M2G Offset Property Monitoring Report

Spring 2013

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Abbreviations

ABBREVIATION	DESCRIPTION
EIS	Environmental Impact Statement
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
LMA	Land Management Agreement
LRMP	Landscape Rehabilitation Management Plan
M2G	Murrumbidgee to Googong Water Transfer Project
MU	Management Unit
ODP	Offset Delivery Plan
OEMP	Operation Environmental Management Plan
ORMP	Offset Rehabilitation Management Plan
PER	Public Environment Report
TEMP	Terrestrial Ecology Management Plan

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Executive summary

The Biodiversity Offset site provided to compensate for impacts resulting from the development of the Murrumbidgee to Googong Water Transfer Project (M2G) was surveyed in spring 2013 as part of a twice-yearly monitoring program implemented to inform the management of the offset.

The spring 2013 surveys found that the offset site is in good condition and is responding well to management actions, such as the exclusion of stock, feral animal control and weed control works. Evidence for this is the abundant natural regeneration of *Eucalyptus* spp. and regeneration of a variety of typical mid-storey species across the offset site, such as *Cassinia* sp. *Dodonaea viscosa* and *Acacia* spp. In addition, there has been a general decrease in the abundance of exotic species observed across the site and an increase of native species diversity recorded at all vegetation monitoring plots. Targeted nocturnal fauna surveys were implemented for the first time during the 2013 spring monitoring. However, fauna habitat features are largely unchanged since the baseline surveys.

A total of 112 *Swainsona recta* plants have been translocated within the southern offset (66 planted in July 2012 and 46 planted in 2013). The monitoring surveys revealed an overall survivorship of 79% (88 of 122). The majority of plants observed from the 2012 plantings were either in flower, or had recently flowered with signs of seed pod development. This is in comparison to only one individual observed flowering from the 2013 plantings. A total of 24 individuals were not observed during the monitoring survey. These individuals have not survived the translocation process or have died-back to a dormant state, which cannot be observed above ground.

Primary weed control activities have been largely successful across the offset site. Follow-up control undertaken mid-year and further follow-up control planned over 2013/2014 is expected to further reduce the abundance and distribution of key weed species across the site. Feral Pig abundance was much reduced compared to that recorded in 2012; however Feral Goat numbers had increased significantly. Feral animal control programs for both species are scheduled for late 2013.

The majority of erosion monitoring points have not shown signs of erosion since the baseline surveys, despite high rainfall events occurring during this time. The lack of erosion at these points indicates that the soil is stable with a low risk of significant erosion occurring in the future. A high vegetation cover across the offset site and the continued exclusion of stock grazing further reduces the risk of erosion occurring. It is recommended that the number of erosion monitoring points be reduced for future surveys.

The overall condition of the Williamsdale property and offset boundary fencing is considered adequate to exclude grazing by stock within the offset site. No immediate management actions are required to be undertaken; however maintenance at some locations is likely to be required in the future.

Further monitoring in 2014 will guide additional or future management actions.

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1 Introduction

1.1 Background

Eco Logical Australia Pty Ltd (ELA) was commissioned by ACTEW Water (ACTEW) to deliver terrestrial ecology services as required by the environmental approval process for the Murrumbidgee to Googong Water Transfer Project (M2G).

The M2G projects falls under the jurisdiction of the Commonwealth Department of the Environment (previously, Department of Sustainability, Environment, Water, Population and Communities), NSW (Department of Planning), and ACT (ACT Planning and Land Authority) Governments and has been subject to assessment and environmental approval processes in all three jurisdictions. Project approval (granted in 2010) has been attained from all three governments, with a considerable number of approval conditions and commitments applied.

Under the environmental approvals process, ACTEW was required to provide compensatory habitat as an offset to compensate for vegetation and habitat losses arising from the construction activities associated with the M2G pipeline. The offset was required to be delivered to meet the conditions outlined in a range of documents including but not limited to, the Environmental Impact Statement (EIS) and Public Environment Report (PER) prepared for the development and relevant approval conditions.

1.2 Purpose of document

Under Condition 2.9b of the NSW Approval and Condition 3.l of the Commonwealth approval conditions for the M2G Project (see Offset Delivery Plan (ODP) for further information), management and monitoring of the offset site is required. The ODP prepared by ELA (April 2012) describes the actions to be taken in establishing and managing the offset site under the approval conditions and commitments including the provision of monitoring actions (Eco Logical Australia 2012).

This report details the spring monitoring surveys for 2013 that were undertaken in accordance with the methodology and aims established in the ODP. It is designed to be a standalone monitoring report mimicking the format of the previous biannual monitoring reports, but also to be read in context with the ODP. The purpose of this document is to report on the ecological condition of the site and management actions conducted within the previous year, to guide future actions within the offset site.

The *Spring 2013 Monitoring Report* incorporates the results of the field surveys and where applicable, provides a comparison against the baseline monitoring surveys undertaken in spring 2011.

1.3 Study area

ACTEW own a land parcel in the southern ACT (Block 1675), referred to here as the Williamsdale property (or 'the property'). The property is located just south of Williamsdale and is bounded by the Monaro Highway to the east; the NSW border to the south; Angle Crossing Road to the north; and the Murrumbidgee River corridor to the west (**Figure 1**). The monitoring surveys were conducted within the offset site (study area of approximately 110 ha), which is wholly contained within the property.

The offset site has been set aside for conservation due to its high biodiversity value; including the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed Box-Gum Woodland, threatened flora and fauna species and/or threatened species habitat.

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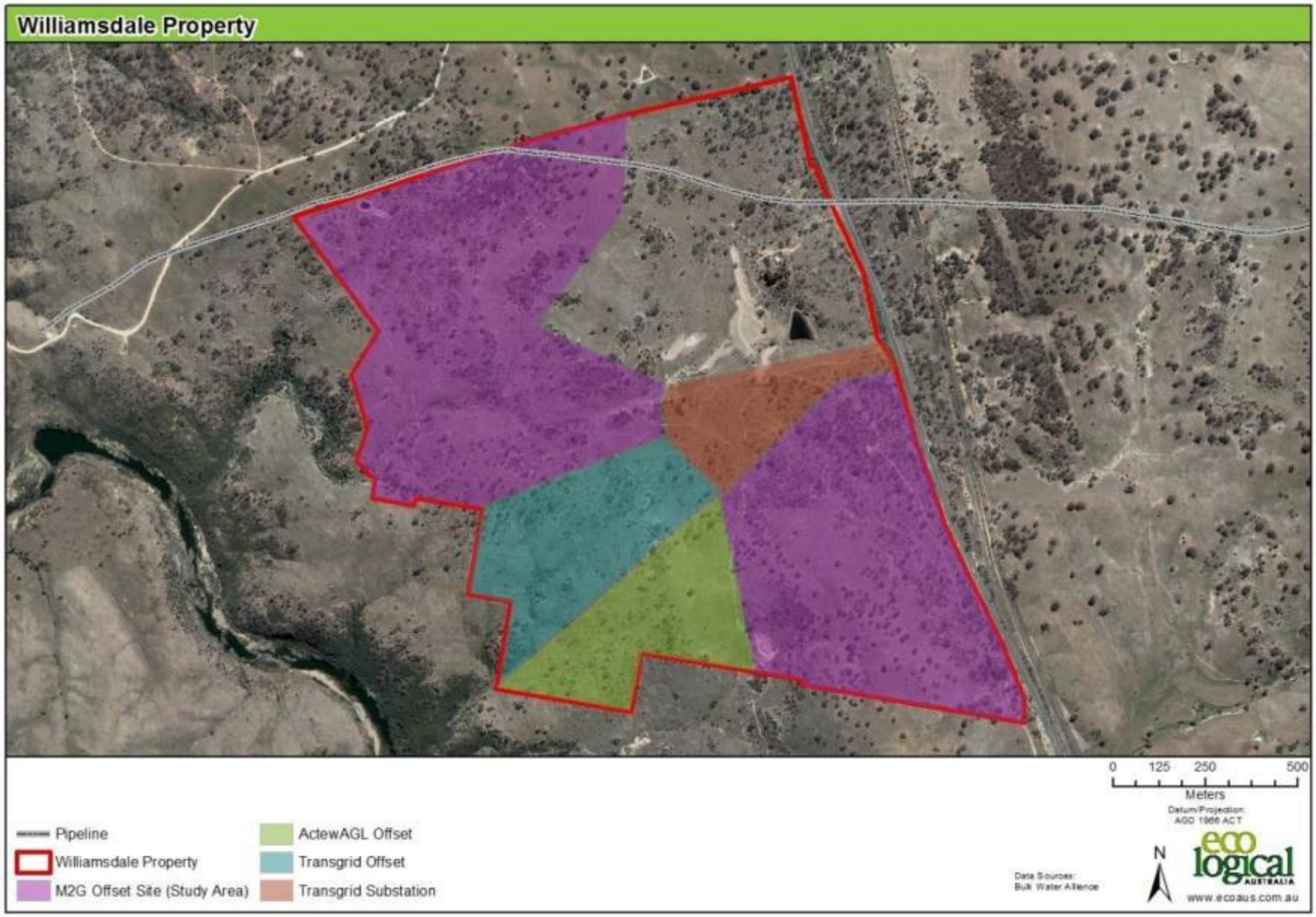

Figure 1: Study area

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2 Field survey methods

The native vegetation and biodiversity values present within the offset site are managed under the ODP and its sub-plans. The ODP establishes the monitoring methodology for each of these values. A summary of the monitoring methodology outlined in the ODP is presented below, followed by the results of the spring 2013 monitoring surveys.

2.1 Vegetation monitoring plot methodology

The monitoring methodology has been adapted from the NSW Biobanking methodology to suit the offset site management requirements. The modified Biobanking methodology proforma uses a combination of quadrat and transect surveys to establish vegetation condition and this approach is mirrored under the monitoring methodology.

Vegetation surveys have been designed to collect the following data:

- Species diversity, including native and exotic species.
- Cover abundance of native and exotic species.
- Identification of any threatened flora.
- Condition of vegetation community.

2.1.1 Floristic quadrats

Eight 20 m x 20 m monitoring quadrats (plots) were established to collect baseline data on the condition and species composition of the offset site during autumn and spring each year (**Figure 2**). The quadrats are permanently erected and marked using a star picket at each corner tagged with flagging tape. The location of each quadrat has been referenced using a GPS device (north-west corner) and their location plotted on a map (**Figure 2**).

Each quadrat was surveyed by walking back and forth along 10 parallel transects approximately 2 m apart. A cumulative list of flora species within each quadrat was recorded and assigned a cover abundance score using the Braun-Blanquet scale.

Two of the eight plots (control plots) were chosen in order to observe natural changes in species composition over time. Both plots were located in areas of good quality EPBC Act listed Box-Gum Woodland and at the time of establishment were free from noxious weeds. Where possible, no management actions, such as weed control, erosion control, or rehabilitation are planned to occur within these monitoring plots over the duration of the monitoring period. However, it is noted that some actions such as feral animal control occurs on an offset site scale. If noxious weeds are observed within the control plots during the biannual monitoring surveys, the weeds will be identified, recorded and then removed. The removal of noxious weeds from the control plots is required to maintain the overall conservation principles of the offset site.

The other six monitoring plots were located in areas where management actions were planned or likely to occur as outlined in the management sub-plans, in order to observe the effect that management actions have on ecological values and species composition.

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A description of the monitoring plots is provided in **Figures 4-10**. The GPS co-ordinates of the north-west corner of each monitoring plot are provided below in **Table 1**. A species list for each of the monitoring plots is included in **Appendix A**.

Table 1: Monitoring plot co-ordinates (GDA 1994 MGA Zone 55).

Monitoring plot	Plot location	Established	North-west corner		Transect	
			Easting	Northing	Easting	Northing
1	MU1A	October 2011	693669.49	6059272.51	693674.98	6059300.56
2	MU2B	March 2012	693529.99	6059555.34	693541.22	6059504.10
3	MU3	October 2011	693872.06	6059467.44	693874.65	6059490.73
4	MU4	October 2011	692349.35	6060568.08	692365.82	6060517.43
5	MU5	October 2011	692559.98	6059906.52	692526.40	6059902.85
6*	MU6	March 2012	692576.25	6060344.05	692622.53	6060358.54
7	MU7	March 2012	692860.59	6060583.39	692874.01	6060542.87
8*	MU3	October 2011	693414.37	6059863.02	693445.95	6059828.31

* Refers to the control plot

2.1.2 Step point transects

A 50 m transect (50 m length of tape) was established at each of the monitoring plots to compliment the floristic quadrat surveys and to determine the projected foliage cover and structural components of the community. Each transect was referenced using a GPS device and 3 photos were taken from the start of the transect (left side, centre, and right side). The 50 m transect was surveyed as follows:

- At every 1 m along the 50 m tape, the understorey layer was assessed (50 survey points per transect) as, native grass, native shrub, native other or exotic species. The understory cover was then presented as a percentage cover of each vegetation type (native or exotic).
- At every 5 m along the 50 m tape, the foliage cover of the native and exotic species in the mid and overstorey layer was recorded (10 survey points per transect). The foliage cover was then recorded as a percentage for each layer.

2.2 Swainsona recta monitoring

A monitoring survey is conducted during the peak flowering period for *Swainsona recta* in October each year. Each individual plant is assessed for its survivorship and flowering condition to determine whether:

- It is present or absent.
- It is in flower.
- It has flowered recently (development of seed pods).
- It is in leaf only.

In addition, the translocation plots are inspected for signs of individual recruitment. The results allow a comparison of survivorship, condition and recruitment events at the end of each monitoring period and provide a picture of the overall success of the propagation program. For further information on the *Swainsona recta* propagation program, refer to **Section 4**.

2.3 Weed monitoring methodology

The management of weeds within the M2G offset site is undertaken in accordance with the Weed Monitoring Sub-Plan. The sub-plan outlines the weed management activities to be undertaken in order to satisfy relevant approval conditions and commitments. As an action under the sub-plan, the monitoring of weeds within the offset is required on a biannual basis to incorporate the seasonal changes in weed abundance and weed control activities.

Weed monitoring is undertaken in autumn and spring using random meander transects, covering both the northern and southern offset. A GPS record is taken when a noxious or locally listed weed species is observed during transects in a patch containing multiple individuals.

2.4 Erosion monitoring methodology

Erosion monitoring sites were established during the autumn 2012 monitoring surveys. Meandering traverses were conducted across the offset site, with particular attention paid to ephemeral drainage lines and higher erosion risk areas. Points of erosion encountered were described in terms of size and their location recorded using a GPS. A photo (**Section 6**) was taken of each point in order to observe any changes over time.

It's important to note that not all points of erosion originally observed were established as a monitoring point, but rather a representative sample encompassing each of the drainage lines.

2.5 Fencing monitoring methodology

Fence monitoring was undertaken by traversing the Williamsdale property border and assessing the condition of the fence. Any damaged areas observed along the fence line were noted and a GPS point taken. Fence damage was categorised into three categories to represent the level of risk of unwanted grazers (such as cattle) entering the offset site:

- *Low* – Small holes (wombat sized) observed at the bottom of the fence that does not require immediate attention and allows native fauna to pass through.
- *Moderate* – Small to moderate sized holes or fence damage that requires monitoring, but no immediate action. Often observed along the fence line bordering the Murrumbidgee River corridor and represents a potential goat or sheep access point.
- *High* – Represents points along the fence line requiring attention. These points represent a risk of cattle and sheep entering the property.

2.6 Fauna habitat and feral animal monitoring methodology

Feral animal monitoring, fauna habitat and fauna surveys have been undertaken using a combination of techniques, including:

- Fauna habitat assessment and random meander surveys.
- Infra-red cameras.
- Nocturnal surveys including Anabats, spotlighting and frog habitat surveys.
- Opportunistic observations.

The locations of the infra-red cameras, spot-light transects, frog surveys and Anabats are shown in **Figure 3**.

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2.6.1 Fauna habitat assessment

A fauna habitat assessment was conducted within each 20 m x 50 m vegetation monitoring plot to observe the number of hollow bearing trees, length of fallen logs (greater than 10 cm width) and dominant habitat features present. In addition, a qualitative assessment of fauna habitat features was undertaken for each of the northern and southern offsets. This assessment included features such as, hollow-bearing trees, logs, litter, fallen timber, stags, surface or outcropping rocks, termite mounds, mistletoe, large trees, natural regeneration and exotic or native shrub thickets.

The fauna habitat assessments are outlined in **Appendix B**.

2.6.2 Infra-red camera surveys

The use of infra-red cameras was recommended as a monitoring method in the *Autumn 2012 Monitoring Report* (ELA 2012). Remote cameras have been used with success in the United States in detecting the presence of Feral Pigs (*Sus scrofa*), estimating abundance, and determining trapping success (Hamrick et al., 2011).

Two infra-red camera surveys were set-up within the offset site and left for a minimum of five days, one within the northern offset and the other in the southern offset. The locations of the infra-red cameras (**Figure 3**) were chosen based on fauna signs, access to water and fauna tracks, such as pig-rooting, wombat tracks and game trails.

2.6.3 Nocturnal surveys

Targeted nocturnal fauna surveys (**Figure 3**) were implemented for the first time during the 2013 spring monitoring surveys and were conducted to obtain a list of fauna species present within the offset site. Surveys techniques included:

- *Spotlighting* – Three 30 minute transects were conducted across the offset site, two transects within the northern offset and one transect in the southern offset. Transect locations targeted stands of vegetation with a mixed-aged overstorey, hollow-bearing trees and flowering Eucalypts.
- *Frog habitat survey* – Active searches and frog call recordings were conducted at the two dams within the offset site for ten minutes each.
- *Anabat* – Two survey nights were conducted using two Anabats to monitor bat activity through ultrasonic echolocation calls. One Anabat was set up at the southern dam and the other in a flyway (fire trail south of main drainage line) to record bat activity between dusk and dawn. Recordings were then sent off for analysis and species identification.

2.6.4 Opportunistic observations

Visual and aural observations of all vertebrate fauna species (including signs of feral animal activity) were recorded opportunistically whilst conducting targeted monitoring surveys across the offset site and using random meander techniques (species list available in **Appendix B**). Locations of conservation significant fauna and signs of feral animal presence were referenced using a GPS device.

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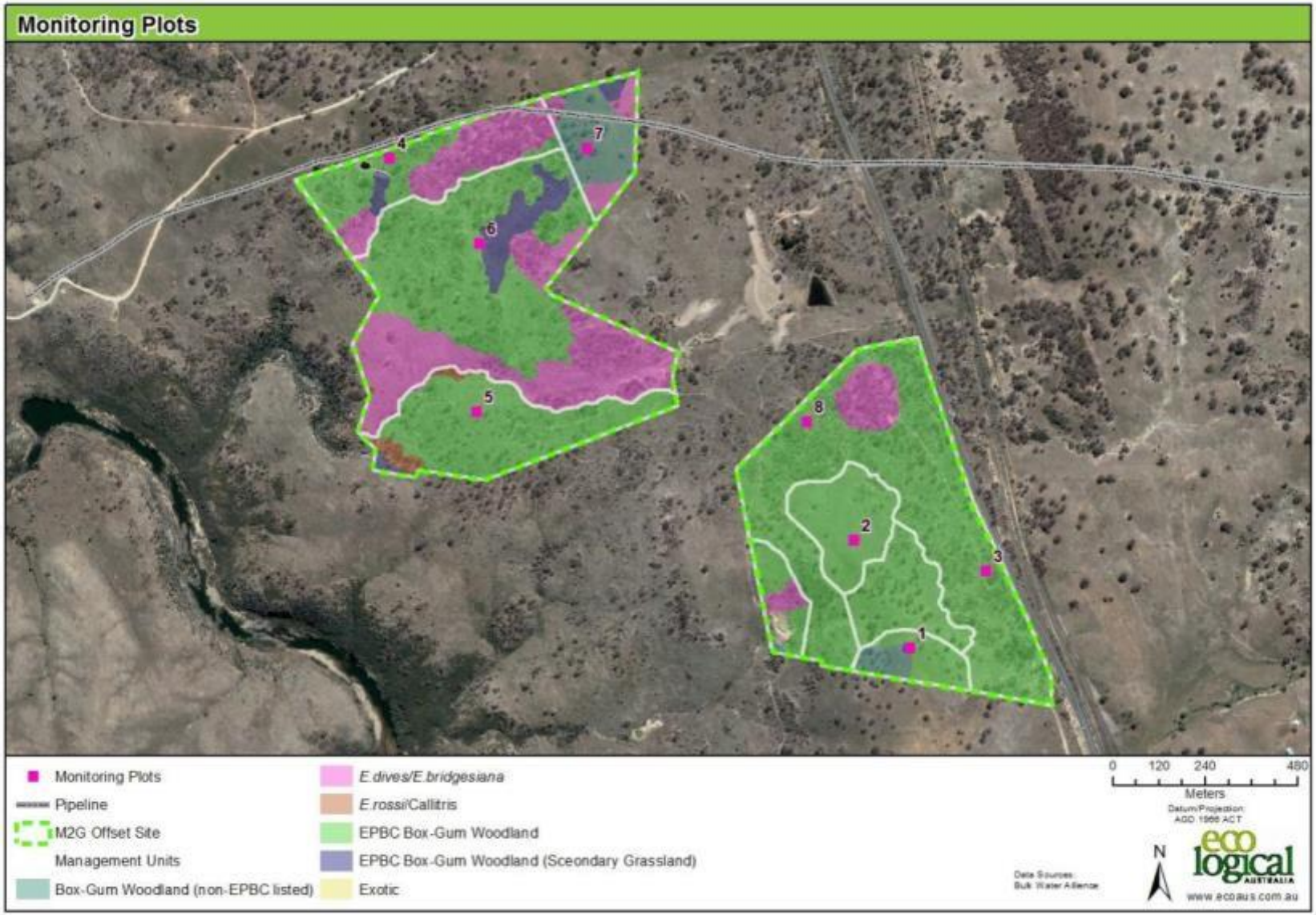

Figure 2: Monitoring plots, management units and baseline offset site ecological values

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Figure 3: Fauna monitoring locations

3 Vegetation and fauna habitat monitoring

3.1 Primary on ground works

A number of primary on-ground works were undertaken throughout 2013 and are planned to be undertaken prior to the autumn 2014 monitoring surveys, including:

- Erection of new fence bordering MU7 of the northern offset (June 2013).
- Removal of internal fencing within the offset site (June 2013).
- Follow-up weed control mid-year (2013) targeting African Lovegrass and Serrated Tussock.
- Summer weed control (late 2012/early 2013 and late 2013) for Sweet Briar, Blackberry, St. John's Wort and Thistle species.
- Bushfire management through track maintenance.
- *Swainsona recta* planting of 46 individuals (September 2013).
- Control for Goats (scheduled Nov 2013) and Pigs (scheduled Nov/Dec 2013)

3.2 Overview of monitoring results

An average rainfall total was recorded over the period since the autumn 2013 surveys. However, twice the monthly average rainfall was received for the months of June (95mm) and September (106mm), with one rainfall event in September recorded as 74mm within 24 hours (BOM 2013; Tharwa General Store, station 70083, approx. 8 km north-west). Other months within this period were comparatively dry and received less than the monthly average monthly rainfall. The conditions prior the survey period were dry with a total of 2.6mm of rain received in the four weeks leading up the spring 2013 monitoring surveys. A total of 9mm of rain was recorded over the survey week, accounting for the majority of water observed within the drainage lines during the erosion monitoring.

A moderate to high increase in the diversity of native herbs and forbs were recorded within the monitoring plots compared to the baseline surveys. However this is a slight decrease in the native diversity recorded during the spring 2012 surveys. The decrease is likely a result of natural / seasonal variation and the wet conditions preceding the spring 2012 surveys.

The removal of stock and grazing pressures appears to have had a significant effect on the amount of overstorey and shrub regeneration observed during the monitoring surveys. Large numbers of young Eucalypts were observed across the offset site and shrub species such as, *Dodonaea viscosa, Cassinia* sp. *Kunzea ericoides*, *Acacia* spp. and *Bursaria spinosa*, were recorded in some areas for the first time. Shrubs species seem to be primarily sprouting from the soil seed bank as most seedlings are not in the vicinity of mature individuals.

Weed control undertaken in 2012 and follow-up control in 2013 (for African Lovegrass and Serrated Tussock) has been successful across the offset site with little regrowth observed. Control for Sweet Briar and Blackberry have also been successful, with limited regeneration of these species recorded. St. John's Wort was observed in the early stages of growth and requires follow-up control (scheduled late 2013). The monitoring surveys recorded high numbers of Feral Goats (*Capra aegagrus hircus*) and low numbers of Feral Pigs utilising the offset site. These species require control, which is scheduled to occur in late 2013.

3.3 Vegetation monitoring plot results

The results of the vegetation monitoring are provided in the following pages. A summary of each plot is provided in **Figure 4** to **Figure 10**. Floristic results from each plot are provided in **Appendix A**.

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3.3.1 Monitoring plot 1

Plot Description				
Management unit	MU1		*Plot number*	1
Vegetation type	Box-Gum Woodland		*Condition*	Low-mod
Plot Statistics (%)	***Baseline***	**Spr. 2013**	**Overstorey**	
Native overstorey cover	*0*	0	Regeneration	Yes
Native midstorey cover	*0*	0	Species	*E. blakelyi*
Native understorey cover (grass)	*40*	50	**Habitat features**	
Native understorey cover (other)	*6*	0	Tree hollows	0
Exotic midstorey plant cover	*0*	0	Fallen logs	0 m
Exotic understorey plant cover	*58*	40		
Other (litter, bare, rock)	*N/R*	26		
Native species diversity	*14*	18		

Monitoring plot 1 is located within MU1 on the southern offset. The plot is composed of relatively lower condition Box-Gum Woodland. Natural regeneration of the overstorey (Eucalypts) was present with a low number of saplings observed. This is in comparison to no regeneration recorded during the baseline surveys. Native species diversity was low-moderate (18 species), but an increase compared to the baseline surveys. Despite lower native diversity, the plot was marginally dominated by native species. The dominant species included *Austrostipa* spp., *Microlaena stipoides* (Weeping Grass) and *Carex inversa* (Common Sedge). It was noted that several *Nassella trichotoma* (Serrated Tussock) have undergone recent control. Fauna habitat features have not changed noticeably since the baseline surveys.

Figure 4: Monitoring Plot 1. (Left: Baseline monitoring photo, October 2011. Right: Monitoring photo October 2013)

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3.3.2 Monitoring plot 2

Plot Description				
Management unit	MU2B		*Plot number*	2
Vegetation type	Box-Gum woodland		*Condition*	Mod-Good
Plot Statistics (%)	***Baseline***	**Spr. 2013**	**Overstorey**	
Native overstorey cover	*0*	1	Regeneration	Yes
Native midstorey cover	*0*	0	Species	*E. blakelyi*
Native understorey cover (grass)	*80*	60	**Habitat features**	
Native understorey cover (other)	*4*	12	Tree hollows	0
Exotic midstorey plant cover	*0*	0	Fallen logs	1 m
Exotic understorey plant cover	*6*	12		
Other (litter, bare, rock)	*7*	22		
Native species diversity	*30*	42		

Monitoring plot 2 is located within MU2 within the southern offset. It is situated on a rocky hill containing Pink-tailed Worm Lizard habitat. It contains relatively good condition mature Box-Gum Woodland with limited regeneration present. However, a regenerating *Cassinia* sp. individual was observed adjacent to the plot, for the first during the spring 2013 monitoring surveys. It contains a moderate to high diversity of native understorey species and is generally devoid of exotic grasses. Outcropping and surface rocks constitutes over 10% of the ground cover. The vegetative groundlayer is dominated by *Rytidosperma* spp., *Austrostipa* spp. and *Chrysocephalum apiculatum* (Common Everlasting). A total of 42 native species were recorded within the plot, an increase of 11 species compared to the baseline. Fauna habitat features have not changed noticeably since the baseline surveys.

Figure 5: Monitoring Plot 2. (Left: Baseline monitoring photo, March 2012. Right: Monitoring photo October 2013)

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3.3.3 Monitoring plot 3

Plot Description				
Management unit	MU3		*Plot number*	3
Vegetation type	Box-Gum Woodland		*Condition*	Mod-Good
Plot Statistics (%)	***Baseline***	**Spr. 2013**	**Overstorey**	
Native overstorey cover	*3.7*	2.5	Regeneration	Yes
Native midstorey cover	*5.2*	4.5	Species	*E. blakelyi*
Native understorey cover (grass)	*80*	58	**Habitat features**	
Native understorey cover (other)	*16*	28	Tree hollows	0
Exotic midstorey plant cover	*0.2*	0	Fallen logs	11 m
Exotic understorey plant cover	*10*	6		
Other (litter, bare, rock)	*N/R*	26		
Native species diversity	*27*	49		

Monitoring plot 3 is located within MU3 in the southern offset. The plot is located in moderate to good quality Box-Gum Woodland. The plot is dominated by mature *E. blakelyi* and a significant amount of natural regeneration is present. The spring 2013 surveys recorded diverse understorey with dominant species including *Themeda australis* (Kangaroo Grass), *Rytidosperma* spp. (Wallaby Grasses) and *Bothriochloa macra* (Red-leg Grass). The understorey has a high diversity of native species (49) which is a significant increase compared to the diversity recorded in the baseline monitoring surveys (27). Weed control activities were undertaken in 2012 and early 2013 targeting *Rosa rubiginosa* (Sweet Briar) with little regrowth observed. Native mid-storey species present include *Bursaria spinosa*. Fauna habitat features have not changed noticeably since the baseline surveys.

Figure 6: Monitoring Plot 3. (Left: Baseline monitoring photo, October 2011. Right: Monitoring photo October 2013)

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3.3.4 Monitoring plot 4

Plot Description				
Management unit	MU4		*Plot number*	4
Vegetation type	Box-Gum Woodland		*Condition*	Mod-Good
Plot Statistics (%)	***Baseline***	**Spr. 2013**	**Overstorey**	
Native overstorey cover	*4.7*	7.1	Regeneration	Yes
Native midstorey cover	*11.5*	5.5	Species	*E. blakelyi*
Native understorey cover (grass)	*74*	84	**Habitat features**	
Native understorey cover (other)	*18*	42	Tree hollows	0
Exotic midstorey plant cover	*2*	0	Fallen logs	22 m
Exotic understorey plant cover	*28*	4		
Other (litter, bare, rock)	*N/R*	4		
Native species diversity	*24*	27		

Monitoring plot 4 is located in the northern offset in MU4. It is located in moderate to good quality Box-Gum Woodland dominated by *E. blakelyi*. The plot supports a moderately diverse understorey composed of 27 native species, slightly down on the diversity recorded during the 2012 surveys. This is likely a result of natural variation and the wet conditions preceding the 2012 surveys. The dominant species are *Themeda australis*, *Schoenus apogon* and *Haloragis heterophylla*. Woody weed control for *R. rubiginosa* is successful with little regrowth observed. A high level of regeneration exists within the management unit, particularly for *Eucalyptus* spp. and mid-storey species (such as *Cassinia* sp. and *Dodonaea viscosa* etc.) compared to the baseline monitoring conducted prior to the removal of grazing. Fauna habitat features have not changed noticeably since the baseline surveys.

Figure 7: Monitoring Plot 4. (Left: Baseline monitoring photo, October 2011. Right: Monitoring photo October 2013)

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3.3.5 Monitoring plot 5

Plot Description				
Management unit	MU5		*Plot number*	5
Vegetation type	Box-Gum woodland		*Condition*	Mod-Good
Plot Statistics (%)	***Baseline***	**Spr. 2013**	**Overstorey**	
Native overstorey cover	*0*	0	Regeneration	Yes
Native midstorey cover	*11*	10	Species	*E. blakelyi*
Native understorey cover (grass)	*76*	72	**Habitat features**	
Native understorey cover (other)	*14*	10	Tree hollows	0
Exotic midstorey plant cover	*0*	0	Fallen logs	3 m
Exotic understorey plant cover	*4*	10		
Other (litter, bare, rock)	*16*	12		
Native species diversity	*29*	39		

Monitoring plot 5 is a control plot located in MU5. No management actions will occur within the boundaries of the plot. Plot 5 is located in moderate-good quality Box-Gum Woodland dominated by *E. blakelyi* with a significant amount of natural regeneration present. The monitoring plot supports a highly diverse understorey of grasses, herbs and forbs with 39 native species recorded in spring 2013. This is an increase on the baseline surveys but lower than the diversity recorded in spring 2012. This is likely a result of natural / seasonal variation and the wet conditions preceding the 2012 surveys. The understorey is known to support typically grazing intolerant species, such as *Swainsona sericea, Microseris lanceolata*, *Arthropodium minus* and *Microtis unifolia* (recorded spring 2012). Fauna habitat features have not changed noticeably since the baseline surveys.

Figure 8: Monitoring Plot 5. (Left: Baseline monitoring photo, October 2011. Right: Monitoring photo October 2013)

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3.3.6 Monitoring plot 6

Plot Description				
Management unit *Vegetation type*	MU6 Box-Gum Woodland		*Plot tumber* *Condition*	6 Mod-Good
Plot Statistics (%)	***Baseline***	**Spr. 2013**	**Overstorey**	
Native overstorey cover	*5.3*	6	Regeneration	yes
Native midstorey cover	*0*	0	Species	*E. blakelyi*
Native understorey cover (grass)	*80*	60	**Habitat features**	
Native understorey cover (other)	*10*	12	Tree hollows	0
Exotic midstorey plant cover	*0*	0	Fallen logs	0 m
Exotic understorey plant cover	*8*	50		
Other (litter, bare, rock)	*N/R*	12		
Native species diversity	*28*	42		

Monitoring plot 6 is located in MU6 along the central ridge line, in moderate-good quality Box-Gum Woodland dominated by *E. blakelyi.* The plot supports a diverse understorey of grasses, herbs and forbs with 42 native species recorded in spring 2013, an increase on the baseline surveys. The plot also supports natural regeneration including native shrubs that will comprise the mid-storey. The understorey was dominated by native perennial tussock grasses including *Austrostipa* spp. and *Rytidosperma* spp. Sweet Briar was present at a low abundance in the plot and observed more broadly in the MU, with weed control mostly successful for these species. However, *Hypericum perforatum* (St John's Wort) was observed widely within the MU and requires follow-up control. Fauna habitat features have not changed noticeably since the baseline surveys.

Figure 9: Monitoring Plot 6. (Left: Baseline monitoring photo, March 2012. Right: Monitoring photo October 2013)

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3.3.7 Monitoring plot 7

Plot Description				
Management unit	MU7		*Plot number*	7
Vegetation type	Box-Gum woodland		*Condition*	low
Plot Statistics (%)	***Baseline***	**Spr. 2013**	**Overstorey**	
Native overstorey cover	*0*	0	Regeneration	No
Native midstorey cover	*0*	0	Species	*N/A*
Native understorey cover (grass)	*74*	58	**Habitat features**	
Native understorey cover (other)	*0*	0	Tree hollows	0
Exotic midstorey plant cover	*0*	0	Fallen logs	8 m
Exotic understorey plant cover	*34*	88		
Other (litter, bare, rock)	*N/R*	0		
Native species diversity	*13*	18		

Monitoring plot 7 is located within MU7 in the northern offset. The MU is composed of degraded Box-Gum Woodland dominated by *E. blakelyi*. Whilst no overstorey regeneration was recorded within the plot, regeneration of *E. blakelyi* was observed in the adjacent area for the first time. Native species diversity was low (18 species) in comparison with other monitoring plots but an increase compared to the baseline surveys (13 native species). Perennial vegetation is dominated by native species (sedges and rushes, *Carex* spp.); however, exotic annual vegetation cover was higher and accounts for the majority of the exotic understorey recorded in the table adjacent. Sheep were observed within MU7 in autumn 2013 and with residual grazing impacts present. Fauna habitat features have not changed noticeably since the baseline surveys.

Figure 10: Monitoring Plot 7. (Left: Baseline monitoring photo, March 2012. Right: Monitoring photo October 2013)

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3.3.8 Monitoring Plot 8

Plot Description				
Management unit	MU3B		*Plot number*	8
Vegetation type	Box-Gum Woodland		*Condition*	Mod-Good
Plot Statistics (%)	***Baseline***	**Spr. 2013**	**Overstorey**	
Native overstorey cover	*0*	0	Regeneration	Yes
Native midstorey cover	*8.5*	9	Species	*E. blakelyi*
Native understorey cover (grass)	*80*	66	**Habitat features**	
Native understorey cover (other)	*14*	12	Tree hollows	0
Exotic midstorey plant cover	*0*	0	Fallen logs	14 m
Exotic understorey plant cover	*4*	2		
Other (litter, bare, rock)	*N/R*	36		
Native species diversity	*26*	36		

Monitoring plot 8 is a control plot located in MU3. No management actions are proposed to occur within the bounds of the plot. The plot is located in good quality Box-Gum Woodland dominated by *E. blakelyi.* The plot supports a diverse understorey of grasses, herbs and forbs with 36 native species recorded in spring 2013, an increase from the baseline surveys, but a slight decrease from spring 2012 (41 species). This is likely a result of natural / seasonal variation and the wet conditions preceding the 2012 surveys. The dominant understorey species included *Themeda australis*, *Rytidosperma* spp. and *Chrysocephalum apiculatum*. Photo comparison shows a healthy understorey dominated by native species with good inter-tussock spacing. Fauna habitat features have not changed noticeably since the baseline surveys.

Figure 11: Monitoring Plot 8. (Left: Baseline monitoring photo, October 2011. Right: Monitoring photo October 2013)

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3.4 Fauna habitat assessment and monitoring surveys

3.4.1 Fauna habitat features

Table 2 outlines the rapid assessment for fauna habitat features observed across the offset site. The following categories were used to identify abundance or frequency of each feature:

- *Abundan*t = feature occurs in an almost continuous manner.
- *Common* = feature encountered commonly i.e. without having to search for it.
- *Occasional* = feature occurs in more than a few cases, but not encountered frequently.
- *Rare* = feature observed very infrequently, one to a few cases at most.

Table 2: Fauna habitat features observed across the offset site

Fauna habitat feature	Northern	Southern
Tree hollows	Occasional	Occasional
Large trees > 60 cm DBH	Occasional	Occasional
Dead standing trees	Occasional	Rare
Stumps (<2 m)	Rare	Rare
Mistletoes	Common	Common
Regenerating tree thickets	Abundant	Abundant
Native shrub thickets	Common	Occasional
Exotic shrub thickets	Occasional	Occasional
Logs (fallen)	Occasional	Occasional
Timber (fallen)	Occasional	Occasional
Litter (leaf, twig, bark)	Common	Common
Loose rocks	Common	Common
Outcropping rocks	Common	Common
Termite mounds	Rare	Rare
Meat ant nests	Occasional	Occasional
Earth banks/deep gully walls	Rare	Rare

Table 3 below outlines the dominant habitat features recorded within each 50 m x 20 m monitoring plot.

Table 3: Habitat assessment within 50 m x 20 m vegetation monitoring plots.

Plot	HBT	Logs	Comment	Dominant habitat features present within 50 m x 20 m plot
1	0	0 m	No change	Limited surface rocks; moderate recent grazing; canopy regeneration
2	0	1 m	No change	Surface & outcropping rocks abundant; shrub regeneration present
3	0	11 m	No change	Litter common; logs occasional; single ant's nest present
4	0	22 m	No change	Limited regeneration; occasional course woody debris
5	0	3 m	No change	Shrub & canopy regeneration; ants nest; course woody debris; limited rocks
6	0	0 m	No change	Course woody debris common; shrub and canopy regeneration present
7	0	8 m	No change	Surface rocks & course woody debris uncommon; abundant exotic annuals
8	0	14 m	No change	Litter; course woody debris; bare ground; hollow logs; surface rocks present

Key for table 3: *HBT's* = Hollow-bearing trees. *Logs* = length of fallen logs > 10 cm width. *Comment* = relates to whether a noticeable or significant change has occurred since the completion of the baseline surveys.

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3.4.2 Nocturnal surveys

The results of the offset site nocturnal surveys are outlined in **Table 4**. A total of 6 species of frog were recorded (aural) during the frog habitat surveys, with all species recorded at the northern dam and 5 of the species recorded at the southern dam. A single species, *Trichosurus vulpecula* (Brushtail Possum) was recorded on two occasions during the spotlight surveys at transect one and three.

Anabats recorded a total of seven species over the two survey nights (**Table 4**). It was the intention to complete four nights of survey (two nights for each Anabat); however, this had to be reduced due to unfavourable weather conditions.

Table 4: Fauna species recorded during targeted nocturnal surveys

Frog habitat survey			
Amphibians	Latin name	Threatened status	Observed
Eastern Common Froglet	*Crinia signifera*	Not listed	North & South Dam
Peron's Tree Frog	*Litoria peronii*	Not listed	North Dam
Plains Froglet	*Crinia parinsignifera*	Not listed	North & South Dam
Smooth Toadlet	*Uperoleia laevigata*	Not listed	North & South Dam
Spotted Marsh Frog	*Limnodynastes tasmaniensis*	Not listed	North & South Dam
Whistling Tree Frog	*Litoria verreauxii*	Not listed	North & South Dam
Spotlighting			
Arboreal Mammals	Latin name	Threatened status	Observed
Brushtail Possum	*Trichosurus vulpecula*	Not listed	Transect 1 & 3
Anabat survey			
Microchiroptera	Latin name	Threatened status	Observed
Gould's Wattled Bat	*Chalinolobus gouldii*		Dam & Flyway
Chocolate Wattled Bat	*Chalinolobus morio*		Dam & Flyway
Eastern Broad-nosed Bat	*Scotorepens orion*		Dam & Flyway
White-striped Sheathtail Bat	*Tadarida australis*		Dam & Flyway
Large Forest Bat	*Vespadelus darlingtoni*		Dam
Eastern Bentwing Bat*	*Miniopterus schreibersii ocenaenesis**		Dam & Flyway
Little Forest Bat	*Vespadelus vulturnus*		Dam & Flyway
Gould's Wattled Bat	*Chalinolobus gouldii*		Dam & Flyway

* This species can overlap in call frequency with other species. See **Appendix B.**

3.4.3 Infra-red camera surveys

All species observed during the surveys from the infra-red cameras were recorded previously, with the exception of Feral Deer (*Dama dama*), which was recorded for the first time in the offset site at the southern dam. A full list of fauna species observed during the monitoring surveys is outlined in **Appendix B**.

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4 Swainsona recta propagation program

4.1 Background

4.1.1 Swainsona recta

Swainsona recta or Small Purple-pea is listed as a threatened species (endangered) under NSW, ACT, Victorian and Commonwealth legislation. It is a slender, erect perennial herb growing to 30 cm tall, with 10 to 20 purple, pea-shaped flowers. It flowers between late September and early December and die's back in summer to a rootstock until it shoots again in autumn. It grows in association with understorey dominants that include *Themeda australis*, *Poa* spp. and *Austrostipa* spp. within woodlands and open-forests (e.g. Box-Gum Woodland).

4.1.2 Environmental approvals and propagation program

Two environmental approval conditions of consent (Commonwealth and ACT, respectively) for the construction of the M2G pipeline were to:

- Conduct a feasibility study for a *Swainsona recta* propagation program.
- Achieve a no net loss of *Swainsona recta* individuals as a result of the construction.

The construction works incorporated micro-alignments of the pipeline prior to construction to avoid any direct impacts to individual plants. Despite achieving a no net loss, ACTEW committed to implementing a propagation program for *Swainsona recta* to enhance the conservation outcome for the species as a result of the project. The *Swainsona recta* propagation then became an attachment to the Biodiversity Management and Offset Plan for the overall M2G project. A partnership between ACTEW Water, Australian National Botanic Gardens (ANBG) and Eco Logical Australia was then established to deliver the program.

4.2 Methodology

4.2.1 Site selection

The M2G offset site (southern offset) was selected as a suitable location for propagated *Swainsona recta* individuals due to its close proximity to known habitat along the M2G pipeline and the known presence of individuals within the offset site. Due to difficulties in undertaking successful propagation programs, a number of plot sites have been selected to mimic the species naturally patchy distribution within areas of uniform habitat and represent a range of microclimatic conditions (**Figure 12**).

4.2.2 Seed collection

Seeds were collected from individual *Swainsona recta* plants from existing populations at Mt. Taylor, Williamsdale and Burra. Seeds collected were either germinated and grown in two different soil types at the ANBG until they were ready for translocation or stored in the ANBG seed bank. To date, seeds have been collected during the species seeding period in December 2010, 2011 and 2012.

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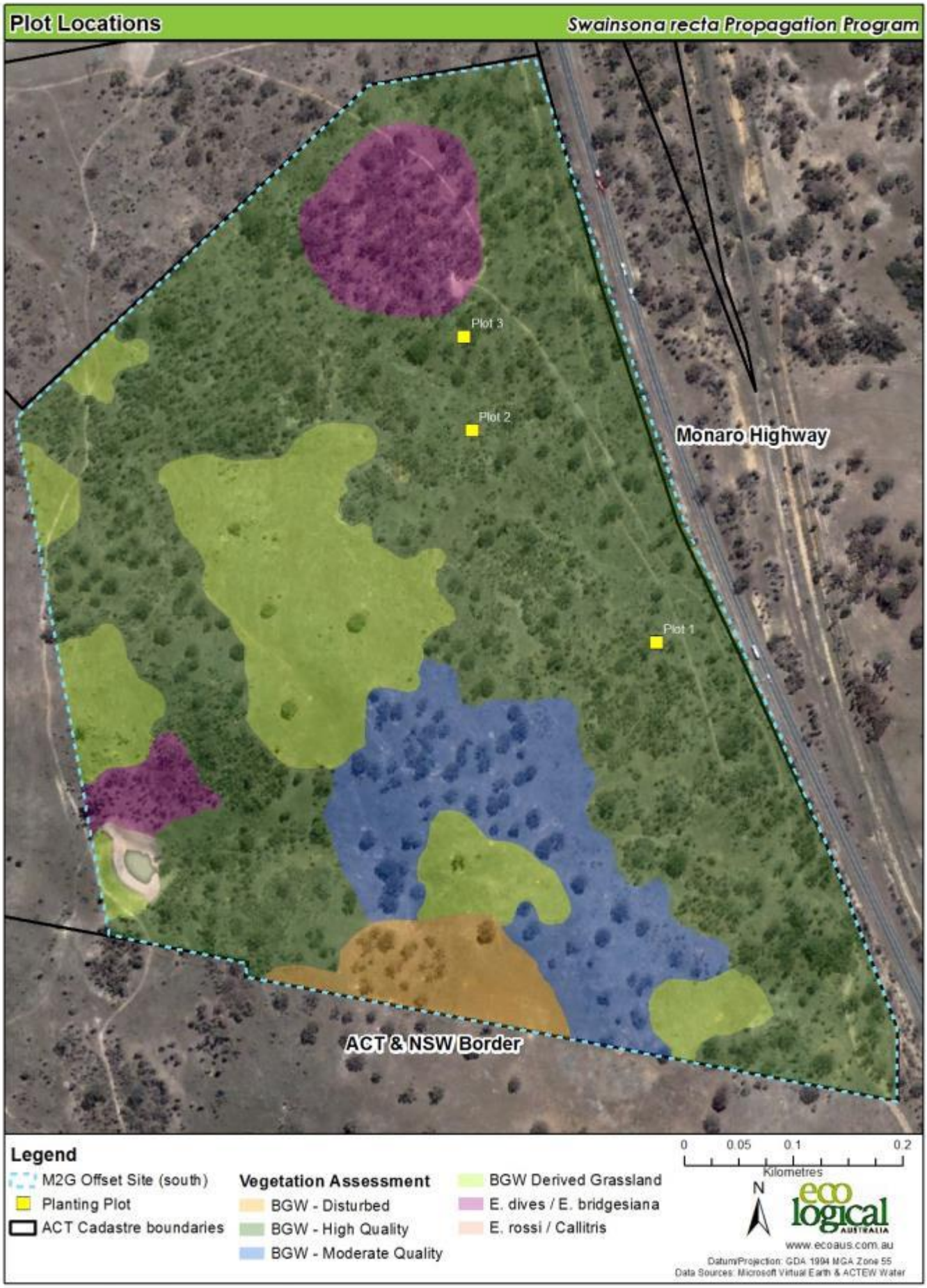

Figure 12: *Swainsona recta* propagation program planting sites

4.2.3 Germination

Germination was achieved using two different methods (scarification and boiling water) to cease physical dormancy and thus allow water imbibition through the seed coat. The scarification method performed the best with a final germination success rate of 100% achieved at 25/15°C followed by 91% germination at 20/10°C. The seeds treated with boiling water recorded a slightly lower final germination rate of 84% and 80% (respectively) to the scarified seeds.

Two soil types were used for the growth stage following germination:

- Potting mix (standard nursery mix)
- Soil mix containing a 1:1 ratio of potting mix and local soil from the seed collection sites.

4.2.4 Plants

A total of 112 individuals have been planted across three translocation plots within the southern offset, of which 66 were translocated in June 2012 and a further 46 translocated in September 2013. Individuals were planted once a suitably sized tap root had developed (approximately 18 months from germination) and planted in winter to enable the plants to establish a strong root system *in-situ* prior to summer as a method of reducing water stress.

There were various combinations of plantings types for the 2012 and 2013 plantings. Each plant could be described as collected from a particular site and whether it was germinated in either a potting mix or soil mix (**Table 5**).

Table 5: Planting key

Collection location	Germination mix	Key	Planted	Water crystals
Mt Taylor	Potting		2012	No
Mt Taylor	Soil		2012	No
Williamsdale	Potting		2013	Yes
Burra	Potting		2013	Yes

At planting, all competition (e.g. grasses and other forbs) was removed in the immediate area of each individual (creating a cleared patched approximately 20 cm in diameter). For the 2013 plantings, a small handful or water crystals were also planted with each individual. All plants were watered on the day of planting and subsequently watered one week after planting.

4.2.5 Plot locations

Three plots were established within the southern offset (**Table 6**). Plot co-ordinates are provided in GDA 1994, MGA Zone 55).

Table 6: Plot co-ordinates

Plot	Easting	Northing
1	693814	6059539
2	693645	6059733
3	693638	6059819

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4.2.6 Plots

Plots have been designed to accommodate up to 40 plants with the idea of alternating seed collection sites and soil growing types within each plot to allow a comparison of methods and increase overall survival rates. Individuals were planted at one metre spacing in a grid format (8 x 5 plants) with a one metre buffer from the outer most plants (**Figure 13**). Plots were established in a north-south direction. Fencing was erected around the plots to incorporate a one metre buffer from the outer most plants. Fencing consisted of rabbit proof fencing (1.2 m high) with steel pickets at least every three metres.

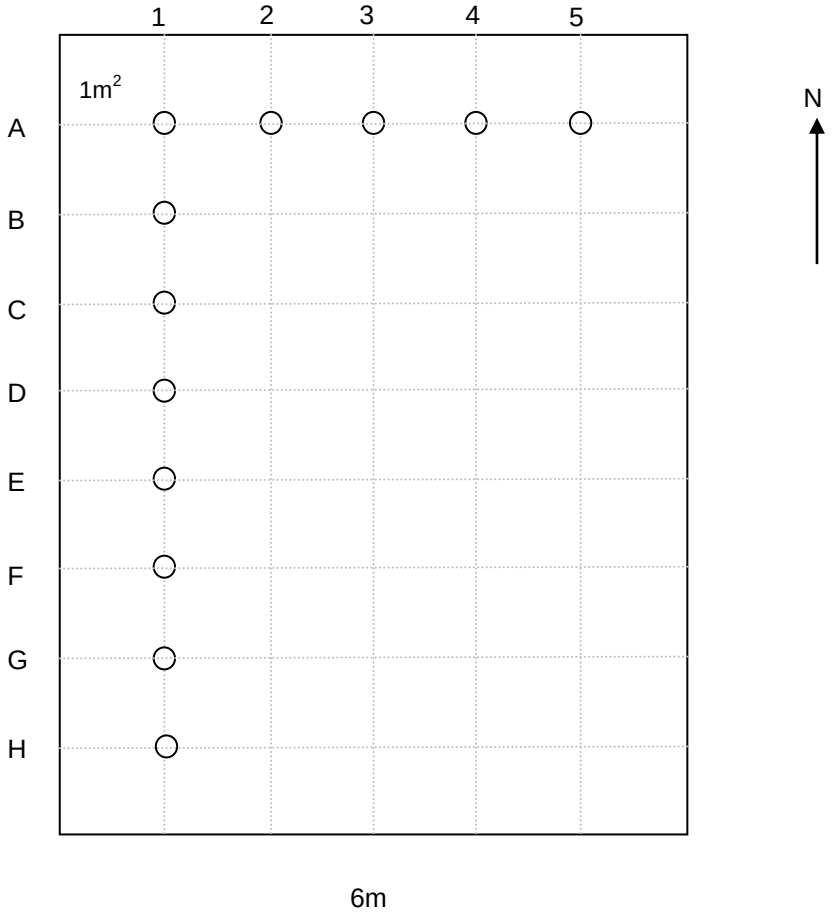

Figure 13: Plot design

4.2.7 Monitoring

A monitoring survey is conducted during the peak flowering period for *Swainsona recta* in October each year. Each individual plant is assessed for its survivorship and flowering condition to determine whether:

- It is present or absent.
- It is in flower.
- It has flowered recently (development of seed pods).
- It is in leaf only.

In addition, the translocation plots are inspected for signs of individual recruitment. The results allow a comparison of survivorship, condition and recruitment events at the end of each monitoring period and provide a picture of the overall success of the propagation program.

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4.3 Plantings and monitoring results

4.3.1 Plot 1

Plot 1 occurs within Box-Gum Woodland with a *Themeda triandra* (Kangaroo Grass) dominated understorey. A high diversity of native species and a low abundance of exotic species have been recorded within the surrounding area. The plot contains some open ground and inter-tussock spacing between *Themeda* tussocks and is on a slight east facing slope. *E. blakelyi* surrounds the plot as the dominant overstorey with natural regeneration present. Shading from the overstorey is relatively low.

Forty individuals have been planted within plot 1, of which 26 were from Mt. Taylor (10 potting mix & 16 soil mix) and 7 were from each of the Williamsdale and Burra populations.

Of the 40 plants, 39 were present (26 from 2012 plantings and 13 from 2013 plantings), representing an overall survivorship of 98 % (**Table 7** and **Figure 14)**. No recruitment was observed within the plot.

Table 7: Plot 1 monitoring results

Key	Results	Comments
○	**Present** - in flower or recently flowered (seeding)	23 observed in flower, all from 2012 plantings
□	**Present** - leaf only	16 observed with leaf only, primarily 2013 plantings
△	**Absent** - not observed	1 individual from 2013 plantings not observed

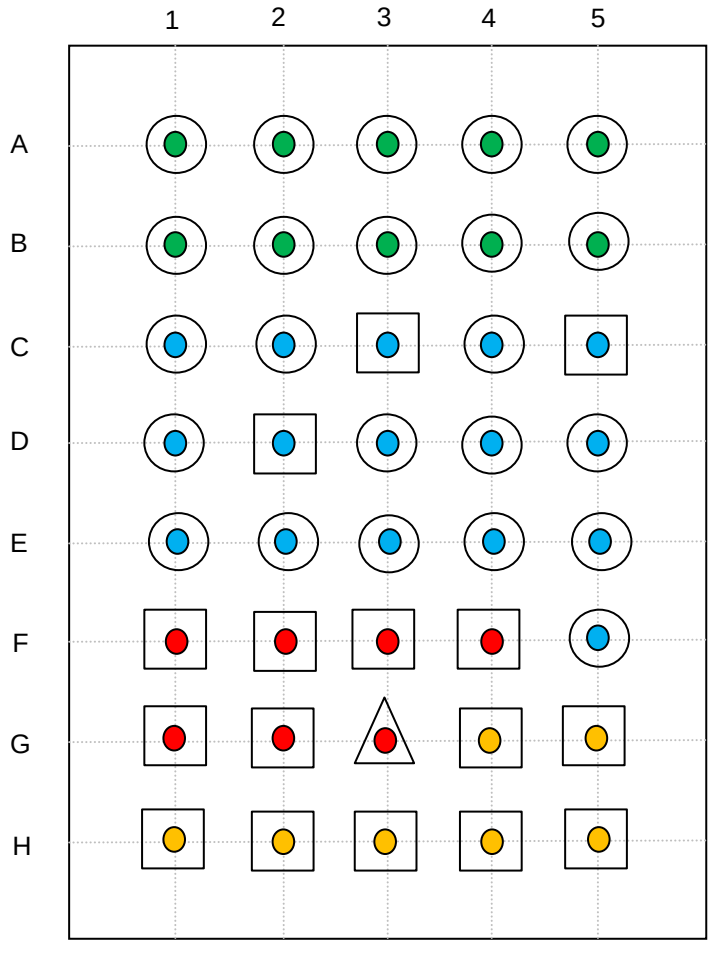

Figure 14: Plot 1 plantings

4.3.2 Plot 2

Plot 2 occurs within *E. blakelyi* dominated Box-Gum Woodland with the understorey dominated by *Austrostipa* spp. (Speargrass). A high diversity of native species and a low abundance of exotic species have been recorded within the surrounding area. The plot is established on a slight north-east facing slope. Natural regeneration is present in the general area, but no shading of the overstorey trees is likely to occur. Some rocky habitat occurs adjacent to the plot, but not within the plot.

Thirty-six individuals have been planted within plot 2, of which 20 were from Mt. Taylor (6 potting mix & 14 soil mix) and 8 were from each of the Williamsdale and Burra populations.

Of the 36 individuals, 18 were observed to be present during the 2013 surveys (15 from 2012 plantings and only 5 from 2013 plantings), representing an overall survivorship of 50 % (**Table 8** and **Figure 15)**. No recruitment was observed within the plot.

Table 8: Plot 2 monitoring results

Key	Results	Comments
○	**Present** - in flower or recently flowered (seeding)	11 observed in flower, all from 2012 plantings
□	**Present** - leaf only	7 observed with leaf only
△	**Absent** - not observed	18 individual not observed, primarily 2013 plantings

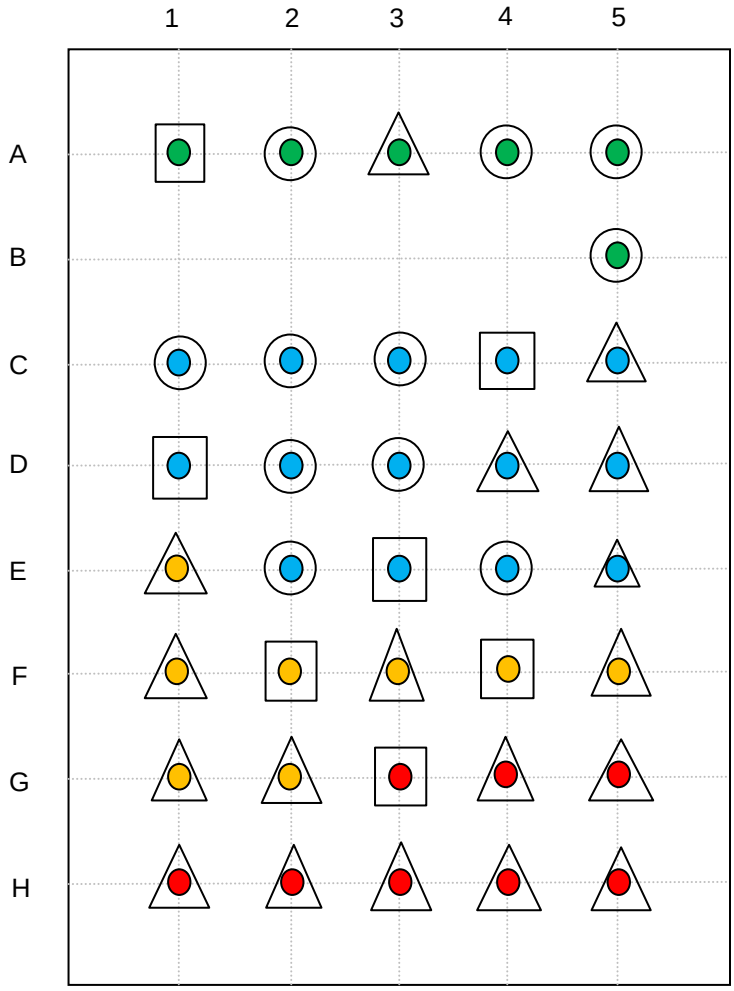

Figure 15: Plot 2 plantings

4.3.3 Plot 3

Plot 3 occurs in *Eucalyptus bridgesiana* (Apple-box) / *E. dives* (Peppermint) woodland with an understorey dominated by *Themeda triandra*. A high diversity of native species and a low abundance of exotic species have been recorded within the surrounding area. The plot is established on a flat area on top of a small knoll. Limited surface rocks were observed within and immediately adjacent to the plot. Plot 3 is likely to experience moderate shading throughout the day from surrounding overstorey.

Thirty-six individuals have been planted within plot 2, of which 20 were from Mt. Taylor (9 potting mix & 11 soil mix), 7 were from the Williamsdale population and 9 from the Burra population.

Of the 36 individuals, 31 were observed to be present during the 2013 surveys (17 from 2012 plantings and only 14 from 2013 plantings), representing an overall survivorship of 86 % (**Table 9** and **Figure 16)**. A single recruitment event was likely observed within plot 3 at individual C3. The presumed new growth is approximately 5 cm from the base of the parent plant and both individuals were at different flowering stages.

Table 9: Plot 2 monitoring results

Key	Results	Comments
○	**Present** - in flower or recently flowered (seeding)	18 observed in flower, primarily from 2012 plantings
□	**Present** - leaf only	13 observed with leaf only, all from 2013 plantings
△	**Absent** - not observed	5 individual not observed

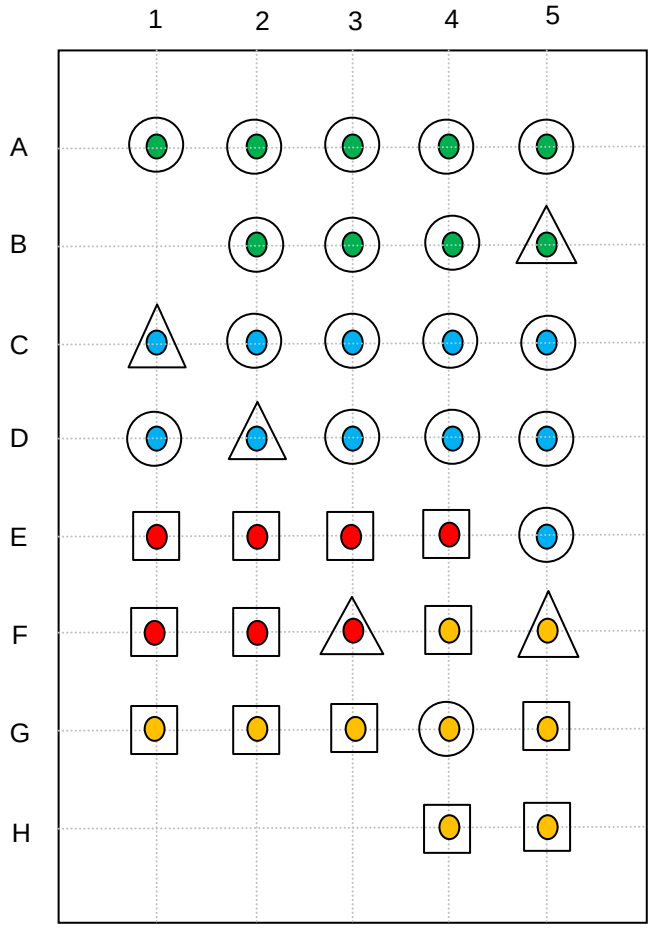

Figure 16: Plot 3 plantings

4.4 Results summary

The spring 2013 monitoring for the *Swainsona recta* propagation program took place on the 21st October 2013. This was 16 months post translocation for individuals planted in 2012 and 6 weeks post translocated for individuals planted in 2012. The typical flowering time for this species occurs between late September and early December, with peak flowering occurring over 2 or 3 weeks in October.

A total of 112 individuals have been planted across three translocation plots within the southern offset. Of these, 66 were planted in July 2012 and a further 46 planted in September 2013. The monitoring surveys revealed an overall survivorship of 79 % (88 of 122) with a range of 50 % survivorship for plot 2 to 98 % survivorship for plot 1. Splitting the survivorship between planting years, reveals a survivorship of 88 % and 65 % for individuals planted in 2012 and 2013 respectively. The majority of plants observed from the 2012 plantings were either in flower, or had recently flowered with signs of seed pod development. This is in comparison to only one individual observed flowering from the 2013 plantings.

A total of 24 individuals were not observed during the monitoring surveys. These individuals have not survived the translocation process or have died-back to a dormant state, which cannot be observed above ground. Since most of the individuals not observed were from the 2013 plantings (six weeks prior to the surveys), it is likely that the translocation process has caused the plants to perish.

It was noted that individuals part of the 2013 plantings were not as developed prior to planting as those from the 2012 plantings, possibility contributing to the reduced survivorship observed. In addition, the use of water crystals did not seem to favour the translocation process. Planting sites were observed to contain cracking soils and holes. This was presumably created by the expansion of water crystals followed by the drying of the surrounding soils. In some cases, individuals had been exerted from their original planted positions.

Figure 17: Left; possible recruitment. Right; Soil cracking and hole from expanding water crystals

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5 Weed monitoring

5.1 Weed management actions undertaken to date

Weed management on site has included control of *Eragrostis curvula* (African Lovegrass) and *Nassella trichotoma* (Serrated Tussock) in mid-2012 and mid-2013 as well as woody weed control undertaken in late 2012 / early 2013. Follow-up control for *Rosa rubiginosa* (Sweet Briar), *Rubus* sp. (Blackberry), *Hypericum perforatum* (St. John's Wort) and other wood weeds is scheduled for late 2013.

For further detail on the management actions recommended, refer to the ODP and sub-plans.

5.2 Weed monitoring results

A summary of the weed occurrences across the offset site and the 2013 spring monitoring results is provided in **Table 10** below.

The relative distribution of key weed species across the offset site has been mapped in **Figure 18** and **Figure 19**.

Table 10: Summary of prior weed occurrence and 2013 spring monitoring results

Species	Weed occurrence prior to surveys*	Spring 2013 monitoring results**
African Lovegrass (*Eragrostis curvula*)	Low, localised areas of dominance. Present across the offset site in isolated patches. Where it occurs, it forms a dense mat of tussocks and dominates the understory.	A number of isolated individuals observed across the offset site with some heavier infestations around main drainage line. Most areas across the offset site exhibited a high level of control for this species. **MU occurrence**: MU3, 4, 5 & 6. **Recommendation**: Follow-up weed control to target drainage lines and isolated individuals.
Serrated Tussock (*Nassella trichotoma*)	Low, scattered individuals in some areas. Present in open areas of the offset site. Primarily present as a number of scattered individuals within MU1 along the southern boundary.	Control for this species was highly successful with a single plant observed within the southern offset (MU1). **MU occurrence**: MU1A, 2A, 3 & 4. **Recommendation**: Maintain weed control program as outlined in the sub-plan.
Blackberry (*Rubus fruticosus*)	Low, localised areas of dominance. Predominantly found within the northern offset, and was more or less restricted to the drainage lines or moist areas.	Primary control for this species occurred in late 2012-early 2013. Control for this species looks highly successful with minimal regrowth observed. No individuals observed within the southern offset. **MU occurrence**: MU4, 5 & 6. **Recommendation**: Follow-up control.

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Species	Weed occurrence prior to surveys*	Spring 2013 monitoring results**
Woody Weeds (*Hawthorn, Prunus, Pyracantha, Cotoneaster & Pinus* sp.)	Very low, isolated individuals. Present within the study area as isolated individuals.	Control for this species was scheduled for late 2012-early 2013; however, some individuals were missed. **MU occurrence**: MU4 & 6. **Recommendation**: Targeted control of isolated individuals.
St John's Wort (*Hypericum perforatum*)	Scattered and moderate occurrence across the offset site.	Control for this species occurred in late 2012-2013. Individuals were observed with new growth in clumps across both the northern and southern offset. **MU occurrence**: MU1B, 2A, 3, 4, 6 & 7. **Recommendation**: Follow up control required.
Thistles (*Onopordum* spp.)	Low, localised areas of dominance.	Very low occurrence, occasional patches of new growth observed. Consider targeted control as part of any future weed spraying. **MU occurrence**: MU1B & 4.
Sweet Briar (*Rosa rubiginosa*)	Moderate, widely distributed at low density with scattered individuals, some areas of dominance. Present right across the offset site, often with larger infestations under mature trees.	Control for this species occurred in late 2012-2013. Control for this species looks excellent with most individuals targeted during the works. A few isolated individuals were missed and others are re-sprouting. **MU occurrence**: MU1B, 2A, 2B, 3, 4, 5, 6 & 7. **Recommendation**: Follow up control including spot spraying of individuals.

5.3 Adaptive management recommendations

ELA recommends that follow-up control for Sweet Briar, Blackberry, St. John's Wort, Thistles and other woody weeds be undertaken. In most instances control works to date have been highly successful, with the exception of St John's Wort being moderately successful. Follow up control works are required and should target re-sprouting individuals and localised clumps.

No additional management actions to the weed control outlined in the weed management sub-plan have been proposed as a result of the spring 2013 monitoring surveys. Targeted weed control programs (further follow-up control) are to be implemented in late 2013 and 2014.

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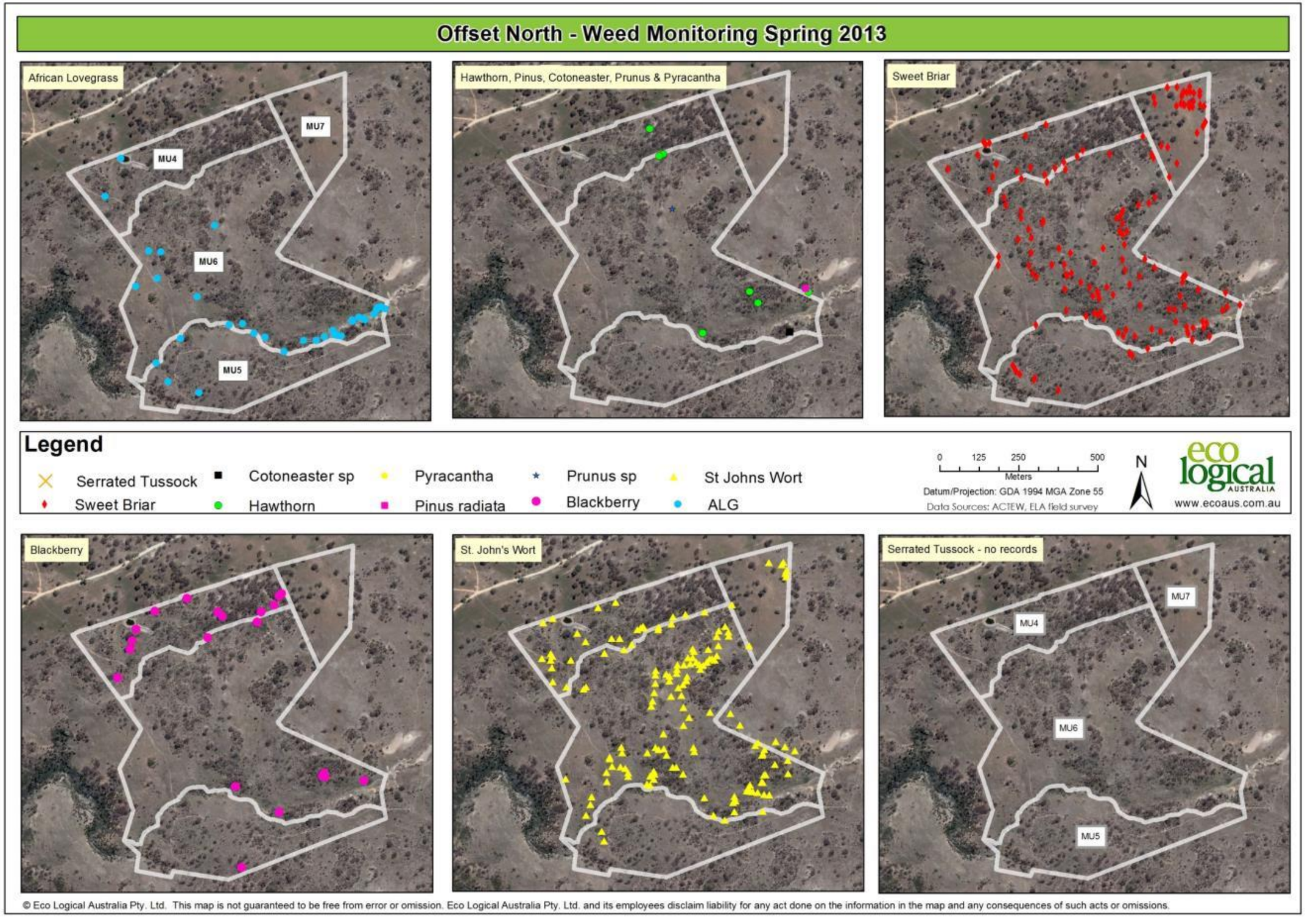

Figure 18: Relative weed distribution, northern offset

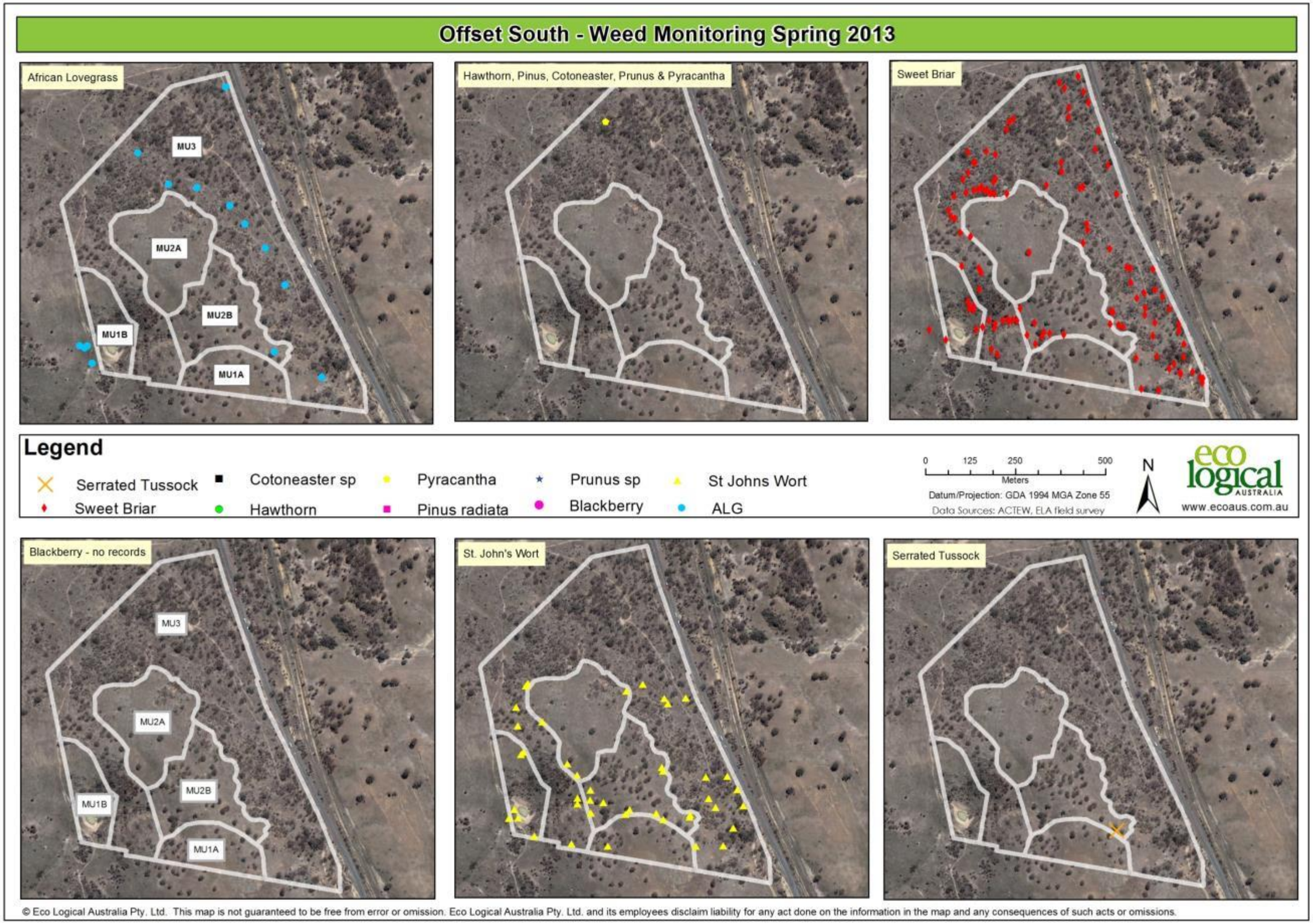

Figure 19: Relative weed distribution in the southern offset

6 Erosion monitoring

6.1 Erosion management actions undertaken to date

It should be noted that no on-ground erosion management activities have been undertaken to date. For further detail on management actions recommended refer to the ODP and Erosion Management Sub-plan.

6.2 Erosion monitoring results

A total of 18 erosion points were recorded during the autumn 2012 monitoring surveys with all points falling within Erosion Management Zone 1 (see ODP). An additional three monitoring points were established in spring 2012, one in autumn 2013 and one in spring 2013. Erosion monitoring points, three and nineteen were ceased for the spring 2013 surveys. Erosion point locations are mapped in **Figure 20** and **Figure 21**.

In the period between the autumn and spring 2013 monitoring surveys, twice the monthly average rainfall was received for the months of June (95mm) and September (106mm), with one rainfall event in September recorded as 74mm within 24 hours (BOM 2013; Tharwa General Store, station 70083, approximately 8 km north-west). Other months within this period received less than the average monthly rainfall. For the purposes of this report, a high rainfall event is considered when 50mm or more of rain falls within a 24 hour period. A high rainfall event has occurred a total of 7 times since the establishment of the erosion monitoring points (BOM 2013).

The majority of erosion points are located along ephemeral drainage lines in the northern offset. The erosion points are in a variety of conditions; however vegetative cover surrounding each point is generally very high. All of the points are currently stable, but some may require minor remediation works in the future if they are found to be continuously active and/or active following a significant rain event. It should be noted that approval is required to undertake any remediation works within a drainage line (see erosion sub-plan), and may influence the type of work to be undertaken. A summary of the erosion points within the offset property is provided below followed by a more detailed description of each point and an accompanying photo.

6.3 Recommendations

It is recommended that the number of erosion monitoring points be reduced for future surveys and where possible, maintain a minimum of one monitoring point for each drainage line in the offset site. The majority of points have not shown signs of erosion since the baseline surveys, despite high rainfall events occurring during this time. The lack of erosion at these points indicates that the soil is stable with a low risk of significant erosion occurring in the future. A high vegetation cover across the offset site and the continued exclusion of stock grazing further reduces the risk of erosion occurring.

It is recommended that future monitoring surveys should reflect the following actions:

- Continue monitoring at erosion points: 2, 4, 7, 8, 9, 10, 13, 18, 21, 22.
- Discontinue monitoring at erosion points: 1, 3, 5, 6, 11, 12, 14, 15, 16, 17, 19, 20.

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Erosion Point 1:

Description: Small erosion point located in southern offset, MU3 situated within a small ephemeral drainage line.

Size: Approximately 1.5m across 0.3m deep and 1.5m long.

Change: No significant change observed since baseline monitoring.

Action required: Remove erosion point from future monitoring surveys.

Autumn 2012 (baseline)

Spring 2013

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Erosion Point 2:

Description: Situated within an ephemeral drainage line in MU4, northern offset.

Size: Approximately 4m across, 0.8m deep and 2.0m in length.

Change: No significant change observed since baseline monitoring survey. Heighten animal activity (tracks) adjacent to the erosion point (red circles).

Action required: No works required at this stage. Continue bi-annual monitoring.

Note: Spring 2013 monitoring photo incorporates more of the erosion point on right hand-side of the photo.

Autumn 2012

Spring 2013

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Erosion Point 4:

Description: Located within an ephemeral drainage line within MU4, northern offset.

Size: Approximately 2.0m wide, 0.5m deep, 2.5m long.

Change: No significant change observed since baseline monitoring survey. Heighten animal activity (tracks) adjacent to the erosion point.

Action required: No works required at this stage. Continue bi-annual monitoring.

Autumn 2012

Spring 2013

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Erosion Point 5:

Description: Located within an ephemeral drainage line within MU4, northern offset. Slight evidence of active erosion increasing the undercut.

Size: Approximately 0.3m wide, 0.5m deep and 1.5m long.

Change: Limited erosion occurring at gully head, no change since spring 2012.

Action required: Remove erosion point from future monitoring surveys.

Note: There is a difference in the scale of the 2 photos. The right photo is zoomed out to incorporate a broader picture of the erosion point.

Autumn 2012

Spring 2013

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Erosion Point 6:

Description: Located within an ephemeral drainage line within MU4, northern offset. Evidence of sheet erosion along bank and rilling.

Size: Approximately 6m long, 1.5m deep and 2.5m wide.

Change: No change observed since baseline monitoring survey.

Action required: Remove erosion point from future monitoring surveys.

Autumn 2012

Spring 2013

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Erosion Point 7:

Description: Located along the main creek line within northern offset. Photo taken from Photo Point 1 (6059835, 692700) looking north-west (315^{o}) and showing the north bank.

Size: Approximately 20m long and 1.0m deep.

Change: No significant change observed since baseline monitoring period, however low active erosion maybe occurring at identified points (red circles). Eucalypt samplings (overstorey regeneration) have been removed in the background of the photo, underneath power line.

Action required: Targeted monitoring at photo point following extreme rainfall event and continue bi-annual monitoring.

Autumn 2012

Spring 2013

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Erosion Point 8:

Description: Located along the main creek line within northern offset. Photo taken from Photo Point 1 (6059835, 692700) looking north-east (45^{o}) and showing the north bank (upstream from erosion point 7).

Size: Approximately 15m long and 1.0m deep.

Change: No significant change observed since baseline monitoring survey. However, evidence of animal tracks developing was observed in autumn 2013 (red circles), with no changes observed within the last six months.

Action required: Targeted monitoring at photo point following extreme rainfall event and continue bi-annual monitoring.

Autumn 2012

Spring 2013

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Erosion Point 9:

Description: Situated near the western boundary of the southern offset.

Size: Approximately 20 m long and 1 m deep.

Change: No significant change observed since baseline monitoring survey. Minor changes were observed, including slight deepening and exposure of smaller rocks on the left hand side of the channel from the autumn 2013 monitoring surveys. Minor slumping may have occurred on the left as well.

Action required: Continued bi-annual monitoring.

Autumn 2012

Spring 2013

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Erosion Point 10:

Description: Situated along the western fence line of the southern offset. Small area of erosion due to upslope runoff.

Size: Approximately 5.0m long, 0.5m deep.

Change: Some minor erosion has occurred adjacent to the new fence line since the baseline surveys (this is within the neighbouring property to the south of the offset site). No change since Spring 2012.

Action required: No immediate action required. Continued bi-annual monitoring.

Autumn 2012

Spring 2013

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Erosion Point 11:

Description: Small area of erosion along an ephemeral drainage line located in offset south.

Size: Approximately 3.0m long, l.5m wide and 0.5m high.

Change: No significant erosion has occurred since the baseline monitoring period.

Action required: Remove erosion point from future monitoring surveys.

Autumn 2012

Spring 2013

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Erosion Point 12:

Description: Erosion point on western boundary of northern offset. Bed rock showing and in-stream vegetation.

Size: Approximately 5.0m long, 0.8 - 1.0m deep (sloping).

Change: No significant erosion has occurred since the baseline monitoring period.

Action required: Remove erosion point from future monitoring surveys.

Autumn 2012

Spring 2013

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Erosion Point 13:

Description: Moderately sized erosion points in northern offset. Evidence of existing slumping.

Size: Approximately 4.0m long, 1.5m deep and 2-3.5m wide.

Change: Some minor slumping at gully head previously occurred. No change since spring 2012.

Action required: No immediate action required. Continue bi-annual monitoring.

Autumn 2012

Spring 2013

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Erosion Point 14:

Description: Small area of erosion along an ephemeral drainage line located in offset north.

Size: Approximately 1.5m wide, 1.5m long and 0.5m deep.

Change: No significant erosion has occurred since the baseline monitoring period.

Action required: Remove erosion point from future monitoring surveys.

Autumn 2012

Spring 2013

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Erosion Point 15:

Description: Heavily vegetated erosion point along small ephemeral drainage line. Undercutting forming and ponding.

Size: Approximately 1m long, 1m wide, 0.5m deep.

Change: No significant erosion has occurred since the baseline monitoring period.

Action required: Remove erosion point from future monitoring surveys.

Autumn 2012

Spring 2013

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Erosion Point 16:

Description: Active erosion likely to be present with evidence of plunge pool formation and ponding.

Size: Approximately 3.0m long, 1.5m wide, 1.0m deep.

Change: Some slight erosion has occurred at the head cut previously. No significant erosion has occurred since the previous monitoring period.

Action required: Remove erosion point from future monitoring surveys.

Autumn 2012

Spring 2013

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Erosion Point 17:

Description: Located along an ephemeral drainage line within northern offset. Evidence of previous erosion, undercutting, pooling and in-stream vegetation.

Size: Approximately 2.5m wide, 2.5m long and 1.0m deep.

Change: No change has occurred since the previous monitoring period.

Action required: Remove erosion point from future monitoring surveys.

Autumn 2012

Spring 2013

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Erosion Point 18:

Description: Located along an ephemeral drainage line within northern offset. Evidence of stream bed exposure, pooling and in-stream vegetation.

Size: Approximately1.5m deep, 3.0m wide, 4.0m long.

Change: No significant erosion has occurred since the baseline monitoring period, however, slight exposure of bank rock evident.

Action required: No ground works required at this stage. Continue bi-annual monitoring.

Autumn 2012

Spring 2013

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Erosion Point 20:

Description: Located in the southern offset, to the east of the Dam. Base of head gully has exposed bedrock, low risk of additional erosion.

Size: 1-2m wide, 0.9m deep, 2m long.

Change: No change since previous monitoring. Heightened animal activity adjacent to erosion monitoring point.

Action required: Remove erosion point from future monitoring surveys.

Spring 2012

Spring 2013

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Erosion Point 21:

Description: Located west (just downstream) from the access track running along the western boundary in the northern offset. The site has developed a plunge pool, which has exposed the bedrock in some parts.

Size: 1-2m wide, 0.6m deep, 1.5-3m long.

Change: No change since previous survey.

Action required: No action is required at this stage. Continual bi-annual monitoring.

Spring 2012

Spring 2013

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Erosion Point 22: New point established at overflow point of southern dam.

Description: Southern dam overflow – directed water flow causing erosion upon exiting overflow pipe.

Size: 20cm wide, 30cm deep, 1.5m long.

Change: N/A

Action required: No action is required at this stage. Continual bi-annual monitoring.

Baseline photo adjacent - Spring 2013	

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Figure 20: Erosion monitoring points in northern offset

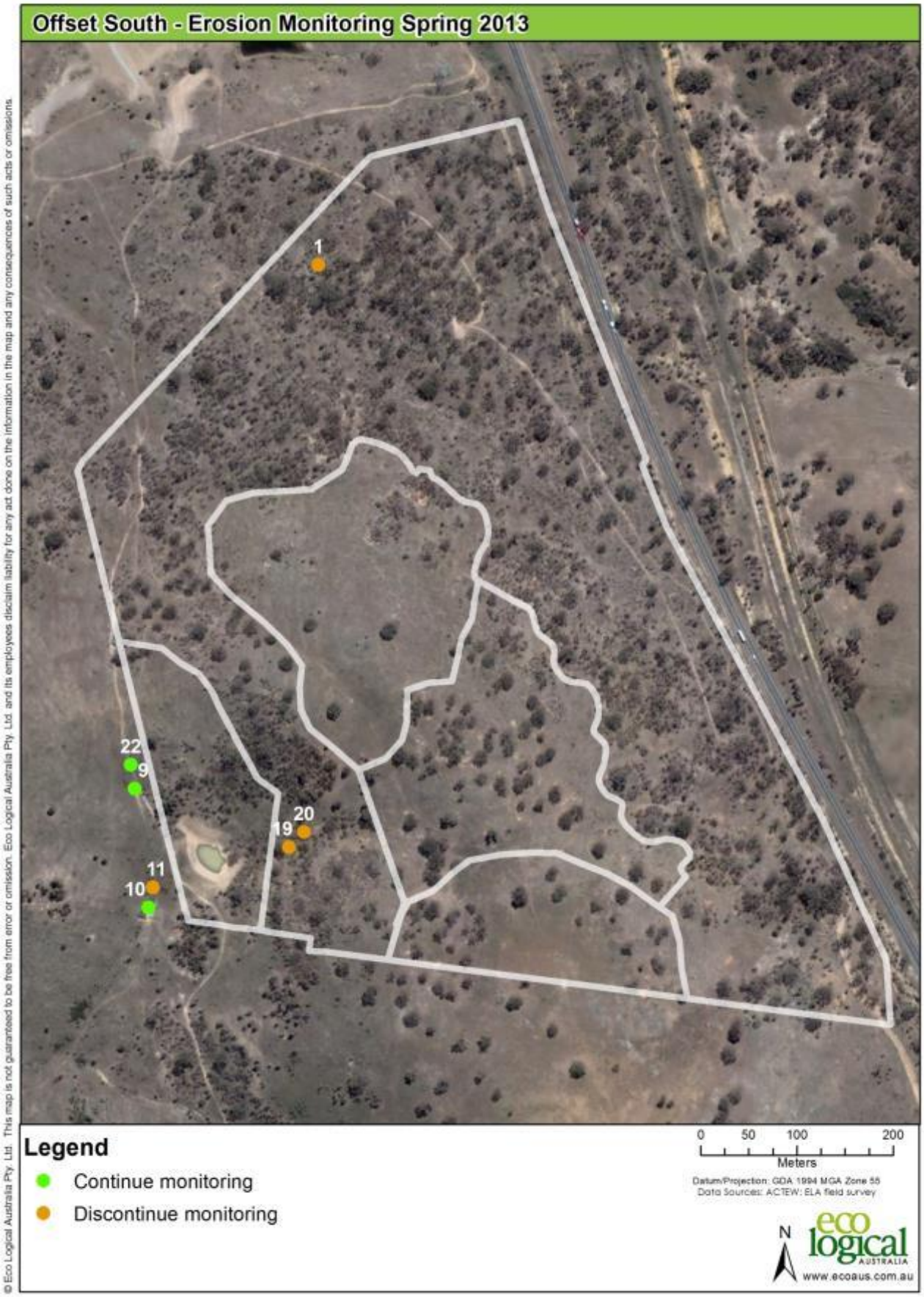

Figure 21: Erosion monitoring points in southern offset

7 Feral animal monitoring

In accordance with the Feral Animal Sub-plan (see ODP) monitoring of the offset site for feral animal activity is being undertaken on a bi-annual basis to inform feral animal control actions. The monitoring results for spring 2013 are presented below.

7.1 Management actions to date

The autumn and spring 2012 monitoring surveys identified Feral Pigs within the offset property. Prior to the autumn 2012 monitoring, this species had not been observed. Disturbance within the offset included pig rooting, often in areas associated with a forage source, and tracks through boggier areas of the site. The disturbance caused by the pigs was locally significant but at a low density across the whole of the offset.

It was recommended that the level of disturbance be monitored and appropriate action taken if the level of disturbance increased significantly. In response to the recommendation, Regional Feral Animal Control (RFAC) was engaged to conduct control activities at the M2G offset site from 11th September 2012 to 3rd October 2012. A total of 21 pigs were trapped and destroyed over the control period. Follow-up monitoring (17th October) conducted by RFAC two weeks following control period did not record any fresh signs of Feral Pigs.

7.2 Feral animal monitoring results – spring 2013

Monitoring of feral animals using infra-red cameras (**Figure 3**) and opportunistic observations was conducted as part of the monitoring surveys. Targeted searches were undertaken around drainage lines, permanent water sources and along animal tracks for fresh signs (scats & tracks) of feral animal activity. The observations (**Figure 22**) included:

- Feral Pigs (*Sus scrofa*): Low signs of Feral Pigs were recorded across the northern and southern offset.
- Feral Goats (*Capra aegagrus hircus*: Two herds of 60+ goats were observed within the offset site (also within adjacent property to the south). The species is considered likely to be utilising a large area, including the offset site, neighbouring properties and Murrumbidgee River corridor. The lack of disturbance (agriculture activities) within the offset site is likely providing a safe refuge for the herds. At this stage, the presence of goats does not seem to be significantly impacting the over quality and condition of the offset site. However, localised goat camps (e.g. under a stand of trees) were observed and increased grazing pressures were identified at these points.
- European Foxes (*Vulpes vulpes*): Foxes were recorded on both remote cameras within the offset site and opportunistically within the northern offset.
- European Rabbits (*Oryctolagus cuniculus*): Signs (scats and infrequently used warren) of low rabbit presence / abundance were observed within the southern offset.
- Hare (*Lepus capensis*): Two separate individuals were observed during the monitoring surveys. This species is predominantly solitary and is not considered a major pest, although it is noted that the species can cause localised damage to plantings and native vegetation.
- Feral Deer (*Dama dama*): This species was observed for the first time during the spring 2013 monitoring surveys. Three individuals were observed in at the southern dam from the infra-red camera surveys.

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7.3 Recommendations and actions

Overall, the incidence of feral animals (excluding goats) within the offset site is low. It is recommended to continue monitoring as outlined in the Feral Animal Management Sub-Plan particularly in relation to the presence and abundance of Foxes and Rabbits. If evidence of an increase in of these species is observed through-out the year, it is recommended that feral animal control be undertaken. This is of particular importance if the dry weather is experienced as these species have the ability to heavily impact on vegetation suffering from water stress.

7.3.1 Goats

It is recommended that immediate action be taken to limit and/or control the number of Goats within the offset site. It is understood (since completing the spring monitoring surveys) that a contractor has been engaged to undertake Feral Goat control in October and November 2013.

It is recommended that a monitoring survey for this species be undertaken, one-month from the conclusion of the control activities to determine if follow-up Goat control is required.

7.3.2 Pigs

Despite the generally low activity of Feral Pigs observed within the offset site, it is recommended that pig control (follow-up to the 2012 control) be implemented. This will prevent pig numbers reaching the heights observed during 2012 and prevent vegetation damage within the offset site. It is understood (since completing the spring monitoring surveys) that RFAC has been engaged to undertake the control activities. This will be undertaken immediately following the Feral Goat control outlined above.

Continued bi-annual monitoring of pigs within the offset site is recommended and will be important to determine the success of the control activity and if additional follow-up control is required.

In addition, reporting of feral animal activity (for goats, pigs and deer) to the local control agencies is recommended. This will assist with information that may guide any broad or landscape scale control activities.

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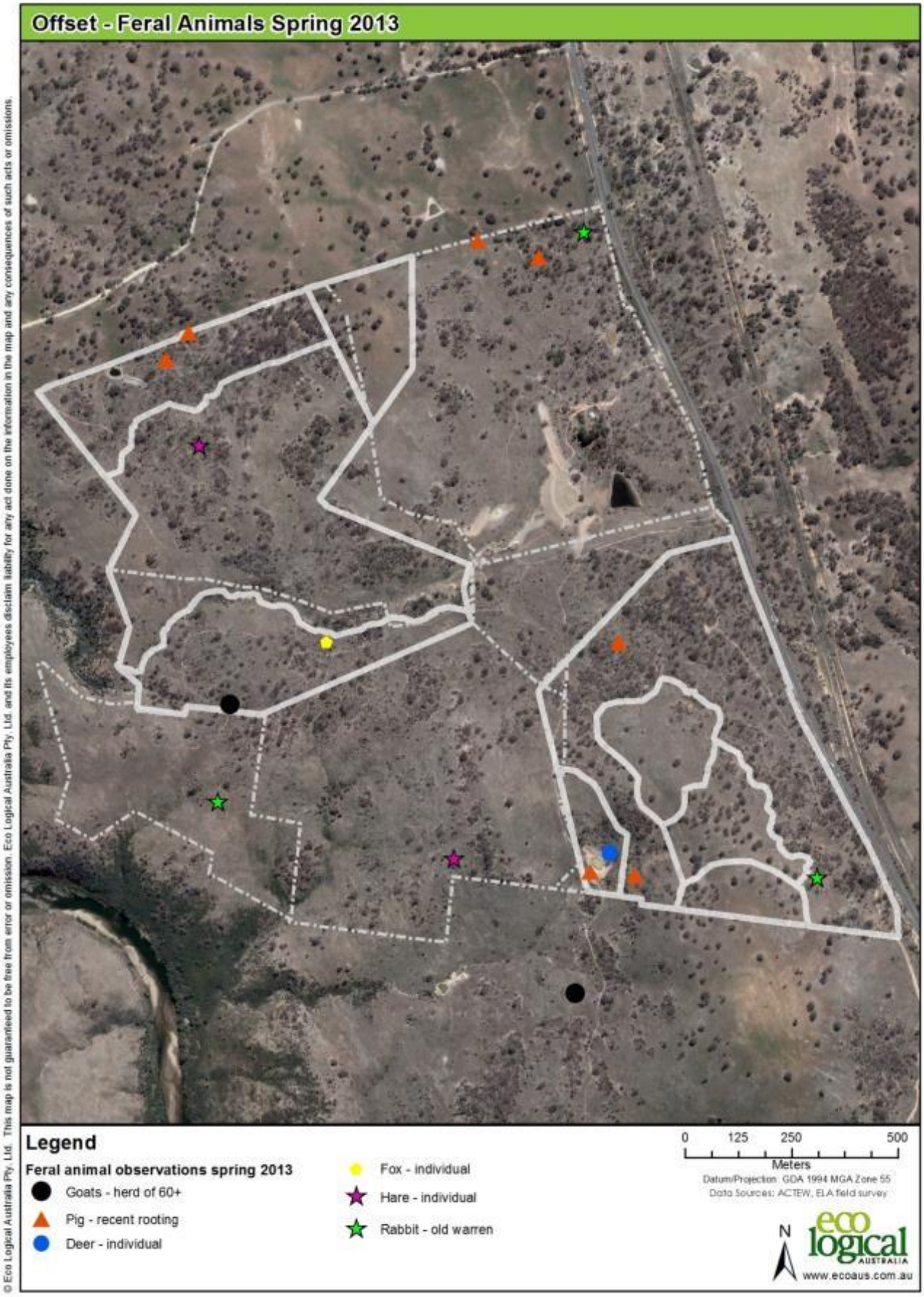

Figure 22: Feral animal observations

8 Fencing monitoring

8.1 Management actions to date

Fencing of the offset site was one of the actions highlighted to be undertaken in the ODP. Fencing is required to prevent grazers such as sheep and cattle entering the offset site from the neighbouring properties. The primary aim of a stock proof fence is to keep grazing stock out of an area (e.g. conservation area) where it is bordered by a private rural property. This type of fencing generally consists of 4 or 5 stranded wire (including 2 or 3 barbed wire strands) with wooden posts and/or star-pickets, approximately 1.2 m high.

In July 2012, Tennant Rural undertook works to remove the existing fence and erect a new fence along the southern boundary of the Williamsdale property (**Figure 23**). The fence was built to specifications to exclude both cattle and sheep (5 wires and 2 barbed wires). The fence was approximately 1.6km in length and included the replacement of 3 gateways.

In June 2013, the erection of new fencing along the eastern border of MU7 in the northern offset was undertaken. This completed the fencing requirements of the offset site (fully enclosed within the Williamsdale property). The fencing arrangements has enabled low intensity grazing to occur within a small proportion of the Williamsdale property, whilst excluding grazing within the offset site in order to satisfy the ACT Government Land Management Agreement (LMA).

In response to recommendations in previous monitoring reports, all internal fencing within the offset site was removed in June 2013 to enhance the wildlife friendly nature of the offset site and be consistent with the biodiversity conservation ideals of the ODP and associated sub-plans.

8.2 Fencing monitoring results

The spring 2013 fencing monitoring results has been outlined below based on the location of the boundaries:

- *Northern boundary*: The northern boundary fence is considered adequate along its length. Small holes at the base of the northern boundary fence were recorded and require continued monitoring. The small holes allow the free movement of wombats and small kangaroos across property boundaries. Minor maintenance maybe required at these points if sheep will be grazing in the paddock north of the Williamsdale property once the pipeline fence has been removed, and holes become large enough for individuals to enter the offset site.
- *Eastern boundary*: The eastern boundary fence of the Williamsdale property, adjacent to the Monaro Highway is mostly considered adequate. One section approximately five metres in length where the fence crosses a drainage line (north of the entrance to the sub-station) requires replacing (refer to **Figure 23**). However, it does not pose an immediate risk to stock entering the offset site. Grazing of stock does not occur along the Monaro Highway and other internal fencing within the Williamsdale property (e.g. boundary of the sub-station and newly erected section along MU7) provide a barrier to the offset site. Small holes similar to those observed along the northern boundary were also recorded at points on the eastern boundary and require continued monitoring.
- *Western boundary*: The western boundary fence is adequate to exclude stock. However, minor maintenance is recommended for consideration for a few points where animals (e.g. wombats, kangaroos and potentially goats) have created small to moderate sized holes.

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These points are identified as moderate damage in **Figure 23**. There is no risk of stock entering the offset site at these points as the western boundary borders the Murrumbidgee River Corridor where grazing does not occur. However, some of these points may be used by goats to enter the property and should be considered as an additional action following the removal of the goats from the offset site (see **Section 6**).

- *Southern boundary*: The southern boundary fence is adequate to exclude stock. However, Small holes at the base of the southern boundary fence were recorded and require continued monitoring.

8.3 Recommendations

The overall condition of the Williamsdale property and offset boundary fencing is considered adequate to exclude grazing by stock within the offset site. Management actions recommended to be undertaken in 2014 by ACTEW Water include:

- Continued monitoring at all points identified in **Figure 23.**
- Consider maintenance actions of points identified as moderate in **Figure 23.**
- Replacement of a small section of fence along the eastern boundary.

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Figure 23: Williamsdale property fence with points recommended for repair

9 Summary & recommendations

9.1 General summary

A number of management actions have been undertaken across the offset site, including:

- Primary on-ground works and actions undertaken in 2012:
  - Erection of new Williamsdale property southern boundary fence (July 2012).
  - Feral Pig control (September 2012).
  - Weed Control for African Lovegrass and Serrated Tussock (July 2012).
  - Weed Control for other weed species (late 2012- early 2013).
- Primary on-ground works and actions undertaken in 2013:
  - Erection of new fence bordering MU7 of the northern offset (June 2013).
  - Removal of internal fencing within the offset site (June 2013).
  - Follow-up weed control mid-year (2013).
  - Bushfire track maintenance.
  - *Swainsona recta* planting of 46 individuals (September 2013).
  - Control for Feral Goats (scheduled Nov 2013) and Pigs (scheduled Nov/Dec 2013).

Based on the spring 2013 monitoring surveys, the offset site is in good condition 18-24 months after establishment and is responding well to management actions implemented. The recommended primary works for the offset site for 2014 include; follow-up weed control to maintain suppression of noxious exotic species across the offset site and feral animal control for Feral Goats and Pigs.

9.1.1 Bushfire

The access track through the offset site is in a satisfactory condition. It is recommended that the track be continue to be maintained in a condition to facilitate bush fire management. If track management is required in the future, it is recommended that care is taken to ensure that the track remains in good condition and does not widen due to overuse, incorrect maintenance, or result in erosion. The track would ideally remain a grassed track to limit impacts on the environment.

9.1.2 Rehabilitation works

Significant natural regeneration of the overstorey (particularly, *E. blakelyi* saplings) was observed during the baseline surveys and continues to be recorded across the offset site. Mid-storey regeneration (native shrubs) was observed for the first time during autumn 2013 and was observed more extensively during the recent spring surveys. However, similar natural regeneration (overstorey or mid-storey) has not been observed within MU7.

The increase and pattern of natural regeneration across the offset site is likely to be correlated with the removal of stock grazing. Grazing was originally removed in 2012 (previously grazing occurred sporadically and at a low density); however a moderate sized herd of sheep were observed grazing within MU7 in autumn 2013. Since then, all sheep have been removed and there have been no records of stock grazing. The recent grazing within MU7 likely impacted the ability for regeneration to occur and may explain the pattern of natural regeneration observed across the offset site.

No rehabilitation works or plantings are recommended for 2014. However, consideration could be given to low density scattered plantings within MU7 following the results of the spring 2014 monitoring surveys, if no signs of natural regeneration are observed. Plantings could include overstorey species (*Eucalyptus blakelyi, E. melliodora, E. dives* and *E. bridgesiana*) and native

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shrubs such as, *Bursaria spinosa, Acacia* spp., *Cassinia* sp., *Dodonaea* sp. Box-Gum Woodland, the dominant vegetation community within MU7 is an open woodland community with a typically absent or scattered mid-storey of native shrubs. It would therefore be applicable to design planting / rehabilitation works that represents this open woodland structure and low density mid-storey.

9.1.3 Swainsona recta propagation program

A total of 112 individuals have been planted across three translocation plots (66 in July 2012 and 46 in September 2013). An overall survivorship of 79 % (88 of 122) was observed with a range of 50 % for plot 2 to 98 % for plot 1. Splitting the survivorship between years, reveals a survivorship of 88 % and 65 % for those planted in 2012 and 2013 respectively. The majority of plants observed from the 2012 plantings (51 of 58) were either in flower, or had recently flowered (seed pods present). This is in comparison to only one individual observed flowering from the 2013 plantings.

9.1.4 Weed

Weed control activities are following the management actions outlined in the relevant sub-plan. Successful suppression of previously dominant species has been observed, particularly for Sweet Briar, Blackberry, African Lovegrass and Serrated Tussock. All species require follow-up control as outlined in the sub-plan, with concerted focus on St. John's Wort regrowth.

9.1.5 Erosion

Erosion points are generally considered stable and do not require active works at this stage. Given this stability, it is recommend that the number of monitoring points be reduced to a representative sample and to target those considered at greatest risk. Erosion monitoring points recommended for removal from future monitoring surveys include; 1, 3, 5, 6, 11, 12, 14, 15, 16, 17, 19, 20.

9.1.6 Feral animal

It is recommended that feral animal control be implemented for Feral Goats and Pig as soon as possible, with follow-up monitoring, one month following any control activities.

9.1.7 Fencing

The condition of the Williamsdale property and offset boundary fencing is considered adequate to exclude grazing by stock within the offset site. Recommended actions to be undertaken in 2014 include, monitoring at all identified damaged points, consider maintenance at moderate damaged points and consider replacement of a small section of fence along the eastern boundary (**Figure 23**).

9.1.8 Grazing

No action is required under the grazing plan other than the continued exclusion of stock and Feral Goat control (outlined above). Opportunistic observations of grazing pressure within and adjacent to the *Swainsona recta* plots indicate that the offset site is grazed at a low intensity consistent with the conservations principles outlined in the ODP. The diversity of native herbs and forbs has increased substantially since the baseline surveys, supporting the continuation of low grazing pressures.

Regular counts of 10-30 Kangaroos (multiple mobs) were made during the spring 2013 surveys. Higher numbers of kangaroos have been recorded during previous monitoring surveys. It is estimated that up to 100 kangaroos maybe utilising the offset site and surrounding properties at any one time. The LMA (ACT Government) for the Williamsdale property does not outline a suitable grazing level for the 'Active Conservation' rural enterprise. Previously, the grazing intensity for the Williamsdale property was set at a Dry Sheep Equivalent (DSE) of 600, which equates to 800 Kangaroos. The current grazing from up to 100 Kangaroos (and including the intermittent movement of goats on the property) is considered consistent with the conservation principles of the ODP.

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9.2 Management unit recommendations

A summary of the recommended adaptive management actions relating to the offset site is provided in **Table 11** below. The actions relate to the appropriate ODP sub-plan and are based on the results presented in the above sections.

Table 11: Summary of proposed actions relating to the ODP

ODP Sub-Plan	Action status	Recommended management actions
Weed	On-going control and monitoring.	Maintain weed control program as outlined in ODP and weed sub-plan. Follow-up targeted control for all species with an emphasis on St. John's Wort regrowth. Weed management activities are applicable to all Management Units.
Rehabilitation	To be considered following 2014 spring monitoring surveys.	Overstorey and mid-storey planting for consideration in MU7 following the 2014 spring monitoring surveys. If no natural regeneration is observed within the management unit, then implement a low-density planting / rehabilitation program. Natural regeneration recorded across all other Management Units.
Sediment and erosion Control	No action required. On-going monitoring	No sediment and erosion required at present. Reduced the number of erosion monitoring points to a representative sample and to target those considered at greatest risk. Erosion monitoring points for removal include: 1, 3, 5, 6, 11, 12, 14, 15, 16, 17, 19, 20. Applicable to MU's 1B, 3, 4 & 6.
Bushfire	Complete. On-going monitoring.	The main access track through the offset site is in a satisfactory condition. It is recommended that the access track be maintained in a condition suitable to facilitate bush fire management requirements. Applicable to MU's 3, 4 & 6.
Feral animal control	On-going control and monitoring	Feral animal control required for Goats and Pigs. Low rabbit numbers continue to exist, but are currently considered a low risk. Continue monitoring to establish if further control activities are required in the future. Applicable to all Management Units.
Fencing	Completed in August 2012 & June 2013. Monitoring on-going	No immediate major actions required. Management activities for 2014 include: monitoring at all damaged points, consider maintenance at moderate damaged points and consider replacement of a small section of fence along the eastern boundary.
Grazing	On-going monitoring	No immediate actions required. Grazing level is suitable across the offset site.

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Appendix A: Flora species list

+ = few, small cover (<5%)

r = solitary, small cover (<5%)

1 = numerous (up to 5%)

2 = 5-25%

3= 25-50%

4= 50-75%

5=>75%

Note: The species cumulative list includes all species observed over all monitoring surveys.

Native									
Plot Number	**Spring 2013**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Species (cumulative list)		**MU1A**	**MU2B**	**MU3**	**MU4**	**MU5**	**MU6**	**MU7**	**MU3**
Acacia dealbata	✓								
Acacia mearnsii	✓								
Acacia rubida	✓								
Acaena novae-zelandiae	✓								
Acaena ovina	✓		1	+	+	+	1	r	1
Ajuga australis	✓								
Alternanthera nana	✓							r	
Aristida ramosa	✓		1	r			+		+
Arthropodium minus	✓		+						1
Asperula conferta	✓		1	1	2	1	+		1
Asplenium flabellifolium	✓								
Astroloma humifusum									
Austrostipa bigeniculata	✓								
Austrostipa densiflora									
Austrostipa scabra	✓	2	3	1		+	2		
Austrostipa sp.	✓		+						2
Bossiaea buxifolia	✓						r		
Bossiaea prostrata	✓								
Bothriochloa macra	✓	1	2	+		2	2		
Brachycome sp.	✓								
Brachyloma daphnoides	✓								
Bulbine bulbosa	✓		r		r	r			1
Bursaria spinosa	✓			r					
Callistemon sieberi	✓								
Callitris endlicheri	✓								
Calocephalus citreus	✓			r					
Calotis scabiosifolia var. integrifolia	✓								
Carex appressa	✓							r	
Carex breviculmis	✓					1	+	2	
Carex inversa	✓				+		+	2	
Carex sp.	✓	2	+	+					r
Cassinia aculeata	✓								
Cassinia quinquefaria	✓						r		

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Native									
Plot Number	**Spring 2013**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Species (cumulative list)		**MU1A**	**MU2B**	**MU3**	**MU4**	**MU5**	**MU6**	**MU7**	**MU3**
Cassinia longifolia	✓								
Cheilanthes sieberi	✓		1	+		+	+		1
Chrysocephalum apiculatum	✓		2	1		2	2		1
Chrysocephalum semipapposum	✓						r		
Clematis microphylla	✓			+			r		
Convolvulus erubescens	✓	+	1	+			+		
Cotula australis	✓	r					+	+	
Craspedia variabilis	✓				1				
Crassula sieberana	✓	+	+				1	1	+
Cryptandra amara	✓					+	r		
Cymbonotus lawsonianus	✓		1	+	+	1	1	1	1
Cymbopogon refractus	✓			r					
Cynoglossum suaveolens									
Daucus glochidiatus	✓		r	r		r	1		r
Desmodium varians	✓	+	+	+		+	1		+
Dianella revoluta									
Dichelachne sp.	✓			r					
Dichondra repens	✓		1			+	+	+	
Dichopogon fimbriatus									
Dillwynia sericea	✓								
Diuris semilunulata	✓								
Dodonaea sp.	✓								
Drosera peltata	✓								
Einadia nutans	✓						+		
Eleocharis sp.	✓								
Elymus scaber	✓	r	1	1	+	1	+		
Enneapogon nigricans	✓						1		
Epilobium billardiereanum									
Eragrostis brownii	✓				+				
Erigeron karvinskianus									
Erodium crinitum	✓							+	
Eryngium ovinum	✓		r	+					+
Eucalyptus blakelyi	✓	+	+	2	2	2	+		2
Eucalyptus bridgesiana	✓								
Eucalyptus dives	✓								
Eucalyptus mannifera	✓								
Eucalyptus melliodora	✓								
Eucalyptus rossii	✓								
Euchiton sp.	✓	+	+	+	+	+	+		1
Fimbristylis sp.									
Galium gaudichaudii	✓		r	r					r
Geranium retrorsum	✓				r				
Geranium solanderi	✓				+		+	+	
Geranium sp.	✓		1	1					
Glycine clandestina	✓								
Glycine tabacina	✓	+	1	r		r			
Gonocarpus tetragynus	✓			1	r	+			1
Goodenia hederacea	✓			+					
Haloragis heterophylla	✓			1	2				1
Hibbertia obtusifolia	✓								
Hydrocotyle laxiflora	✓	+	1	1	1	1	+	1	+
Hypericum gramineum	✓			+	+	+			r

Native									
Plot Number	**Spring 2013**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Species (cumulative list)		**MU1A**	**MU2B**	**MU3**	**MU4**	**MU5**	**MU6**	**MU7**	**MU3**
Indigofera australis	✓								
Isolepis sp.									
Joycea pallida	✓								
Juncus sp.	✓		r					+	
Juncus subsecundus	✓				1			1	
Juncus usitatus				+					
Kunzea ericoides	✓		r						
Leptorhynchos squamatus	✓			1	+	1			1
Leptospermum continentale	✓								
Leucochrysum albicans var. *tricolor*	✓								
Linum marginale									
Lomandra bracteata	✓								
Lomandra coriacea	✓			r					1
Lomandra filiformis	✓				+	+	r		
Lomandra longifolia	✓								
Lomandra multiflora	✓			r					
Luzula densiflora	✓		r	r		+			r
Melichrus urceolatus	✓		r			r	r		r
Microlaena stipoides	✓	2	1	1		1	+	1	
Microseris lanceolata	✓								
Microtis unifolia	✓			r					+
Myosotis sylvatica	✓								
Oreomyrrhis eriopoda	✓		r						
Oxalis perennans	✓						+		
Oxalis sp.	✓	1	1	+					
Panicum effusum	✓								
Pellaea calidirupium	✓								
Persicaria prostrata	✓								
Pimelea curviflora	✓								
Plantago gaudichaudii	✓				r				
Plantago varia	✓	+		1		+			
Poa labillardieri	✓								
Poa sieberiana	✓			2					1
Poa sp.	✓				1				
Pseudognaphalium luteoalbum	✓								
Pultenaea procumbens	✓								
Ranunculus sp.	✓					r		r	
Rumex brownii	✓	+		+	+		r	1	
Schoenus apogon	✓		1	1	3	1			
Rytidosperma caespitosa									
Rytidosperma carphoides	✓								
Rytidosperma racemosa	✓								
Rytidosperma sp.	✓	1	2	1		1	2		1
Solenogyne gunnii	✓				1				
Spergularia brevifolia									
Sporobolus sp.									
Stackhousia monogyna	✓			+		+			+
Swainsona monticola	✓								
Swainsona recta (propagated)	✓								
Swainsona sericea	✓			+		r			
Thelymitra pauciflora	✓								
Thelymitra sp.	✓								r

Native									
Plot Number	**Spring 2013**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Species (cumulative list)		**MU1A**	**MU2B**	**MU3**	**MU4**	**MU5**	**MU6**	**MU7**	**MU3**
Themeda australis	✓		+	3	3	3			4
Thysanotus patersonii									
Thysanotus tuberosus									
Tricoryne elatior									
Triptilodiscus pygmaeus	✓		1	+		1	1		1
Veronica calycina	✓		1			+			
Veronica sp.	✓			r					
Vittadinia cuneata	✓		+			r	r		
Vittadinia muelleri	✓	r	r			r	+		+
Wahlenbergia communis	✓								
Wahlenbergia gracilis	✓					r	r		1
Wahlenbergia sp.	✓		1	1			1		
Wahlenbergia stricta	✓								1
Wurmbea dioica	✓		+		r	r	+		
Xerochrysum viscosum	✓								
Total native species	**137**	**18**	**42**	**49**	**27**	**39**	**42**	**18**	**36**
Baseline total native species	66	14	30	27	24	29	28	13	26

Exotic									
Plot Number	**Autumn 2013**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Species (cumulative list)		**MU1A**	**MU2B**	**MU3**	**MU4**	**MU5**	**MU6**	**MU7**	**MU3**
Acetosella vulgaris	✓		+				+	r	
Aira sp.	✓	1	+	1	1	1	1	1	1
Anagallis arvensis	✓			r					
Aphanes sp.	✓						+	1	
Arctotheca calendula									
Avena sp.	✓								
Briza minor	✓			1	1	1			r
Bromus diandrus	✓								
Bromus hordeaceus	✓	2	r	r	1	1	1	2	
Bromus sp.									
Capsella bursa-pastoris	✓	r					r	1	
Carduus sp.	✓							+	
Carthamus lanatus	✓	2							
Centaurium erythraea						r	r		
Cerastium sp.									
Cirsium vulgare	✓				+		r	+	
Conyza sp.	✓	+			r			r	
Cotoneaster sp.									
Crataegus monogyna	✓						r		
Cynosurus echinatus	✓		+	+					
Cyperus eragrostis	✓								
Cyperus sp.	✓							1	
Echium plantagineum	✓			r					
Eragrostis cilianensis									
Eragrostis curvula	✓							r	
Erodium botrys	✓								
Erodium cicutarium	✓	+					+		
Erodium sp.	✓							1	
Geranium ? Molle	✓							+	
Holcus lanatus									

Exotic									
Plot Number	**Autumn 2013**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Species (cumulative list)		**MU1A**	**MU2B**	**MU3**	**MU4**	**MU5**	**MU6**	**MU7**	**MU3**
Hordeum glaucum	✓							2	
Hordeum sp.	✓	1							
Hypericum perforatum	✓	1		+	1	1	+	+	
Hypochaeris glabra	✓						1	r	
Hypochaeris radicata	✓	1	1	r	+	1	+	+	+
Linaria arvense	✓	+	+	+	r	+	1		
Linaria pelisseriana	✓		+	+					1
Lolium rigidum	✓								
Malva nicaeensis	✓							r	
Malva parviflora	✓	r						r	
Marrubium vulgare									
Myosotis discolor	✓						+	r	
Nassella trichotoma	✓	r							
Onopordum acanthium									
Orobanche minor	✓								
Parentucellia latifolia	✓								
Paronychia brasiliana	✓	1	+				1	1	
Petrorhagia nanteuilii	✓		r	r			1		
Phalaris aquatica	✓								
Plantago lanceolata	✓	+	+	+	1	+	+	1	
Poa pratensis	✓				+	1			
Polygonum aviculare	✓							r	
Prunus sp.	✓								
Rosa rubiginosa	✓	r	r	r	+	r	r	r	
Rubus fruticosus	✓		r		r			r	
Sanguisorba minor	✓								
Sonchus sp.	✓								
Stellaria sp.				+					
Taraxacum officinale	✓							r	
Tolpis umbellata	✓								
Trifolium arvense	✓				+	+	1		
Trifolium campestre	✓		+	+			+		
Trifolium dubium	✓				1	1			
Trifolium glomeratum	✓	+		r			+		
Trifolium repens	✓								
Trifolium sp.	✓							1	
Trifolium subterraneum	✓	1					+	1	
Urtica urens	✓							+	
Verbascum thapsus	✓								
Verbena bonariensis	✓							r	
Vicia sp.									
Vulpia sp.	✓				+	1	1	2	1
Total exotic species	**61**	**17**	**13**	**16**	**15**	**13**	**23**	**30**	**5**
Baseline total exotic species	46	18	7	14	16	8	17	15	26

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Appendix B: Fauna lists and habitat features

Fauna observations

Fauna species recorded during the Spring 2013, Autumn 2013, Spring 2012, Autumn 2012 and the 2011 baseline monitoring surveys (spring) either through opportunistic observations or target survey are outlined below. A = Autumn, B = Spring.

Common Name	Latin Name	2011B	2012A	2012B	2013A	2013B
Australasian Grebe	*Tachybaptus novaehollandiae*		✓		✓	✓
Australian Magpie	*Gymnorhina tibicen*	✓	✓	✓	✓	✓
Australian Raven	*Corvus coronoides*	✓	✓	✓	✓	✓
Australian Wood Duck	*Chenonetta jubata*			✓	✓	✓
Black-faced Cuckoo-Shrike	*Coracina novaehollandiae*		✓	✓		✓
Brown Falcon	*Falco berigora*					✓
Common Bronzewing	*Phaps chalcoptera*	✓			✓	
Crested Pigeon	*Ocyphaps lophotes*				✓	✓
Diamond Firetail	*Stagonopleura guttata*	✓			✓	
Double Barred Finch	*Taeniopygia bichenovii*				✓	
European Goldfinch	*Carduelis carduelis*				✓	
Fan-tailed Cuckoo	*Cacomantis flabelliformis*					✓
Galah	*Eolophus roseicapillus*	✓		✓		✓
Grey Butcherbird	*Cracticus torquatus*		✓	✓		
Grey Fantail	*Rhipidura albiscapa*	✓	✓	✓		✓
Grey Shrike-Thrush	*Colluricincla harmonica*		✓		✓	✓
Hard Head	*Aythya australis*			✓	✓	
Honeyeater, White-Eared	*Lichenostomus penicillatus*	✓	✓		✓	
Honeyeater, White-Plumed	*Lichenostomus penicillatus*				✓	✓
Honeyeater, Yellow Faced	*Lichenostomus chrysops*			✓		
Jacky Winter	*Microeca fascinans*	✓		✓		✓
Kookaburra	*Dacelo novaeguineae*	✓		✓		
Leaden Flycatcher	*Myiagra rubecula*			✓		
Magpie Lark	*Grallina cyanoleuca*	✓	✓	✓	✓	✓
Masked Lapwing	*Vanellus miles*					✓
Nankeen Kestrel	*Falco cenchroides*					✓
Noisy Friarbird	*Philemon corniculatus*			✓		✓
Noisy Miner	*Manorina melanocephala*	✓	✓	✓	✓	✓
Pacific Black Duck	*Anas superciliosa*			✓	✓	✓
Pardalote, Spotted	*Pardalotus punctatus*	✓	✓	✓	✓	
Pardalote, Striated	*Pardalotus striatus*	✓		✓	✓	✓
Pied Currawong	*Strepera graculina*	✓	✓	✓	✓	✓
Quail	*Coturnix sp.*	✓				✓
Red-Browed Finch	*Neochmia temporalis*			✓	✓	✓
Red Wattlebird	*Anthochaera carunculata*					✓
Robin, Flame	*Petroica phoenicea*	✓				
Robin, Hooded	*Melanodryas cucullata cucullata*	✓				
Robin, Scarlet	*Petroica boodang*		✓		✓	
Rosella, Crimson	*Platycercus elegans*	✓	✓	✓	✓	✓
Rosella, Eastern	*Platycercus adscitus*	✓	✓	✓	✓	✓

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Common Name	Latin Name	2011B	2012A	2012B	2013A	2013B
Sacred Kingfisher	*Todiramphus sanctus*			✓		
Speckled Warbler	*Chthonicola sagittatus*				✓	
Sulphur-Crested Cockatoo	*Cacatua galerita*	✓				✓
Superb Fairy Wren	*Malurus cyaneus*	✓	✓	✓	✓	✓
Thornbill, Brown	*Acanthiza pusilla*	✓		✓	✓	✓
Thornbill, Yellow-Rumped	*Acanthiza chrysorrhoa*	✓	✓	✓	✓	✓
Tree Martin	*Petrochelidon nigricans*					✓
Wedge-Tailed Eagle	*Aquila audax*	✓	✓		✓	
Weebill	*Smicrornis brevirostris*				✓	
Whistler, Golden	*Pachycephala pectoralis*	✓	✓			✓
Whistler, Rufous	*Pachycephala rufiventris*			✓	✓	✓
White-bellied Sea-Eagle	*Haliaeetus leucogaster*					✓
White Throated Tree Creeper	*Cormobates leucophaeus*	✓	✓	✓	✓	✓
White-fronted Gerygone	*Gerygone olivacea*			✓		✓
White-winged Chough	*Corcorax melanorhamphos*		✓	✓		✓
Willie Wagtail	*Rhipidura leucophrys*	✓	✓		✓	✓
Yellow Tailed Black Cockatoo	*Calyptorhynchus funereus*				✓	

Mammals	Latin Name	2011B	2012A	2012B	2013A	2013B
Cow	*Bos Taurus*	✓				
European Rabbit	*Oryctolagus cuniculus*	✓	✓	✓	✓	✓
Feral Deer	*Dama dama*					✓
Feral Goat	*Capra aegagrus hircus*		✓	✓	✓	✓
Feral Pig	*Sus scrofa*		✓			✓
Fox	*Vulpes vulpes*	✓	✓	✓	✓	✓
Kangaroo	*Macropus giganteus*	✓	✓	✓	✓	✓
Sheep	*Ovis aries*				✓	✓
Swamp Wallaby	*Wallabia bicolor*					✓
Wombat	*Vombatus ursinus*	✓	✓	✓	✓	✓
Brushtail Possum	*Trichosurus vulpecula*					✓

Other	Latin Name	2011B	2012A	2012B	2013A	2013B
Eastern Bearded Dragon	*Pogona barbata*			✓		
Eastern Common Froglet	*Crinia signifera*		✓	✓	✓	✓
Eastern Long-necked Tortoise	*Chelodina longicollis*		✓		✓	✓
Echidna	*Tachyglossus aculeatus*					✓
Mountain Dragon	*Rankinia diemensis*	✓				
Peron's Tree Frog	*Litoria peronii*					✓
Plains Froglet	*Crinia parinsignifera*			✓	✓	✓
Smooth Toadlet	*Uperoleia laevigata*					✓
Spotted Marsh Frog	*Limnodynastes tasmaniensis*			✓	✓	✓
Sugar Glider*	*Petaurus breviceps*					✓
Whistling Tree Frog	*Litoria verreauxii*			✓		✓

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Anabat Results

Two Anabat nights were conducted using two separate Anabats on the night of the 7 November 2013.

Bat calls were analysed using the program AnalookW (Version 3.8 25 October 2012, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW. Available: (http://www.forest.nsw.gov.au/research/bats/default.asp).

Bat calls are analysed using species-specific parameters of the call profile such as call shape, characteristic frequency, initial slope and time between calls (Rinehold et al. 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et. al. 2006) were followed:

- Search phase calls were used in the analysis, rather than cruise phase calls or feeding buzzes (McKenzie et al. 2002).
- Recordings containing less than three pulses were not analysed and these sequences were labeled as short (Law et al. 1999).
- Four categories of confidence in species identification were used (Mills et al. 1996):
    - definite – identity not in doubt
    - probable – low probability of confusion with species of similar calls
    - possible – medium to high probability of confusion with species with similar calls
    - unidentifiable – calls made by bats that cannot be identified to even a species group.
- *Nyctophilus* spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al. 2004).
- Sequences not attributed to microbat echolocation calls were labeled as junk or non-bat calls and don't represent microbat activity at the site.
- Sequences labelled as low were of poor quality and therefore not able to be identified to species, they can however be used as an indicator of microbat activity at the site.

There were 554 sequences recorded from two Anabat detectors placed within the M2G offset site. Approximately 75% of sequences submitted were able to be identified to genus or species with the remainder being too short or of low quality preventing positive identification. General microbat activity was moderate across the site with the dam recording slightly more bat passes. Activity was recorded more often than every ten minutes but less often than every 2 minutes throughout the evening.

Feeding buzzes were regularly observed in the data set indicating that bats were actively foraging in this area. Activity was recorded on dusk indicating that bats were roosting nearby (within 1 km).

There were at least seven species identified, although it was not possible to provide confident identifications for some species as described below (**Tables 12 & 13**). One of those species, *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat), with a low confidence level is listed as vulnerable under the NSW TSC Act 1987. The most commonly recorded species was *Chalinolobus gouldii* (Gould's Wattled Bat) accounting for 68% of positively identified calls.

The calls of *F. tasmaniensis*, *S. rueppellii* and *Scotorepens orion* (Eastern Broad-nosed Bat) can be difficult to separate in this geographic region as their call frequencies and some other call characteristics overlap falling between 32 and 40 kHz. Calls were only positively identified when defining characteristics were present such as call shape and when the characteristic frequency allowed discrimination of a species.

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The calls of *C. gouldii* and the *Mormopterus* group of species can be difficult to separate. Calls were identified as *C. gouldii* with a frequency of 27.5 – 32.5 kHz and alternation in call frequency between pulses. When no distinguishing characteristics were present calls were assigned as follows '(*C. gouldii / Mormopterus spp.'* or '*Mormopterus spp.*').

Calls of *Miniopterus schreibersii oceanensis* overlap in frequency with those of *Vespadelus. darlingtoni* (Large Forest Bat) and *V. regulus (*Southern forest Bat*)*. Calls were identified as *V. regulus / M.s.oceanensis* when they fell between 44 – 47kHz, because they did not fall neatly into the documented range of either species. M.s.oceanensis can be distinguished by a down-sweeping tail, drop of more than 2 kHz in the pre-characteristic section, and variable pulse shape and time between calls. Calls were identified as *V. darlingtoni* when the characteristic frequency fell between 40 – 44 kHz and the characteristic section was long.

The calls of *V. vulturnus* and *Chalinolobus morio* (Chocolate Wattled Bat) can be difficult to separate in the range 50.5 – 53 kHz. Calls were identified as *C. morio* when there was a down-sweeping tail. There were also several calls from an unidentified species in the range 24 – 25kHz. The calls matched the flat shape of *Mormopterus* species calls (Freetail bats), but there are no documented references for calls of this description in the area.

Table 12: Anabat results from the flyway outside of Williamsdale, ACT on 7 November 2013.

Species name	Common name	# Calls	Definite	Probably	Possible
Chalinolobus gouldii	Gould's Wattled Bat	152	145	4	3
Chalinolobus morio	Chocolate Wattled Bat	14	11		3
Tadarida australis	White-striped Sheathtail Bat	20	20		
*Vespadelus regulus / Miniopterus schreibersii ocenaenesis**	Eastern Forest Bat / Eastern Bentwing Bat	3			3
Vespadelus vulturnus	Little Forest Bat	1	1		
Unknown		2			
Low		10			
Short		41			
	Total sequences	**243**			

* Threatened species (NSW)

Table 13: Anabat results from a dam outside of Williamsdale, ACT on 7 November 2013*

Species name	Common name	# Calls	Definite	Probably	Possible
Chalinolobus gouldii	Gould's Wattled Bat	134	128	3	3
Chalinolobus morio	Chocolate Wattled Bat	19	16		3
Scotorepens orion	Eastern Broad-nosed Bat	1			1
Tadarida australis	White-striped Sheathtail Bat	30	29		1
Vespadelus darlingtoni	Large Forest Bat	6	5		1
*Vespadelus regulus / Miniopterus schreibersii ocenaenesis**	Eastern Forest Bat / Eastern Bentwing Bat	4			4
Vespadelus vulturnus	Little Forest Bat	21	13	3	5
Unknown		11			
Low		11			
Short		74			
	Total sequences	**311**			

* Threatened species (NSW)

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