Canberra | Sydney

Planting Monitoring Report M2G Construction Corridor (Late Spring 2012)

Tom O'Sullivan
March 2013

Ref: 1305

Blue Gum Ecological Consulting
PO Box 3568, Weston Creek, 2611, ACT
P: (02) 6140 2570 / M: 0488 227 287 / E: tosullivan@bluegumeco.com.au

Contents

Figures

Tables

Plates

1 Introduction

1.1 Background

Eco Logical Australia (ELA) was commissioned by ACTEW Corporation (ACTEW) to deliver terrestrial ecological services as required by the environmental approval process for the Murrumbidgee to Googong Water Transfer Project (M2G). A component of that service is to provide post-construction rehabilitation monitoring in accordance with the Landscape Rehabilitation Management Plan (LRMP) for the M2G project, which has been undertaken by Blue Gum Ecological Consulting on behalf of ELA.

The following report contains the results of the initial monitoring study for rehabilitation planting[1] within the construction corridor and structure sites. This is the first in a series of bi-annual reports that will record the progress of tree, shrub and herbaceous plantings.

1.2 Study area

The study area extended from the Low Lift Pump Station (LLPS) at Angle Crossing on the Murrumbidgee River to the discharge facility at Burra Creek, situated near the intersection of Williamsdale and Burra Roads. The pipeline construction corridor has a total length of about 12km (Figures 1-3, Appendix 1).

The study area falls entirely within the Williamsdale (8726-4N) 1:25,000 Map Sheet and is part of the South-east Highlands Bioregion (Commonwealth of Australia 2012).

1.3 Study aims

The aim of the study is to monitor representative sub-sets of tree, shrub and herbaceous plantings and provide an indicative measure of planting success across the entire M2G construction site and compare these results against desired performance targets.

1.4 Planting regime

Approximately 5,000 tree and shrub seedlings (Hiko Cells, 45Lt and 300SR containers) and 136,000 herbaceous tube-stock (Viro Cells) were planted within the M2G construction corridor and structure sites during Spring 2011 and Autumn 2012. Native plantings comprised: nine tree species; eleven shrub species; eight grass species; five forb species; and six sedge and rush species. In

[1] Concurrent plot-based sampling is being undertaken to monitor seeding rehabilitation of the construction corridor and is presented in separate series of reports (i.e. *Rehabilitation Monitoring (Spring 2012) Report: M2G Construction Corridor. Blue Gum Ecological Consulting December 2012*).

addition, five non-native tree and shrub species were also planted in the eastern sections of the construction corridor at the request of landowners. An inventory of planted species and the approximate number of individuals in each category are provided in Table 1.

Species selected for planting, as well as planting distributions, were guided by former vegetation type, spatial characteristics of the vegetation and total vegetation loss resulting from construction activity. Additional woody plantings were included as part compensatory measure for habitat loss as well as for amenity.

Groundcover rehabilitation involved a multi-phased approach, which included: the reinstatement of top-soil; initial widespread seeding of native and mostly sterile non-native grasses (this component is monitored separately); and subsequent herbaceous and woody species planting regime, which is examined herein. This latter component included the placement of herbaceous tube-stock over an estimated 30,000m^2 with a planting rate of between 2.5 and 5 plantings per 1m^2.

A performance target of 90% survival rate was set for all planted tube-stock.

Table 1: Species planted within the M2G construction corridor and structure sites. Total plantings for each category are indicative.

Scientific Name	Common Name	Total planting pipeline corridor	Total planting structures	Total
Native tree				
Eucalyptus blakelyi	Blakely's Red Gum			
Eucalyptus bridgesiana	Apple Box			
Eucalyptus mannifera	Brittle Gum			
Eucalyptus melliodora	Yellow Box			
Eucalyptus polyanthemos	Red Box			
Eucalytus pauciflora	Snow Gum			
Eucalyptus rubida	Candlebark Gum			
Eucalyptus viminalis	Manna Gum			
Callitris endlicheri	Black Crypress Pine			
Sub-total		**624**	**148**	**772**
Native shrub				
Acacia dealbata	Silver Water			
Acacia genistifolia	Spreading Wattle			
Acacia rubida	Red Stemmed Wattle			
Acacia siculiformis	Dagger Wattle			
Banksia marginata	Silver Banksia			
Bursaria spinosa	Hairy Bursaria			
Leptospermum myrtifolium	Myrtle Tea Tree			
Leptospermum obovatum	River Tea Tree			
Kunzea ericoides	Burgan			
Cassinia longifolia	Shiny Cassinia			
Indigofera australis	Austral Indigo			

Scientific Name	Common Name	Total planting pipeline corridor	Total planting structures	Total
Sub-total		**3,016**	**1,055**	**4,071**
Non-native tree/shrub				
Ulmus parvifolia	Chinese Elm			
Quercus robur 'Fastigiata'	Upright English Oak			
Castane sativa	European Chestnut			
Populus spp.	Poplar (TBC)			
Pyrus ussuriensis	Manchurian Pear			
Sub-total		**19**	**-**	**19**
Grass				
Austodanthonia carphoides	Short Wallaby Grass			
Austrostipa scabra	Spear Grass			
Bothriochloa macra	Red Grass			
Elmyus scaber	Wheat Grass			
Microlaena stipoides	Weeping Grass			
Themeda australis	Kangaroo Grass			
Chloris truncata	Windmill Grass			
Poa labillardieri	Tussock Grass			
Sub-total		**75,542**	**9,303**	**84,845**
Forb				
Chrysocephalam apiculatum	Yellow Buttons			
Convolvulus erubescens	Australia Bindweed			
Desmodium varians	Slender Tick Trefoil			
Leptorhynchos squamatus	Scaly Buttons			
Wahlenbergia stricta	Tall Bluebell			
Sub-total		**21,746**	**1,340**	**23,086**
Sedge and rush				
Carex apressa	Tall Sedge			
Eleocharis acuta	Common Spike Rush			
Isolepsis fluitans	Floating Club Rush			
Pragmites australis	Common Reed			
Juncus usitatus	Common Rush			
Lomandra longifolia	Mat Rush			
Sub-total		**21,085**	**7,292**	**28,377**
Total native trees/shrub		**3,640**	**1,203**	**4,843**
Total non-native tree/shrub		**19**	**-**	**19**
Total herbaceous		**118,373**	**17,935**	**136,308**
Total		**122,032**	**19,138**	**141,170**

2 Methods

2.1 Monitoring regime

Permanent planting sites will be established within the M2G construction corridor and structure sites and monitored on a bi-annual basis (Autumn and Spring/Summer periods) over a period of at least two-years post-construction.

The current (initial) planting monitoring was conducted on 5 and 6 November 2012.

2.2 Selection of monitoring sites

Twenty-five monitoring (sample) sites were selected from approximately 280 planting arrays (about 200 herbaceous[2] and 80 tree and shrub sites) within the M2G construction corridor and structure sites (Figures 1 – 3, Appendix 1). Twelve sample sites were established in the ACT and thirteen in NSW (Table 2).

Planting categories comprised Woody (tree and shrub) plantings were monitored at twelve sample sites (coded TSP), and herbaceous (grasses, forbs, sedges and rushes) plantings at thirteen sample sites (coded HP), see Table 2.

Sample sites in each planting category were spaced between 220 m and 1,935 m apart within the western and central sections of the construction corridor. This interval increased to 2,875 m in the eastern section in response to a reduced planting frequency – reflecting the shift from native to non-native vegetation. Sites were selected to include variations in landform: such as slope and aspect, and influences of soil moisture and land use.

Each site was marked with a single red-tipped stake, at which grid co-ordinates (using a hand-held Garmin GPS 60 set to WGS 84) and photograph taken.

Table 2: Planting monitoring sites. Sites are numbered sequentially from TSP1, IDs indicate site category i.e. TSP = tree & shrub planting; HP = herbaceous plantings. TSPs are shaded in grey.

Site Sequence	Site ID	Approx. chainage from LLPS	Co-ordinates	Jurisdiction	Property
1	TSP1	250	691345 - 6060236	ACT	PCS (Murrumbidgee R. corridor)
2	HP1	750	691706 - 6060396	ACT	PCS (Murrumbidgee R. corridor)
3	TSP2	1,025	691964 - 6060519	ACT	PCS (Murrumbidgee R. corridor)
4	HP2	1,300	692219 - 6060594	ACT	ACTEW leasehold
5	TSP3	1,350	692256 - 6060605	ACT	ACTEW leasehold
6	HP3	1,550	692459 - 6060660	ACT	ACTEW leasehold
7	TSP4	1,900	692592 - 6060707	ACT	ACTEW leasehold
8	HP4	1,770	692797 - 6060687	ACT	ACTEW leasehold

[2] Herbaceous monitoring sites varied in shape and size (ranging from about 40 m^2 to over 400 m^2) and density of planted material. A few so-called marginal planting sites (drainage lines) exceeded 3,000 m^2 in area.

Site Sequence	Site ID	Approx. chainage from LLPS	Co-ordinates	Jurisdiction	Property
9	TSP5	2,325	693226 - 6060578	ACT	ACTEW leasehold
10	HP5	2,550	693442 - 6060534	ACT	ACTEW leasehold
11	TSP6	2,650	693528 - 6060505	ACT	ACTEW leasehold
12	HP6	2,780	693683 - 6060542	ACT	ACT Conservation zone
13	TSP7	3,040	693927 - 6060542	NSW	Smith
14	HP7	3,200	694084 - 6060511	NSW	Smith
15	HP8	3,650	694525 - 6060591	NSW	McDonald
16	HP9	4,050	694890 - 6060767	NSW	McDonald
17	HP10	4,475	695248 - 6060569	NSW	McDonald
18	TSP8	4,975	695663 - 6060392	NSW	Lonergan
19	TSP9	5,475	696175 - 6060305	NSW	Lonergan
20	HP11	6,175	696826 - 6060127	NSW	Codd / Howarth
21	TSP10	6,425	697084 - 6060204	NSW	Johanson
22	HP12	7,550	698003 - 6060755	NSW	Devitt
23	HP13	8,250	698541 - 6061210	NSW	Boss
24	TSP11	9,300	699277 - 6061925	NSW	Latimer
25	TSP12	11,900	701346 - 6063099	NSW	Discharge facility

***Site Sequence = in order of occurrence from the HLPS.**

2.3 Survey techniques

The structural form, low planting frequency and low species diversity made quantifying woody plantings a far simpler process than the intermixed assortment of herbaceous groundcover vegetation. Moreover, there was little confidence in the ability to uniformly discriminate between planted and non-planted individuals of the same species, and therefore provide a quantifiable measure of herbaceous planting success. Consequently, different monitoring strategies were required for the two planting categories, which are discussed in the following sections.

2.3.1 Tree and shrub planting

Quantitative sampling was conducted for woody tube-stock (trees and shrubs) at twelve sample sites. Specimens were identified, counted and their morphological characteristics noted according to the following criteria:

- *Good Health* - indicated by vigorous growth, fully leaved and showed expected colouration for that species;
- *Poor Health* - stems or leaves discoloured, foliage limited or easily dislodged, specimen may appear stunted or heavily browsed; or,
- *Dead* - absence of leaves, stem discoloured or desiccated, no visable vegetative material.

2.3.2 Herbaceous (grasses and forbs) planting

As indicated above, isolating planted herbaceous specimens from other non-planted specimens of the same species (which have germinated from either rehabilitation seeding or from pre-existing soil seed bank; or other forms of

vegetative growth) proved difficult and time consuming. It was not possible, therefore, to quantify herbaceous plantings in the same way as for trees and shrubs and a qualitative approach was adopted to measure herbaceous planting performance, albeit a modified one.

All native herbaceous species (planted and non-planted) within each sample site were recorded and their cover abundances estimated using a modified Braun-Blanquet scale. However, the size and shape of sample sites were not uniform or standardised (sample sites conformed to the original configuration of planting plots) and ranged from about 40 m^2 to 400 m^2 in size. This limited the capacity to compare results between sample sites in the same manner as formal plot-based study, as is currently done to monitor seeding rehabilitation. Nevertheless, samples taken were considered representative of both planted tube stock and planting sites, for which the results could be extrapolated, with qualification, to all herbaceous plantings.

3 Results

3.1 Overview

Data for tree and shrub monitoring appears in Section 3.1 and for herbaceous species monitoring in Section 3.2.

Monitoring was conducted on 5 & 6 November 2012 at a total of twenty-five sample sites. Tree and shrub plantings were sampled at twelve sites and herbaceous plantings at thirteen sites. According to the planting regime outlined in the M2G Pipeline Landscape Reinstatement Plan (PLRP) the current monitoring surveys account for approximately 13% of all woody plantings and between 3.6% and 7.2%[3] of all herbaceous plantings, from twelve and thirteen sample sites, respectively.

As explained, in Section 2.3 above, quantifying individual herbaceous plantings proved problematic and a modified qualitative approach was adopted.

3.2 Tree and shrub monitoring

A total of 661 tree and shrub seedlings were monitored from twelve sample sites representing about 13% of the total tree and shrub planting population (see Appendix 2 for full species list and sample site data). Of these, 364 seedlings were in good condition, 188 in poor health and 109 were dead, which represents 55%, 28.5% and 16.5%, respectively, of the total sample (Table 3).

Extrapolating these percentages to the entire planted population (est. 5,000 trees and shrubs) would give 2,750 seedlings in good health; 1,425 in poor health; and 825 dead. Assuming an error of +/- 5% the estimate, of specimens in good health, might be as high as 3,000 or as low as 2,500.

Table 3: Results of tree and shrub monitoring at 12 sample sites.

Site ID	Site Sequence*	Seedling Health			Combined Poor & Dead	Total	% per site	
		Good	Poor	Dead			*Good*	*Poor & Dead*
TSP1	1	69	15	7	22	91	*75.8*	*24.2*
TSP2	3	68	46	13	59	127	*53.5*	*46.5*
TSP3	5	39	39	17	56	95	*41.1*	*58.9*
TSP4	7	19	27	28	55	74	*25.7*	*74.3*
TSP5	9	8	6	2	8	16	*50.0*	*50.0*
TSP6	11	3	10	7	17	20	*15.0*	*85.0*
TSP7	13	14	2	2	4	18	*77.8*	*22.2*
TSP8	18	6	0	3	3	9	*66.7*	*33.3*
TSP9	19	20	3	0	3	23	*87.0*	*13.0*

[3] Figures were based on a planting frequency of between 2.5 to 5 Viro Cells per 1 m^2. Assuming that the average size of each monitoring site was 150 m^2 then the total number of herbaceous plantings at sample sites would range between 4,875 and 9,750 planting cells, which represents between 3.6% and 7.2% of all herbaceous plantings.

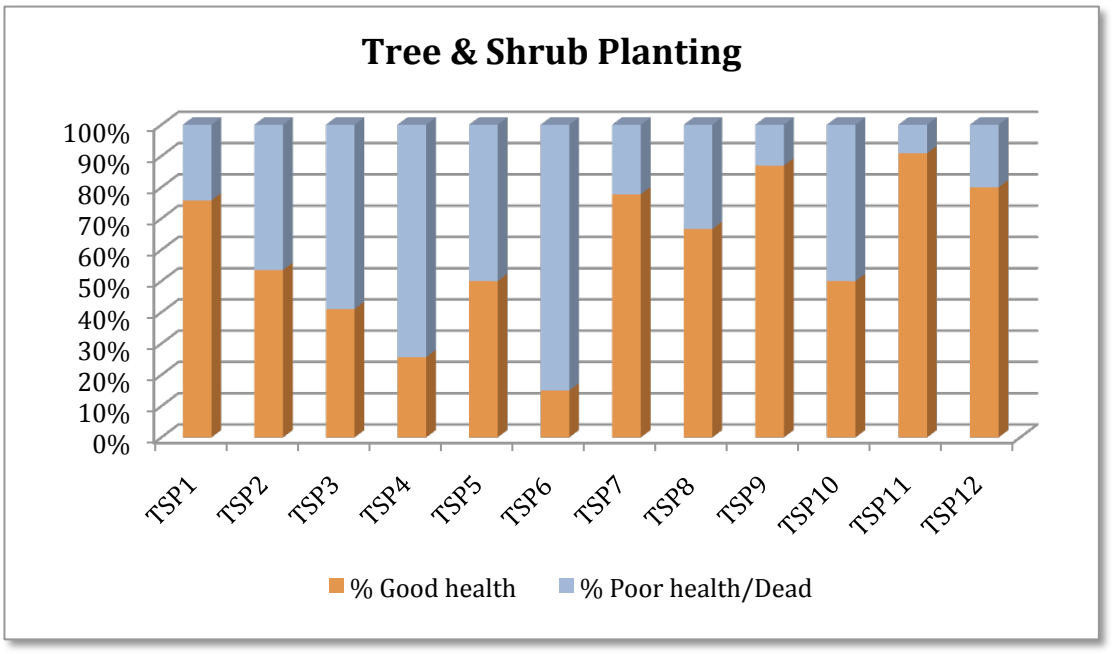
Site ID	Site Sequence*	Seedling Health			Combined Poor & Dead	Total	% per site	
		Good	Poor	Dead			Good	Poor & Dead
TSP10	21	56	31	25	56	112	*50.0*	*50.0*
TSP11	24	10	1	0	1	11	*90.9*	*9.1*
TSP12	25	52	8	5	13	65	*80.0*	*20.0*
Total No.		**364**	**188**	**109**	**297**	**661**		
Total Av		**30.33**	**15.67**	**9.08**	**24.75**	**55.08**		
Total %		**55.07**	**28.44**	**16.49**	**44.93**	**100.00**		

***Site Sequence = combines both TSP and HP monitoring sites in order of occurrence.**

Five sites (TSP1, 7, 9, 11 and 12) exhibited greater than 75% of seedlings in good health and were the best performing sites. Four sites had between 50% and 66% of specimens in good health and the remaining three sites had 42% or less in good health (Chart 1). TSP 6 and TSP 4 were the worst performing sites with 85% and 74.3%, respectively, of specimens either in poor health or dead.

On the strength of these results the performance target of 90% success rate was not met.

Chart 1: Proportions of specimens in good or poor/dead health at each monitoring site.



Summaries of each TSP monitoring site are provided in the following sections.

3.2.1 Monitoring Site TSP1 (1)

Jurisdiction	**ACT**
Co-ordinates	691345 - 6060236
No. of tree & shrub species	**7**
Seedling Health	
Good	69
Poor	15
Dead	7
Total plantings	**91**

TSP1 located W and NW of the HLPS about 250 m from the LLPS, within the Murrumbidgee River Corridor.

NOTE: About 40% of herbaceous plantings along the N batter of the HLPS had been either eaten or removed by herbivores.

N/A

Plate 1: Monitoring Site TSP1

3.2.2 Monitoring Site TSP2 (3)

Jurisdiction	**ACT**
Co-ordinates	691964 - 6060519
No. of tree & shrub species	**5**
Seedling Health	
Good	68
Poor	46
Dead	13
Total plantings	**127**

TSP2 is located within the Murrumbidgee River Corridor, about 1,025 m from the LLPS.

N/A

Plate 2: Monitoring Site TSP2

3.2.3 Monitoring Site TSP3 (5)

Jurisdiction	ACT
Co-ordinates	692256 - 6060605
No. of tree & shrub species	**4**
Seedling Health	
Good	39
Poor	39
Dead	17
Total plantings	**95**

TSP3 is located within the Murrumbidgee River Corridor, about 1,350 m from the LLPS.

N/A

Plate 3: Monitoring Site TSP3

3.2.4 Monitoring Site TSP4 (7)

Jurisdiction	ACT
Co-ordinates	692592 - 6060707
No. of tree & shrub species	**3**
Seedling Health	
Good	19
Poor	27
Dead	28
Total plantings	**74**

TSP4 is located about 1,900 m from the LLPS within the ACT.

N/A

Plate 4: Monitoring Site TSP4

3.2.5 Monitoring Site TSP5 (9)

Jurisdiction	**ACT**
Co-ordinates	693226 - 6060578
No. of tree & shrub species	**2**
Seedling Health	
Good	8
Poor	6
Dead	2
Total plantings	**16**

TSP5 is located about 2,325 m from the LLPS within the ACT.

Note: Small infestation of ALG along S corridor boundary fence at 693271 - 6060554.

N/A

Plate 5: Monitoring Site TSP5

3.2.6 Monitoring Site TSP6 (11)

Jurisdiction	ACT
Co-ordinates	693528 - 6060505
No. of tree & shrub species	**2**
Seedling Health	
Good	3
Poor	10
Dead	7
Total plantings	**20**

TSP6 is located about 2,650 m from the LLPS - west of and adjacent to the Monaro Hwy within the ACT.

N/A

Plate 6: Monitoring SiteTSP6

3.2.7 Monitoring Site TSP7 (13)

Jurisdiction	ACT
Co-ordinates	693927 - 6060542
No. of tree & shrub species	**2**
Seedling Health	
Good	14
Poor	2
Dead	2
Total plantings	**18**

TSP7 is located about 3,040 m from the LLPS within the Smith property, NSW.

NOTE: site separated in to two areas on the N and S side of the construction corridor.

N/A

Plate 7: Monitoring Site TSP7

3.2.8 Monitoring Plot TSP8 (18)

Jurisdiction	**NSW**
Co-ordinates	695663 - 6060392
No. of tree & shrub species	**2**
Seedling Health	
Good	6
Poor	0
Dead	3
Total plantings	**9**

TSP8 is located about 4,975 m from the LLPS within the Lonergan property, NSW.

NOTE: Threatened Brown Treecreeper *Climacteris picumnus* at 695469 – 6060425 in stand of Yellow Box Woodland N. of construction corridor.

N/A

Plate 8: Monitoring Site TSP8

3.2.9 Monitoring Site TSP9 (19)

Jurisdiction	NSW
Co-ordinates	695663 - 6060392
No. of tree & shrub species	**4**
Seedling Health	
Good	20
Poor	3
Dead	0
Total plantings	**23**

TSP9 is located about 5,475 m from the LLPS within the Lonergan property, NSW.

N/A

Plate 9: Monitoring Site TSP9

3.2.1 Monitoring Site TSP10 (21)

Jurisdiction	**NSW**
Co-ordinates	697084 - 6060204
No. of tree & shrub species	**7**
Seedling Health	
Good	56
Poor	31
Dead	25
Total plantings	**112**

TSP10 is located about 6,425 m from the LLPS within the Johanson property, NSW.

NOTE: top-soil erosion and minor gullying evident through this section of the corridor.

N/A

Plate 10: Monitoring Site TSP10

3.2.2 Monitoring Site TSP11 (24)

Jurisdiction	NSW
Co-ordinates	699277 - 6061925
No. of tree & shrub species	**2**
Seedling Health	
Good	10
Poor	1
Dead	0
Total plantings	**11**

TSP11 is located about 9,300 m from the LLPS within the Latimer property, NSW.

NOTE: Vipers Bugloss *Echium vulgare* infestation adjacent to sample site.

N/A

Plate 11: Monitoring Site TSP11

3.2.3 Monitoring Site TSP12 (25)

Jurisdiction	NSW
Co-ordinates	701346 - 6063099
No. of tree & shrub species	**3**
Seedling Health	
Good	52
Poor	8
Dead	5
Total plantings	**65**

TSP12 is located about 11,900 m from the LLPS near the Discharge facility, NSW.

N/A

Plate 12: Monitoring Site TSP12

3.3 Herbaceous species monitoring

A total of 37 native herbaceous species[4] were recorded at thirteen monitoring sites within the M2G construction corridor and structure sites. This included at least 15[5] of 19 *planted* species (Table 1) and 21 *non-planted* native species. The distribution of planted species across all sample sites was variable with *Austrodanthonia* sp. and *Microlaena stipoides* occurring at all thirteen sites, followed by *Austrostipa* spp. (twelve sites), *Chrysocephalum apiculatum* (nine sites), *Themeda australis* (eight sites), *Wahlenbergia* sp. and *Chloris truncata* (six sites) and *Elymus scaber* (five sites), with remaining species were see Table A3.2 in Appendix 3.

Planted species not observed were: Slender Tick Trefoil *Desmodium varians*; Scaly Buttons *Leptorhynchos squamatus*, Floating Club Rush *Isolepis fluitans*; and Common Reed *Pragmites australis*. The latter two species are associated with wetter areas and may be more common in drainage channels not sampled. The former species was, according to the Landscape Reinstatement Plan, widely planted and should have been recorded at the sample sites.

Species diversity

Diversity among planted species per sample site ranged from four (HP3 & 4) to nine (HP8), and for non-planted species zero (HP5, 6, 7 & 13) to ten (HP2 & 8). Site HP 8 had the highest combined native species diversity of nineteen. The average number per site was 6.4 for planted species and 3.4 for non-planted native species (Table 4). A graph of these data is provided in Chart 2.

Five sites (HP1, 2, 8, 9 & 10) had cumulative (planted and non-planted) native species counts of ten or more, which is seemingly indicative of their longer establishment periods. The remaining eight sites were either covered by mulch, jute mesh or had had herbicide applied prior to planting, and as a result many specimens were either yet to emerge or too small to confidently identify.

The non-planted group has ostensibly germinated from alternative sources, including soil seed bank, artificial seeding and recruitment from surrounding vegetation, or combinations of these.

Cover abundance estimates

No single species cover abundance score exceeding 5% at any of the sample sites, although a combined planted species cover score of 5-25% was obtained at sites HP8 and HP9, and for non-planted species at HP2 and HP8 (Table 4).

Site HP8, situated in the McDonald property, had both the highest combined planted species diversity and cover abundance score.

[4] Exotic species were excluded from the sample.

[5] Two genera *Austrostipa* and *Wahlenbergia* are likely to comprise at least two species each though it was not possible to differentiate between planted and non-planted forms. *Austrodanthonia* sp. that was recorded was assumed to be the planted *A. carphoides*.

The cumulative foliage cover of planted species across all sample sites was conservatively estimated at 10% (which would increase slightly if the cover scores of non-planted natives were added). Given that the average size of each sample sites was 150m^2 and that the observed cover abundance for planted species was about 10% (or 15m^2 per site), then the estimated projected foliage cover of planted native herbaceous species across all 200 planting sites would be about 3,000m^2.

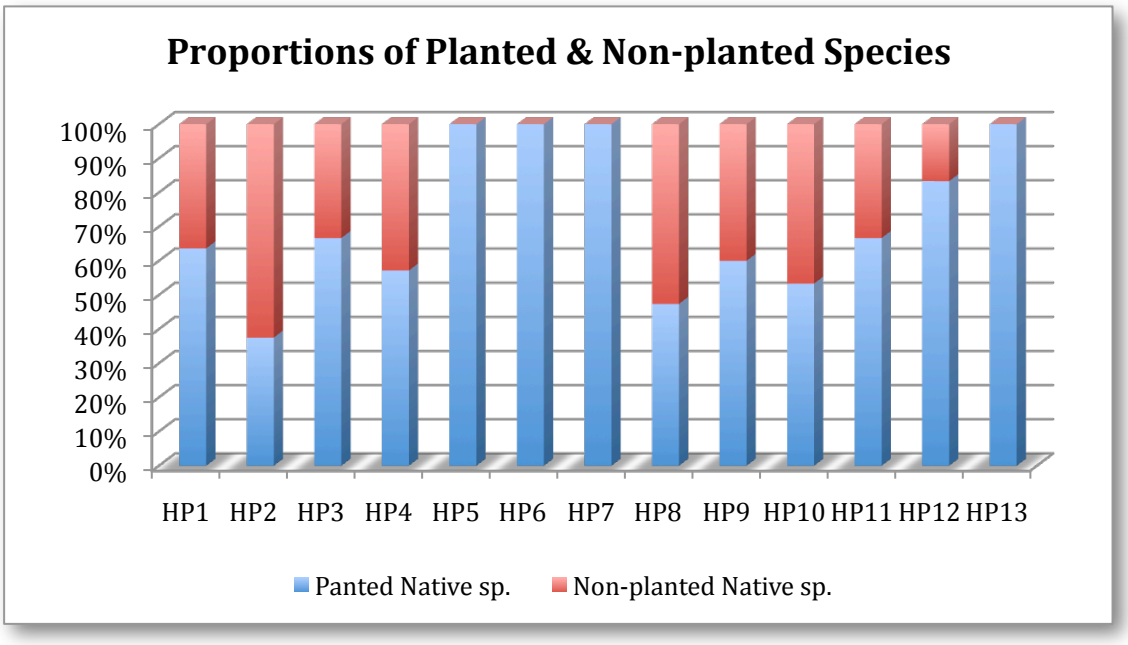
Fifteen of the nineteen the planted herbaceous species were recorded though their diversities were highly variable and not all species were widespread, however, on the basis of low species richness (that is the number of individuals in a given area) and low cover abundance the performance target of 90% success rate has not been met.

Table 4: Summary of herbaceous species monitoring at 13 sample sites

Site ID	Site Sequence*	No. of planted native sp.	No. of non-planted native sp.	Total sp. / site	Estimated cover of planted native sp.	Estimated cover of non-planted native sp.
HP1	2	7	4	11	<5%	<5%
HP2	4	6	10	16	<5%	5-25%
HP3	6	4	2	6	<5%	<5%
HP4	8	4	3	7	<5%	<5%
HP5	10	9	0	9	<5%	<5%
HP6	12	6	0	6	<5%	<5%
HP7	14	5	0	5	<5%	<5%
HP8	15	9	10	19	5-25%	5-25%
HP9	16	6	4	10	5-25%	<5%
HP10	17	8	7	15	<5%	<5%
HP11	20	6	3	9	<5%	<5%
HP12	22	5	1	6	<5%	<5%
HP13	23	8	0	8	<5%	<5%
Av		**6.4**	**3.4**	**9.8**		

***Site Sequence = combines both TSP and HP monitoring sites in order of occurrence.**

Chart 2: Proportion of planted and non-planted native herbaceous species at each monitoring site.



3.3.1 Monitoring Site HP1 (2)

Jurisdiction	**ACT**
Co-ordinates	691706 - 6060396
No. of native herbaceous species	**11**
Planted	7
Non-planted	4
Estimated cumulative cover score	
Planted	<5%
Non-planted	<5%

HP1 is located about 750 m from the LLPS within the Murrumbidgee River corridor.

NOTE: Weeds: *Echium* sp., *Conya* sp, *Briza maxima* and *Hirschfeldia incana*.

N/A

Plate 13: Monitoring Site HP1

3.3.2 Monitoring Site HP2 (4)

Jurisdiction	**ACT**
Co-ordinates	692219 - 6060594
No. of native herbaceous species	**16**
Planted	6
Non-planted	10
Estimated cumulative cover score	
Planted	<5%
Non-planted	5-25%

HP2 is located about 1,300 m from the LLPS within the ACT.

NOTE: Plot sprayed out. Non-native *Conyza* sp., dominant. The NSW threatened Silky Swainson-pea *Swainsona sericea* was recorded within monitoring site, may have germinated from an existing tuber or seeded.

N/A

Plate 14: Monitoring Site HP2

3.3.3 Monitoring Site HP3 (6)

Jurisdiction	**NSW**
Co-ordinates	692459 - 6060660
No. of native herbaceous species	**6**
Planted	4
Non-planted	2
Estimated cumulative cover score	
Planted	<5%
Non-planted	<5%

HP3 is located about 1,550 m from the LLPS within the ACT.

NOTE: Plot was treated with herbicide prior to planting. Surrounding groundcover is a result of artificial seeding and other forms of regeneration.

A large proportion of Viro Cells have been removed or have not survived. Dominant grasses non-native: *Vulpia* sp., *Lolium* sp. and *Brome* sp.

N/A

Plate 15: Monitoring Site HP3

3.3.4 Monitoring Site HP4 (8)

Jurisdiction	**NSW**
Co-ordinates	692797 - 6060687
No. of native herbaceous species	**7**
Planted	4
Non-planted	3
Estimated cumulative cover score	
Planted	<5%
Non-planted	<5%

HP4 is located about 1,770 m from the LLPS within the ACT.

NOTE: Plot sprayed out. Dominated by non-native grasses. Low proportion of native herbaceous species.

N/A

Plate 16: Monitoring Site HP4

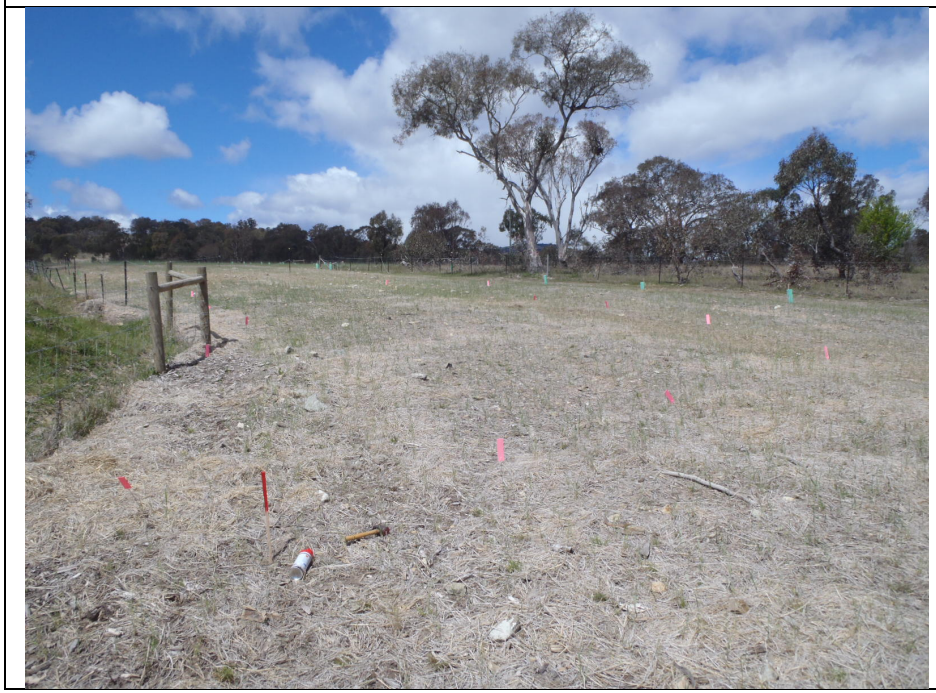
3.3.5 Monitoring Site HP5 (10)

Jurisdiction	**NSW**
Co-ordinates	693442 - 6060534
No. of native herbaceous species	**9**
Planted	9
Non-planted	0
Estimated cumulative cover score	
Planted	<5%
Non-planted	0

HP5 is located about 2,550 m from the LLPS within the ACT, W of the Monaro Hwy.

NOTE: Evidence of cell removal. Exotic grasses emerging: i.e. *Bromus* sp., *Loilium* sp., *Briza* sp. though not dominant.

Approximately +400 ALG tussocks S. of the construction corridor on W. side of the Monaro Hwy at coordinates 693550 - 6060502.



N/A

Plate 17: Monitoring Site HP5

3.3.6 Monitoring Site HP6 (12)

Jurisdiction	**NSW**
Co-ordinates	693683 - 6060542
No. of native herbaceous species	**6**
Planted	6
Non-planted	0
Estimated cumulative cover score	
Planted	<5%
Non-planted	0

HP6 is located about 2,780 m from the LLPS within the ACT, between the Monaro Hwy and Cooma-Goulburn Railway corridor.

NOTE: Sparse ground cover vegetation. Three cells dead one in poor condition with roots not penetrating surrounding soil.

N/A

Plate 18: Monitoring Site HP6

3.3.7 Monitoring Site HP7 (14)

Jurisdiction	**NSW**
Co-ordinates	694084 - 6060511
No. of native herbaceous species	**5**
Planted	5
Non-planted	0
Estimated cumulative cover score	
Planted	<5%
Non-planted	0

HP7 is located about 3,200 m from the LLPS within the Smith property, NSW.

NOTE: One cell removed and one dead. Groundcover sparse.

N/A

Plate 19: Monitoring Site HP7

3.3.8 Monitoring Site HP8 (15)

Jurisdiction	**NSW**
Co-ordinates	694525 - 6060591
No. of native herbaceous species	**19**
Planted	9
Non-planted	10
Estimated cumulative cover score	
Planted	5-25%
Non-planted	5-25%

HP8 is located about 3,650 m from the LLPS within the McDonald property, NSW.

NOTE: Exotic *Bromus hordeaceus* dominant.

N/A

Plate 20: Monitoring Site HP8

3.3.9 Monitoring Site HP9 (16)

Jurisdiction	**NSW**
Co-ordinates	694890 - 6060767
No. of native herbaceous species	**10**
Planted	6
Non-planted	4
Estimated cumulative cover score	
Planted	5-25%
Non-planted	<5%

HP9 is located about 4,050 m from the LLPS within the McDonald property, NSW

NOTE: ALG present (marked with stake and pink tape). Site dominated by *Bromus hordeaceus*. Threatened Silky Swainson-pea *Swainsona sericea* in adjacent areas of retained groundcover within construction corridor W of multi gate complex.

N/A

Plate 21: Monitoring Site HP9

3.3.10 Monitoring Site HP10 (17)

Jurisdiction	**NSW**
Co-ordinates	695248 - 6060569
No. of native herbaceous species	**15**
Planted	8
Non-planted	7
Estimated cumulative cover score	
Planted	<5%
Non-planted	<5%

HP10 is located about 4,475 m from the LLPS within the McDonald property, NSW.

NOTE: Exotic *Bromus hordeaceus* was dominant. At least 8 cells have been removed, with 21 additional cells removed from nearby planting sites. Two cells were desiccated *in situ*.

N/A

Plate 22: Monitoring Site HP10

3.3.11 Monitoring Site HP11 (20)

Jurisdiction	**NSW**
Co-ordinates	696826 - 6060127
No. of native herbaceous species	**11**
Planted	6
Non-planted	3
Estimated cumulative cover score	
Planted	<5%
Non-planted	<5%

HP11 is located about 6,175 m from the LLPS within the Codd/Howarth property, NSW.

N/A

Plate 23: Monitoring Site HP11

3.3.12 Monitoring Site HP12 (22)

Jurisdiction	**NSW**
Co-ordinates	698003 - 6060755
No. of native herbaceous species	**6**
Planted	5
Non-planted	1
Estimated cumulative cover score	
Planted	<5%
Non-planted	<5%

HP12 is located about 7,550 m from the LLPS within the Devitt property, NSW.

NOTE: Heavy mulch cover persists. *Austrostipa* sp. tube stock appears to be in poor health, although some tussocks have produced seed.

N/A

Plate 24: Monitoring Site HP12

3.3.13 Monitoring Site HP13 (23)

Jurisdiction	**NSW**
Co-ordinates	698541 - 6061210
No. of native herbaceous species	**8**
Planted	8
Non-planted	0
Estimated cumulative cover score	
Planted	<5%
Non-planted	0

HP13 is located about 8,250 m from the LLPS within the Boss property, NSW.

NOTE: Non-viable cells accounted for approximately 50% of all plantings.

NOTE: Diamond Firetail x2 observed attempting to feed on non-native grass seed at edge of property access.

N/A

Plate 25: Monitoring Site HP13

3.4 Weeds

Weed monitoring was not a specific component of this study, however, any new or previously unreported infestation was noted.

A large infestation (+400 tussocks) of African Lovegrass *Eragrostis curvula* (ALG) occurred on the western side of the Monaro Highway immediately south of the construction corridor at co-ordinates 693550 - 6060502. A smaller infestation (3-5 tussocks) of ALG occurred along the southern boundary fences of the construction corridor within the ACT at co-ordinates 693271 - 6060554.

Small eruptions of Vipers Bugloss *Echium vulgare* were observed at HP1 in the ACT and TSP11 in eastern section of the construction corridor.

3.5 Threatened plants

The NSW threatened Silky Swainson-pea *Swainsona sericea* was recorded in HP2 within the ACT, and has either re-sprouted from rootstock or has germinated from seed. The same species was recorded in moderate numbers within patches of retained groundcover vegetation adjacent to HP9 within the McDonald property (NSW).

3.6 Threatened fauna

A pair of Brown Treecreeper *Climacteris picumnus* were observed in Yellow Box Woodland north of the construction corridor (near TSP8) and a pair of Diamond Firetail *Stagonopleura guttata* as part of a mixed feeding flock near HP13.

3.7 Other observations

Mobs of Grey Kangaroo *Macropus giganteus*, roaming Wombat *Vombatus ursinus*, flocks of Galah *Eolophus roseicapillus* and Sulphur-crested Cockatoo *Cacatua galerita*, European Rabbit *Oryctolagus cuniculus* and occasionally stock have been observed within the construction corridor and have had widespread though variable effects on the development of tube-stock. This was most evident on the northern batter of the HLPS and within the eastern sections of the McDonald property (near HP10) where significant levels of tube-stock damage (cells removed from soil) and mortality were observed.

Feral Pig *Sus scrofa* and Goat *Capra aegagrus hircus* could also occur within the construction corridor, though there has been no evidence of their occurrence to date.

4 Conclusion

Monitoring surveys were conducted over a two-day period during late Spring in November 2012 to measure the performance of rehabilitation plantings within the M2G construction corridor and structure sites.

Quantitative sampling methods were applied to woody plantings and a modified qualitative approach, based on species presence and cover abundance, was used for herbaceous plantings.

Tree and Shrub Monitoring

About 13% (661 specimens) of total tree and shrub plantings were monitored at twelve sample sites. Of these, 364 (55%) were in good health, 188 (28.5%) were in poor health and 109 (16.5%) were dead. Transferring the survival rate in good health to all woody plantings would yield a total of 2,750 specimens.

Even if 50% of the specimens that were in poor health were to survive the desired performance target of 90% would not be met. Realistically, most specimens in poor health are unlikely to survive the short-term and replanting of at least 1,750 specimens (35% of total woody plantings) would be required to reach the 90% target, but this would only be achieved if all new plantings and the 55% in good health were to survive.

Herbaceous Monitoring

A total of 37 native herbaceous species were recorded at thirteen monitoring sites, this included 15 of 19 planted species and 21 non-planted native species. Cover abundance scores for individual species did not exceed 5% of the sample area, although cumulative cover scores of planted species was estimated at 10%, which represented about 3,000m^2 of the total 30,000m^2 of herbaceous planting area.

Due to the restrictions imposed by the sampling methodology it was not possible to extrapolate these data, in any quantitative way, to herbaceous plantings across the construction area.

On the basis of low species richness and low cover abundance the performance target of 90% success rate of herbaceous plantings has not been met.

5 References

Eco Logical Australia (March 2011). Summary of existing vegetation condition – Murrumbidgee to Googong Water Transfer Project. Prepared for Bulk Water Alliance Joint Venture.

Blue Gum Ecological Consulting (July 2012) Rehabilitation Monitoring Report (Spring): M2G Construction Corridor.

Commonwealth of Australia (2012). Interim Biogeographic Regionalisation for Australia, Version 7. Map produced by ERIN for the National Reserved System Section, Australian Government Department of Sustainability, Environment, Water, Population and Communities.

Appendix 1: Figures

Figure 1: The location monitoring sites within the western section of the M2G construction corridor. Map prepared by EcoLogical Australia.

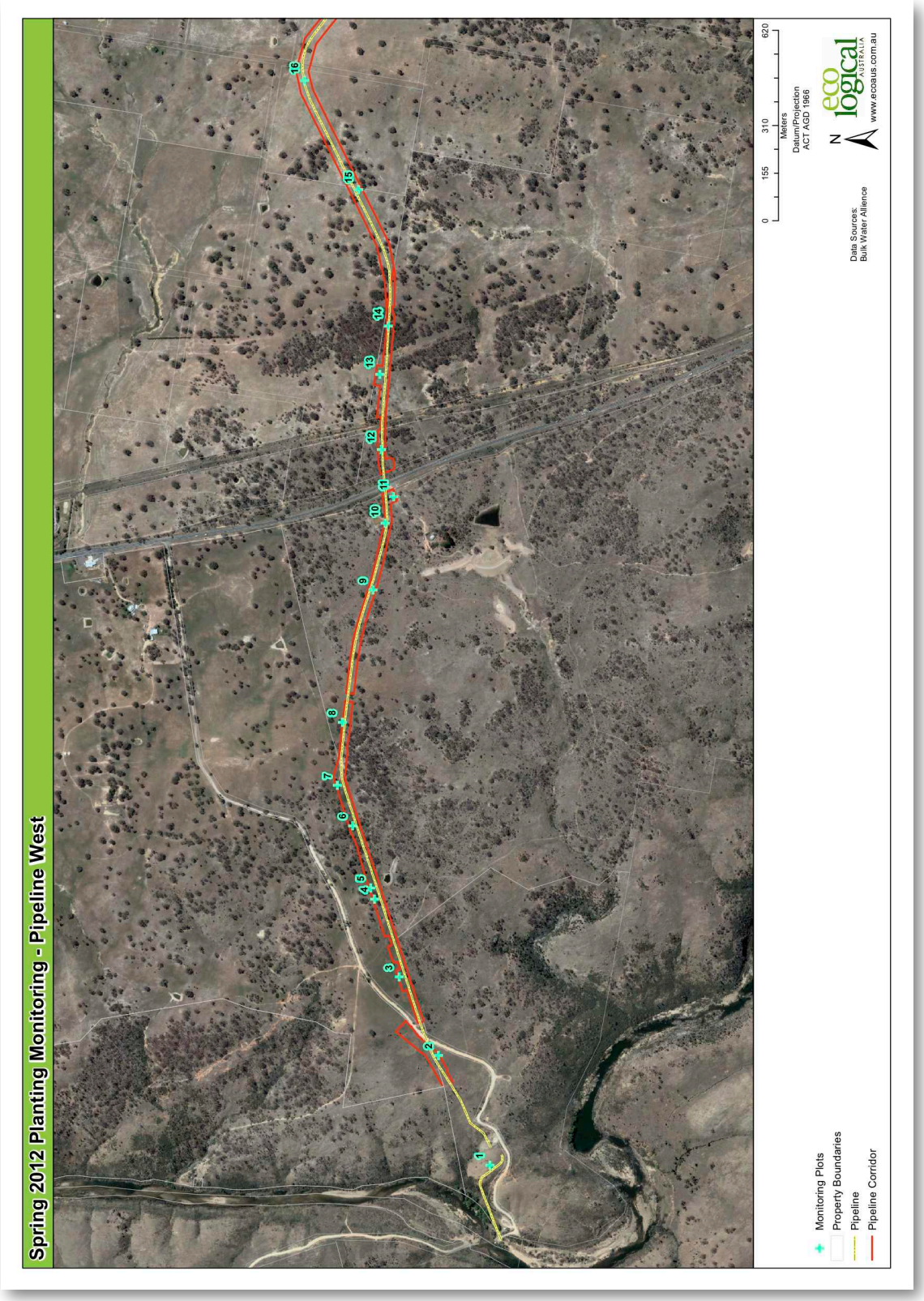


Figure 2: The location monitoring plots within the central section of the M2G construction corridor. Map prepared by EcoLogical Australia.

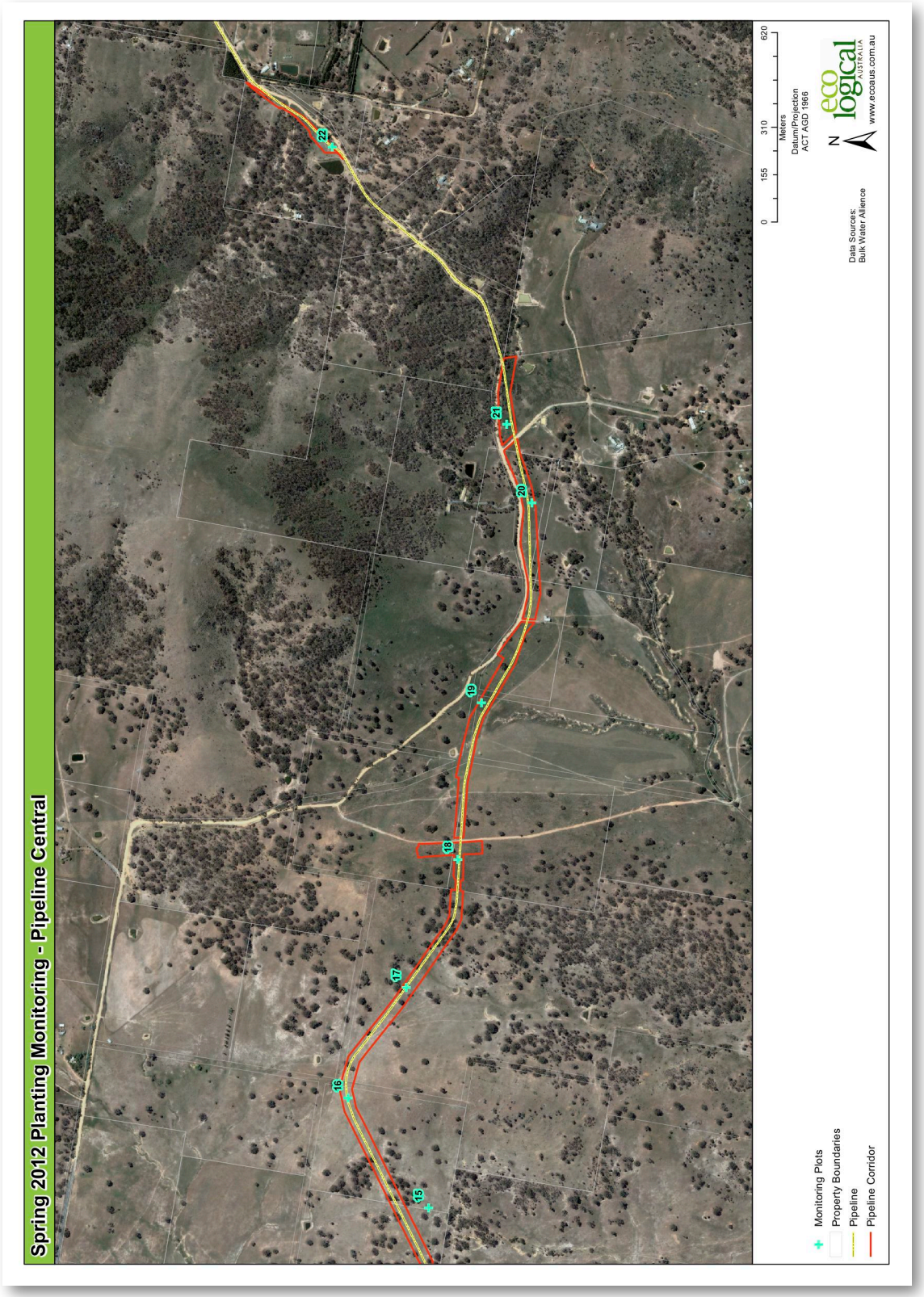
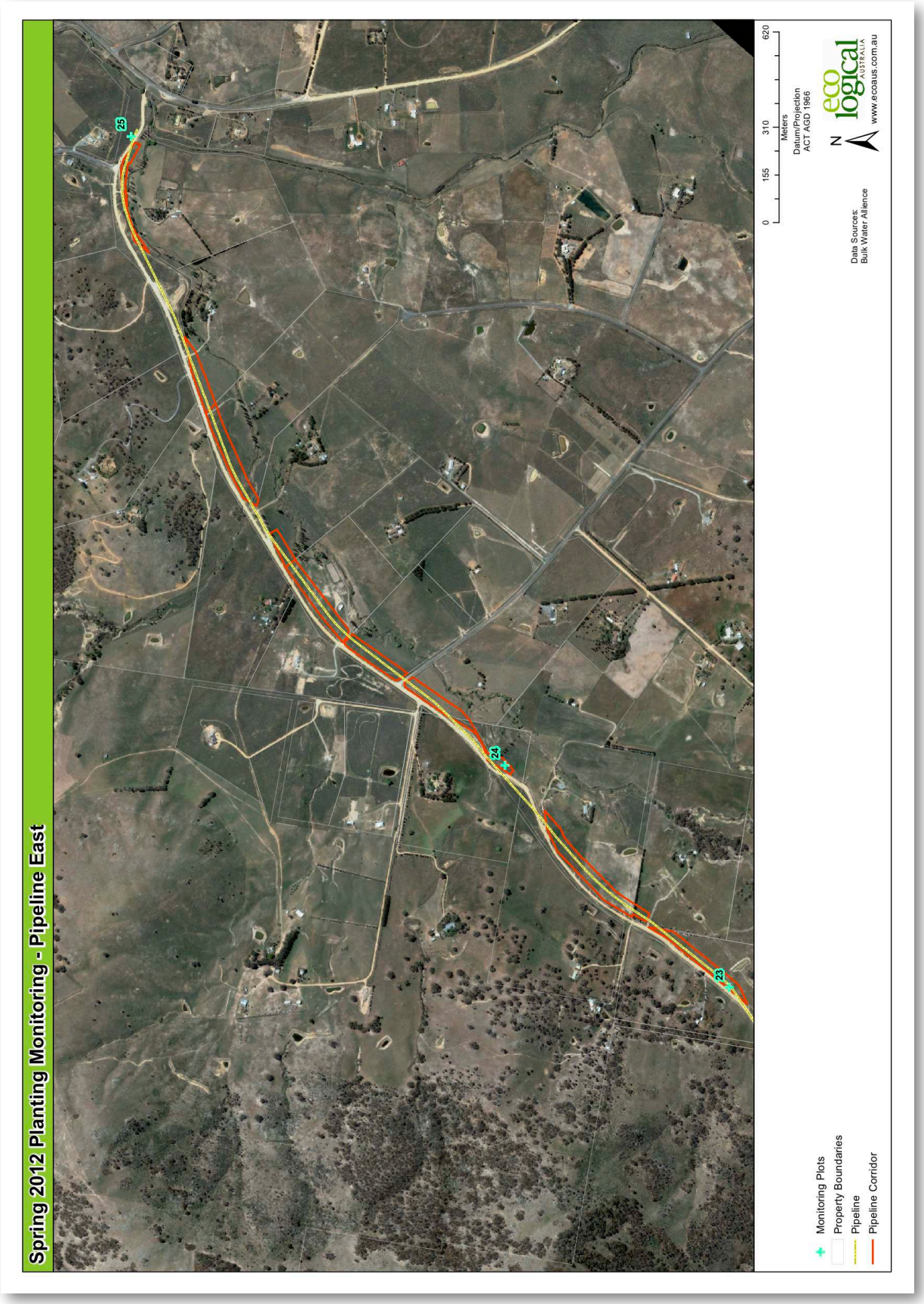


Figure 3: The location monitoring plots within the eastern section of the M2G construction corridor. Map prepared by EcoLogical Australia.



Appendix 2: Floristic Data: Woody Plantings

Table A2.1. Presence and condition assessments of woody (tree and shrub) plantings at twelve sampling sites TSP1 - TSP 12.

Site Sequence	Site ID	Species	Seedling success	Poor Health (not sp. specific)	Dead (not sp. specific)	Total
1	TSP1	*Acacia sp.*	32	15	9	
1	TSP1	*Bursaria spinosa*	7			
1	TSP1	*Cassinia sp.*	13			
1	TSP1	*Leptospermum sp.*	1			
1	TSP1	*Hakea sp.*	1			
1	TSP1	*E. mannifera*	12			
1	TSP1	*E. melliodora*	3			
Total			**69**	**15**	**7**	**91**
% good health			**76%**			
% poor or dead					**24%**	
3	TSP2	*Acacia sp.*	47	46	13	
3	TSP2	*Bursaria spinosa*	10			
3	TSP2	*Cassinia sp.*	2			
3	TSP2	*Leptospermum/Kunzea*	6			
3	TSP2	*Hakea sp.*	3			
Total			**68**	**46**	**13**	**127**
% good health			**53.5%**			
% poor or dead					**46.5%**	
5	TSP3	*Acacia sp.*	5	39	17	
5	TSP3	*Bursaria spinosa*	9			
5	TSP3	*Leptospermum sp.*	24			
5	TSP3	*Kunzea sp.*	1			
Total			**39**	**39**	**17**	**95**
% good health			**41%**			
% poor or dead					**59%**	
7	TSP4	*Acacia sp.*	6	27	28	
7	TSP4	*Bursaria spinosa*	7			
7	TSP4	*Leptospermum sp. /Kunzea sp.*	6			
Total			**19**	**27**	**28**	**74**
% good health			**26%**			
% poor or dead					**74%**	
9	TSP5	*E. bridgesiana*	6	6	2	
9	TSP5	*E. melliodora*	2			
Total			**8**	**6**	**2**	**16**
% good health			**50%**			
% poor or dead					**50%**	
11	TSP6	*E. bridgesiana*	2	10	7	
11	TSP6	*E. melliodora*	1			
Total			**3**	**10**	**7**	**20**
% good health			**15%**			

Site Sequence	Site ID	Species	Seedling success	Poor Health (not sp. specific)	Dead (not sp. specific)	Total
% poor or dead					**85%**	
13	TSP7	*E. melliodora*	8	2	2	
13	TSP7	*E. bridgesiana*	6			
Total			**14**	**2**	**2**	**18**
% good health			**78%**			
% poor or dead					**22%**	
18	TSP8	*E. melliodora*	3		3	
18	TSP8	*E. mannifera*	3			
Total			**6**	**0**	**3**	**9**
% good health			**50%**			
% poor or dead					**50%**	
19	TSP9	*E. melliodora*	16	3		
19	TSP9	*E. blakelyi*	1			
19	TSP9	*E. polyanthemos*	3			
Total			**20**	**3**	**0**	**23**
% good health			**87%**			
% poor or dead					**13%**	
21	TSP10	*E. melliodora*	7	31	25	
21	TSP10	*E. mannifera*	1			
21	TSP10	*E. polyanthemos*	22			
21	TSP10	*Dodonaea sp.*	4			
21	TSP10	*Callistemon sp.*	4			
21	TSP10	*Acacia sp.*	18			
Total			**56**	**31**	**25**	**112**
% good health			**50%**			
% poor or dead					**50%**	
24	TSP11	*E. melliodora*	5	1	0	
24	TSP11	*E. bridgesiana*	5			
Total			**10**	**1**	**0**	**11**
% good health			91%			
% poor or dead					**9%**	
25	TSP12	*Leptospermum sp.*	18	8	5	
25	TSP12	*Bursaria spinosa*	9			
25	TSP12	*Acacia sp.*	25			
Total			**52**	**8**	**5**	**65**
% good health			**80%**			
% poor or dead					**20%**	
TOTAL						**661**

Appendix 3: Floristic Data: Herbaceous Plantings

Table A3.1. Monitoring results of native herbaceous plantings at thirteen sample sites HP1 - HP13. Planted species are shown in bold type.

Cover abundance scores for recorded native species based on Braun Blanquet scale, as follows.

r = < 5% cover and solitary (< 4 individuals)
\+ = < 5% cover and few (4-15 individuals)
1 = < 5% cover and numerous/scattered (>15 individuals)
2 = 5% - 25% cover
3 = 25% - 50% cover
4 = 50% - 75% cover
5 = > 75% cover

Site Sequence	Site ID	Species	Planted	Non-planted	Est Cover	Planted cumulative cover	Non-planted cumulative cover	Notes
2	HP1	***Themeda australis***	**1**	-	+			
2	HP1	***Austrostipa sp.***	**1**	-	r			
2	HP1	*Hypericum gramineum*	-	1	r			
2	HP1	***Austrodanthonia sp.***	**1**	-	+			
2	HP1	***Chrysocehpalum apiculatum***	**1**	-	**1**			
2	HP1	***Convolvulus erubescens***	**1**	-	r			
2	HP1	*Crassula sieberiana*	-	1	+			
2	HP1	***Microlaena stipoides***	**1**	-	**1**			
2	HP1	*Geranium solanderi*	-	1	r			
2	HP1	***Wahlenbergia sp.***	**1**	-	+			
2	HP1	*Euchiton sp.*	-	1	r			
TOTAL			**7**	**4**		**<5%**	**<5%**	
4	HP2	*Swainsona sericea*	-	1	+			**Threatened**
4	HP2	***Chrysocehpalum apiculatum***	**1**	-	**1**			
4	HP2	*Crassula sieberiana*	-	1	1			
4	HP2	*Plantago varia*	-	1	1			
4	HP2	*Wurmbea dioica*	-	1	+			
4	HP2	***Microlaena stipoides***	**1**	-	+			
4	HP2	*Cymbonotus lawsonianus*	-	1	r			
4	HP2	***Convolvulus erubescens***	**1**	-	r			
4	HP2	***Wahlenbergia sp.***	**1**	-	+			
4	HP2	*Eryngium ovinum*	-	1	1			
4	HP2	*Geranium solanderi*	-	1	+			
4	HP2	***Austrodanthonia sp.***	**1**	-	+			
4	HP2	*Bulbine bulbosa*	-	1	r			
4	HP2	*Euchiton sp.*	-	1	+			

Site Sequence	Site ID	Species	Planted	Non-planted	Est Cover	Planted cumulative cover	Non-planted cumulative cover	Notes
4	HP2	*Einadia sp.*	-	1	r			
4	HP2	***Austrostipa sp.***	**1**	**-**	**r**			
TOTAL			**6**	**10**		**<5%**	**5-25%**	
6	HP3	***Chrysocehpalum apiculatum***	**1**	**-**	**1**			
6	HP3	*Hydrocotyle laxiflora*	-	1	+			
6	HP3	*Geranium solanderi*	-	1	+			
6	HP3	***Austrodanthonia sp.***	**1**	**-**	**+**			
6	HP3	***Microlaena stipoides***	**1**	**-**	**+**			
6	HP3	***Austrostipa sp.***	**1**	**-**	**r**			
TOTAL			**4**	**2**		**<5%**	**<5%**	
8	HP4	*Wurmbea dioica*	-	1	+			
8	HP4	*Hydrocotyle laxiflora*	-	1	+			
8	HP4	***Chrysocehpalum apiculatum***	**1**	**-**	**+**			
8	HP4	***Austrodanthonia sp.***	**1**	**-**	**r**			
8	HP4	***Austrostipa sp.***	**1**	**-**	**r**			
8	HP4	*Geranium solanderi*	-	1	+			
8	HP4	***Microlaena stipoides***	**1**	**-**	**r**			
TOTAL			**4**	**3**		**<5%**	**<5%**	
10	HP5	***Austrodanthonia sp.***	**1**	**-**	**1**			
10	HP5	***Themeda australis***	**1**	**-**	**r**			
10	HP5	***Elymus scaber***	**1**	**-**	**r**			
10	HP5	***Chrysocehpalum apiculatum***	**1**	**-**	**1**			
10	HP5	***Microlaena stipoides***	**1**	**-**	**1**			
10	HP5	***Convolvulus erubescens***	**1**	**-**	**r**			
10	HP5	***Wahlenbergia sp.***	**1**	**-**	**r**			
10	HP5	***Austrostipa sp.***	**1**	**-**	**+**			
10	HP5	***Chloris truncata***	**1**	**-**	**+**			
TOTAL			**9**	**0**		**<5%**	**0**	
12	HP6	***Microlaena stipoides***	**1**	**-**	**1**			
12	HP6	***Chrysocehpalum apiculatum***	**1**	**-**	**1**			
12	HP6	***Themeda australis***	**1**	**-**	**+**			
12	HP6	***Austrodanthonia sp.***	**1**	**-**	**+**			
12	HP6	***Elymus scaber***	**1**	**-**	**+**			
12	HP6	***Wahlenbergia sp.***	**1**	**-**	**+**			
TOTAL			**6**	**0**		**<5%**	**0**	
14	HP7	***Microlaena stipoides***	**1**	**-**	**1**			
14	HP7	***Chrysocehpalum apiculatum***	**1**	**-**	**1**			
14	HP7	***Austrostipa sp.***	**1**	**-**	**+**			
14	HP7	***Austrodanthonia sp.***	**1**	**-**	**1**			
14	HP7	***Wahlenbergia stricta***	**1**	**-**	**+**			
TOTAL			**5**	**0**		**<5%**	**0**	
15	HP8	*Bulbine bulbosa*	-	1	1			
15	HP8	***Themeda australis***	**1**	**-**	**+**			

Site Sequence	Site ID	Species	Planted	Non-planted	Est Cover	Planted cumulative cover	Non-planted cumulative cover	Notes
15	HP8	***Austrodanthonia sp.***	**1**	**-**	**1**			
15	HP8	***Austrostipa scabra***	**1**	**-**	**1**			
15	HP8	***Lomandra sp.***	**1**	**-**	**+**			
15	HP8	*Tryptilodiscus pygmaeus*	-	1	1			
15	HP8	***Wahlenbergia sp.***	**1**	**-**	**1**			
15	HP8	*Cymbonotus lawsonianus*	-	1	+			
15	HP8	*Hypericum gramineum*	-	1	+			
15	HP8	*Geranium solanderi*	-	1	+			
15	HP8	*Euchiton sp.*	-	1	r			
15	HP8	***Chloris truncata***	**1**	**-**	**+**			
15	HP8	*Eragrostis ? benthamii*	-	1	1			
15	HP8	*Panicum effusum*	-	1	+			
15	HP8	*Schoenus apogon*	-	1	+			
15	HP8	***Microlaena stipoides***	**1**	**-**	**+**			
15	HP8	*Hydrocotyle laxiflora*	-	1	+			
15	HP8	***Bothriochloa macra***	**1**	**-**	**+**			
15	HP8	***Elymus scaber***	**1**	**-**	**+**			
TOTAL			**9**	**10**		**5-25%**	**5-25%**	
16	HP9	***Chrysocehpalum apiculatum***	**1**	**-**	**r**			
16	HP9	***Microlaena stipoides***	**1**	**-**	**1**			
16	HP9	***Themeda australis***	**1**	**-**	**1**			
16	HP9	***Chloris truncata***	**1**	**-**	**1**			
16	HP9	***Austrodanthonia sp.***	**1**	**-**	**1**			
16	HP9	*Panicum effusum*	-	1	1			
16	HP9	*Tryptilodiscus pygmaeus*	-	1	+			
16	HP9	***Austrostipa sp.***	**1**	**-**	**+**			
16	HP9	*Vittadinia sp.*	-	1	+			
16	HP9	*Crassula sieberiana*	-	1	1			
TOTAL			**6**	**4**		**5-25%**	**<5%**	
17	HP10	*Solenogyne dominii*	-	1	r			
17	HP10	***Austrodanthonia sp.***	**1**	**-**	**1**			
17	HP10	***Microlaena stipoides***	**1**	**-**	**1**			
17	HP10	***Bothriochloa macra***	**1**	**-**	**+**			
17	HP10	*Carex breviculmis*	-	1	1			
17	HP10	***Austrostipa sp.***	**1**	**-**	**r**			
17	HP10	***Themeda australis***	**1**	**-**	**r**			
17	HP10	***Chloris truncata***	**1**	**-**	**r**			
17	HP10	*Cymbonotus lawsonianus*	-	1	r			
17	HP10	***Chrysocehpalum apiculatum***	**1**	**-**	**+**			
17	HP10	***Wahlenbergia sp.***	**1**	**-**	**+**			
17	HP10	*Geranium solanderi*	-	1	r			
17	HP10	*Euchiton sp.*	-	1	+			
17	HP10	*Tryptilodiscus pygmaeus*	-	1	r			

Site Sequence	Site ID	Species	Planted	Non-planted	Est Cover	Planted cumulative cover	Non-planted cumulative cover	Notes
17	HP10	*Eragrostis ? benthamii*	-	1	r			
TOTAL			**8**	**7**		**<5%**	**<5%**	
20	HP11	***Austrodanthonia sp.***	**1**	**-**	**1**			
20	HP11	***Austrostipa scabra***	**1**	**-**	**1**			
20	HP11	***Microlaena stipoides***	**1**	**-**	**1**			
20	HP11	*Carex ? breviculmis*	-	1	+			
20	HP11	*Lomandara sp.*	-	1	+			
20	HP11	***Poa sp. (labillardierei)***	**1**	**-**	**+**			
20	HP11	*Epilobium billardierianum*	-	1	r			
20	HP11	***Eleocharis sp.***	**1**	**-**	**r**			
20	HP11	***Elymus scaber***	**1**	**-**	**+**			
TOTAL			**6**	**3**		**<5%**	**<5%**	
22	HP12	***Microlaena stipoides***	**1**	**-**	**1**			
22	HP12	***Chloris truncata***	**1**	**-**	**1**			
22	HP12	***Austrostipa scabra***	**1**	**-**	**1**			
22	HP12	*Euchiton sp.*	-	1	+			
22	HP12	***Austrodanthonia sp.***	**1**	**-**	**1**			
22	HP12	***Themeda australis***	**1**	**-**	**+**			
TOTAL			**5**	**1**		**<5%**	**<5%**	
23	HP13	***Microlaena stipoides***	**1**	**-**	**1**			
23	HP13	***Austrostipa scabra***	**1**	**-**	**+**			
23	HP13	***Chloris truncata***	**1**	**-**	**+**			
23	HP13	***Austrodanthonia sp.***	**1**	**-**	**1**			
23	HP13	***Elymus scaber***	**1**	**-**	**r**			
23	HP13	***Themeda australis***	**1**	**-**	**+**			
23	HP13	***Carex ? appressa***	**1**	**-**	**r**			
23	HP13	***Juncus sp.***	**1**	**-**	**+**			
TOTAL			**8**	**0**		**<5%**	**0**	

Table A3.2. Total species tallies at herbaceous planting sample sites.

Species	HP1	HP2	HP3	HP4	HP5	HP6	HP7	HP8	HP9	HP10	HP11	HP12	HP13	Total
Austrodanthonia sp.	1	1	1	1	1	1	1	1	1	1	1	1	1	**13**
Austrostipa scabra								1			1	1	1	**4**
Austrostipa sp.	1	1	1	1	1		1		1	1				**8**
Bothriochloa macra								1		1				**2**
Bulbine bulbosa		1						1						**2**
Carex ? appressa													1	**1**
Carex breviculmis										1	1			**2**
Chloris truncata					1			1	1	1		1	1	**6**
Chrysocehpalum apiculatum	1	1	1	1	1	1	1		1	1				**9**
Convolvulus erubescens	1	1			1									**3**
Crassula sieberiana	1	1							1					**3**
Cymbonotus lawsonianus		1						1		1				**3**
Einadia sp.		1												**1**
Eleocharis sp.											1			**1**
Elymus scaber					1	1		1			1		1	**5**
Epilobium billardierianum											1			**1**
Eragrostis ? benthamii								1		1				**2**
Eryngium ovinum		1												**1**
Euchiton sp.	1	1						1		1		1		**5**
Geranium solanderi	1	1	1	1				1		1				**6**
Hydrocotyle laxiflora			1	1				1						**3**
Hypericum gramineum	1							1						**2**
Juncus sp.													1	**1**
Lomandara sp.								1			1			**2**
Microlaena stipoides	1	1	1	1	1	1	1	1	1	1	1	1	1	**13**
Panicum effusum								1	1					**2**
Plantago varia		1												**1**
Poa sp.											1			**1**
Schoenus apogon								1						**1**
Solenogyne dominii										1				**1**
Swainsona sericea		1												**1**
Themeda australis	1				1	1		1	1	1		1	1	**8**
Tryptilodiscus pygmaeus								1	1	1				**3**
Vittadinia sp.									1					**1**
Wahlenbergia sp.	1	1			1	1		1		1				**6**
Wahlenbergia stricta							1							**1**
Wurmbea dioica		1		1										**2**
Total	**11**	**16**	**6**	**7**	**9**	**6**	**5**	**19**	**10**	**15**	**9**	**6**	**8**	