Post Construction Grassland Restoration Experiment: Flora Monitoring Results

2009 – 2011

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Document History and Status

Revision	Reviewed By	Approved By	Date Approved	Revision Type
1	Z Hall	SPA Project Manager	25/10/2011	Final

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Purpose

The purpose of this document is to:

- Describe the general approach proposed by the Alliance to undertake flora monitoring on the Sheoak Grassland Restoration experiment;
- Summarise the results of the flora monitoring of the Sheoak Grassland Restoration experiment; and
- Provide recommendations for further monitoring and management actions.

The purpose of flora monitoring as a part of the Grassland Restoration experiment is to:

- Document the change in species cover and composition of both native and introduced flora species over time;
- Document the variation in inter-tussock distances between the experimental plots over time; and
- Document the success of the different methods of reinstatement utilised during the Grassland Restoration experiment.

Abbreviations

Term	Description
Alliance	Sugarloaf Pipeline Alliance
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts (now DESEWPC)
DSE	Victorian Department of Sustainability and Environment
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
EMP	Environmental Management Plan
EMS	Environmental Management Strategy
EPBC	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FFG	Victorian *Flora and Fauna Guarantee Act 1988*
GSM	Golden Sun Moth
HLPS	High-lift Pump Station
ROW	Construction Right of Way
SLPA	Sugarloaf Pipeline Alliance (the 'Alliance')

1 Introduction

The Golden Sun Moth (*Synemon plana*) (GSM) occurs in grasslands and open grassy woodlands in south-eastern mainland Australia. The native grassland and grassy woodland habitats used by the GSM are amongst the most threatened of all vegetation types in Australia, with more than 99.5% estimated to have been grossly altered or destroyed (DEWHA 2009, Kirkpatrick et al. 1995, Lunt 1991). The GSM is generally found in grassy habitats that are dominated by native grass species, but they have also been occasionally found within areas dominated by non-native grasses. The species is listed as 'critically endangered' on the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999,* 'threatened' on the Victorian *Flora and Fauna Guarantee* (FFG) *Act 1988* and 'critically endangered' on the Department of Sustainability and Environment (DSE) *Advisory List of Threatened Invertebrate Fauna in Victoria* (DSE 2009).

In late 2008, targeted surveys undertaken by the Sugarloaf Alliance (the 'Alliance') identified the presence of flying adult GSM at a number of locations along the proposed Construction Area alignment for the Sugarloaf Pipeline Project ('the Project'). Most observations were within the 3-5 km stretch of the alignment south of Yea, including the property proposed to contain the Sheoak High Lift Pump Station (HLPS)[1].

One of the post construction monitoring experiments designed to both help mitigate the impacts of the project on GSM, and to further develop scientific understanding of the species was the Sheoak Grassland Restoration experiment (SLPA 2009ab).

[1] The Sheoak property is owned by Melbourne Water; a member of the Sugarloaf Pipeline Alliance.

2 Establishment

The Sheoak Grassland Restoration experiment was established at the Sheoak property in the re-instated area following construction of the pipe in October 2009 according to the requirements outlined in section 7.1.2 of the Fauna Management Program - Sheoak High Lift Pump Station (SPLA 2009a). The experimental design comprised a total of 60 3 x 3 m plots, with 10 replicates of the following 'treatments':

- Control – plots located in unaffected grassland adjacent to the ROW;
- Subsoil – plots reinstated to subsoil only with topsoil removed;
- Natural Regeneration – plots re-instated with top-soil but no other action;
- Direct Seeding – plots re-instated with topsoil and seed collected from the Sheoak property;
- Tubestock planting – plots re-instated with topsoil and tubestock (36 per plot) comprising species in pre-clearance grasslands at the site as follows
    - *Austrodanthonia setacea* 12 – 13 plants per plot;
    - *Austrostipa rudis* var. *rudis* 7 – 8 plants per plot;
    - *Aceana echinata* 3 plants per plot;
    - *Microlaena stipoides* var. *stipoides* 4 – 5 plants per plot;
    - *Lomandra longifolia* 3 – 4 plants per plot;
    - *Juncus amabilis* 3 – 4 plants per plot;
    - *Elymus scaber* var. *scaber* 1 – 2 plants per plot; and
- Tussock replacement – plots reinstated with topsoil and tussocks (*Austrostipa* sp., *Austrodanthonia* sp., *Juncus* sp.) that were salvaged from the site prior to the site being cleared. Tussocks were randomised across plots. Approximately 40 tussocks were reinstated into each plot.

The 50 treatment plots (all except the 10 controls) were randomly allocated to one of the five treatments. The location and layout of the plots are shown in Appendix A. Flora monitoring has been undertaken seven times to date.

Tussocks were collected for the tussock replacement experiment in March 2009 and stored in wooden boxes on the Sheoak property until October 2009. During this time, many of the collected tussocks entered a dormant phase and weeds germinated and became dominant within the boxes. Despite this all tussocks were placed back into the plots, however, it was not possible to determine the exact number of tussocks and species returned to each plot but is between 35 and 45 per plot.

Due to the late spring establishment of the experiment, an irrigation system was set up on all plots with the exception of the controls. All plots were watered twice weekly, or at greater frequency if deemed necessary until April 2010.

A decision was made to delay the direct seeding experiment until autumn 2010 as the prospect of a hot summer would compromise the effectiveness of this treatment. Unfortunately, seed collected by contracted seed collectors in 2009 was not viable and appropriate seed complying with the requirements of the approved management program (SPLA 2009b) could not be sourced elsewhere. This treatment was therefore discontinued and incorporated into the natural regeneration treatment which now constitutes 20 plots. 10 plots from these 20 will be randomly selected for the final analyses.

3 Methods

Monitoring was undertaken in accordance with the methodology outlined in the Golden Sun Moth Overarching Document (SLPA 2009).

Monitoring included an assessment of the following factors:

- Full species list including native and introduced species;
- Percentage cover of each species within each experimental plot;
- Percentage cover of each life form within each experimental plot (e.g. graminoids, forbs);
- Percentage cover of bare ground within each experimental plot;
- Vertical structure of each life form within each experimental plot; and
- Inter-tussock distance as measured at five random points (four quadrants per point) within each experimental plot (i.e. 20 points per plot).

The dates of each round of flora monitoring for the grassland restoration experiment are documented in Table 1 below.

Table 1 Flora monitoring undertaken to date for the Grassland Restoration Experiment

Assessment type	Date
Assessment 3 months after establishment	January 2010
Assessment 6 months after establishment	April 2010
Assessment 9 months after establishment	July 2010
Assessment 12 months after establishment	October 2010
Assessment 15 months after establishment	January 2011
Assessment 18 months after establishment	April 2011
Assessment 21 months after establishment	July 2011

4 Compliance with Management Plans

This report outlines the vegetation monitoring undertaken in accordance with the measures outlined in section 7.1.2.5 of the Fauna Management Program - Sheoak High Lift Pump Station (SPLA 2009a). Some changes to the monitoring became necessary when considering the practicalities of collecting the data in the field, with the changes being:

- No recording of tussock density or tussock condition and survivorship. These measures proved impractical to measure reliably in the field due to difficulty in identifying individual tussocks in the majority of instances. Although tussocks could easily be identified in the surrounding grasslands, this proved extremely difficult to determine in regenerating plots and did not provide useful or comparable data; and
- Structure was measured in four classes which are indicative of plant form and maturity rather than 10 cm intervals which proved impractical to measure in the field. The height intervals were 0–10 cm, 10-30 cm, 30-100 cm and over 100 cm.

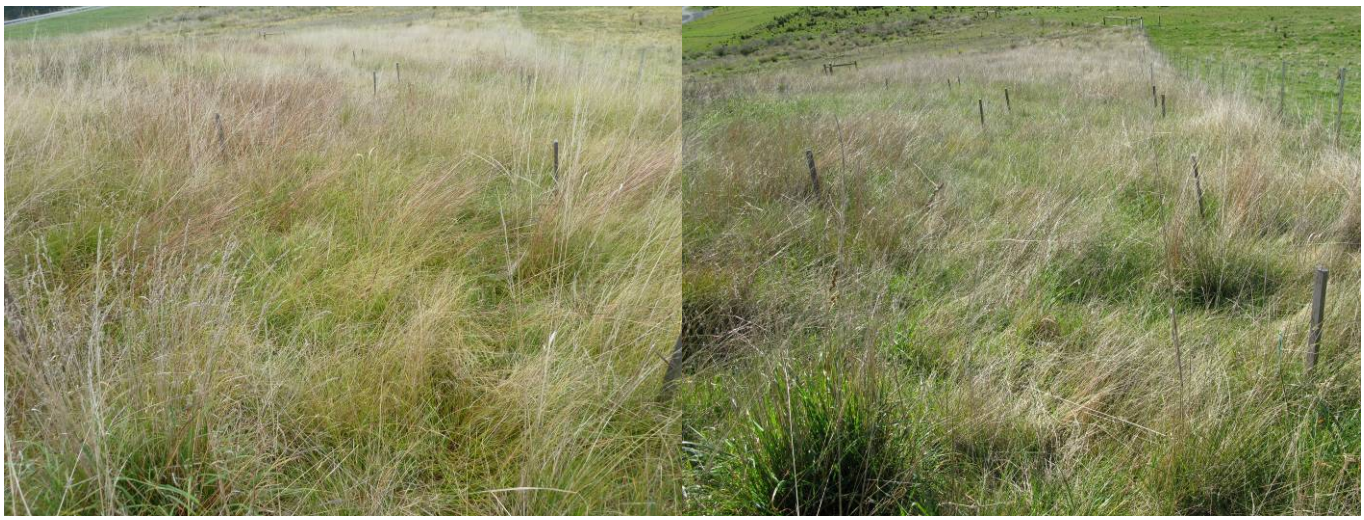
The required photographs and monitoring data has been collected at three monthly intervals with this report describing changes noted in the latest round of monitoring (July 2011). Examples of photographs taken are included in this report and an example of the monitoring sheet illustrating the collected data is included in Appendix B.

5 Results

The data collected to date have not been statistically analysed (which will occur at the end of the experiment), however, key findings are evident for each of the established treatments and are discussed in the sections below. This report highlights changes evident since the previous report was written following the April 2011 round of monitoring.

5.1 Control

It was noted in the last report (for observations to April 2011) that the control plots, whilst not changing noticeably in species composition, had shown an increase in recruitment, likely as a result of the high rainfall in the previous year. These recruits had grown on in the three months to July during the active growth period for many grasses. The species composition and cover were virtually identical to previous periods, including the relative cover of native and introduced species. It is worth noting that the high levels of growth shown in the photos is in relatively stark contrast to the surrounding area where grazing has kept the biomass levels lower than within the experimental areas.

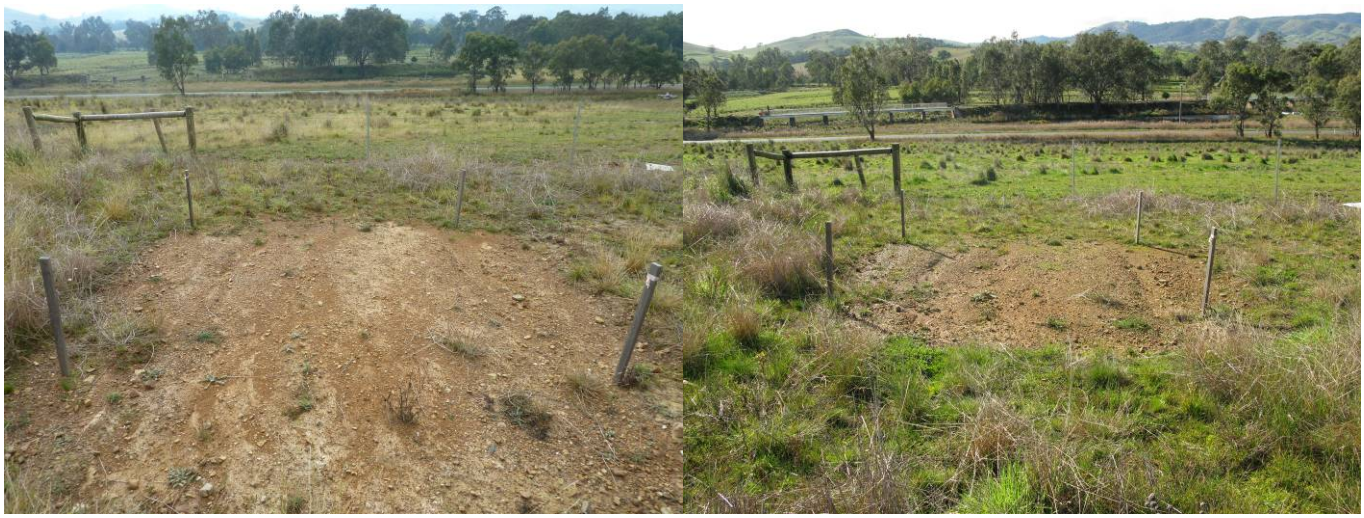


April 2011 July 2011

Control (no clearing) (Plot 51)

5.2 Sub-soil Reinstatement

The previous report (to April 2011) predicted that there would be an increase in cover in these plots based on a number of seedlings noted during the April round of monitoring. Whilst there has been some measurable increase in overall vegetation cover, these plots are still relative bare in relation to the rest of the experimental plots and the surrounding areas (see photos below). One theory to be tested by these plots is that the low nutrient status of the subsoil and the removal of the weed seed-bank present in the topsoil would favour growth of native species. Based on the data collected to date, there appears to be little evidence that native species are favoured.

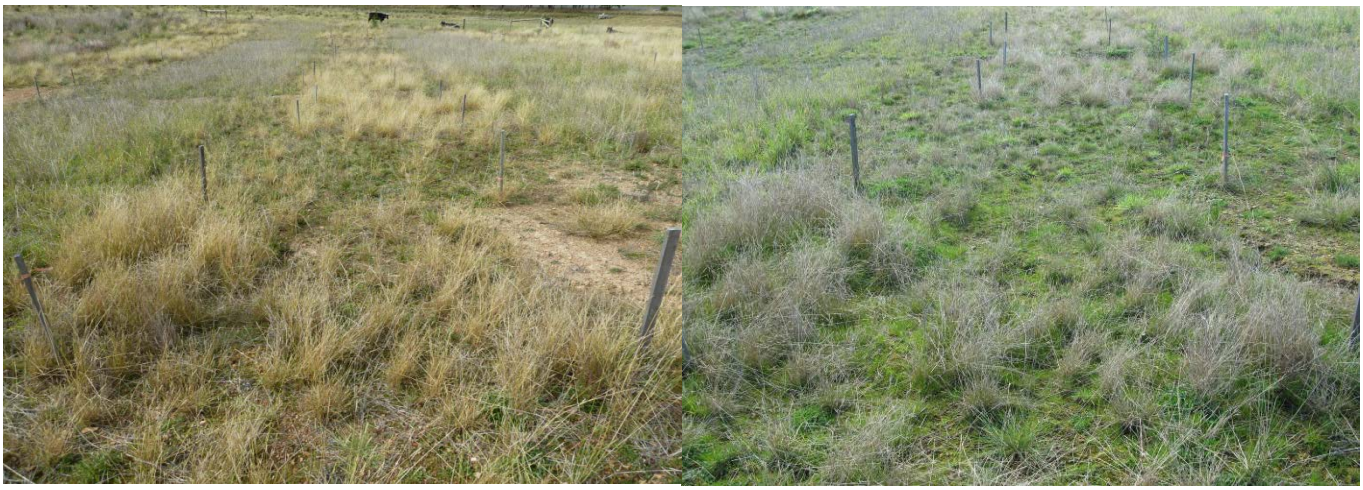


April 2011 July 2011

Sub soil Reinstatement (Plot 1)

5.3 Natural Regeneration

There was little noticeable change in either species composition or cover on these plots between April and July when the latest round of monitoring occurred. The increase in native species noted in the previous monitoring report was maintained, and the growth of grass seedlings has progressed during what is the active growth season for many grasses. Importantly, the cover attributable to the weed *Arctotheca calendula* (Cape Weed), which was a dominant plant across a number of these plots at the same time last year, is relatively low for this round of monitoring. This species is present across almost all plots, but the growth of other species and the reduction in the amount of bare ground has contributed to the relatively low growth of this problematic weed.

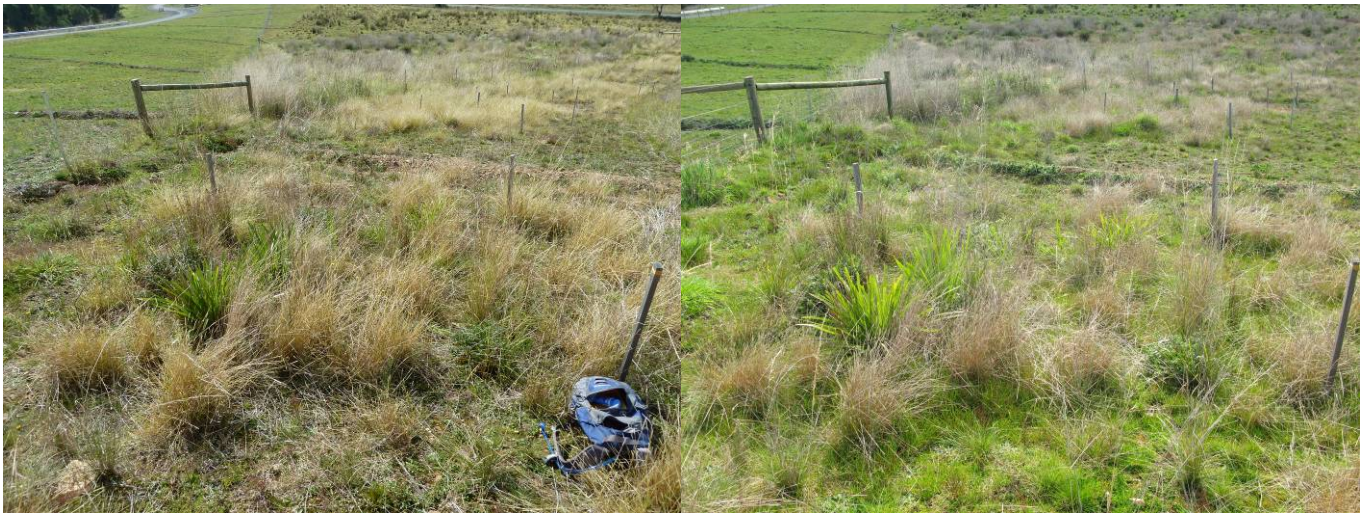


April 2011 July 2011

Natural Regeneration (Plot 20)

5.4 Tubestock Planting

The high survivorship of the planted species has been maintained in these planted plots and these plants are now very well established. The grasses planted have had one season of seeding to date and a number of positively identifiable recruits of the planted native species could be identified in the latest round of monitoring, although a number of introduced species were also noted as recruiting within the plots. The growth of the new grass seedlings, both native and introduced species, is filling in the gaps between the established tussocks and there is a noticeable increase in the cover across these plots, though little identifiable change in the species diversity noted in the previous reports.

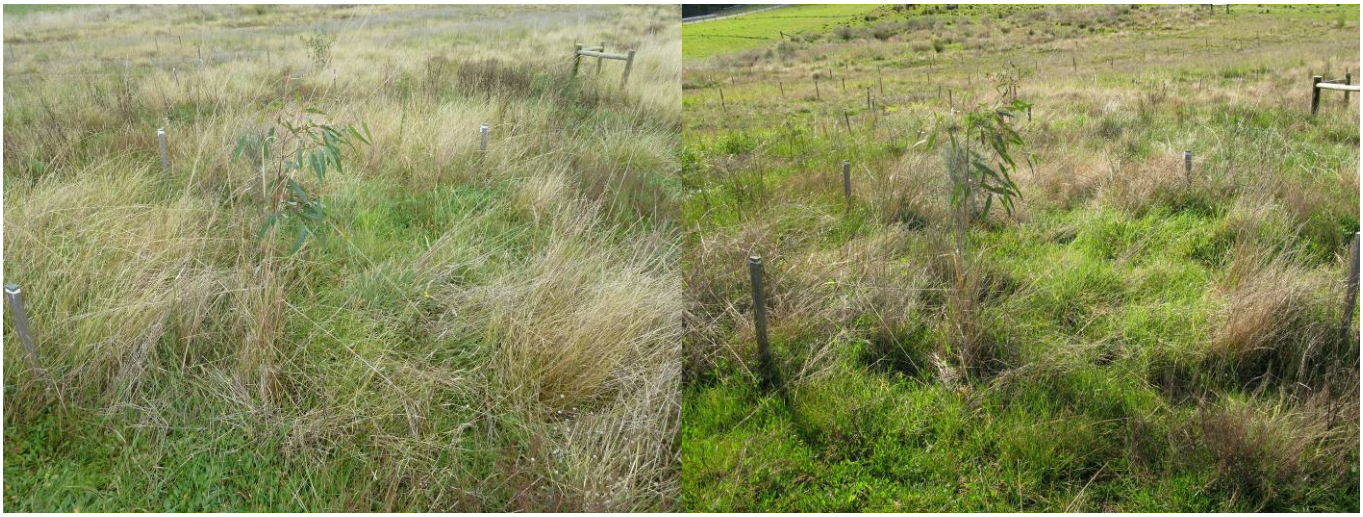


April 2011 July 2011

Tubestock planting (Plot 22)

5.5 Tussock Replacement

As noted in previous reports, the tussock replacement plots have yielded mixed results and little has changed up to the latest round of monitoring. These plots have the highest cover of all the plots, although this is dominated by introduced species, whilst the species diversity is also highest of the various treatments, particularly of native species. The prevalence of the native grass *Microlaena stipoides* var. *stipoides* (Weeping Grass) which was noted in the previous report has increased and on some plots this is now the dominant grass. This species tends to favour wetter conditions compared to the other native species observed on the site and this dominance may be a response to the wetter conditions. As can be seen in the photos below, a number of these plots include seedlings of *Eucalyptus camaldulensis* (River Red-gum), which is likely a result of the tussocks being stored under trees of this species during the construction phase of the project. These trees do form a natural component of the grasslands across the property and the retention of some of these trees following the conclusion of the experiment should be considered.



April 2011 July 2011

Tussock replacement (Plot 29)

5.6 Overall

The major observation in the latest round of monitoring is the growth of new grass seedlings in all plots, which is relatively unsurprising giving that this round has incorporated the major season of growth for most of the grass species observed. The grass seedlings are a mixture of native and introduced grasses and reflect the diversity of grasses which occur within the plots. Other than the consequent increase in cover and reduction in inter-tussock distance, there are few changes of note and the conclusions that can be made at this stage are largely unchanged from the previous report, namely:

- The soil seed bank was apparently dominated by introduced species;
- Tussock replacement does re-introduce a range of native species more quickly than other treatments, but that is moderated by the re-introduction of many introduced species at the same time;
- Additional monitoring is required to determine longer term effects of treatments.

6 Next Steps

6.1 Future Monitoring works

There is one more round of monitoring of this experiment required, in October 2011, after which the data will be analysed and the relative success of the treatments quantifiably assessed. However, it appears that conclusive results are only likely to be available from three or more years of monitoring, rather than two years, particularly for treatments. If additional monitoring were to be undertaken, the most appropriate times of year are likely to be October and January.

The next round of monitoring is due to be undertaken in October 2011.

References

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2009) *Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (*Synemon plana*) January 2009.* http://www.environment.gov.au/epbc/publications/pubs/golden-sun-moth.rtf Accessed 24 June 2009@15.47:22

Kirkpatrick, J.B., K. McDougall & M. Hyde (1995) Australia's most threatened ecosystem – the southeastern lowland native grasslands. Surrey Beatty and Sons, Chipping North, NSW.

Lunt, I.D. (1991) Management of lowland grasslands and grassy woodlands for nature conservation: a review. Victorian Naturalist 108, (3): 56-66.

Sugarloaf Pipeline Alliance (SLPA) (2009a) *Fauna Management Program – Sheoak High Lift Pump Station Document No. SPA-EPR-SH-ENV-0005-rev 0–version 00.* Prepared as part of the Sugarloaf Pipeline Project.

Sugarloaf Pipeline Alliance (SLPA) (2009b). *Golden Sun Moth Overarching Document. Document No. SPA-XXX-GL-ENV-0001-rev B-version 01.* Prepared as part of the Sugarloaf Pipeline Project.

Appendix A

Location of sites within Sheoak Property

362000

28

324

326

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

362000

Sugarloaf Pipeline Project

Figure - Grassland Resoration Experiment

SUGARLOAF PIPELINE ALLIANCE

GDA94 MGA55

N

0 7.5 15 30 45

Metres

Legend

- Grassland Restoration Plot

EVC within Sheoak

- 175-GC
- 68/R
- NNV

- Sheoak Construction ROW
- Property
- Easement

NNV = Non-Native Vegetation

Appendix B

Example of completed monitoring form

31 21633 13: Sheoak Grassland Restoration Floristic Survey

Date	5/10/10	Observers	TJW / DJK	Time started	12:50pm
Site no. / ID	6	Photo #	7955	Quadrat dimensions 3 x 3 m	
Control site	Y / (N)	**Overall cover abundance of vegetation**		6	

1. Species abundance, Vertical structure and Overall composition

+	1	2	3	4	5	6
<1%	<5%	5<15%	15<25%	25-50%	50-75%	75-100%

Turns replacement
* 33 spp!!

Native species (tick if present)	√?	Cover
Acaena sp.		
Austrodanthonia caespitosa		
Austrodanthonia duttoniana		
Austrodanthonia setacea		
Austrodanthonia sp.		
Austrostipa rudis var. *rudis*		
Austrostipa sp.	✓	+
Bothriochloa macra		
Cassinia sp.		
Chamaesyce drumondii		
Convulvus erubescens		
Convulvus sp.		
Crassula sp.	✓	+
[illegible]modium varians		
[illegible]ondra repens		
Elymus scaber var. *scaber*		
Epilobium hirsutum		
Eucalyptus camaldulensis	✓	+
Eucalyptus sp.		
Glycine tabacina		
Juncus bufonius	✓	+
Juncus flavidus		
Juncus pallidus		
Juncus sp.	✓	+
Lomandra filiformis		
Lomandra longifolia		
Lythrum hyssopifolia	✓	+
Microlaena stipoides var. *stipoides*	✓	+
Oxalis perennans	✓	+
Pseudognaphalium luteoalbum		
Rumex brownii		
Isolepis	✓	+
Hyper gramin	✓	+

Introduced species (tick if present)	√?	Cover
Acetosella vulgaris	✓	1
Agrostis capillaris		
Agrostis stoloniferous		
Arctotheca calendula	✓	3
Aphanes arvensis	✓	+
Avena sp.	✓	1
Bromus catharticus		
Bromus diandrus	✓	+
Bromus hordeaceus	✓	+
Chenopodium album		
Chenopodium pumilio		
Cirsium vulgare		
Cynodon dactylon var. *dactylon*	✓	+
Dactylis glomerata	✓	+
Erodium sp.		
Holcus lanatus	✓	1
Hordeum sp.	✓	+
Hypochoeris radicata	✓	+
Lactuca serriola		
Lolium sp.	✓	3
Lotus sp.	✓	+
Lythrum juncea		
Paspalum dilatatum		
Phalaris aquatica		
Phalaris minor		
Poa annua	✓	+
Polygonum aviculare	✓	+
Romulea rosea	✓	+
Rumex crispis		
Rumex sp.		
Setaria parviflora	✓	+
Solanum nigrum s.s.		
Sonchus sp.		
Trifolium repens		
Trifolium sp.	✓	2
Vulpia sp.	✓	2
Unknown Introduced Poaceae		
Sonchus asper	✓	+
Unknown Asteraceae (latex)	✓	+
Sonchus olar	✓	+
Trifolium ~~[illegible]~~ camp/dubi (yellow flowers <20 flowers)	✓	+

Native graminoids % cover (inc.Juncus, Lomandra,	1	Introduced graminoids % cover	5
Native forbs % cover	+	Introduced forbes % cover	4
Bryophytes/Lichens % cover	1	Bare ground % cover	1
Litter % cover	+	Overall % cover of introduced species	6

2. Vertical Structure

	0-10cm	10-30cm	30-100cm	>100cm
Native grasses (Poaceae)	+	+	+	–
Introduced grasses	5	2	1	+
Native sedge or rush (eg. *Lomandra, Juncus*)	+	–	–	–
Introduced sedge or rush	–	–	–	–
Native forbs	+	+	–	–
Introduced forbs (inc. *R.rosa*)	4	2	1	–

3. Inter tussock distance (irrespective of whether tussock native or introduced, alive or dead) for 10 random points within treatment/control area. Note: SM = Soil Moisture

* Distance (cm) to edge of closest tussock (inc. Juncus) **with diameter of 3 cm** (if Cynodon, distance to closest point where plant is completely attached, not just a rooting point along a rhizome).

17

1	Species	Distance*
1	Hole lana	11
2	Micr stip	9
3	Lolium sp.	10
4	"	16

24

2	Species	Distance*
1	Lolium sp.	11
2	~~Brom~~ "	27
3	Seta parv	6
4	Lolium sp.	19

73

3	Species	Distance*
1	Lolium sp.	24
2	Avena sp.	11
3	Lolium sp	11
4	"	16

72

4	Species	Distance*
1	Micr stip	6
2	Lolium sp.	10
3	"	23
4	UK	16

47

5	Species	Distance*
1	Dact glom	10
2	Lolium sp.	9
3	"	13
4	Avena sp.	16

Random numbers (start from the point using first and second number of site ID e.g. #43 is 4 for first number and 3 for second number. Update from Random number 2.xls for each monitoring period).

Second number	First Number: 0 (and 60)									
1	5	5	5	2	2	4	4	4	3	7
2	6	1	1	3	7	0	8	2	8	3
3	9	8	8	6	2	6	7	3	0	4
4	4	2	3	7	6	0	4	3	5	1
5	4	3	3	1	1	8	6	5	3	7
6	1	8	4	6	2	8	5	4	8	0
7	0	3	5	5	8	5	3	3	7	6
8	6	1	9	1	3	8	2	1	8	1
9	4	4	8	7	8	4	7	1	7	4
0	1	7	7	3	4	7	1	7	2	4

Second number	First Number: 1									
1	9	5	4	7	4	8	7	5	7	3
2	8	7	5	3	6	4	4	4	1	3
3	3	2	5	4	8	4	7	4	5	5
4	2	7	1	5	7	2	8	4	5	6
5	9	6	4	5	6	5	5	5	7	6
6	5	3	6	1	1	6	2	4	6	3
7	5	2	4	4	8	3	0	1	2	8
8	4	0	2	4	5	3	4	6	8	4
9	1	0	8	3	5	8	7	3	6	7
0	7	2	6	0	8	6	8	7	6	3

Second number	First Number: 2									
1	5	1	3	1	3	3	0	6	2	3
2	8	1	3	5	8	4	0	5	8	7
3	1	4	3	4	3	2	7	1	3	0
4	1	4	2	4	7	6	7	4	8	2
5	2	1	9	2	1	7	2	8	2	3
6	2	3	5	7	9	1	7	2	9	3
7	5	1	7	4	8	6	1	3	2	1
8	1	4	7	4	1	5	3	1	7	1
9	2	5	8	5	5	6	9	7	9	5
0	4	3	4	3	7	6	9	8	6	0

Second number	First Number: 3									
1	8	2	5	7	6	4	1	6	9	4
2	3	4	5	3	4	3	3	8	1	1
3	7	6	2	4	1	4	5	3	2	2
4	3	6	3	1	5	2	7	8	5	4
5	2	3	3	6	6	1	3	2	6	7
6	5	7	3	4	3	4	7	2	5	7
7	6	7	9	7	2	7	5	7	2	4
8	4	2	6	7	8	4	7	7	6	3
9	7	1	2	5	5	2	8	2	0	3
0	6	3	6	7	2	8	1	8	7	0

Second number	First Number: 4									
1	8	7	6	1	4	7	4	3	6	0
2	8	1	0	5	4	7	4	2	7	0
3	7	3	5	3	3	0	0	5	1	2
4	7	4	2	6	1	7	3	3	0	0
5	7	1	2	2	9	8	2	5	4	5
6	2	6	2	3	1	6	4	1	1	4
7	0	6	4	6	4	2	1	3	0	2
8	5	8	9	0	7	2	0	2	5	2
9	5	4	1	1	3	3	3	6	3	4
0	2	0	2	6	1	4	3	5	2	6

Second number	First Number: 5									
1	7	4	7	7	4	1	4	6	3	2
2	6	5	3	7	6	1	1	8	6	6
3	7	3	3	3	8	6	3	5	3	1
4	4	4	0	1	5	1	8	6	7	1
5	4	2	7	6	4	4	9	0	1	8
6	3	6	2	5	6	1	4	1	7	3
7	3	4	7	1	1	2	1	7	4	8
8	5	7	1	6	9	7	8	3	7	2
9	9	3	3	6	1	4	8	6	3	4
0	3	3	9	2	2	6	7	5	3	8