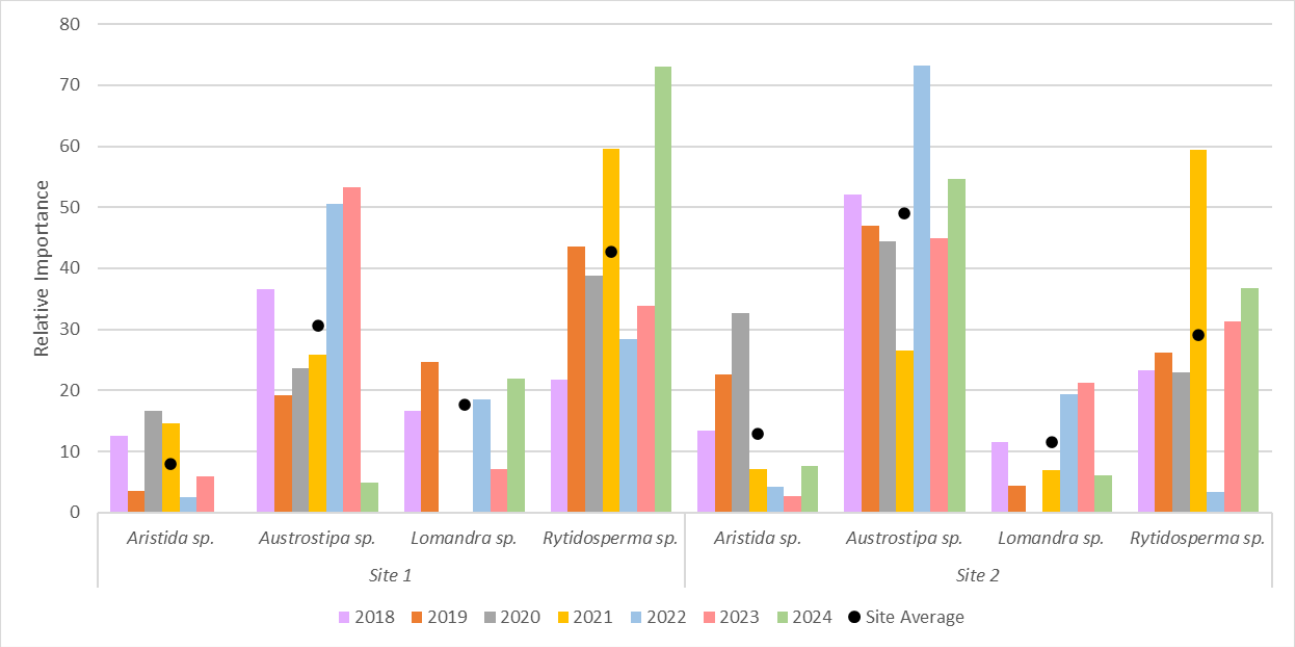
4.3.6 Species Composition

The most frequently recorded perennial plant genus in 2024 was *Rytidosperma* which was recorded at 65 % of all the PCQM quarters surveyed across both sites (**Graph 4.7**). This is the highest frequency recorded for *Rytidosperma* to date. Whereas, *Austrostipa* species has occurred at its lowest frequency to date at only 15 %. The only other genus recorded by the PCQM in 2024 was *Lomandra*, which occurred at 2.5 % of the quarters surveyed. For the first time, *Aristida* which is another genus which is often recorded during the PCQM, was not recorded via PCQM in 2024 (**Graph 4.7**).

The relative importance score showed that the dominant grass in terms of cover and frequency at Site 1 was *Rytidosperma* sp. (73.11), while at Site 2 it was *Austrostipa* sp. (54.57) (**Graph 4.8**). This is the first year since 2021 that *Rytidosperma* was the dominant grass at a site. *Austrostipa* sp. has been the dominant grass for both sites each year, aside from 2021, but the relative importance of the genus drastically dropped at Site 1 in 2024 (4.93) (**Graph 4.8**).



Graph 4.7 Frequency (%) of Perennial Grasses at Sample Points (2018–2014)



Graph 4.8 Relative Importance of Perennial Native Grasses (2018–2024)

4.4 Quadrat Sampling

4.4.1 Grassland Health Indicators

A summary of the grassland health indicator results in comparison to benchmark scores for the community from 2019 onwards (when this part of the method was introduced) is provided in **Table 4.5**.

In 2024, neither site met the benchmark for the cryptogam percentage as it was too low. Similarly, neither site met the benchmark for litter percentage as it was too high. However, both sites did meet the benchmark for the presence of *Lomandra* and the bare ground percentage was met for Site 2 but not Site 1.

Despite not meeting the benchmark for cryptogam and litter, both have improved since 2023. However, bare ground percentage has increased drastically with Site 1 no longer meeting the benchmark. Both sites showed a decrease in overall quality since the survey in 2019, with lower cryptogam cover and less native cover in 2024. Litter cover in 2024 was higher in Site 1 but lower in Site 2 compared to the 2019 survey. Bare ground is much lower in 2024 compared to the 2019 survey. While bare ground was stable from 2020 to 2023 (**Table 4.5**) and was considered within the range considered 'healthy' according to the benchmark condition scores outlined for Mid-North Grasslands (Pedler et al. 2007), it has now increased drastically compared to 2023.

Similar to 2023, *Lomandra* was present in 20% of quadrats (i.e. 2 quadrats) at Site 1 and at 10% of quadrats at Site 2 (i.e. 1 quadrat) in 2024. This would be considered on the lower end of the acceptable range for density of *Lomandra* tussocks, with INTG's typically having a density of 10% to 70% of ground area cover (Turner 2012).

Table 4.5 Summary of Grassland Health Indicator Results 2019-2024 and Compared to Benchmark

Assessment Site	% Cryptogams	% Litter	% Bare Ground	% Rock	% Native Cover	% Lomandra Presence
2024						
1	23.6	74.5	12.3	4.7	10.9	0.20
2	31	53	3	9.9	6	0.10
2023						
1	0.95	83.00	0.25	1.75	10.20	0.20
2	4.00	78.00	0.60	4.45	9.30	0.10
2022						
1	4.90	71.10	0.70	2.20	17.60	0.40
2	1.70	93.00	0.15	1.75	3.80	0.20
2021						
1	8.90	55.50	1.90	2.40	13.70	0.20
2	4.60	63.50	0.90	3.10	10.40	0.10
2020						
1	55.00	24.00	1.70	8.20	26.00	NA
2	16.50	39.50	7.60	6.80	24.70	NA
2019 (first survey for Grassland Health Indicators)						
1	56.50	56.00	12.90	7.00	20.80	NA
2	42.50	73.45	13.50	12.80	15.30	NA
Offset Area Mean	**20.85**	**63.71**	**4.62**	**5.42**	**14.06**	**0.18**
***Benchmark (goal)**	**~50%**	**<25%**	**<5%**	**NA**	**NA**	**0.1-0.7**

*** Unofficial benchmark values for Grasslands in the Northern Lofty botanical region (Pedler et al. 2007). Green highlights where goal has been met.**

4.4.2 Weeds

Across the Offset Area, 16 weed species were recorded in 2024 (**Table 4.6**), one more than 2023. One new species, *Taraxacum officinale* (Common Dandelion), was recorded in the Offset Area in 2024. Based on the cover ratings assessed in 1 m x 1 m quadrats along the Assessment Site monitoring transects, the mean percentage weed cover in 2024 was 49.7 %, a result that is significantly higher than the 2023 average of 11.6 %, which is the lowest to date (**Table 4.6** and **Appendix 3**). The baseline survey in 2019 also recorded a low weed coverage where Site 1 recorded 10.78 % and Site 2 recorded 27 %, which is lower than what was recorded in 2024. Similar to all other years, Site 2 (67.45 %) had a higher average weed cover than Site 1 (31.95 %).

Similar to 2023, *Avena barbata* had the greatest cover of any weed species in 2024, but with a higher cover of 28.2 % at Site 1 and 47 % at Site 2 (**Table 4.6**). All species which were recorded along the monitoring transect in 2024 had an increase of cover, with the only exception being *Hypochaeris radicata* (Rough Cat's Ear) which was only recorded during the ramble.

Table 4.6 Average Coverage (%) of Weed Species at Each Assessment Site in 2024

Scientific Name	Common Name	Site 1 (%)	Site 2 (%)	Average Cover (%)
Avena barbata	Bearded Oat	28.2	47	37.6
*Cynara cardunculus**	Artichoke Thistle	0	0	0
*Echium plantagineum**	Salvation Jane	1.7	1.4	1.55
Erodium cicutarium	Cut-leaf Heron's-bill	0.8	3.15	1.975
Hypochaeris radicata	Rough Cat's Ear	-	0	0
Lepidium africanum	Common Peppercress	0.4	0.05	0.225
Lolium sp.	Ryegrass	0.2	0.6	0.4
*Marrubium vulgare**	Horehound	0	0	0
Medicago polymorpha var. *polymorpha*	Burr-medic	-	0.6	0.3
Moraea setifolia	Thread Iris	0	0.05	0.025
Romulea rosea	Onion Weed	0.3	0.2	0.25
Salvia verbenaca var.	Wild Sage	0.05	14.2	7.125
Taraxacum officinale	Common Dandelion	-	0	0
Trifolium angustifolium	Narrow-leaf Clover	0.15	0.1	0.125
Trifolium arvense	Rabbitfoot Clover	0.1	0.1	0.1
Vulpia sp.	Fescue	0.05	0	0.025
Total weed coverage (%)		**31.95**	**67.45**	**49.7**

* = *Landscape South Australia Act 2019* Declared species
Results of '0' indicates the species was recorded via ramble but not in the PCQM quadrats.

Three weeds listed as Declared under the *Landscape South Australia Act 2019* (LSA Act) were observed in 2024, including *Cynara cardunculus* (Artichoke Thistle), *Echium plantagineum* (Salvation Jane) and *Marrubium vulgare* (Horehound) (**Appendix 6**). The management requirements, in accordance with the LSA Act, for each Declared weed species are provided in **Table 4.7**.

Table 4.7 Management Requirements for Declared Weeds Observed in 2024

Scientific Name	Common Name	LSA Act Requirements
Cynara cardunculus	Artichoke Thistle	Take reasonable steps to kill plants and prevent spread. Must not be traded or sold in any way, including as a contaminant of anything. Must not be transported on a public road including as a contaminant of anything.
Echium plantagineum	Salvation Jane	Take reasonable steps to kill plants and prevent spread. Must not be traded or sold in any way, including as a contaminant of anything. Must not be transported on a public road including as a contaminant of anything.
Marrubium vulgare	Horehound	Take reasonable steps to kill plants and prevent spread. Must not be traded or sold in any way, including as a contaminant of anything. Must not be transported on a public road including as a contaminant of anything.

Cynara cardunculus (Artichoke Thistle), which was first noted near Site 1 in 2020, was present in 2024 (**Figure 4.2**). The species was only found during the ramble survey at Site 1 where regenerating individuals were recorded. These individuals will require treatment to control the spread within the Offset Area.

Echium plantagineum (Salvation Jane), has been present across both Assessment Sites for all monitoring years aside from 2021 (**Figure 4.3**). In 2024 the species had an average cover of 1.55 %, but individuals were sparsely distributed across the entirety of the Assessment Sites.

This is the first time that *Marrubium vulgare* (Horehound) has been recorded in the Offset Area (**Figure 4.4**). The species was recorded at both Assessment Sites, with regenerating individuals recorded in Site 1. These individuals will require treatment to control the spread within the Offset Area.

Assessment Site 1 had a weed abundance and threat condition score of 21, which is considered as "Moderate" condition, while the weed abundance and threat condition score for Site 2 was 26, which is considered as "Poor" condition. Both *Avena barbata* and *Echium plantagineum* were recorded to have one of the highest cover ratings across both sites, with *Salvia verbenaca* var. having a high cover rating only in Site 2.



Figure 4.2 Declared Weed *Cynara Cardunculus* (Artichoke Thistle) Observed at Site 1 via Ramble Survey



Figure 4.3 Declared Weed *Echium Plantagineum* (Salvation Jane)



Figure 4.4 Declared Weed *Marrubium vulgare* (Horehound) Observed at Site 1

4.5 Ramble Survey

4.5.1 Native Species Diversity

A total of 20 native flora species were observed during the ramble survey at the two Assessment Sites in 2024 (in conjunction with species recorded during PCQM survey) (**Table 4.8**). This is a slight decrease in diversity compared to the 2023 survey which recorded 22 species.

Table 4.8 Native Species Recorded at Each Assessment Site in 2024

Life Form	Scientific Name	Common Name	Assessment Site	
			1	2
Broad-leaf Herb	*Convolvulus remotus*	Australian Bindweed	✓	✓
	*Rumex dumosus**	Wiry Dock	✓	✓
	Vittadinia cuneata	Fuzzy New Holland Daisy	✓	✓
	Vittadinia gracilis	Woolly New Holland Daisy	✓	✓
	Wahlenbergia stricta	Tall Bluebell		✓
Disturbance Resistant Broad-leaf Herb	*Convolvulus angustissimus*	Bindweed	✓	✓
	Euphorbia drummondii group	Spurge	✓	✓
	Maireana enchylaenoides	Wingless Fissure-plant	✓	✓
	Oxalis perennans	Native Sorrel	✓	✓
	Ptilotus spathulatus	Pussy-tails	✓	✓
	Sida corrugata var. *angustifolia*	Corrugated Sida	✓	✓
Grass	*Aristida behriana*	Brush Wire-grass	✓	✓
	Austrostipa blackii	Crested Spear-grass	✓	
	Austrostipa nitida	Spear-grass	✓	✓
	Austrostipa scabra ssp. *scabra*	Rough Spear-grass	✓	✓
	Chloris truncata	Windmill Grass	✓	
	Enneapogon nigricans	Black-head Grass	✓	✓
	Rytidosperma sp.	Wallaby-grass	✓	✓
Sedge	*Lomandra multiflora* ssp. *dura*	Hard Mat-rush	✓	✓
Shrub	*Cryptandra campanulate**	Bitter Cryptandra	✓	
Total			**19**	**17**

* *National Parks and Wildlife Act 1972* SA Rare species

4.5.2 INTG TEC Condition Class

Site 1 has qualified as INTG TEC Condition Class B since 2019 and was found to remain as Condition Class B in 2024. As of 2023, Site 2 had an improvement of species diversity, with an increase from 14 species to 17 species, which exceeded the threshold (≥15 species) required for listing as Condition Class B and still meets the requirements in 2024 (**Table 4.9**). Of note, for Site 1 the number of tussocks per metre squared was 1.84 in 2023 but has experienced a drastic increase to 20.21/m^2 in 2024. Site 2 also has had an increase of tussocks per metre since 2023, which was 1.44/m^2 and in now in 2024 is 8.78/m^2. The tussocks per metre for both sites have increased since the baseline survey, where it was 3.39/m^2 for Site 1 and 5.25/m^2 for Site 2 (**Table 4.9**).

Table 4.9 INTG TEC Condition Class Data for Each Site for 2018-2024 (With Criteria in Green)

Assessment Site (Size)	Year	Diversity of Native Species[1]	No. of Broad-leaved Herbaceous Species[1] in Addition to Identified Disturbance Resistant Species[2]	No. of Perennial Grass Species[1] (Excluding *Lomandra*)	Tussock Count[3] (Including *Lomandra*)	TEC Condition Class
>0.1ha	-	≥30	≥10	≥5	≥1/ m²	A
>0.25ha	-	≥15	≥3	≥4	≥1/ m²	B
No min.	-	≥5	-	≥1	-	C
Site 1	2018	9	NA	7	~3.39 / m²	C
	2019	17	3	4	~11.85 / m²	B
	2020	20	7	7	~19.47 / m²	B
	2021	20	8	8	~14.91 / m²	B
	2022	17	5	5	~7.65/ m²	B
	2023	19	5	6	~1.84/ m²	B
	2024	**18**	**5**	**6**	**~20.21/ m²**	**B**
Site 2	2018	9	NA	4	~5.25 / m²	C
	2019	19	4	5	~6.02 / m²	B
	2020	20	5	7	~5.69 / m²	B
	2021	14	6	5	~6.49 / m²	C
	2022	14	3	4	~0.83/ m²	C
	2023	17	4	6	~1.44/ m²	B
	2024	**16**	**5**	**4**	**~8.78/ m²**	**B**

Red highlights where goal has not been met and value falls short of EPBC Class B listing.

1: As measured in a 50 m x 50 m quadrat.

2: Disturbance resistant species: *Ptilotus spathulatus* forma *spathulatus, Sida corrugata*, *Oxalis perennans*, *Convolvulus angustissimus*, *Euphorbia drummondii*, and *Maireana enchylaenoides.*

3: As measured along a 50 m transect.

4.5.3 Rare Flora

Two *National Parks and Wildlife Act 1972* (NPW Act) listed Rare species, *Cryptandra campanulata* (Long-flowered Cryptandra) (**Figure 4.5**) and *Rumex dumosus* (Wiry Dock) (**Figure 4.6**) were recorded in 2024, with *C. campanulata* observed at Site 1 and *R. dumosus* observed at Site 2 (**Appendix 6**). Both of these species have been recorded during previous monitoring events.



Figure 4.5 A Heavily Grazed *Cryptandra campanulata* Specimen



Figure 4.6 Close-up of a *Rumex dumosus* Specimen

4.5.4 Grazing and Erosion

Both Site 1 and Site 2 were under grazed at the time of the monitoring survey, as the weeds present were uncontrolled. Erosion was minimal, present only as pedestal erosion around shrubs.

5.0 Discussion

5.1 Summary of Condition Within the Offset Area

The Offset Area is still in the early stages and significant improvements are expected to become more evident in years to come. The 2024 survey highlighted that the impacts of inefficient grazing regimes on grassland ecosystems are compounded by climatic variability and the necessity for consideration of climatic differences between years when planning a grazing regime.

Previously, a high level of grazing, coupled with drought conditions in the baseline survey of 2018, resulted in the Offset Area being in poor condition. The combination of high rainfall in 2020 and 2022 resulting in extensive weed growth and lack of evidence of any grazing resulted in weedy winter grasses such as *Avena barbata* and *Lolium* sp. smothering the Offset Area. The 2024 results recorded an increase in the number of perennial plants per hectare from 2023, which has led to a decrease in average spacing, basal width, and height of perennial plants. There was also a decrease in average dead material of these perennial plants. A high proportion of dead material is consistent with the high weed cover observed in 2022 and the reduction of rainfall in 2023 and 2024, leading to significant die-off of annual weed species.

The Offset Area has visibly improved in terms of a reduction in grazing pressure on native plants since the baseline survey. In the initial years of the monitoring program, the combination of drought and unrestricted grazing was evident in the poor health and condition of perennial grass tussocks and PCQM plant attributes such as height. In 2019, it was noted that grazing pressure had reduced since 2018, but with continued drought conditions the improvement of flora condition was minimal. In 2020, the combination of reduced grazing and increased rainfall improved conditions within the Offset Area. In 2022, above average rainfall in the two months prior to the survey period, coupled with reduced grazing, led to a substantial increase in weed species across the Offset Area.

Prior to the 2021 survey, the Offset Area had been on a positive trajectory, with increased rainfall and reduced grazing pressure resulting in new records of native flora species and grassland health indicators reaching the desired range. Unfortunately, increased rainfall in 2020, followed by above average rainfall in the two months prior to the 2022 survey, created opportunities for weed species to set seed, and without an adaptive grazing regime being implemented, the condition of the Offset Area deteriorated. The condition improved in 2023, however has now dropped again in 2024. Results demonstrate the importance of continued adaptive management to maintain the positive trajectory of flora conditions.

A carefully implemented and managed grazing regime as outlined in the Offset Management Plan (OMP) (EBS 2017) is imperative to continue to return to the previously recorded positive trend, and to limit the likelihood of weedy species dominating the grassland and shading out opportunities for new growth of broad-leaved native herbaceous species.

5.2 PCQM

The PCQM results indicate an overall improvement in INTG condition since the 2018 survey, with an increase in plants per hectare, plant height, number of rare flora species, and native diversity and a decrease of spacing between plants and dead material in 2024 compared to the baseline results (**Table 5.1**). The only result which was a negative trend was a decrease in basal width. Changes may indicate an improvement in the size and quantity of individual grasses in the Offset Area or results may be due to variability in data parameters and annual fluctuations. Trends may become more apparent as the dataset increases.

Table 5.1 Summary of Monitoring Results Based on the PCQM and Ramble Surveys Averaged Across Site 1 and Site 2 (2018–2024)

Year	Perennial Plants Per Hectare (PPH)	Spacing of Perennial Plants (cm)	Basal Width (cm)	Plant Height (cm)	% Dead Material	Rare Flora (# of species)	Native Diversity
Mean 2018	43,201	48.98	8.80	2.60	53.60	0	9
Mean 2019	89,359	34.90	10.00	10.40	50.60	1	18
Mean 2020	125,800	32.30	17.27	19.14	36.30	1	20.5
Mean 2021	106,927	32.58	5.080	22.43	38.55	1	17
Mean 2022	42,391	73.09	8.34	24.98	45.19	1	15.5
Mean 2023	65,524	39.29	7.02	10.04	70.06	1	18
Mean 2024	161,592	26.20	7.38	9.93	41.91	1	17
***Trend**	**Positive**	**Positive**	**Negative**	**Positive**	**Positive**	**Positive**	**Positive**

Positive (green): indicates desirable trend (since 2018 baseline). Negative (red): indicates undesirable trend (since 2018 baseline).

5.2.1 Perennial Plants Per Hectare

There is an upwards trend for the number of perennial plants per hectare for Site 1 since the baseline survey. However, at Site 2, since the baseline survey in 2018, the trend has remained relatively stable, apart from in 2024 there has been an increase which may indicate an upcoming upwards trend. In 2022, PPH decreased substantially at both sites directly related to the increase in the spacing of perennial plants. Over the last two years the perennial grasses have repopulated to stable numbers at the sites. It is unknown if there has been a change in grazing regime (for example, reduction in stock numbers/density and/or a reduction in duration and/or frequency of grazing) or if this change is related to rainfall.

5.2.2 Spacing of Perennial Plants

Spacing of perennial plants can be used to determine the density of plants on a site and can be an indicator of changes in tussock density which may relate to seasonal conditions (such as proliferation of juvenile plants after a good season) or long-term changes at a site (decline in density). The smaller the spacing of perennial plants from the centre point, the higher the density of perennial plants, and so a downward trend would indicate an increase in perennial plant density.

Site 1 appears to have a downwards trend since the baseline survey, but the trend becomes more stable as of 2019. While in Site 2, the trend appears to downwards to stable with the mean spacing of perennial plants in 2022 being an outlier. The 2022 results may be explained by the above average rainfall prior to the 2022 monitoring survey, with many weed species being in abundance and smothering both sites making perennial grass species difficult to locate. The dry and early spring preceding the 2023 and 2024 survey may have enabled surveyors to locate perennial grass species more easily.

5.2.3 Basal Cover

It is hoped that over the life of the monitoring, basal cover (or basal area) can be used to track variation due to seasonal conditions, as well as detect changes in the dominance of perennial plants over time. In 2024, only the three dominant perennial native grasses were recorded (*Austrostipa* sp., *Lomandra* sp., and *Rytidosperma* sp.), with the aim to improve rigour and meaningfulness of data over time.

In 2024, basal cover was not consistent between Site 1 and Site 2. Site 2 showed an increase from 2023 results, while Site 1 stayed relatively stable. The result for Site 2 was the highest to date, while the result was the lowest to date for Site 1 by being slightly lower than 2023. If results had increased across both sites this would indicate recruitment of juvenile plants or may suggest the dieback of weeds enabled observers to more clearly identify where tussocks were present. The variation between the two Sites may indicate a difference in soil composition, or another external variable that relates to the hydrology or topography of the landscape.

5.2.4 Plant Height

The trend for both sites for plant height was upwards from 2018 until 2023 when it decreased. Results between Sites have been fairly consistent, although Site 2 has typically had a greater average height than Site 1.

Seasonal conditions and time of year are likely to impact the height of grasses to an extent by influencing their growth vigour, however, it is likely that grazing intensity and timing would have the largest impact, as grasses are likely to obtain their typical growth form in the absence of grazing. Conditions within the Offset Area since 2023 were indicative of grazing. Although annual rainfall was low in both 2023 and 2024, which may have resulted in some die-off, grass height is more closely related to the subjected level of grazing, with a cease in grazing allowing grasses to reach and maintain their typical height.

Conditions within the Offset Area in 2022 were again indicative of minimal or no grazing, with most grasses reaching their full potential height, as what was observed in 2021 and 2020 following a high rainfall year. Above average rainfall in the two months prior to the 2022 survey was recorded which may attribute to some of this growth but grass height is more closely related to the subjected level of grazing, with a cease in grazing allowing grasses to reach and maintain their typical height. The decrease in height in 2024 compared to 2022 may have been due to the lower-than-average annual rainfall that has occurred in the past two years.

Austrostipa sp. and *Rytidosperma* sp. had a slight increase in average height from 2023 to 2024, while the height of *Lomandra* sp. has begun to decrease. Prior to 2023, all common grass species were on a positive growth trajectory, increasing in average height almost every year. It is likely that *Lomandra* sp. did not decrease in height because it is less palatable to livestock and has reached close to its maximum growth potential. Grazing on *Lomandra* sp. May have occurred in 2024, however typically only occurs when grazing is heavy or there is limited availability of food resources for stock, which is unlikely the case due to the higher number of perennial grasses. Despite the decrease, *Lomandra* tussocks have doubled in height since the baseline survey which was when heavy grazing was observed on the species. These results indicate that existing *Lomandra* tussocks have recovered following impacts from heavy grazing and are within the expected height range of 30-60 cm for this species (eFloraSA 2007).

5.2.5 Plant Health

Percentage dead material is an indicator of plant health, but this parameter can vary widely depending on factors such as seasonal conditions, time of year, and grazing pressure. A stable or downward trend is desirable over a long-term dataset. However, from year to year, percentage dead material is likely to be highly variable. A high percentage of dead material coupled with a decrease in basal area of plants may indicate declining plant health.

Dead material at Site 1 seems to have a stable trend since the baseline survey, with 2023 and 2020 being outliers. Whereas Site 2 seems to have a downwards trend since the baseline survey. The overall plant health has improved since 2023 as the dead material has dropped for both sites. It is currently unclear why plant health has improved since last year as there has been a lower annual rainfall.

5.2.6 Species Composition

Relative importance scores showed an increase in the prevalence of *Rytidosperma* sp., while *Austrostipa* sp. and *Lomandra* sp. decreased in prevalence and *Aristida* sp. was not recorded via PCQM in 2024. Differences in the assemblages of grasses at a site may be related to a combination of factors including their growth pathway (C3: cool season, or C4: warm season), grazing frequency, timing and intensity, and palatability. Understanding the grazing regimes undertaken annually at each site is likely to increase understanding of these trends. Differences within the Offset Area may indicate the influence of an external variable such as soil composition, which are more suitable to *Lomandra* sp. or vice versa.

5.3 Condition Class

The INTG TEC for both Sites met the criteria for Condition Class B in 2024. Site 1 has met the criteria for Condition Class B each year since 2019 after an increase of native diversity and number of non-disturbance resistant herbaceous species from the baseline survey. In 2022, Site 2 did not meet the criteria for Condition Class B due to an insufficient number of native species observed at the site and a low tussock density per m^2. However, Site 2 met the requirements in 2023 following an increase from 2022 in the number of native species and tussocks per m^2.

Both Sites are in better condition than when the baseline survey was undertaken in 2018, when only nine native species were recorded. While there was a decrease in tussock density at Site 1 from 2021 to 2023, where density was lower than it was during the baseline survey in 2018, tussock density has now returned to a greater level than the baseline survey.

5.4 Grassland Health Attributes

Most of the grassland health attributes for both Assessment Sites failed to achieve the desired benchmark for the community in 2024. The only attributes which achieved the desirable benchmark was the percentage of *Lomandra* tussocks present at both sites and the percentage of bare ground cover at Site 2. Despite both percentage of cover for cryptogams and litter not achieving the benchmark, these attributes have improved compared to 2023 and are closer to achieving the desired benchmark. The bare ground cover has drastically increased compared to 2023, which has caused Site 1 to not achieve the desired benchmark for the first time since 2020. Unlike in 2023, the trends between Assessment Sites were consistent with one another which is similar to most other years. It is possible that in 2023 an external variable has contributed to the difference in results between Sites.

It would be expected that the below average annual rainfall from the last two years would cause a reduction in cryptogram, native cover and an increase in litter as annual weed species die off. In 2023, these attributes responded to the lack of rainfall as expected. However, in 2024 cryptogam cover increased and litter cover decreased which may be due to the lack of annual weed species, like *Avena Barbata,* occurring in the last two years. High litter cover observed in 2022 may be attributable to the above average rainfall received in the two months prior to the 2022 survey and may be attributable to the density of weeds observed in 2020 and associated dieback of these annual species. Additionally, in dry seasonal conditions (such as those noted in 2021), cryptogam cover can be more difficult to detect as it becomes dry and difficult to distinguish from the soil. It is possible that a reduction in recorded cover of cryptogam, bare ground and rock may be attributable to the high litter cover observed for years where high litter cover is recorded, as the weeds obscure view of the ground.

Native herbaceous species require an inter-tussock space to grow, and within reason, the greater the gap the greater the abundance and diversity of non-grass herbs (Pedler et al. 2007). As exotic grasses and herbs continue to fill the inter-tussock space, density and diversity of herbaceous species will continue to decline within the Offset Area. A managed grazing regime as per the schedule outlined the OMP is likely to help restore this balance.

Continuing to monitor these attributes will provide an indication of meaningful change over time, and ideally these scores will be consistently within the benchmark range regardless of seasonal conditions.

5.5 Weeds

5.5.1 Weed Cover

Weed cover per species was not recorded in 2018 and so comparisons between years can only be made from 2019, during which variable seasonal conditions were experienced. Overall, weed cover in 2024 has significantly increased, compared to 2023 and what was observed during 2019.

Avena barbata (Bearded Oat) has continued to be the most dominant weed species across the Offset Area. Appropriately timed grazing should reduce the dominance of weedy species, including *A. barbata*. Prevalence of weeds should continue to be monitored to gain a clearer understanding of how seasonal conditions influence weed growth and prevalence, and if weed cover is changing within the Offset Area over time.

As weed cover seems to be highly variable, it is important to monitor grassland attributes, grazing pressure and weed cover and ensure livestock are removed in spring to allow native herbs to set seed and regenerate and ensure that vulnerable species are not lost from the ecosystem. It may be desirable to remove livestock in mid (rather than late) spring to facilitate regeneration, particularly during times of dry climatic conditions when there is reduced available feed. Conversely, following years of higher rainfall, livestock should be introduced earlier in the season to enable grazing of annual weedy species before they set seed. Management actions including stocking levels and grazing timetables (duration and frequency) should be recorded and provided to ecological consultants each year, to enable adaptable land management recommendations based on the results of the annual monitoring survey.

5.5.2 Declared species

Three Declared species were found to be present in the 2024 survey, including *Cynara cardunculus* (Artichoke Thistle), *Echium plantagineum* (Salvation Jane), and *Marrubium vulgare* (Horehound) but not all were present within both Assessment Sites, rather they were observed opportunistically throughout the Offset Area (**Section 4.4.2)**. The legal requirements for each of these Declared weed species is provided in **Table 4.7**.

***Cynara cardunculus* (Artichoke Thistle)**

Cynara cardunculus (Artichoke Thistle) was recorded in 2024 during the ramble survey at both Sites with there being regeneration of individuals. This species was first recorded at Site 1 in 2020 and has previously only been recorded at Site 1. In 2023, it was noted that the plant health was poor, indicative of treatment and that recruitment likely occurred following treatment as there were juveniles present.

Artichoke Thistle is a perennial herb which spreads rapidly and forms high density populations in pasture and native grasslands. The control of Artichoke Thistle requires a long-term approach and is most effective when populations are not established. Eradication is most effective before individual plants begin to flower (from June to November) (NAYLB 2023). Ideally plants should be removed prior to spring, which is when the species' rapid growth occurs. The presence of Artichoke Thistle in these areas should be monitored closely in future survey years.

***Echium plantagineum* (Salvation Jane)**

Echium plantagineum (Salvation Jane) has been prevalent in the Offset Area since the baseline survey, as the species has been recorded at both sites each year, apart from 2021. After above average rainfall in the two months prior to the survey period in 2022 and in general, favourable seasonal conditions during the year (see **Section 4.1**), Salvation Jane was identified in large numbers in 2022. The drier year following 2022 appears to have been less favourable for the species based on the significant reduction in cover. Although a number of individuals have continued to persist, likely a result of what remains of its long-term seedbank in the area.

Salvation Jane is an annual forb which has become a dominant pasture weed within SA, at times completely dominating pastures to the detriment of other grasses and grazing animals as it is toxic to most livestock. Salvation Jane has a long-term seedbank viability, and it is likely that the high rainfall that occurred in 2022 replenished the seedbank.

***Marrubium vulgare* (Horehound)**

Marrubium vulgare (Horehound) was detected at both sites during the ramble survey in 2024, with many individuals being recorded at Site 2, but only regenerated individuals at Site 1. This is the first ever recording of Horehound in the Offset Area.

Horehound is an unpalatable perennial herb that increases by seed produced in tiny burrs, where it is spread across the landscape on the fur of animals, on clothing and vehicles. Horehound grows larger and produces more seeds (up to 1,000 annually per square metre) than in its native range. It is primarily an agricultural weed, is unpalatable to stock, and forms dense thickets which inevitably reduces quality and diversity of native habitat. Methods of chemical control are available but often impractical in areas of large infestations, where a suite of biological control agents may be more effective at reducing the population (PIRSA 2025). When infestations are small, mechanical removal is recommended, followed by monitoring.

5.6 OMP Targets

The OMP targets that have been set for the Offset Area (as outlined in **Section 2.3.1** and the OMP (EBS 2017)) and their current status based on 2024 monitoring results are presented in **Table 5.2**. Values indicate that the Offset Area has maintained minimum criteria for listing as Condition Class B INTG. Over the course of the monitoring program (as outlined previously in **Section 4.5.2**) the INTG has generally improved in condition since establishment in 2018.

However, Site 2 recorded a decrease in the diversity of native species, from 21 in 2020, to 14 in both 2021 and 2022. Similarly, the density of tussocks per metre squared in 2022 was 0.83/m^2, which was also below the threshold value. While the diversity of native species is still higher than the original condition, it indicates impacts of reduced grazing were short-lived, and it seems that a lack of grazing has allowed weed species to proliferate locally and smother the inter-tussock space that native herbaceous species required at Site 2. A substantial increase in the weed cover in 2022 may be why the density of tussocks per metre squared was so low as exotic grasses and herbs (which later die off) continue to fill the inter-tussock space. It is possible that some additional species were present at the site, but were not detected, due to the high cover of weedy grasses.

While initially, heavy grazing and drought conditions were thought to be responsible for the poor condition of the Offset Area, a change in seasonal conditions and an apparent cease of grazing has seemingly raised problems. Overall, the health of individual tussocks within the Offset Area has increased. However an increase in exotic species and exotic species cover following better seasonal conditions has likely led to a decline in species diversity, which is likely to continue if an adaptive grazing regime isn't implemented.

Table 5.2 Status of Offset Area Management Objectives and INTG TEC Condition (2024)

Offset Area INTG TEC Management Objective (for INTG TEC Status) (as listed in the OMP)	Current Status		Reached Criteria for Class B
	Site 1	Site 2	
Increase the diversity of native species from nine (baseline value) to above 15 (i.e. >15).	19	17	Yes
Increase the number of broad-leaved herbaceous species (in addition to disturbance resistance species) to three or more (i.e. ≥3).	5	4	Yes
Increase the number of perennial native grass species to four or more species (i.e. ≥4).	6	6	Yes
Increase the density of tussock grass species to one per metre (i.e. 1/m^2).	1.84/ m^2	1.44 / m^2	Yes
Status	**Class B**	**Class B**	

6.0 Recommendations

6.1.1 Grazing Management

Grazing management recommendations remain largely the same as previous monitoring years but are repeated for clarity. Ideally a grazing management plan that allows for indigenous species to set seed and compete a full lifecycle, while reducing the density of annual invasive species which smother and outcompete indigenous species for light and moisture resources, should be undertaken on a rotational basis. The following approach is recommended.

- The annual grazing period is between 30 April and 15 November at the latest. However, during dry conditions, it is recommended that livestock are introduced later (i.e., mid-winter) and removed earlier (e.g., mid-spring). Spring is the growing season for most plants in the grassland and in favourable conditions, a week should be acceptable as a maximum grazing period provided there is enough feed (or possibly less than a week depending on the number and type of sheep grazing). The time allowed for spelling between grazing events will vary according to the conditions and the time of year. A minimum of four weeks, but up to an average of 35 days is likely to be adequate. However, longer spelling and shorter grazing durations will assist in facilitating native plants and herbaceous species to flower and set seed.

- Optimally, grazing should be timed to coincide with the elongation of annual weedy grass stems, prior to development of seed heads. Grazing at this time will reduce seed set of annual weedy grasses while enabling soil seed bank and recruitment of native perennial grasses to improve.

- At no time should stock be left within the Offset Area for longer than seven days, irrespective of the amount of feed in the paddock. After seven days, any actively growing plants will be at risk of being overgrazed. Moving the animals onto fresh native grassland pasture and allowing the grazed pastures to rest and plants to recover, with a return grazing later in the season, will result in healthier grassland and better animal performance.

Grazing management requires adjusting to reflect climatic conditions and although it is a useful tool in weed control and reducing thatch on grasses, during extreme dry conditions livestock numbers require adjusting accordingly to enable plants to reshoot and retain enough green plant material to survive. As per the OMP, ENGIE must ensure that the Landholder:

1. Provides the necessary information for ENGIE to submit the *Activity Record Datasheet* (**Appendix 4**), at the end of each financial year (for 10 years, until 2027, as stated in OMP).

2. Provides the necessary information to ENGIE to complete and submit the *Paddock Monitoring Sheet* (**Appendix 5**) to assist with management of the grazing program.

Provision of these important records to ENGIE and to contractors undertaking annual ecological monitoring (in this case Umwelt) will enable monitoring of grassland health and condition to be attributable to management actions and determine impacts and any necessary changes to management to provide the desired outcome for the Offset Area.

An annual review of the status of the Offset Area is recommended as part of the annual monitoring and reporting program, including liaison between the landholder, ENGIE and the ecological consultant. It is recommended that following finalisation of this report, a meeting between involved parties be arranged to discuss the findings of this monitoring report and management actions going forward.

As stated previously, the OMP was reviewed in 2024 and the *Willogoleche Wind Farm Offset Management Plan – 5 Year Review* (EBS Ecology 2024a) should be read in conjunction with the OMP. A 10-year review of the OMP and Offset Area monitoring data is recommended to be undertaken in 2029.

6.1.2 Weed Management

Weeds should be managed opportunistically and without the use of selective herbicides due to sensitivity of native species. Woody weed and targeted herbaceous species can be manually managed within the Offset Area. Based on the 2024 survey the following weed control measures are recommended:

- Use short term winter grazing to control winter active grassy weeds such as Avena barbata (Wild Oats).
- Graze earlier (i.e., late autumn) in above average (summer) rainfall years, and later (i.e., mid-late winter) in lower-than-average rainfall years.
- Remove *Cynara cardunculus* (Artichoke Thistle) individuals (**Appendix 6**) by hand pulling preferably, ensuring trap root is removed to prevent re-establishment. Alternatively, cut flower stems before reaching maturity to reduce seed production.
- Control (physical removal recommended) small localised (<5 plants) outbreaks of Declared weeds, including *Marrubium vulgare* (Horehound) and *Echium plantagineum* (Salvation Jane). If large outbreaks are detected, then the use of herbicide should be used in a controlled manner by focusing on these outbreaks.
- Continue to monitor the site for new weeds and control promptly to avoid spread.

There is potential for the introduction of additional weeds when new stock (i.e. sheep) are brought onto the property. Sheep can readily carry weed seed from a previous property in their wool, which can then be accidentally deposited on the new property. There may be a need for a quarantine procedure before introducing new stock into the Offset Area, where stock could be kept outside the site for a minimum period of seven days prior to entry to the Offset Area paddock. A quarantine procedure would not be necessary when the sheep are from the same property.

The LSA Act requirements for Declared Weeds in the Offset Area, including *Cynara cardunculus* (Artichoke Thistle), *Echium plantagineum* (Salvation Jane) and *Marrubium vulgare* (Horehound) are highlighted in **Table 4.7**.

7.0 References

Bureau of Meteorology (BOM) (2025a) Climate Data Online: Monthly rainfall: Hallett (Lorraine) weather station (#21024). Available at: <http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=2024&p_c=-88431295&p_stn_num=21024 [Accessed 15/05/2025]>.

Bureau of Meteorology (BOM) (2025b) Climate Data Online: Monthly rainfall: Yongala weather station (#019062). Available at: <http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=2024&p_c=-72701549&p_stn_num=19062 [Accessed 15/05/2025]>.

Department of Sustainability, Environment, Water, Population and Communities (2012) Offsets Assessment Guide. 2 October 2012. Available from: <https://www.dcceew.gov.au/sites/default/files/documents/offset-assessment-guide.xlsm [Accessed 15/05/2025]>.

Department of the Environment and Water Resources (DEWR) (2007) EPBC Act Policy Statement 3.7 - Peppermint Box (*Eucalyptus odorata*) Woodland of South Australia and Iron-grass Natural Temperate Grassland of South Australia. Department of the Environment and Water Resources, Australian Government

EBS Ecology (2013) Willogoleche Hill EPBC Offset Area Investigation. Report to Client. EBS Ecology, Adelaide.

EBS Ecology (2017) Willogoleche Wind Farm Offset Management Plan (OMP). Report to ENGIE. EBS Ecology, Adelaide.

EBS Ecology (2018) Willogoleche Wind Farm Offset Area Monitoring Report 2018. Report to ENGIE. EBS Ecology, Adelaide.

EBS Ecology (2020) Willogoleche Wind Farm Offset Area Monitoring Report 2019. Report to ENGIE. EBS Ecology, Adelaide.

EBS Ecology (2021) Willogoleche Wind Farm Offset Area Monitoring Report 2020. Report to ENGIE. EBS Ecology, Adelaide.

EBS Ecology (2022) Willogoleche Wind Farm Offset Area Monitoring Report 2021. Report to ENGIE. EBS Ecology, Adelaide.

EBS Ecology (2023) Willogoleche Wind Farm Offset Area Monitoring Report 2022. Report to ENGIE. EBS Ecology, Adelaide.

EBS Ecology (2024a) Willogoleche Wind Farm Offset Management Plan – 5 Year Review. Report to ENGIE. EBS Ecology, Adelaide.

EBS Ecology (2024b) Willogoleche Wind Farm Offset Area Monitoring Report 2023. Report to ENGIE. EBS Ecology, Adelaide.

Electronic Flora of South Australia (eFloraSA) (2007) *Lomandra multiflora*. Available at: <http://www.flora.sa.gov.au/cgibin/speciesfacts_display.cgi?form=speciesfacts&name=Lomandra_multiflora> [Accessed 14/03/2025].

Pedler, J.A., Croft, S.J. & Milne, T.I (2007) Bushland condition monitoring manual: Northern Agricultural & Yorke Peninsula Regions. Published by Nature Conservation Society of South Australia.

NRMDB (Natural Resources SA Murray-Darling Basin) (2019) 'Iron-grass native grassland project – Native grasslands, more than just grass!', Landscape Ecology Team, Government of South Australia, Fact sheet March 2019. Available from: https://cdn.environment.sa.gov.au/landscape/docs/mr/more-than-just-grass-intg-fact2.pdf [Accessed 21/03/2025].

Northern and Yorke Natural Resources Management Board (NY NRM) (2018) Northern and Yorke Regional NRM Plan: Strategic Plan 2019-2029. Natural Resources, Northern and Yorke, Government of South Australia. Available at: <https://www.naturalresources.sa.gov.au/files/sharedassets/northern_and_yorke/corporate/board/2019-29-strategic-plan-signed.pdf> [Accessed 14/03/2025].

Northern and Yorke Landscape Board (NAYLB) (2023) Wild artichoke (*Cynara cardunculus*). Landscape South Australia, Northern and Yorke, Government of South Australia. Available at: <https://cdn.environment.sa.gov.au/landscape/docs/ny/220614_Wild-artichoke-fact-sheet.pdf> [Accessed 07/04/2025].

Department of Primary Industries and Regions (PIRSA) (2025) Weed Control Handbook for Declared Weeds in South Australia – PIRSA. Available at: <https://pir.sa.gov.au/__data/assets/pdf_file/0020/232382/weed-control-handbook.pdf> [Accessed 08/05/2025].

Threatened Species Scientific Committee (TSSC) (2007) Commonwealth Listing Advice on Iron-grass Natural Temperate Grassland of South Australia. Available from: <http://www.environment.gov.au/biodiversity/threatened/communities/pubs/l-effusa.pdf>. [Accessed 14/03/2025].

Tongway, D.J., and Hindley, N.L. (2005) Landscape Function Analysis: Procedures for monitoring and assessing landscapes. With special reference to Mine sites and Rangelands. CSIRO Sustainable Ecosystems, Canberra.

Turner, J. (2012) National Recovery Plan for the Iron-grass Natural Temperate Grassland of South Australia ecological community 2012. Department of Environment and Natural Resources, South Australia.



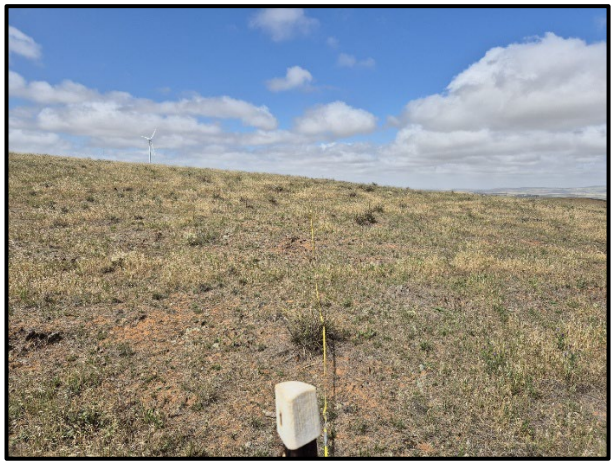
APPENDIX 1

Important Dates, Monitoring and Offset Area Milestones

Year	Phase	Date	Comment
2014	Approval	28 January 2014	EBPC Approval granted with conditions.
2016	Approval	12 December 2016	Variation to Conditions attached to EPBC Approval.
2017	Planning	18 January 2017	OMP submitted to the Minister for approval.
2017	In-principle approval	2 February 2017	Heritage Agreement under SA *Native Vegetation Act 1991* over the Offset Area confirmed.
2017	Approval	3 February 2017	OMP approved by the Minister.
2017	Construction	9 September 2017	Construction works commenced.
2018	Baseline (year 0)	8 October 2018	Offset Area baseline survey completed: Willogoleche Wind Farm Offset Area Monitoring Report 2018 (EBS Ecology 2018).
2019	Approval	9 August 2019	Heritage Agreement registered.
2019	Construction	12 November 2019	Sectional completion achieved (construction and commissioning completed) and entire wind farm operational.
2019	Monitoring (year 1)	13 November 2019	Offset Area annual monitoring for 2019 completed with additional methodology added: Willogoleche Wind Farm Offset Area Monitoring Report 2019 (EBS Ecology 2020).
2020	Monitoring (year 2)	18 November 2020	Offset Area annual monitoring for 2020 completed: Willogoleche Wind Farm Offset Area Monitoring Report 2020 (EBS Ecology 2021).
2021	Monitoring (year 3)	5 November 2021	Offset Area annual monitoring for 2021 completed with PCQM methodology altered and new method added: Willogoleche Wind Farm Offset Area Monitoring Report 2021 (EBS Ecology 2022).
2022	Monitoring (year 4)	4 November 2022	Offset Area annual monitoring for 2022 completed: Willogoleche Wind Farm Offset Area Monitoring Report 2022 (EBS Ecology 2023).
2023	Monitoring (year 5)	3 November 2023	Offset Area annual monitoring for 2023 completed: Willogoleche Wind Farm Offset Area Monitoring Report 2023 (EBS Ecology 2024b).
2024	OMP 5-year Review	July–November 2024	OMP reviewed and revised: Willogoleche Wind Fm Offset Management Plan – 5 Year Review (EBS Ecology 2024a).
2024	Monitoring (year 6)	23 October 2024	Offset Area annual monitoring for 2024 completed (this report).
2044	Approval	31 January 2044	EPBC Act approval has effect until 31 January 2044.

APPENDIX 2

Offset Area Site Photographs (2018-2024)



Site 1 2024 (Start, looking south)



Site 1 2024 (End, looking North)



Site 1 2023 (Start, looking south)



Site 1 2023 (End, looking North)



Site 1 2022 (Start, looking south)



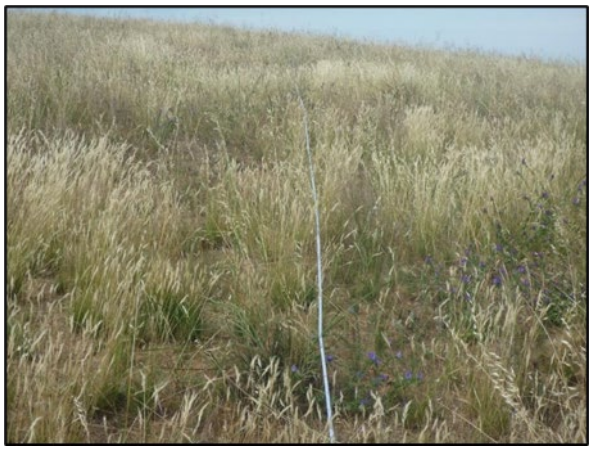
Site 1 2022 (End, looking North)



Site 1 2021 (Start, looking south)



Site 1 2021 (End, looking North)



Site 1 2020 (Start, looking south)



Site 1 2020 (End, looking North)



Site 1 2019 (Start, looking south)



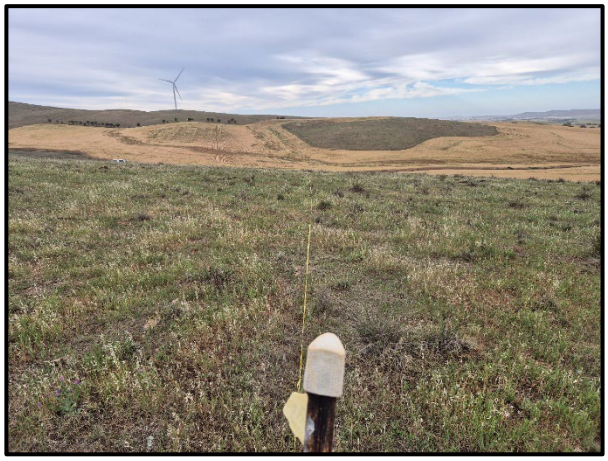
Site 1 2019 (End, looking North)



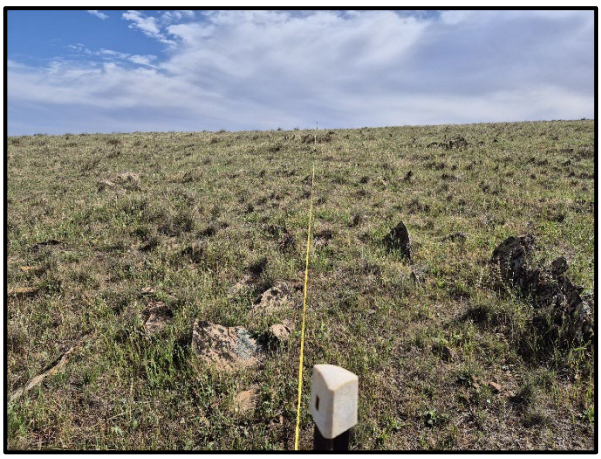
Site 1 2018 (Start, looking south)

N/A

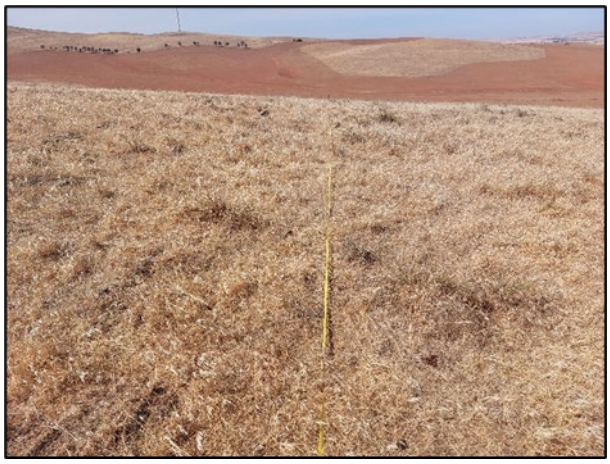
Site 1 2018 (End, looking North)



Site 2 2024 (Start, looking south)



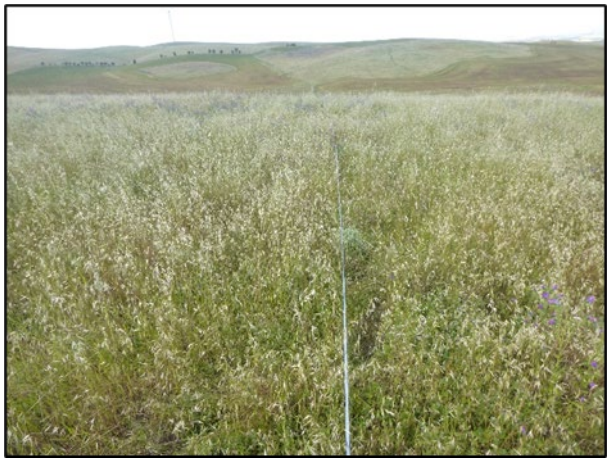
Site 2 2024 (End, looking North)



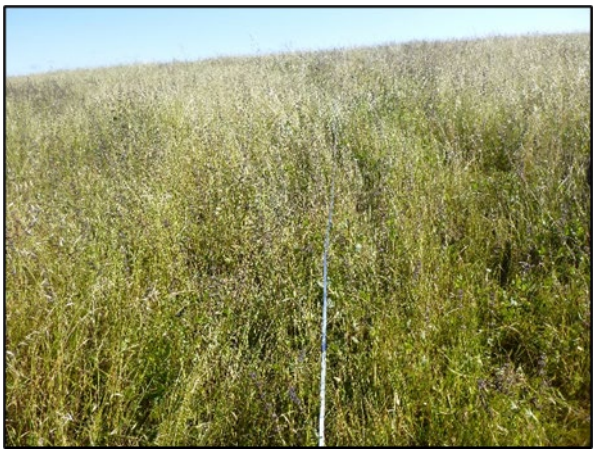
Site 2 2023 (Start, looking south)

N/A

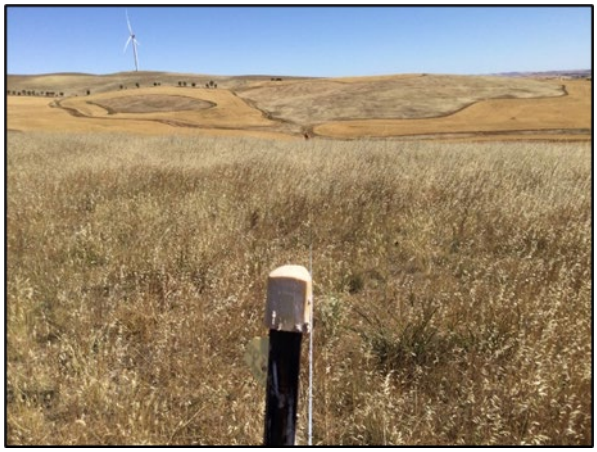
Site 2 2023 (End, looking North)



Site 2 2022 (Start, looking south)



Site 2 2022 (End, looking North)



Site 2 2021 (Start, looking south)



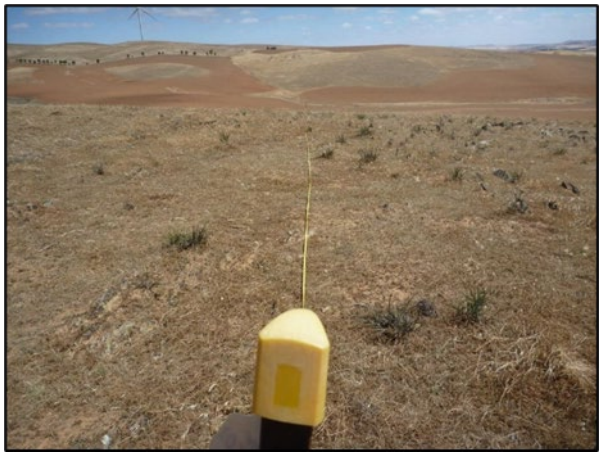
Site 2 2021 (End, looking North)



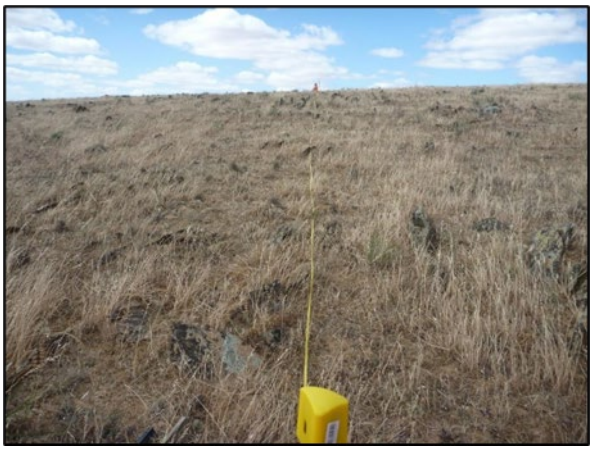
Site 2 2020 (Start, looking south)



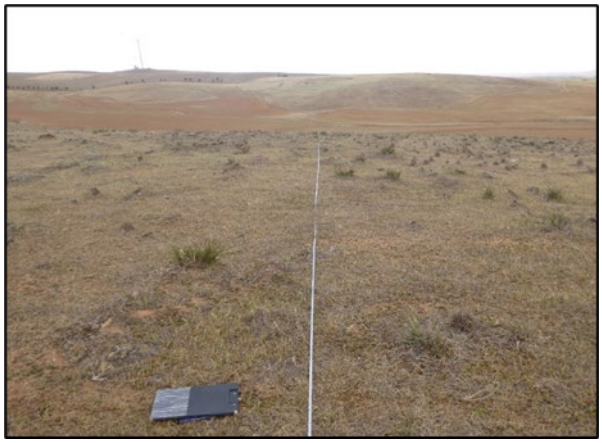
Site 2 2020 (End, looking North)



Site 2 2019 (Start, looking south)



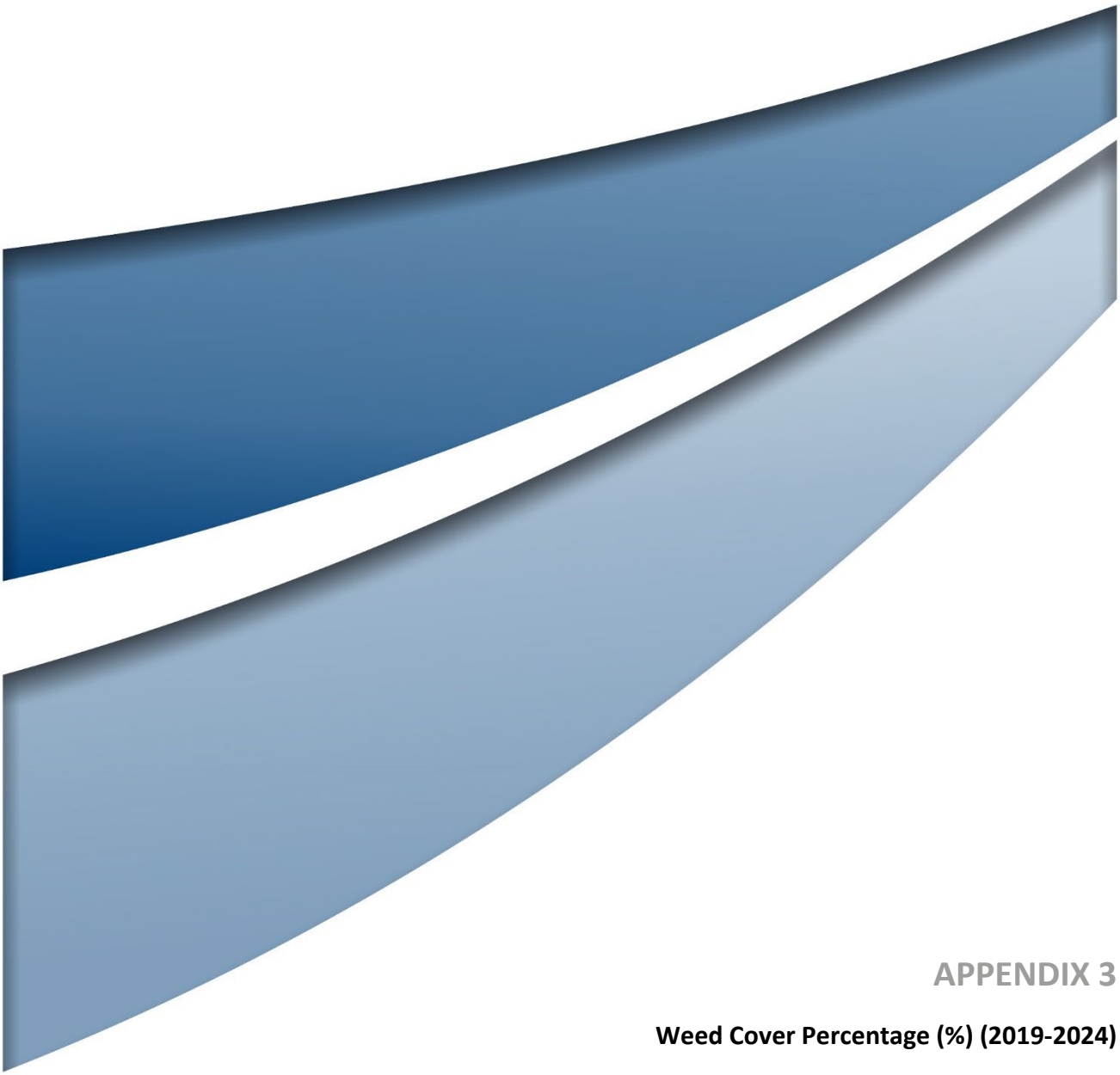
Site 2 2019 (End, looking North)



Site 2 2018 (Start, looking south)

N/A

Site 2 2018 (End, looking North)

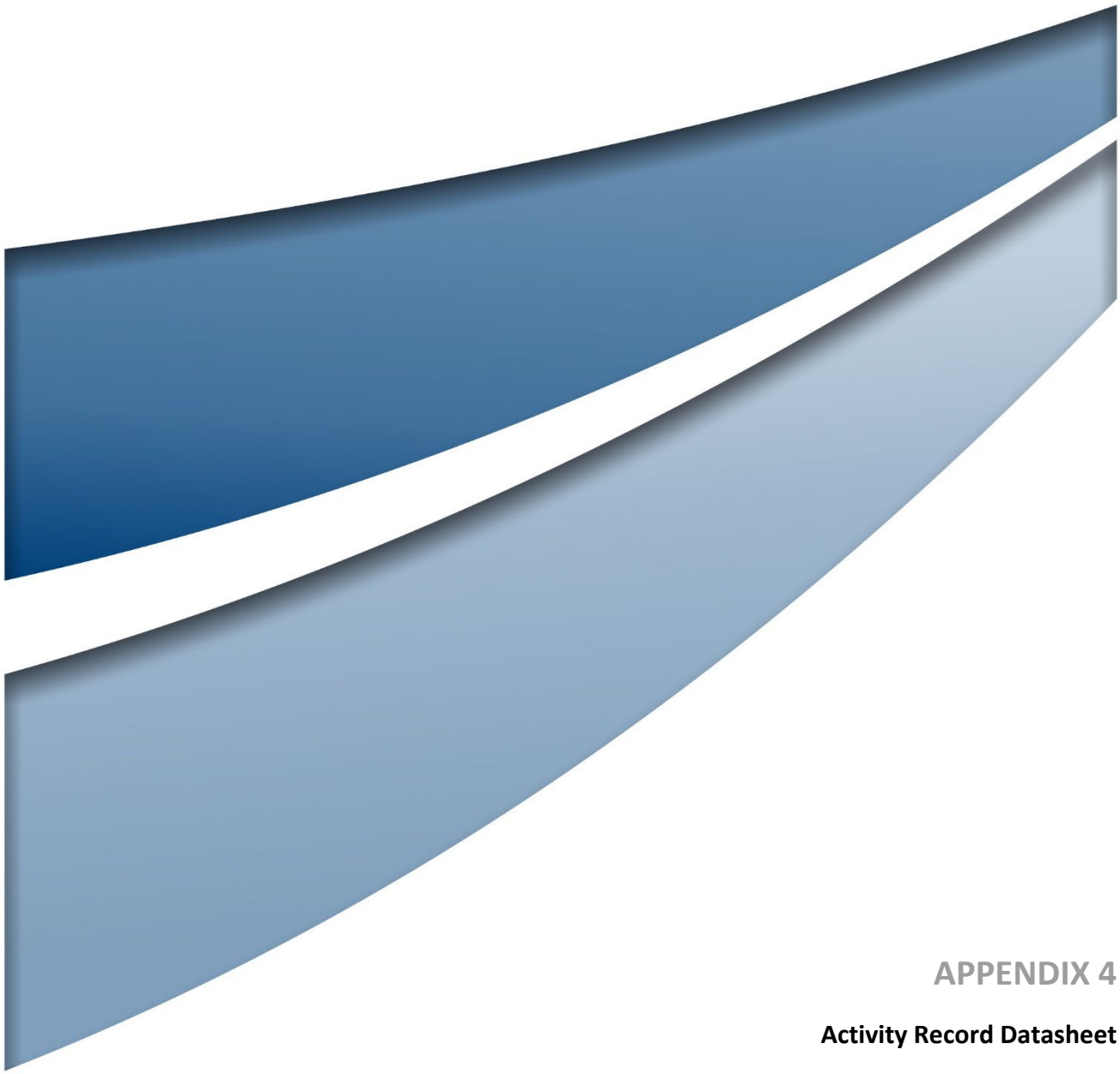


APPENDIX 3

Weed Cover Percentage (%) (2019-2024)

Scientific Name	Common Name	2019		2020		2021		2022		2023		2024	
		Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
Aira sp.	Hair-grass	-	-	-	-	-	-	0.05	-	-	-	-	-
Avena barbata	Bearded Oat	0.70	1.75	10.90	14.20	10.60	15.10	50.00	52.50	12.40	8.10	28.2	47
Bromus diandrus	Great Brome	-	-	-	-	-	1.30	0.00	0.00	0.00	0.05	-	-
Bromus rubens	Red Brome	-	-	-	-	0.00	-	-	0.00	-	0.10	-	-
Bromus sp.	(A type of Brome)	0.00	0.10	-	-	-	-	-	-	-	-	-	-
Carthamus lanatus	Saffron Thistle	0.00	0.00	0.00	0.00	-	-	-	-	-	-	-	-
Convolvulus arvensis	Field Bindweed	-	-	-	-	-	0.00	0.00	-	0.00	0.00	-	-
Cynara cardunculus	Artichoke Thistle	-	-	-	-	0.00	-	-	-	0	-	0	0
Echium plantagineum	Salvation Jane	0.50	0.10	4.70	1.00	-	-	2.50	6.00	0.25	0.15	1.7	1.4
Erodium cicutarium	Cut-leaf Heron's-bill	4.81	13.65	0.00	0.00	2.55	0.90	0.50	0.00	-	-	0.8	3.15
Hypochaeris radicata	Rough Cat's Ear	0.00	0.00	0.00	0.50	-	0.05	0.05	0.20	0.05	0.00	-	0
Lepidium africanum	Common Peppercress	0.00	1.60	1.75	0.00	0.35	1.50	0.30	0.00	0.15	0.05	0.4	0.05
Lolium sp.	Ryegrass	1.46	6.10	2.40	13.00	0.35	4.00	0.25	9.20	0.05	0.35	0.4	0.05
Lupinus sp.	Lupine	-	-	-	-	0.00	-	-	-	-	-	-	-
Medicago polymorpha var. *polymorpha*	Burr-medic	2.91	0.00	12.00	12.30	0.30	0.85	4.30	9.00	-	0.05	-	0.6
Medicago sativa	Alfalfa/Lucerne	-	-	-	-	-	-	0.00	-	0.00	-	-	-
Moraea setifolia	Thread Iris	0.05	3.10	1.00	0.50	1.20	0.70	-	0.00	-	-	0	0.05
Romulea rosea	Onion Weed	-	-	3.70	3.70	-	-	0.00	-	-	-	0.3	0.2
Salvia verbenaca var.	Wild Sage	0.00	0.00	0.00	8.00	0.00	4.70	0.05	14.00	0.00	0.45	0.05	14.2
Sonchus oleraceus	Sow Thistle	0.00	0.00	0.00	0.05	-	-	0.10	-	-	-	-	-
Taraxcum officinale	Common Dandelion	-	-	-	-	-	-	-	-	-	-	-	0
Trifolium angustifolium	Narrow-leaf Clover	-	-	0.50	6.60	0.15	1.45	0.60	3.25	0.10	0.00	-	-
Trifolium arvense	Rabbitfoot Clover	-	-	10.90	2.80	1.90	0.65	18.70	4.00	0.00	0.15	-	-
Trifolium sp.	Clover	0.05	0.35	-	-	-	-	-	-	-	-	-	-
Vulpia sp.	Fescue	0.30	0.25	0.70	3.65	4.25	4.15	0.85	0.30	-	0.30	-	-
Total		**10.78**	**27**	**48.55**	**66.3**	**21.65**	**35.35**	**78.25**	**98.45**	**13**	**9.75**	**31.95**	**67.45**

Results of '0.00' indicates the species was recorded via ramble but not in the PCQM quadrats (so cover data is not available).

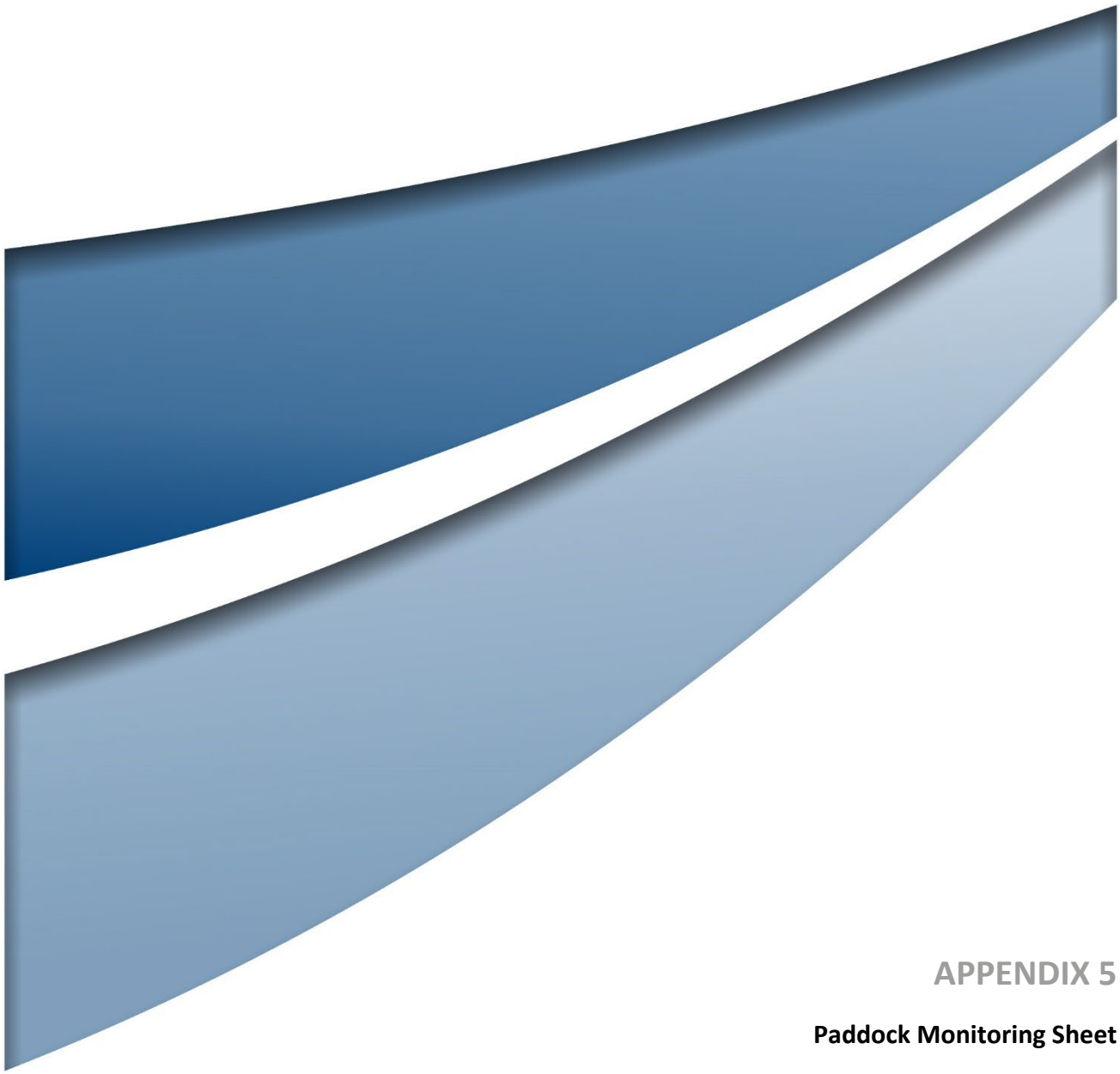


APPENDIX 4

Activity Record Datasheet

Activity Record Datasheet – To be filled in by landholder as management actions are undertaken

Management Action (e.g. fox baiting / shooting, boxthorn control, horehound control)	Date	Time spent on tasks (hrs / days)	Comments (Completed/more remaining/ follow up required – provide estimate of time remaining)



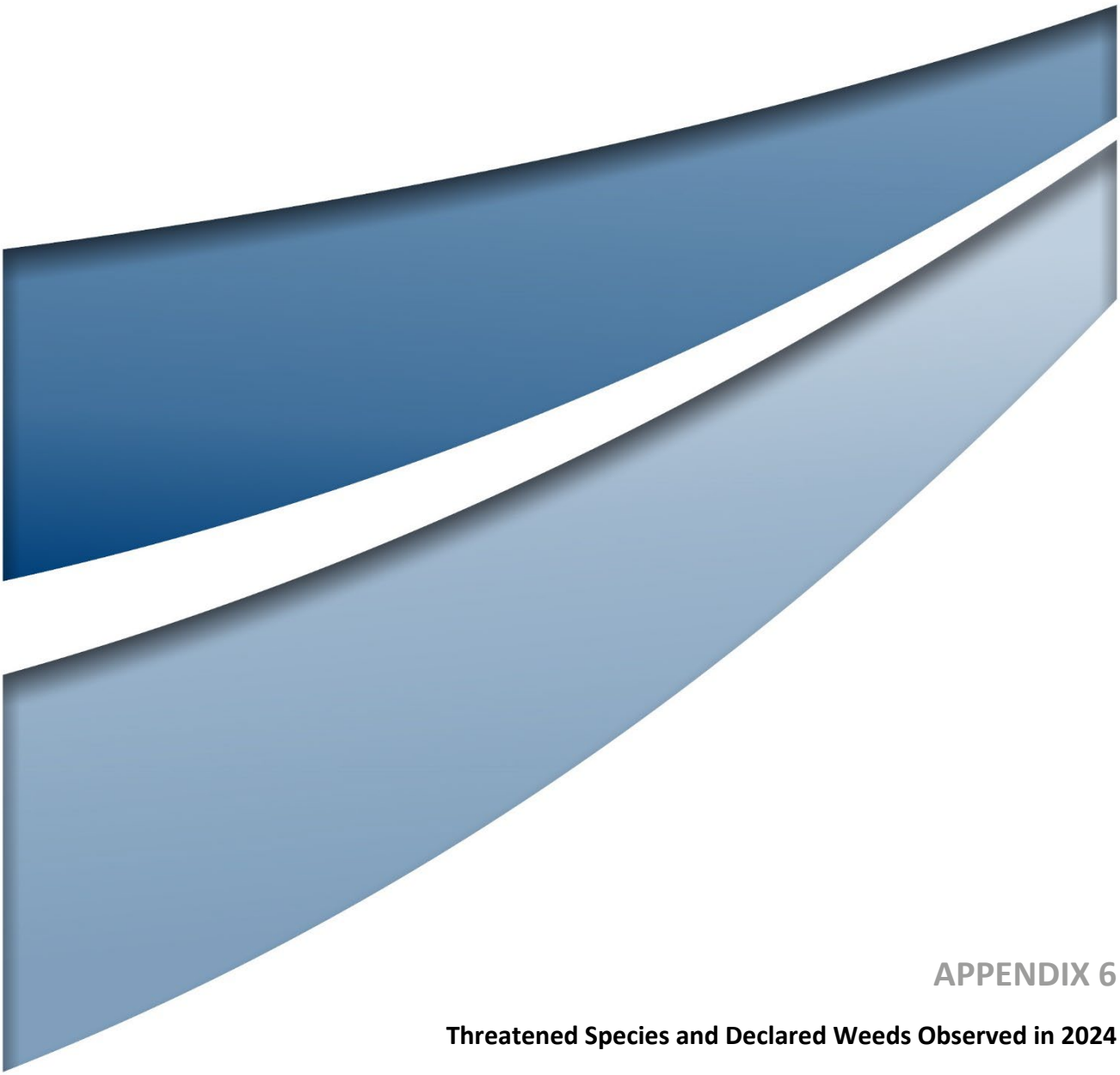
APPENDIX 5

Paddock Monitoring Sheet

Paddock Monitoring Sheet - To be filled in by landholders as grazing management progresses

(Mid North Grasslands Working Group and Land Water & Wool 1986)

Paddock Name: _____											
Paddock Size	**Date in**	**Date out**	**A. Grazing Days**	**B. Estimate of feed left (kg/DM/ha)**	**C. Sheep number and type**	**D. DSE rating**	**E. Total DSE of mob**	**F. Feed utilised (kg)**	**G. Rest Period (days)**	**I. DSE days/ha**	**J. DSE days/ha/yr**



APPENDIX 6

Threatened Species and Declared Weeds Observed in 2024

Appendix 6: Threatened Species and Declared Weeds Observed in 2024



Offset Area
Offset Area Assessment Site
Monitoring Transect

Declared Weeds

- Artichoke thistle (*Cynara cardunculus*)
- Horehound (*Marrubium vulgare*)

Threatened Species

- Long-flower Cryptandra (*Cryptandra campanulata*)
- Wiry Dock (*Rumex dumosus*)

31500_R03_Willo_OffsetArea_v3 (31500_R03_A0006_SurveyObservations)

umwelt
Environmental & Social Consultants

Data Source: Umwelt (2025), ESRI (2025), DEW (2022), DIT (2022)

Date Exported: 8/07/2025 10:30 AM
Created by: sophie.haswell

COPYRIGHT: Use or copying of this map in whole or in part without the written permission of Umwelt constitutes an infringement of copyright. LIMITATION: This map has been prepared on behalf of and for the exclusive use of Umwelt's Client, and is subject to and issued in connection with the provisions of the agreement between Umwelt and its Client. Umwelt accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this map by any third party.

GDA2020 MGA Zone 54

N

0 25 50 m



umwelt
Environmental & Social Consultants

Umwelt (Australia) Pty Limited

T| 1300 793 267 E| info@umwelt.com.au www.umwelt.com.au