

Warrell Creek to Nambucca Heads Landscape Rehabilitation Monitoring – Operational Phase Spring 2021

Prepared for:

**Sandpiper Ecological Surveys
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Prepared by:

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1 Introduction

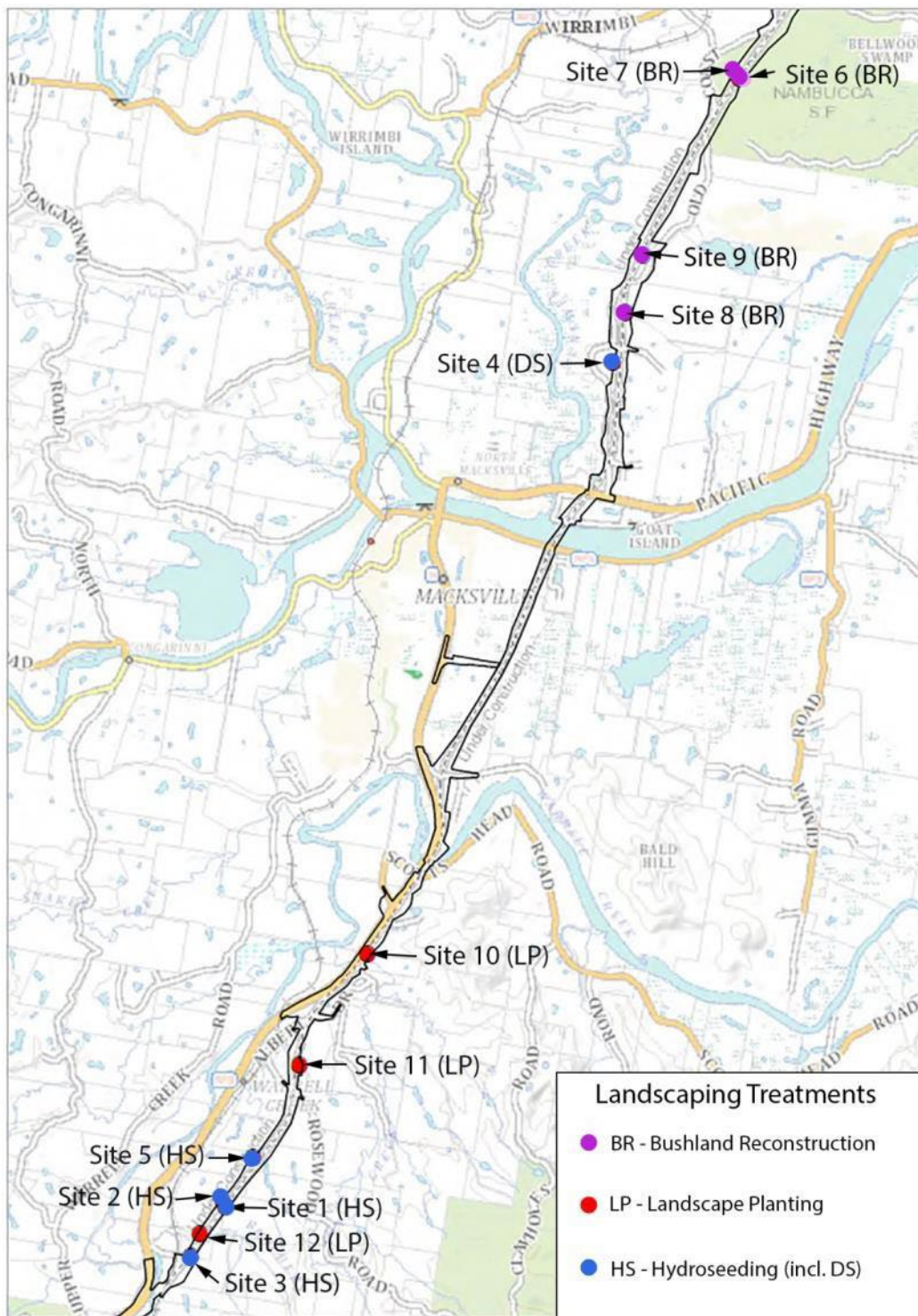
To assess the results and effectiveness of the landscape rehabilitation treatments, 12 Sites representing four landscaping treatments are being monitored for the first four years of operation of the upgrade, as required by the *Warrell Creek to Nambucca Heads Operational Ecological and Water Quality Monitoring Brief* (Roads and Maritime Services 2018a) and the *Warrell Creek to Nambucca Heads Stage 2 Ecological Monitoring Program Revision C, June 2018* (Roads and Maritime Services 2018b).

Table 1 Monitoring locations and landscaping treatments (RMS 2018a).

No.	Location	Treatment
1	Fill 4 Embankment East – Southern Zone	Seed Mix 1 (hydroseeding)
2	Fill 4 Embankment West – Southern Zone	Seed Mix 2 (hydroseeding)
3	Cut 2 Embankment East – Southern Zone	Seed Mix 3 (hydroseeding)
4	Ancillary Area Fill 19 West – Northern Zone	Seed Mix 4 (direct seeding)
5	Fill 5 Vegetated Drainage Swale – Southern Zone	Seed Mix 5 (hydroseeding)
6	Cut 22 Embankment East – Northern Zone	Bushland Reconstruction (see note 1 below)
7	Cut 22 Embankment West – Northern Zone	Bushland Reconstruction
8	Fill 20 Embankment East – Northern Zone	Bushland Reconstruction
9	Cut 18 Embankment East – Northern Zone	Bushland Reconstruction
10	Williamson Creek	Landscape Planting (see note 2 below)
11	Stoney Creek	Landscape Planting
12	Butchers Creek	Landscape Planting

Monitoring methods are described in the annual monitoring report.

The following report presents the results of quarterly monitoring for Spring 2021.



LEGEND
 — Project boundary
 ● Landscape monitoring site

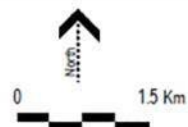


Figure 1: Monitoring Site Locations and Landscaping Treatments

Results

Hydroseeding - (Sites 1, 2, 3 and 5)

- *Setaria* and *Acacia* spp. remain dominant

Direct seeding (Sites 4)

- The direct seeding treatment was represented by one location. This Site is dominated by exotic pasture grasses and is slashed.

Bushland reconstruction (Sites 6, 7, 8 and 9)

- Sites continued to have relatively high native species diversity; cover of exotic species very low, except for Site 9.
- *Setaria* absent or scarce at most Sites, particularly Sites on cut batters where a thin layer of topsoil was applied, salvaged from bushland not paddocks.
- The native parasitic vine *Cassytha melantha* still dense in plots 6 and 7
- Good native grass cover - *Cymbopogon refractus* and *Themeda australis* in all plots.
- Eucalypt saplings coming up from seed dispersed from adjoining forest.
- Site 9 was half slashed, letting the weeds in.

In Site 6, *Acacia longifolia*, *Cassytha pubescens* and *Dodonaea triquetra* decreased, while *Cymbopogon refractus* and *Hypocheirus radicata* increased. Floristic composition indicates topsoil came from wet and dry Sites.

Landscape planting (Sites 10, 11 and 12)

- These Sites are all on creek drainage lines reinstated after completion of construction. Effects of floods in summer 2020 (e.g. scoured banks, deposits of gravel, flattening of vegetation) hardly evident now, covered by grass and herb regrowth.
- A few stems of *Maundia* still present in Site 10 (translocation site) in rock lined drain under highway bridge. Large in situ patch downstream just outside project boundary.
- *Persicaria strigosa* has replaced *P. laphthifolium* (Knotweeds) as the dominant aquatic plant.



Site 1: southern end, Spring 2021.



Site 1: northern end, Spring 2021.



Site 2: southern end, Spring 2021.



Site 2: northern end, Spring 2021.



Site 3: southern end, Spring 2021.



Site 3: northern end, Spring 2021.



Site 4: southern end, Spring 2021.



Site 4: northern end, Spring 2021.



Site 5: southern end, Spring 2021.



Site 5: northern end, Spring 2021.



Site 6, southern end, Spring 2021.



Site 6, northern end, Spring 2021.



Site 7, southern end, Spring 2021.



Site 8, southern end, Spring 2021.





Site 9, southern end, Spring 2021.





Site 10, eastern end, Spring 2021.



Site 10, western end, Spring 2021.



Site 11, southern end, Spring 2021.



Site 11, northern end, Spring 2021.



Site 12, southern end, Spring 2021.



Site 12, northern end, Spring 2021.

Monitoring Sites – plant species composition recorded Spring 2021

Landscape monitoring site 1 – Hydroseeding/Seed Mix treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
28/11/2021	1	490057, 6595205	490079, 6595238
Plant species		Braun-Blanquet scale of cover abundance (% crown cover)	
<i>Acacia fimbriata</i>		6	
<i>Acacia irrorata</i>		2	
<i>Acacia longifolia</i>		2	
<i>Acacia melanoxylum</i>		1	
<i>Ageratum houstonianum</i>		2	
<i>Cinnamomum camphora</i>		2	
<i>Commersonia dasyphylla</i>		1	
<i>Conyza bonariensis</i>		1	
<i>Kennedia rubicunda</i>		1	
<i>Lantana camara</i>		1	
<i>Passiflora edulis</i>		1	
<i>Passiflora subpeltata</i>		1	
<i>Physalis peruviana</i>		1	
<i>Senecio madagascariensis</i>		2	
<i>Setaria sphacelata</i>		6	
<i>Siratro atropurpureum</i>		2	
<i>Verbena bonariensis</i>		2	

Braun-Blanquet scale (% crown cover): 1 = <1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-100%.

Landscape monitoring site 2 – Hydroseeding Seed Mix treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
28/11/2021	2	490052, 6595299	490026, 6595259
Plant species		Braun-Blanquet scale of cover abundance (% crown cover)	
<i>Acacia fimbriata</i>		5	
<i>Acacia irrorata</i>		4	
<i>Acacia longifolia</i>		2	
<i>Billardiera scandens</i>		1	
<i>Conyza bonariensis</i>		2	
<i>Ageratum houstonianum</i>		2	
<i>Grevillea banksii</i>		1	
<i>Kennedia rubicunda</i>		1	
<i>Paspalum mandiocanum</i>		1	
<i>Physalis peruviana</i>		1	
<i>Pultenaea villosa</i>		1	
<i>Setaria sphacelata</i>		6	
<i>Senna floribunda</i>		1	
<i>Sida rhombifolia</i>		1	
<i>Verbena rigida</i>		2	

Braun-Blanquet scale (% crown cover): 1 = <1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-100%.

Landscape monitoring site 3 – Hydroseeding/Seed Mix 3 treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
28/11/2021	3	489722, 6594721	489686, 6594689
Plant species		Braun-Blanquet scale of cover abundance (% crown cover)	
<i>Acacia fimbriata</i>		5	
<i>Acacia melanoxylon</i>		2	
<i>Acacia longifolia</i>		2	
<i>Acacia melanoxylum</i>		1	
<i>Conyza bonariensis</i>		1	
<i>Eucalyptus microcorys</i>		1	
<i>Hakea sericea</i>		1	
<i>Kennedia rubicunda</i>		1	
<i>Lantana camara</i>		1	
<i>Macroptilium atropurpureum</i>		1	
<i>Paspalum mandiocanum</i>		2	
<i>Polygala multiflora</i>		1	
<i>Pultenaea villosa</i>		1	
<i>Senecio madagascariensis</i>		1	
<i>Setaria sphacelata</i>		6	

Braun-Blanquet scale (% crown cover): 1 = <1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-100%.

Landscape monitoring site 4 – Direct Seeding mix 4 treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
28/11/2021	4	494369, 6604590	494387, 6604626
Plant species	Braun-Blanquet scale of cover abundance (% crown cover)		
<i>Acacia falcata</i>	1		
<i>Acacia irrorata</i>	2		
<i>Acacia melanoxylon</i>	2		
<i>Ageratum houstonianum</i>	2		
<i>Centella asiatica</i>	1		
<i>Conyza bonariensis</i>	2		
<i>Cynodon dactylon</i>	2		
<i>Dodonaea triquetra</i>	1		
<i>Gomphocarpus fruticosus</i>	2		
<i>Hypochaeris radicata</i>	1		
<i>Kennedia rubicunda</i>	1		
<i>Paspalum dilatatum</i>	1		
<i>Paspalum mandiocanum</i>	3		
<i>Senecio madagascariensis</i>	1		
<i>Setaria sphacelata</i>	6		
<i>Sida rhombifolia</i>	1		

Braun-Blanquet scale (% crown cover): 1 = <1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-100%.

Landscape monitoring site 5 – Hydroseeding/Seed Mix 5 treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
28/11/2021	5	490383, 6595788	490359, 6595741
Plant species	Braun-Blanquet scale of cover abundance (% crown cover)		
<i>Acacia fimbriata</i>	3		
<i>Acacia irrorata</i>	2		
<i>Acacia melanoxylum</i>	1		
<i>Centella asiatica</i>	1		
<i>Conyza bonariensis</i>	1		
<i>Cynodon dactylon</i>	1		
<i>Eucalyptus microcorys</i>	1		
<i>Paspalum dilatatum</i>	1		
<i>Paspalum mandiocanum</i>	1		
<i>Senecio madagascariensis</i>	1		
<i>Setaria sphacelata</i>	6		
<i>Verbena bonariensis</i>	1		

Braun-Blanquet scale (% crown cover): 1 = <1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-100%.

Landscape monitoring site 6 – Bushland Reconstruction treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
29/11/2021	6	495781, 6607729	495814, 6607767
Plant species	Braun-Blanquet scale of cover abundance (% crown cover)		
<i>Acacia fimbriata</i>	3		
<i>Acacia irrorata</i>	1		
<i>Acacia longifolia</i>	3		
<i>Acacia ulicifolia</i>	1		
<i>Allocasuarina torulosa</i>	1		
<i>Alphitonia excelsa</i>	1		
<i>Bidens pilosa</i>	1		
<i>Billardiera scandens</i>	2		
<i>Callistemon sp.</i>	2		
<i>Carex maculata</i>	1		
<i>Cassytha sp.</i>	4		
<i>Conyza bonariensis</i>	2		
<i>Cymbopogon refractus</i>	4		
<i>Cynodon dactylon</i>	1		
<i>Dodonaea triquetra</i>	2		
<i>Doodia aspera</i>	1		
<i>Entolasia stricta</i>	1		
<i>Eucalyptus microcorys</i>	2		
<i>Eucalyptus pilularis</i>	2		
<i>Eucalyptus resinifera</i>	1		
<i>Fimbristylis dichotoma</i>	1		
<i>Gonocarpus tetragynus</i>	1		
<i>Hibbertia aspera</i>	1		
<i>Hypochaeris radicata</i>	3		
<i>Ipomea cairica</i>	2		
<i>Lepidosperma laterale</i>	1		
<i>Leptospermum polygalifolium</i>	3		
<i>Lomandra longifolia</i>	1		
<i>Mitrasacme sp.</i>	1		
<i>Native Stipa sp.</i>	1		
<i>Ozothamnus diosmifolius</i>	1		
<i>Paspalum urvillei</i>	1		
<i>Persoonia stradbrogensis</i>	2		
<i>Polygala multiflora</i>	2		
<i>Pultenaea retusa</i>	1		
<i>Pultenaea villosa</i>	1		
<i>Scleria rugosa</i>	1		
<i>Themeda australis</i>	3		
unknown spurge	1		

Braun-Blanquet scale (% crown cover): 1 = <1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-100%.

Landscape monitoring site 7 – Bushland Reconstruction treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
28/11/2021	7	495744, 6607783	495782, 6607824
Plant species	Braun-Blanquet scale of cover abundance (% crown cover)		
<i>Acacia fimbriata</i>	2		
<i>Acacia elongata</i>	1		
<i>Acacia longifolia</i>	4		
<i>Allocasuarina torulosa</i>	1		
<i>Billardiera scandens</i>	2		
<i>Callistemon sp.</i>	2		
<i>Cassytha pubescens</i>	5		
<i>Centaurium erythraea</i>	3		
<i>Cheilanthes sieberi</i>	1		
<i>Conyza bonariensis</i>	1		
<i>Cymbopogon refractus</i>	3		
<i>Daviesia ulicifolia</i>	1		
<i>Dodonaea triquetra</i>	3		
<i>Eucalyptus microcorys</i>	1		
<i>Eucalyptus pilularis</i>	2		
<i>Gahnia aspera</i>	2		
<i>Hakea gibbosa</i>	1		
<i>Gonocarpus tetragynus</i>	1		
<i>Hibbertia aspera</i>	1		
<i>Hypocheirus radicata</i>	2		
<i>Lepidosperma laterale</i>	2		
<i>Lepidosperma laterale</i>	1		
<i>Leptospermum juniperinum</i>	1		
<i>Leptospermum sp. aff polygalifolium</i>	3		
<i>Lomandra longifolia</i>	1		
<i>Melaleuca linariifolia</i>	1		
<i>Melaleuca sieberi</i>	1		
<i>Ozothamnus diosmifolius</i>	1		
<i>Persoonia sp.</i>	1		
<i>Polygala multiflora</i>	1		
<i>Pultenaea villosa</i>	1		
<i>Pratia purpurascens</i>	1		
<i>Themeda australis</i>	1		

Braun-Blanquet scale (% crown cover): 1 = <1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-100%.

Landscape monitoring site 8 – Bushland Reconstruction treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
28/11/2021	8	494514, 6605138	494523, 6605177
Plant species	Braun-Blanquet scale of cover abundance (% crown cover)		
<i>Acacia falcata</i>	2		
<i>Acacia fimbriata</i>	6		
<i>Acacia floribunda</i>	1		
<i>Acacia irrorata</i>	2		
<i>Acacia longifolia</i>	3		
<i>Acacia myrtifolia</i>	2		
<i>Ageratina adenophorum</i>	1		
<i>Ageratum houstonianum</i>	2		
<i>Baccharis halimifolia</i>	2		
<i>Cassutha pubescens</i>	2		
<i>Centella asiatica</i>	2		
<i>Conyza bonariensis</i>	1		
<i>Cymbopogon refractus</i>	2		
<i>Dodonaea triquetra</i>	2		
<i>Kennedia rubicunda</i>	1		
<i>Lobelia alata</i>	1		
<i>Megthyrrhus maximus</i>	1		
<i>Ozothamnus diosmifolius</i>	1		
<i>Panicum sp.</i>	3		
<i>Paspalum conjugatum</i>	1		
<i>Paspalum dilatatum</i>	1		
<i>Paspalum mandiocanum</i>	3		
<i>Paspalum urvillei</i>	1		
<i>Plantago lanceolata</i>	2		
<i>Pultenaea villosa</i>	1		
<i>Polygala multiflora</i>	1		
<i>Senecio madagascarensis</i>	1		
<i>Setaria sphacelata</i>	6		
<i>Sida rhombifolia</i>	1		

Braun-Blanquet scale (% crown cover): 1 = <1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-100%.

Landscape monitoring site 9 – Bushland Reconstruction treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
28/11/2021	9	494703, 6605781	494721, 6605830
Plant species	Braun-Blanquet scale of cover abundance (% crown cover)		
<i>Acacia fimbriata</i>	5		
<i>Acacia floribunda</i>	1		
<i>Acacia irrorata</i>	2		
<i>Acacia longifolia</i>	2		
<i>Alphitonia excelsa</i>	2		
<i>Babingtonia sylvestris</i>	1		
<i>Billardiera scandens</i>	2		
<i>Callistemon salignus</i>	1		
<i>Commersonia dasyphylla</i>	1		
<i>Centalla asiatica</i>	2		
<i>Conyza bonariensis</i>	3		
<i>Cymbopogon refractus</i>	3		
<i>Daviesia ulicifolia</i>	1		
<i>Desmodium rhytidophyllum</i>	1		
<i>Dodonaea triquetra</i>	1		
<i>Entolasia stricta</i>	2		
<i>Eucalyptus microcorys</i>	2		
<i>Eucalyptus pilularis</i>	1		
<i>Fimbristylis dichotoma</i>	1		
<i>Gahnia aspera</i>	1		
<i>Gonocarpus tetragynus</i>	1		
<i>Hardenbergia violacea</i>	1		
<i>Hibbertia aspera</i>	1		
<i>Hibbertia scandens</i>	1		
<i>Kennedia rubicunda</i>	1		
<i>Lantana camara</i>	1		
<i>Lophostemon suaveolens</i>	1		
<i>Ozothamnus diosmifolius</i>	1		
<i>Passiflora edulis</i>	1		
<i>Paspalum mandiocanum</i>	4		
<i>Paspalidium distans</i>	2		
<i>Paspalum urvillei</i>	2		
<i>Persoonia adenanthera</i>	1		
<i>Polymeria calycina</i>	2		
<i>Setaria sphacelata</i>	2		
<i>Themeda australis</i>	3		

Braun-Blanquet scale (% crown cover): 1 = <1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-100%.

Landscape monitoring site 10 – Landscape Planting treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
28/11/2021	10	491650, 6598045	491599, 6598037
Plant species	Braun-Blanquet scale of cover abundance (% crown cover)		
<i>Acacia irrorata</i>	1		
<i>Aster subulatus</i>	1		
<i>Baumea articulata</i>	1		
<i>Carex appressa</i>	1		
<i>Conyza bonariensis</i>	2		
<i>Cyperus polystachyos</i>	2		
<i>Cyclosorus interruptus</i>	1		
<i>Hypolepis muelleri</i>	2		
<i>Juncus ursitatus</i>	2		
<i>Ludwigia peploides</i>	2		
<i>Maundia triglochinos</i>	1		
<i>Nymphaea capensis</i>	2		
<i>Panicum obseptum</i>	1		
<i>Paspalum distichum</i>	1		
<i>Paspalum mandicanum</i>	2		
<i>Paspalum urvillei</i>	3		
<i>Persicaria lapathifolia</i>	1		
<i>Persicaria strigosa</i>	5		
<i>Schoenoplectus vallidus</i>	2		
<i>Setaria sphacelata</i>	2		
<i>Sida rhombifolia</i>	1		
<i>Typha orientalis</i>	2		
<i>Verbena bonariensis</i>	1		

Braun-Blanquet scale (% crown cover): 1 = <1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-100%.

Landscape monitoring site 11 – Landscape Planting treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
28/11/2021	11	490895, 6596807	490897, 6596754
Plant species	Braun-Blanquet scale of cover abundance (% crown cover)		
<i>Acacia fimbriata</i>	2		
<i>Acacia irrorata</i>	1		
<i>Acacia melanoxyllum</i>	2		
<i>Acacia longifolia</i>	2		
<i>Ageratum houstonianum</i>	2		
<i>Ambrosia psilostachya</i>	1		
<i>Aster subulatus</i>	1		
<i>Axonopus affinis</i>	1		
<i>Baccharis halimifolia</i>	1		
<i>Baumea articulata</i>	2		
<i>Carex appressa</i>	1		
<i>Casuarina cunninghamii</i>	1		
<i>Ciclospermum leptophyllum</i>	1		
<i>Conyza bonariensis</i>	2		
<i>Crassocephalum crepidoides</i>	1		
<i>Cynodon dactylon</i>	2		
<i>Cyperus polystachyos</i>	2		
<i>Dodonaea triquetra</i>	1		
<i>Eleocharis acuta</i>	3		
<i>Isachne globosa</i>	2		
<i>Juncus prismatocarpus</i>	2		
<i>Juncus usitatus</i>	2		
<i>Lantana camara</i>	1		
<i>Leptospermum polygalifolium</i>	1		
<i>Lomandra hysteryx</i>	2		
<i>Lomandra longifolia</i>	1		
<i>Ludwigia peploides</i>	2		
<i>Microlaena stipoides</i>	2		
<i>Myriophyllum aquaticum</i>	2		
<i>Nymphaea capensis</i>	1		
<i>Paspalum mandiocanum</i>	2		
<i>Paspalum urvillei</i>	2		
<i>Persicaria strigosa</i>	3		
<i>Rubus sp.</i>	1		
<i>Sacciolepis indica</i>	1		
<i>Senecio madagascariensis</i>	1		
<i>Setaria sphacilata</i>	3		
<i>Tradescantia fluminensis</i>	1		
<i>Themeda australis</i>	1		
<i>Verbena bonariensis</i>	1		

Braun-Blanquet scale (% crown cover): 1 = <1%, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-100%.

Landscape monitoring site 12 – Landscape Planting treatment

Date	Site no.	Stake 1 coordinates	Stake 2 coordinates
28/11/2021	12	489789, 6594939	489789, 6594909
Plant species	Braun-Blanquet scale of cover abundance (% crown cover)		
<i>Acacia fimbriata</i>	2		
<i>Acacia irrorata</i>	3		
<i>Cirsium vulgare</i>	1		
<i>Conyza bonariensis</i>	2		
<i>Cyclosporum leptophyllum</i>	1		
<i>Cyperus sp.</i>	1		
<i>Gahnia aspera</i>	1		
<i>Geitonoplesium cymosum</i>	1		
<i>Hypocheirus radicata</i>	2		
<i>Juncus ursitatus</i>	1		
<i>Lantana camara</i>	1		
<i>Lomandra hysteryx</i>	2		
<i>Lomandra longifolia</i>	2		
<i>Paspalum dilatatum</i>	2		
<i>Paspalum mandiocanum</i>	2		
<i>Paspalum urvillei</i>	2		
<i>Phytolacca octandra</i>	2		
<i>Senecio madagascariensis</i>	1		
<i>Setaria sphacelata</i>	3		