Koala Habitat Rehabilitation Monitoring Report – 4th Monitoring Period – Yarrabilba

EPBC Number:	2013/6791
Project Name:	Yarrabilba
Proponent's ACN:	103 578 436
Proposed Action:	To construct the Yarrabilba residential development and associated infrastructure approximately 40 kilometres south east of Brisbane, Qld (see EPBC Act referral 3013/6791 and request to vary proposal dated 5 August 2013)
Prepared for:	Lendlease
Prepared by:	Dr M.N. Runkovski, J. Pittard, B. Steinrücken, M. Brett, K. Richardt, K. Leopold
Date:	31 May 2019

Natura Consulting – Document Control Sheet

Project	
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Revision History

Version:	**Purpose:**	**Issued by:**	**Date**	**Reviewer:**	**Date:**
0.1	Peer review	K. Leopold	13/03/2019	M.N. Runkovski	04/04/2019
1.0	Quality assurance	M.N. Runkovski	11/04/2019	D. Coburn	15/05/2019

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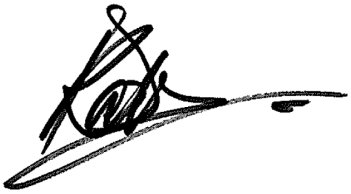
Signed 

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Date

19 / 12 / 2019

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1 Executive summary

Natura Consulting has developed this *Habitat Rehabilitation Monitoring Report* for the 4th monitoring period for rehabilitation within the Yarrabilba Koala Habitat Areas as prescribed in the *Habitat Rehabilitation and Management Plan* (Natura Consulting, March 2015) and the Approval Conditions set out under the *Environmental Protection and Biodiversity Conservation Act 1999* originally dated 13 November 2014 and varied 8 December 2017.

The intent of this plan is to provide 4th monitoring period information to direct the rehabilitation works associated with koala habitat within the 'koala habitat areas to be protected and managed' on the Yarrabilba site. These areas are to be rehabilitated, ensuring that koala habitat outside of the offset sites areas are protected and managed. This report provides 4th monitoring period data for the rehabilitation of these areas, from the 62 sites monitored (see later). Each monitoring site is located within a Koala Habitat Rehabilitation Unit (HRU1 to HRU31) including Road Crossing Rehabilitation Units (CRU2, CRU4 to CRU7 and CRU9 to CRU14), with the pre-clearing Regional Ecosystem, management type and corridor type tabulated.

Each rehabilitation unit is to be rehabilitated to a vegetation structure and species composition that is in line with that of the appropriate pre-clearing Regional Ecosystem (RE). This is derived from the vegetation structure and species composition of the appropriate pre-clearing RE. The Final Benchmark for rehabilitation is derived from the definition of remnant vegetation under the *Vegetation Management Act 1999* (canopy is 70% of the height, 50% of the cover and similar species composition of the appropriate pre-clearing RE). Interim Benchmarks are also provided whereby an assessment at regular intervals will be made on the progress of the rehabilitation / revegetation efforts towards achieving this plan's outcomes. For Interim Benchmark years 1 to 10, vegetation structure has been quantified from a cumulative growth curve (CGC). The reference benchmark, Interim Benchmarks and Final Benchmarks have been tabulated for each RE, with the relevant rehabilitation unit also identified. A species list for each RE, including dominant species within each stratum, has also been provided.

Provision of contingency measures and corrective actions will account for instances of when Interim Benchmarks are not being met. 'As constructed' data and surveyed boundaries will also be provided for each rehabilitation unit to test and demonstrate compliance with the requirement to maintain and protect existing koala habitat.

The monitoring methodology that is applied has been detailed, where a minimum of two monitoring sites per rehabilitation unit will be surveyed in order to document and assess rehabilitation through time. All final locations of the 62 monitoring sites have been mapped. Monitoring includes photo point monitoring and transect and quadrat monitoring to monitor changes in species richness, percentage foliage cover for the ground layer, shrub and canopy layers, canopy height, and weed prevalence.

An assessment of site species richness and structure was undertaken to determine the baseline condition against the benchline values. A number of sites already meet the Final Benchmark for some individual parameters. Rehabilitation efforts need to ensure that the full suite of species represented in the pre-RE condition for each rehabilitation unit are planted where possible, with a strong focus on eradicating exotic weeds.

A total of 26 sites (42%) meet a benchmark for canopy tree cover (up from 15 sites (24%) in 3rd monitoring period), 31 sites (50%) meet a benchmark for canopy tree height (up from 25 sites (40%) in 3rd monitoring period), 62 sites (100%) meet a benchmark for small tree cover (up from 56 sites (90%) in 3rd monitoring period), 62 sites (100%) meet a benchmark for small tree height (up from 61 sites (98%) in 3rd monitoring period), Perhaps the greatest improvement was seen in shrub cover, where 53 (85%) sites meet a benchmark (up from 19 sites (31%) in 3rd monitoring period). 57 sites

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(92%) meet a benchmark for shrub height (up from 55 sites (89%) in 3rd monitoring period), 61 sites (98%) meet a benchmark for ground-cover (same as 3rd monitoring period), and 23 sites (37%) meet the <5% cover benchmark for weed cover of the ground-layer (down from 28 (45%) in 3rd monitoring period).

Overall, this assessment supports findings of the 3rd monitoring period - that rehabilitation works need to continue prioritising weed control of the ground-layer in order to provide opportunity for native species richness and shrub cover to increase proportionally. Furthermore, strategic rehabilitation of the ground, shrub and tree layers will ensure that weeds are outcompeted and shaded out over time. A number of sites do not yet meet a benchmark for tree and shrub structure, and so these sites will need to be prioritised for rehabilitation within the next 6 months to ensure that they meet the IMO-3 year benchmark at minimum. However, management actions are proving successful, with a number of 3rd monitoring priority sites showing improvement and being replaced by new priority management areas.

Ten sites are regarded as the poorest in terms of height and cover and meeting low benchmarks (IMO-1, IMO-2) or no benchmarks at all, in four or more categories across canopy, shrub and ground-layers with % weed cover also taken into consideration. These include 4 top rehabilitation units most urgently requiring management actions for improving multiple benchmarks and weed cover, including sites 1 (HRU1), 89 (HRU23), 139 and 140 (CRU7 same as 3rd monitoring) and HRU15 (same as 3rd monitoring) and a further 6 rehabilitation units requiring targeted management for overall ground cover improvement, including sites 81 (HRU20), 17 (HRU5), 105 (HRU26), 126 (HRU31), 122 (HRU30) and 95 (HRU17). In summary, therefore, the following 10 rehabilitation units require the most urgent management attention: HRU1, HRU23, CRU7, HRU15, HRU20, HRU5, HRU26, HRU31, HRU30 and HRU17.

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2 Introduction

2.1 Background

The Yarrabilba development site is located on the eastern side of Waterford - Tamborine Road and to the south of Logan Village (refer to Figure 1). It is bounded by rural residential areas to the north, Plunkett Road to the south and the Plunkett Conservation Park to the east. The site consists of approximately 2,200 ha, of which 1,931 ha is controlled by Lendlease Communities (Yarrabilba) Pty Ltd. The land has been historically used for pine forestry, a military training camp in WWII and for live stock grazing, when first cleared. Yarrabilba is predominately vegetated with areas of regrowth native vegetation, regenerating pines and exotic grasslands. Some limited areas of native remnant and regrowth vegetation exist but they are mostly confined to creeks, drainage channels and wetlands.

The site is currently in the early stages of development with the growth of Yarrabilba projected to span approximately 30 years. The long-term master-planned development incorporates an extensive network of dedicated open space (in excess of 25% of the site). A significant component of the open space is dedicated to the conservation of habitat for koalas (*Phascolarctos cinereus*).

Habitat rehabilitation is intended to improve koala habitat quality within the site in order to significantly increase the site's koala carrying capacity in the medium to long term. In addition, the configuration of key elements of the open space system (Fauna Corridor, Greenspace Corridor and Environmental Protection Zone) will enhance the site's contribution to koala movement opportunities within the context of larger areas of koala habitat to the east and west of the site (Austecology 2012). Under the development of Yarrabilba, all existing fragments of remnant vegetation which have value for koalas will be retained (approximately 5.4% of the total site area) (Austecology 2012). The rehabilitation of the Fauna Corridor, Greenspace Corridor and Environmental Protection Zone will significantly expand on these values by providing additional koala habitat (Natura Consulting 2011).

Natura Consulting has developed this *Habitat Rehabilitation Monitoring Report – 4th Monitoring Period within Koala Habitat Areas* prior to the commencement of habitat rehabilitation in Koala Habitat Areas in the Yarrabilba Residential Development. This report provides data for the 4th monitoring period for the rehabilitation of Koala Habitat Areas within the development site, with 62 sites monitored. As noted in previous monitoring reports, Slash pine (*Pinus elliottii*) control has already occurred throughout >90% of the entire development site.

2.2 Objectives

The intent of this report is to provide 4th monitoring period data with which to assess the rehabilitation of koala habitat within the 'koala habitat to be protected and managed'.

This report is consistent with the *Habitat Rehabilitation and Management Plan* (Natura Consulting 2015), *Offset Management Plan* (Austecology 2015), *Koala Management Plan* (Austecology 2012) and *Fauna Corridor Infrastructure Master Plan* (Natura Consulting 2011). Specifically the objectives of this report are to:

- describe the rehabilitation areas and clear and concise rehabilitation outcomes and performance indicators against which achievement of the rehabilitation will be measured
- identify contingency measures and appropriate corrective actions that will be undertaken if the performance indicators or outcomes are not being met
- outline the monitoring methodology including monitoring site locations
- present the 4th monitoring period results
- assess whether rehabilitation is on-track to meet the next interim performance indicator

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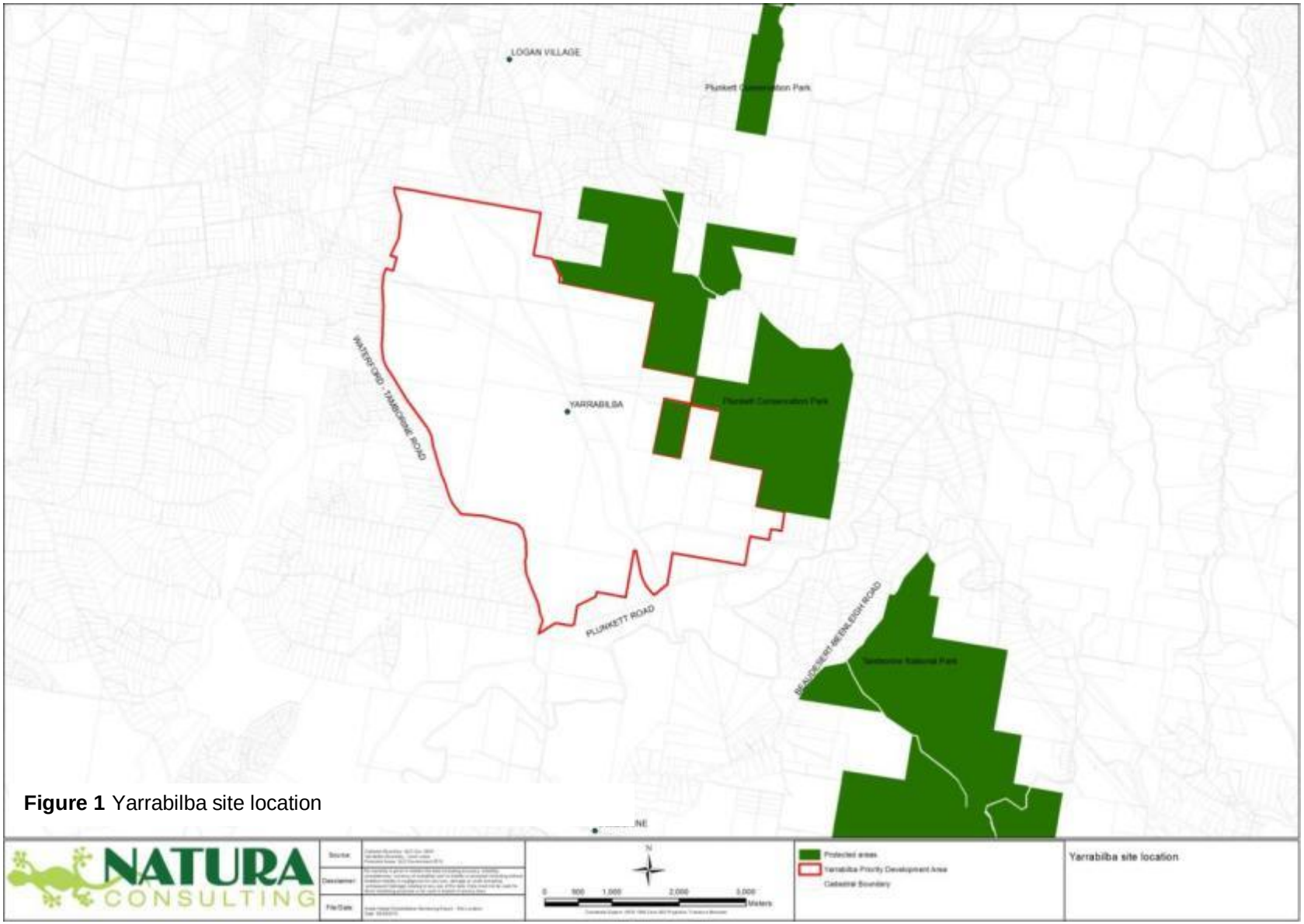

Figure 1 Yarrabilba site location

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3 Rehabilitation areas

3.1 Purpose of habitat rehabilitation

Koala habitat rehabilitation is to be undertaken within *Existing Assessable Koala Habitat to be protected and managed* within Fauna Corridors, Greenspace Corridors and Environmental Protection Zones. This totals an area of 754,657 m^2 (75.5 ha) within *Existing Assessable Koala Habitat* areas outside of Offset areas (195 ha), comprising a combined area of 2,736,428 m^2 (273.6 ha).

The koala habitat rehabilitation area has been divided into Offset Rehabilitation and Habitat Rehabilitation Units and Crossing Rehabilitation Units. This report is relevant to the Habitat Rehabilitation Units and Crossing Rehabilitation Units.

3.2 Habitat Rehabilitation Units (HRU)

Koala habitat rehabilitation is to occur within Habitat Rehabilitation Units as shown in Figure 2. Each rehabilitation unit (HRU1 to HRU31) is a mapped polygon, where the polygon boundaries are the mapped Pre-Clearing Regional Ecosystems. The Regional Ecosystem (RE) code applicable to each unit was determined by overlapping Pre-Clearing Regional Ecosystem mapping (Queensland Government 2015b) with maps of *Existing Assessable Koala Habitat – to be protected and managed* within the Fauna Corridors, Greenspace Corridors and Environmental Protection Zones.

The following table (Table 1) presents a summary of rehabilitation unit attributes, including the:

- area of the rehabilitation unit in square metres
- corridor within which the rehabilitation unit is located
- RE code for pre-clearing vegetation within the rehabilitation unit and the landzone / geology of the rehabilitation unit

It is noted that the minimum rehabilitation unit size is ~2,500 m^2 to reflect the mapping limitation of the Pre-Clearing Regional Ecosystems mapping dataset (Queensland Government 2015a). However, there are two rehabilitation units with areas of slightly less than 2,500 m^2, which were retained due to their immediate proximity to adjacent rehabilitation units.

3.3 Crossing Rehabilitation Units (CRU)

Rehabilitation and monitoring is also being undertaken where road and infrastructure traverses a Habitat Rehabilitation Unit. These areas are known as Crossing Rehbilitation Units. Crossing Rehabilitation Units have been identified by overlaying the proposed internal road network with the Pre-Clearing Regional Ecosystem mapping (Queensland Government 2015a) and Koala Habitat Rehabilitation Unit mapping. Each Crossing Rehabilitation Unit (CRU1 to CRU15) is a mapped polygon. It is noted that these locations are indicative and may change with the final alignment of roads. Table 2 presents a summary of the Crossing Rehabilitation Units, which are subject to rehabilitation actions outlined in this report.

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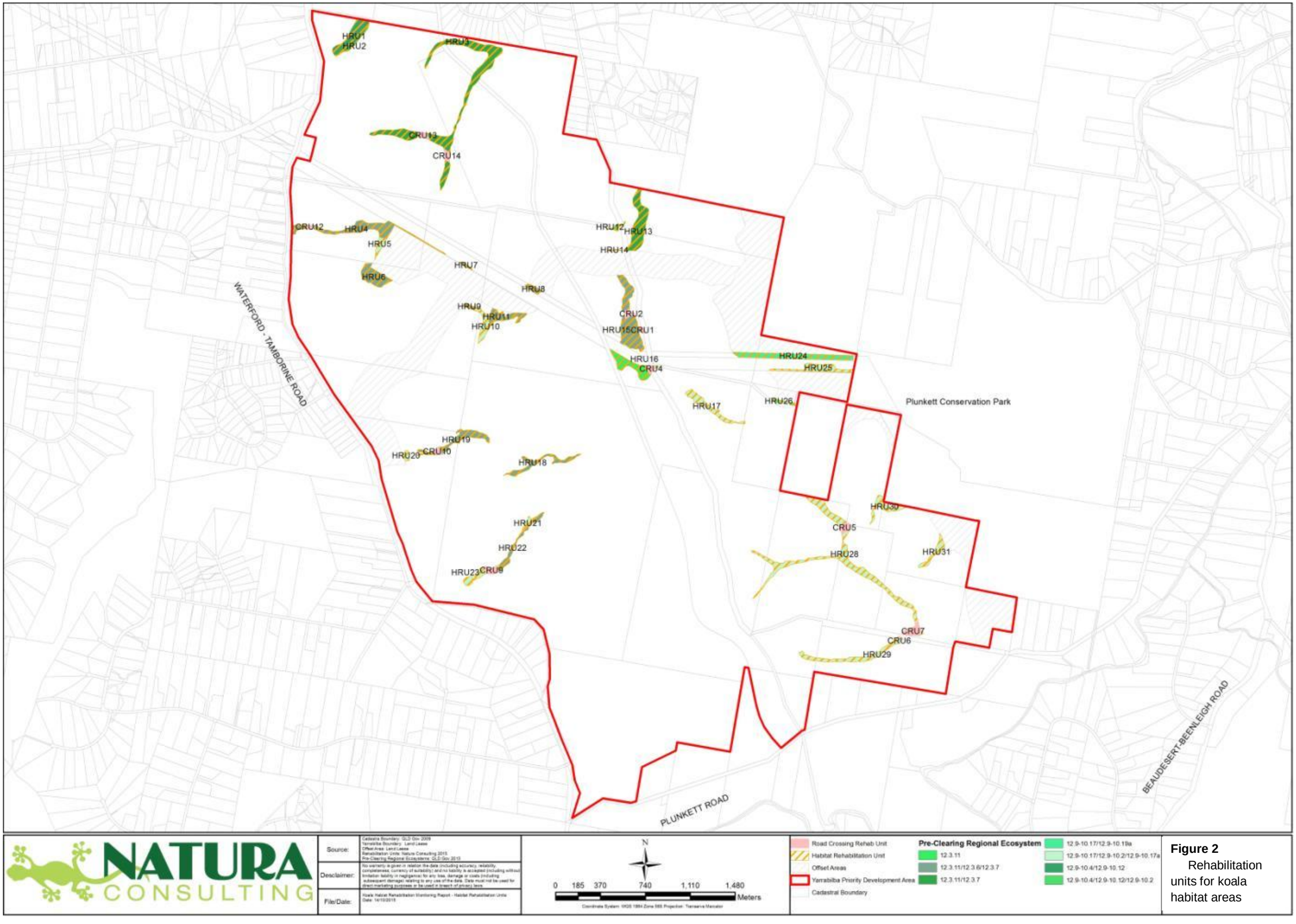

Figure 2 Rehabilitation units for koala habitat areas

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Table 1 Habitat Rehabilitation Units (HRU) within the corridor network

Rehab. Unit	Area (m^2)	Corridor Type	RE Code(s)	Landzone / Geology
HRU1	31,875	Greenspace Corridor	12.9-10.4/12.9-10.12	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU2	2,947	Greenspace Corridor	12.9-10.4/12.9-10.12/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU3	116,097	Greenspace Corridor	12.3.11/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU4	47,894	Fauna Corridor Greenspace Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU5	6,788	Greenspace Corridor	12.9-10.17/12.9-10.2	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU6	26,102	Greenspace Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU7	1,684	Fauna Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU8	5,206	Fauna Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU9	2,935	Greenspace Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU10	13,511	Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU11	19,528	Greenspace Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU12	3,128	Greenspace Corridor	12.9-10.4/12.9-10.12/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU13	42,093	Greenspace Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU14	910	Greenspace Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU15	62,944	Fauna Corridor Greenspace Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU16	29,486	Fauna Corridor Greenspace Corridor	12.3.11	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU17	19,638	Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU18	19,604	Fauna Corridor Greenspace Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU19	29,070	Fauna Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats
HRU20	3,784	Fauna Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU21	5,688	Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU22	14,158	Greenspace Corridor	12.3.11/12.3.6/12.3.7	Recent quaternary alluvial systems – Alluvial river and creek flats

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Rehab. Unit	Area (m^2)	Corridor Type	RE Code(s)	Landzone / Geology
HRU23	15,932	Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU24	38,783	Environmental Protection	12.9-10.17/12.9-10.19	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU25	22,618	Environmental Protection	12.9-10.17/12.9-10.2/12.9-10.19	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU26	2,818	Environmental Protection	12.9-10.17/12.9-10.19	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU27	15,379	Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU28	99,585	Fauna Corridor Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU29	27,237	Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU30	15,378	Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
HRU31	11,857	Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
Total	**754,657**			

Table 2 Road and infrastructure crossing rehabilitation units (CRU) traversing Habitat Rehabilitation Units (HRU)

Crossing Rehab. Unit	Area (m^2)	Traversing ORU	Corridor Type	RE Code(s)	Landzone / Geology
CRU1	1,369	HRU15	Greenspace Corridor	12.3.11/12.3.6/12.3.7	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
CRU2	3,670	HRU15	Fauna Corridor Greenspace Corridor	12.3.11/12.3.6/12.3.7	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
CRU4	3,347	HRU16	Greenspace Corridor	12.11.3	Metamorphic rocks - hills and lowlands on metamorphic rocks
CRU5	6,013	HRU28	Fauna Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
CRU6	731	HRU29	Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
CRU7	10,045	HRU28	Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
CRU9	5,542	HRU22, HRU23	Greenspace Corridor	12.9-10.17/12.9-10.2	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
CRU10	3,555	HRU19	Fauna Corridor	12.3.11/12.3.6/12.3.7	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
CRU12	1,775	HRU4	Greenspace Corridor	12.3.11/12.3.6/12.3.7	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
CRU13	3,766	HRU3	Greenspace Corridor	12.3.11//12.3.7	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
CRU14	3,496	HRU3	Greenspace Corridor	12.3.11//12.3.7	Fine grained sedimentary rocks – Undulating country on fine grained sedimentary rocks
Total	**43,309**				

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3.4 Pre-clearing Regional Ecosystems Rehabilitation Units

A short description of the pre-clearing Regional Ecosystems identified in the Koala Habitat Rehabilitation Units and Crossing Rehabilitation Units is provided in Table 3.

Table 3 Summary of pre-clearing Regional Ecosystems within Offset Rehabilitation Units and Crossing Rehabilitation Units

RE Code	RE short description (extract from Qld Herbarium) RE Description Database	Vegetation Management Act class	Biodiversity status
12.3.6	*Eucalyptus tereticornis*, *Casuarina cunninghamiana* subsp. *cunninghamiana* +/- *Melaleuca* spp. fringing woodland	Least concern	No concern at present
12.3.7	*Melaleuca quinquenervia* +/- *Eucalyptus tereticornis*, *Lophostemon suaveolens* open forest on coastal alluvial plains	Least concern	No concern at present
12.3.11	*Eucalyptus tereticornis* +/- *Eucalyptus siderophloia*, *Corymbia intermedia* open forest on alluvial plains	Of concern	Of concern
12.9-10.2	*Corymbia citriodora* subsp. *variegata* +/- *Eucalyptus crebra* open forest on sedimentary rocks	Least concern	No concern at present
12.9-10.4	*Eucalyptus racemosa* subsp. *racemosa* woodland on sedimentary rocks	Least concern	No concern at present
12.9-10.12	*Eucalyptus seeana*, *Corymbia intermedia*, *Angophora leiocarpa* woodland on sedimentary rocks	Endangered	Endangered
12.9-10.17	*Eucalyptus acmenoides*, *E. major*, *E. siderophloia* +/- *Corymbia citriodora* subsp. *variegata* woodland on sedimentary rocks	Least concern	No concern at present
12.9-10.19	*Eucalyptus fibrosa* subsp. *fibrosa* woodland on sedimentary rocks	Least concern	No concern at present
12.11.3	*Eucalyptus siderophloia*, *E. propinqua* +/- *E. microcorys*, *Lophostemon confertus*, *Corymbia intermedia*, *E. acmenoides* open forest on metamorphics +/- interbedded volcanics	Least concern	No concern at present

Source: QLD Government 2015a

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4 Rehabilitation performance indicators

In accordance with the *EPBC Act 1999* decision notice, the *Koala Habitat Rehabilitation Management Plan* (Natura Consulting 2015) was formulated reflecting the onsite rehabilitation requirements of Fauna and Green Space Corridors, Regional Ecosystems, drainage lines and post development fauna movement pathways within Offset Areas on the site. This plan identifies koala habitat rehabilitation benchmarks and determines restoration actions to meet these benchmarks.

Each rehabilitation unit is to be rehabilitated to a vegetation structure and species composition that is in line with that of the appropriate pre-clearing RE (identified in Table 5 and Table 6). The reference benchmark for rehabilitation of each rehabilitation unit is derived from the vegetation structure and species composition of the appropriate pre-clearing Regional Ecosystem (RE) (refer to Table 5 and Table 6). These benchmarks quantify average canopy cover, shrub cover, ground cover, species richness and average height of the canopy and have been sourced from the Queensland Herbarium (Queensland Government 2015b). These technical descriptions are a compilation of data from multiple sites for canopy cover, shrub cover, and average stem density for each strata, groundcover and average species richness (Queensland Government 2015b). Through establishing these benchmarks, a reasonable comparison can be made between the floristic composition and vegetation structure of a given rehabilitation unit and the appropriate pre-clearing RE.

4.1 Performance indicators

The Final Benchmark for rehabilitation is derived from the definition of remnant vegetation under the *Vegetation Management Act 1999.* Vegetation can be mapped as remnant vegetation and associated essential habitat for koalas if the canopy is 70% of the height, 50% of the cover and similar species composition of the appropriate pre-clearing RE (Queensland Government 2015b). Therefore, the Final Benchmark for rehabilitation is 70% of the reference benchmark cover (for canopy, shrub and ground-layer) and 50% of the reference benchmark height (for canopy and shrub layer) of the appropriate RE.

Six rehabilitation performance indicators were selected:

1. average canopy cover
2. average height of canopy
3. dominant canopy species
4. average shrub cover
5. average groundcover
6. species richness
7. weed cover

Weed cover needs to be considered for rehabilitation benchmarks for this site, particularly in the canopy where numerous exotic pine trees exist. Throughout the life of the development a weed cover of ≤5% is to be maintained.

The reference and Final Benchmark vegetation structure and species composition for each of the pre-clearing REs identified within the mapped rehabilitation units is identified in Table 5 and Table 6 respectively. Note that exotic species identified in Table 6 are to assist with identification purposes only and are to be controlled and managed, not planted or assisted.

Rehabilitation units are to be managed and restored until they reach the Final Benchmark condition as identified in Table 4 and Table 5, along with the objectives of the Habitat Rehabilitation and Management Plan. The objectives of this plan are long term and are likely to require more than 15 years to be achieved, within each rehabilitation unit, after implementation is commenced.

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Interim Benchmarks are also provided whereby an assessment at regular intervals can be made on the progress of the rehabilitation / revegetation efforts towards achieving this plan's outcomes. Given this, adaptive management approaches can also be employed to redirect restoration approaches, in the event that Interim Benchmarks are not being met. Table 5 provides a summary of the timeframe to achieve the Interim and Final Benchmarks.

For Interim Benchmark years 1 to 10, vegetation structure has been quantified from a cumulative growth curve (CGC), which for biological organisms, including trees and shrubs, is sigmoidal (Brack and Wood 1996). As the reference benchmarks applied for this report are at the Regional Ecosystem level, and site data and long term tree and shrub growth curves are not available for Yarrabilba, we have derived general growth curves for each Regional Ecosystem. This is based on a sigmoidal growth curve, the average reference benchmark height of the stratum, the minimum height at which regrowth vegetation is considered to be of equivalent height as the RE (50% of reference benchmark height), and the average height of tubestock (20 cm) that is predominately used for revegetation in southeast Queensland.

The Final Benchmark at year 15 is 70% of the reference benchmark cover (for canopy, shrub and ground-layer) and 50% of the reference benchmark height (for canopy and shrub layer) of the appropriate pre-clearing RE. See Appendix A for species composition of Final Benchmark Regional Ecosystems.

4.2 Contingency measures and corrective actions

4.2.1 Meeting benchmarks

During the course of monitoring, if Interim Benchmarks are not being met, the timeframes to achieve the Final Benchmarks will be reviewed and extended, whereby Lendlease will continue to undertake rehabilitation works with continued monitoring until the Final Benchmarks are met. The review of the success of meeting Interim Benchmarks will be undertaken at each monitoring event and reported on. Where the extension of rehabilitation works is required for particular Rehabilitation Units, discussions will be undertaken with the Department of Environment, to ensure that any additional requirements are also highlighted and addressed.

4.2.2 As constructed data

Constructed data and surveyed boundaries will be provided for each Rehabilitation Unit, within three months of completion of earthworks. This will be undertaken to test and demonstrate compliance within the offset area (195 ha) requirement.

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Table 4 Reference, Interim & Final Benchmark vegetation structure for each pre-clearing RE detailed for rehabilitation units (HRU) & crossing rehabilitation units (CRU)

Benchmark Condition (where rehabilitation units are treated individually, at least 70% of height and 50% of cover values to be attained within first 15 years of commencement of rehabilitation works)											
RE Code	**Name**	**VMA Status**	**Biodiversity**	**Habitat Rehabilitation Unit**				**Crossing Rehabilitation Unit**			
12.3.6	***Melaleuca quinquenervia* +/- *Eucalyptus tereticornis*, *Lophostemon suaveolens* open forest on coastal alluvial plains**	Least concern	No concern at present	HRU4, HRU6, HRU7, HRU8, HRU9, HRU11, HRU13, HRU14, HRU15, HRU18, HRU19, HRU22							
				Average Canopy Cover (%)	**Average Canopy Height (m)**	**Average T2-T3 Canopy Cover (%)**	**Average T2-T3 Canopy Height (m)**	**Average Shrub Cover (%)**	**Average Shrub Height (m)**	**Average Ground cover (%)**	**Species Richness (av. +/- SD)**
			Interim Benchmark by 1 year	10.0	1.5			1.5	0.5	6.0	
			Interim Benchmark by 2 years	14.0	3.0			2.0	0.8	10.0	
			Interim Benchmark by 3 years	16.0	4.0			2.5	1.2	15.0	
			Interim Benchmark by 5 years	22.0	6.0			3.0	1.4	20.0	
			Interim Benchmark by 10 years	28.0	9.2			4.0	1.5	25.0	
			Final Benchmark by 15 years	**30.5**	**10.7**			**4.5**	**1.6**	**29.2**	**-**
			Reference Benchmark (Pre-Clearing RE)	**60.9**	**15.3**			**8.9**	**2.3**	**58.4**	**33.3 +/- 10.5**
12.3.7	***Eucalyptus tereticornis*, *Casuarina cunninghamiana* subsp. *cunninghamiana* +/- *Melaleuca* spp. fringing woodland**	Least concern	No concern at present	HRU3, HRU4, HRU6, HRU7, HRU8, HRU9, HRU11, HRU13, HRU14, HRU15, HRU18, HRU19, HRU22							
				Average Canopy Cover (%)	**Average Canopy Height (m)**	**Average T2-T3 Canopy Cover (%)**	**Average T2-T3 Canopy Height (m)**	**Average Shrub Cover (%)**	**Average Shrub Height (m)**	**Average Ground cover (%)**	**Species Richness (av. +/- SD)**
			Interim Benchmark by 1 year	5.5	1.6	2.0	0.8	2.5	0.5	6.0	
			Interim Benchmark by 2 years	6.0	2.9	3.0	2.7	3.0	0.8	7.0	
			Interim Benchmark by 3 years	7.0	4.1	4.0	3.7	3.5	1.2	8.0	
			Interim Benchmark by 5 years	9.0	6.2	5.9	5.2	4.0	1.4	10.0	
			Interim Benchmark by 10 years	12.0	10.1	9.3	7.3	6.0	1.5	12.0	
			Final Benchmark by 15 years	**13.3**	**13.6**	**11.5**	**8.2**	**6.6**	**1.6**	**14.4**	**-**
			Reference Benchmark (Pre-Clearing RE)	**26.6**	**19.4**	**15.3**	**9.0**	**13.2**	**2.3**	**28.7**	**52.8 +/- 7.5**
12.3.11	***Eucalyptus tereticornis* +/-**	Of concern	Of concern	HRU3, HRU4, HRU6, HRU7, HRU8, HRU9, HRU11, HRU13,							

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Benchmark Condition (where rehabilitation units are treated individually, at least 70% of height and 50% of cover values to be attained within first 15 years of commencement of rehabilitation works)												
RE Code	**Name**	**VMA Status**	**Biodiversity**	**Habitat Rehabilitation Unit**				**Crossing Rehabilitation Unit**				
	***Eucalyptus siderophloia*, *Corymbia intermedia* open-forest on alluvial plains**			HRU14, HRU15, HRU16, HRU18, HRU19								
				Average Canopy Cover (%)	**Average Canopy Height (m)**	**Average T2-T3 Canopy Cover (%)**	**Average T2-T3 Canopy Height (m)**	**Average Shrub Cover (%)**	**Average Shrub Height (m)**	**Average Ground cover (%)**	**Species Richness (av. +/- SD)**
			Interim Benchmark by 1 year	7.0	1.6	2.0	0.8	2.0	0.4	1.5	
			Interim Benchmark by 2 years	10.0	3.0	3.0	2.8	4.0	0.7	2.0	
			Interim Benchmark by 3 years	12.0	4.2	4.2	3.8	5.0	1.1	3.0	
			Interim Benchmark by 5 years	18.0	6.4	6.4	5.5	7.0	1.3	4.5	
			Interim Benchmark by 10 years	22.0	10.7	10.7	8.2	9.0	1.5	7.0	
			Final Benchmark by 15 years	**25.6**	**16.7**	**13.9**	**9.6**	**10.9**	**1.9**	**8.5**	**-**
			Reference Benchmark (Pre-Clearing RE)	**51.1**	**23.8**	**23.9**	**11.3**	**21.7**	**2.7**	**17**	**40.6 +/- 8.5**
12.9-10.2	***Corymbia citriodora* subsp. *variegata* +/- *Eucalyptus crebra* open forest on sedimentary rocks**	Least concern	No concern at present	HRU2, HRU5, HRU10, HRU12, HRU17, HRU20, HRU21, HRU23, HRU27, HRU28, HRU29, HRU30, HRU31				CRU5, CRU6, CRU9				
				Average Canopy Cover (%)	**Average Canopy Height (m)**	**Average T2-T3 Canopy Cover (%)**	**Average T2-T3 Canopy Height (m)**	**Average Shrub Cover (%)**	**Average Shrub Height (m)**	**Average Ground cover (%)**	**Species Richness (av. +/- SD)**
			Interim Benchmark by 1 year	6.0	1.6	2.0	0.8	6.0	0.4	6.0	3.0
			Interim Benchmark by 2 years	10.0	2.9	2.9	2.8	6.5	0.7	7.0	4.0
			Interim Benchmark by 3 years	12.0	4.2	4.0	3.8	7.0	1.1	12.0	5.0
			Interim Benchmark by 5 years	18.0	6.3	6.0	5.3	8.5	1.3	18.0	7.0
			Interim Benchmark by 10 years	22.0	10.5	9.6	7.7	11.4	1.5	22.0	9.0
			Final Benchmark by 15 years	**26.8**	**15.5**	**11.9**	**8.9**	**15.1**	**1.8**	**23.6**	**10.8**
			Reference Benchmark (Pre-Clearing RE)	**53.5**	**22.2**	**16.5**	**10.1**	**21.6**	**2.5**	**47.2**	**21.6**
12.9-10.17	***Eucalyptus acmenoides, Eucalyptus major, Eucalyptus siderophloia* +/- *Corymbia citriodora subsp. variegata* woodland on sedimentary**	Least concern	No concern at present	HRU5, HRU10, HRU17, HRU20, HRU21, HRU23, HRU24, HRU25, HRU26, HRU27, HRU28, HRU29, HRU30, HRU31				CRU5, CRU6, CRU7, CRU9				
				Average Canopy Cover	**Average Canopy Height**	**Average T2-T3 Canopy**	**Average T2-T3 Canopy Height**	**Average Shrub Cover (%)**	**Average Shrub Height (m)**	**Average Ground cover**	**Species Richness (av. +/- SD)**

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Benchmark Condition (where rehabilitation units are treated individually, at least 70% of height and 50% of cover values to be attained within first 15 years of commencement of rehabilitation works)											
RE Code	**Name**	**VMA Status**	**Biodiversity**	**Habitat Rehabilitation Unit**				**Crossing Rehabilitation Unit**			
	rocks			**(%)**	**(m)**	**Cover (%)**	**(m)**			**(%)**	
			Interim Benchmark by 1 year	6.0	1.6	2.0	0.8	6.0	0.6	10.0	
			Interim Benchmark by 2 years	10.0	3.0	3.0	2.8	7.0	1.0	20.0	
			Interim Benchmark by 3 years	12.0	4.2	4.3	3.9	10.0	1.5	25.0	
			Interim Benchmark by 5 years	18.0	6.4	6.5	5.7	14.0	1.8	30.0	
			Interim Benchmark by 10 years	22.0	10.9	11.3	8.9	16.0	2.2	35.0	
			Final Benchmark by 15 years	**27.2**	**18.2**	**15.0**	**10.4**	**20.0**	**2.8**	**43.9**	-
			Reference Benchmark (Pre-Clearing RE)	**54.3**	**26.0**	**30.5**	**12.9**	**40.0**	**4.0**	**87.8**	**36.5 +/- 15.1**
12.9-10.19	***Eucalyptus fibrosa subsp. fibrosa* woodland on sedimentary rocks**	Least concern	No concern at present	HRU24, HRU25, HRU26							
				Average Canopy Cover (%)	**Average Canopy Height (m)**	**Average T2-T3 Canopy Cover (%)**	**Average T2-T3 Canopy Height (m)**	**Average Shrub Cover (%)**	**Average Shrub Height (m)**	**Average Ground cover (%)**	**Species Richness (av. +/- SD)**
			Interim Benchmark by 1 year	6.0	1.6	2.0	0.8	2.5	0.4	2.5	
			Interim Benchmark by 2 years	7.0	3.0	2.9	2.7	4.0	0.7	3.0	
			Interim Benchmark by 3 years	9.0	4.2	4.0	3.7	5.0	1.1	4.0	
			Interim Benchmark by 5 years	12.0	6.3	6.0	5.2	7.0	1.3	6.0	
			Interim Benchmark by 10 years	15.0	10.5	9.6	7.3	9.0	1.5	8.0	
			Final Benchmark by 15 years	**20.9**	**15.8**	**11.9**	**8.2**	**9.6**	**1.7**	**8.2**	-
			Reference Benchmark (Pre-Clearing RE)	**41.8**	**22.5**	**16.4**	**9.0**	**19.1**	**2.4**	**16.4**	**30.1 +/- 4.6**
12.9-10.4	***Eucalyptus racemosa* subsp. *racemosa* woodland on sedimentary rocks**	Least concern	No concern at present	HRU1, HRU3							
				Average Canopy Cover (%)	**Average Canopy Height (m)**	**Average T2-T3 Canopy Cover (%)**	**Average T2-T3 Canopy Height (m)**	**Average Shrub Cover (%)**	**Average Shrub Height (m)**	**Average Ground cover (%)**	**Species Richness (av. +/- SD)**
			Interim Benchmark by 1 year	6.0	1.6	2.0	0.8	2.5	0.6	6.0	

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Benchmark Condition (where rehabilitation units are treated individually, at least 70% of height and 50% of cover values to be attained within first 15 years of commencement of rehabilitation works)											
RE Code	**Name**	**VMA Status**	**Biodiversity**	**Habitat Rehabilitation Unit**				**Crossing Rehabilitation Unit**			
		Interim Benchmark by 2 years		7.0	3.0	2.5	2.7	4.0	0.9	10.0	
		Interim Benchmark by 3 years		9.0	4.2	3.8	3.7	5.0	1.5	15.0	
		Interim Benchmark by 5 years		12.0	6.3	5.3	5.2	7.0	1.8	20.0	
		Interim Benchmark by 10 years		15.0	10.5	7.4	7.3	9.0	2.1	25.0	
		Final Benchmark by 15 years		**20.9**	**15.8**	**10.4**	**8.2**	**9.6**	**2.6**	**29.2**	-
		Reference Benchmark (Pre-Clearing RE)		**38**	**23.2**	**11.8**	**8.9**	**15.7**	**4.1**	**59.9**	**35.4 +/- 5.2**

Adapted from Queensland Government (2015).* No pre-defined benchmarks for this RE are provided within the RE technical descriptions (Queensland Government 2015a) and therefore, these numbers have been based on data collected in the field from previous assessments and reference sites within this RE type.

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5 Monitoring methodology

The following monitoring program was implemented to capture baseline data prior to rehabilitation treatments being applied. Adaptive management strategies will be used where a rehabilitation treatment does not produce the desired result. When this occurs, the treatment will be identified and/or modified.

For this monitoring program, a minimum of two monitoring sites per rehabilitation unit is sufficient to identify any major changes and to provide a 'snap shot' of ecological conditions. Monitoring in this way will allow the ongoing collection of information to demonstrate the effectiveness of habitat rehabilitation efforts, and the frequency of monitoring activities will enable management prescriptions to be adjusted to bring about any necessary changes and corrective actions (adaptive management).

5.1 Sites

Vegetation monitoring for the 4th monitoring period occurred in a network of 62 sample sites.

The final location of each monitoring site within its representative rehabilitation unit was identified by GPS coordinates and direction (compass bearing). Monitoring site locations are identified in Figure 3.

Site locations have been permanently marked by two steel pickets with yellow safety caps, placed approximately 50 m apart. This is a change from the previous years of monitoring where the pickets were 100 m apart. Existing start points were utilised, with new 50 m end points recorded and added to the database. The yellow safety caps were used to mark the site number and distance e.g. 0 m and 50 m. Lastly, wooden stakes mark quadrat locations at 10 m, 20 m, 30 m and 40 m along the transect.

62 sites were sampled during the 4th monitoring period, being the same sites that were sampled in the 3rd monitoring period.

The following methodology will be applied to monitoring at each of the sampled sites.

5.2 Photo point monitoring

For each site, a permanently marked photo point has been established at the first marker picket with a photograph taken towards the first wooden stake at 10 m along the relevant compass bearing. Yellow safety caps are labelled with a permanent marker identifying site number (refreshed each monitoring round). All photos were taken such that the 0 m picket was located in the bottom left hand corner of the photo.

The photos were saved with the following information recorded for each file:

- site number
- survey (i.e. baseline)
- date

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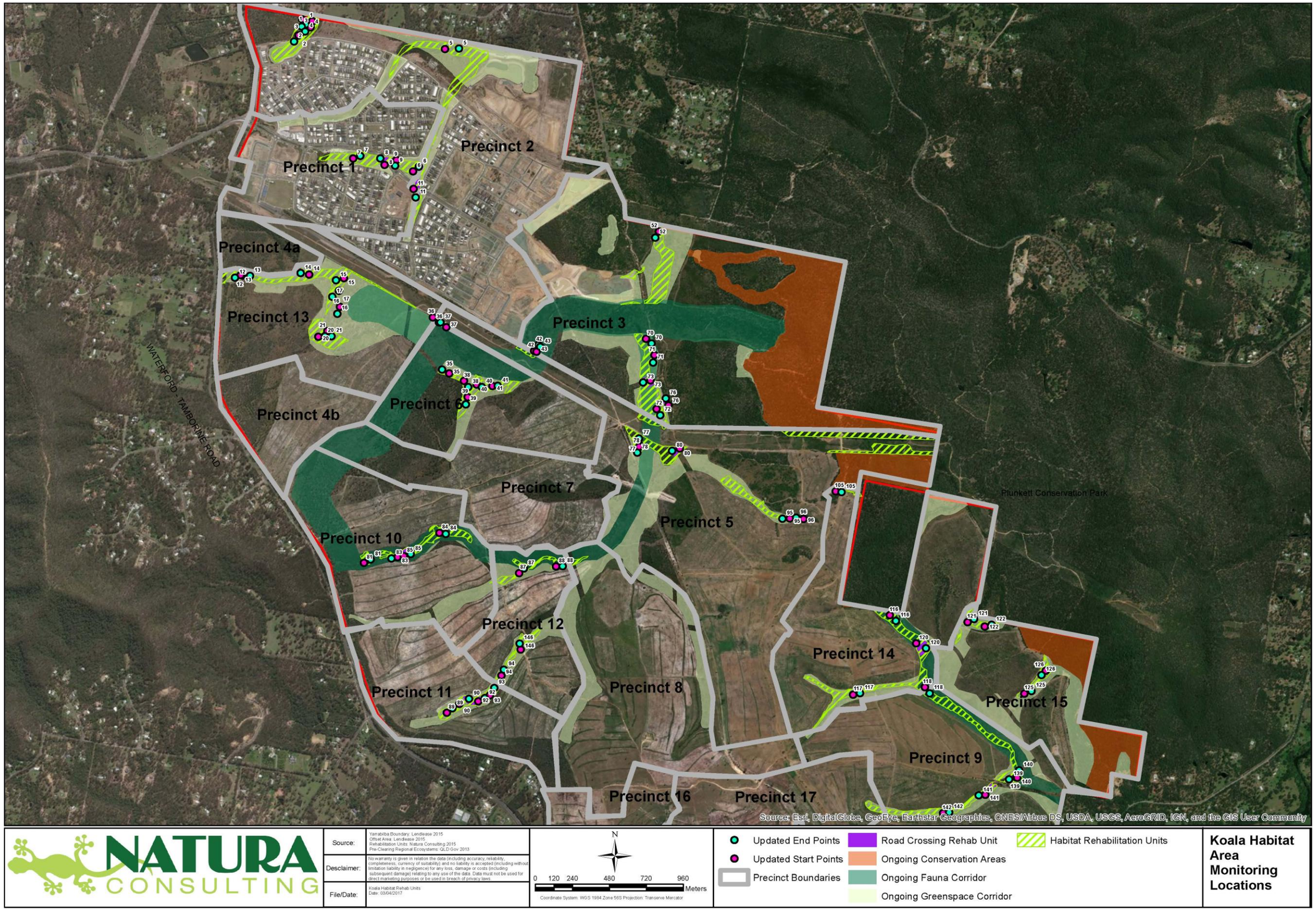

Figure 3 Koala Habitat Rehabilitation Units and habitat monitoring permanent transect locations

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5.3 Transect and quadrat monitoring

Quantitative site data, including the attributes of species richness, percentage foliage cover for the ground layer, shrub and canopy layers, canopy height, and weed cover are to be collected from field transects and quadrats established at each of the monitoring sites:

- A 50 m transect was placed between two metal pickets (0 m and 50 m).

- Quadrats were placed along the transect:
  - 50 x 10 m plot positioned at the transect start at 0 m on the righ hand side of the transect.
  - 1 x 1 m subplots positioned at 0 m, 10 m, 20 m, 30 m and 40 m. Adjustments were made for each subplot if its positioning was placed over a trunk, fallen tree or roots. Locations of quadrats along transect are identified using wooden stakes such that the quadrat is consistently placed at this location during future monitoring.

Given the above, each monitoring site had the same information collected (detailed in Table 5). This benchmark monitoring process will be undertaken at 10 succeeding intervals from baseline roughly 6 months apart until the 3rd year, upon which monitoring becomes annual.

Table 5 Data collected at monitoring sites.

Method of collection	Data collected
50 m x 10 m quadrat (plot)	Species richness
50 m transect	Canopy species (height = >5m) cover and height, shrub cover
Five 1 x 1 m quadrats (subplot)	Percentage cover in ground layer (including regenerating native canopy cohorts)

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6 Results

6.1 Photo-point monitoring

Photo monitoring results are reported in the following table (Table 6), showing the variety of vegetation types and their condition. The vegetation varies from exotic grass pasture such as *Chloris gayana* and *Setaria sphacelata* with sparse native regenerating shrubs and trees, to eucalypt forest with intact structure and species composition. Note that the number of sites showing visible *Lantana camara* infestations has decreased.

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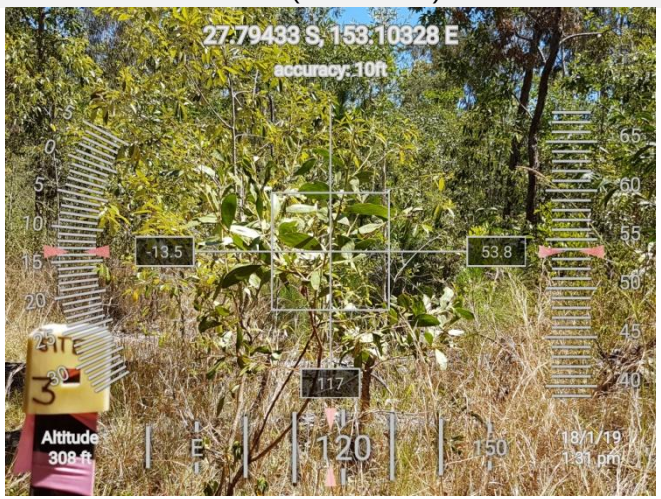
Table 6 Photo monitoring images

Site 1 (18/01/2019)

Site 2 (18/01/2019)

Site 3 (18/01/2019)



Site 4 (18/01/2019)

Site 5 (25/01/2019)

Site 6 (01/02/2019)

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Site 7 (11/01/2019)

Site 8 (11/01/2019)

Site 9 (11/01/2019)

Site 11 (01/02/2019)

Site 12 (09/01/2019)

Site 13 (09/01/2019)

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Site 14 (08/01/2019)

Site 15 (09/01/2019)

Site 16 (08/09/2019)

Site 17 (09/01/2019)

Site 20 (08/01/2019)

Site 21 (08/01/2019)

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Site 35 (10/01/2019)

Site 36 (10/01/2019)

Site 37 (10/01/2019)

Site 38 (09/01/2019)

Site 39 (10/01/2019)

Site 40 (10/01/2019)

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Site 41 (10/01/2019)

Site 42 (05/02/2019)

Site 43 (05/02/2019)

Site 52 (23/01/2019)

Site 70 (22/01/2019)

Site 71 (22/01/2019)

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Site 72 (23/01/2019)

Site 73 (23/01/2019)

Site 77 (30/01/2019)

Site 78 (30/01/2019)

Site 80 (30/01/2019)

Site 81 (24/01/2019)

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Site 83 (24/01/2019)

Site 84 (24/01/2019)

Site 85 (24/01/2019)

Site 87 (19/02/2019)

Site 88 (19/02/2019)

Site 89 (05/02/2019)

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Site 90 (05/02/2019)

Site 92 (14/02/2019)

Site 93 (14/02/2019)

Site 94 (14/02/2019)

Site 95 (20/02/2019)

Site 96 (20/02/2019)

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Site 105 (19/02/2019)

Site 116 (30/01/2019)

Site 117 (16/01/2019)

Site 118 (16/01/2019)

Site 120 (16/01/2019)

Site 121 (31/01/2019)

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Site 122 (31/01/2019)

Site 125 (01/02/2019)

Site 126 (31/01/2019)

Site 139 (15/01/2019)

Site 140 (15/01/2019)

Site 141 (15/01/2019)

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Site 142 (15/01/2019)

Site 146 (14/02/2019)

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6.2 Transect and quadrat monitoring

6.2.1 Species richness

At baseline in May 2016, a total of 339 species were recorded within monitoring sites in the koala habitat areas (Habitat Area). During the 1st monitoring period a total of 313 species were recorded within the 64 monitoring sites. During the 2nd monitoring period a total of 334 species were recorded within the 59 monitoring sites (an increase since 1st monitoring period of 21 species). During the 3rd monitoring period a total of 310 species were recorded within 62 monitoring sites (a decrease since 2nd monitoring period of 24 species). During the current 4th monitoring period, a total of 359 species were recorded in the different strata within 62 monitoring sites (an increase since 3rd monitoring period of 49 species).

Species richness within sites ranged from 12 to 68 species, with an average of 40.8 species per site (4.8 species more than 3rd monitoring period). The largest number of species was observed in sites 15, 12, 37, 117 and 41 (from lowest to highest in species richness), ranging between 61-68 species. This differed from the 3rd monitoring period, where the largest number of species was observed in 73, 88, 12, 83 and 142 – including Precincts 3, 9, 10, 12 and 13 - and was therefore quite spread out across Yarrabilba within fauna corridors (sites 73, 83 and 88) and greenspace corridors (sites 12 and 28).

Consistent with the 3rd monitoring period, the lowest number of species was observed in site 89 (12 species) located in the southern reaches of the greenspace corridor in Precinct 11, which lies to the mid south west of the development area.

Canopy tree species (T1 stratum) common across the Habitat Area include *Eucalyptus tereticornis, Eucalyptus siderophloia, Lophostemon suaveolens, Corymbia trachyphloia, Eucalyptus resinifera, Angophora leiocarpa* and the exotic weed tree *Pinus elliotti* (from highest to lower abundance). Native canopy tree species that were most rare (found only at one site) across the Habitat Area include *Casuarina glauca, Corymbia intermedia, C. tesselaris, Eucalyptus acmenoides, E. fusiformis* and *E. racemosa*, which differs slightly from the 3rd monitoring period where the rarest species were *Corymbia tesselaris, Eucalyptus propinqua, E. microcorys* and *E. fusiformis*.

Small tree species (T2-T3) common across the Habitat Area only varied slightly to those recorded in the 3rd monitoring period and include *Lophostemon suaveolens, Eucalyptus tereticornis, Melaleuca quinquenervia, M. linariifolia, Corymbia intermedia* and the exotic weed tree *Pinus elliotti* (from highest to lower abundance). There were eight small native tree species that were rare across the Habitat Area (found only at one site), including *Angophora subvelutina, Araucaria cunnninghamii, Corymbia tesselaris, Eucalyptus carnea, E. propinqua, Leptospermum polygalifolium, Macaranga tanarius* and *Melaleuca saligna,* with some of the rare species recorded in the 3rd monitoring period becoming absent from the T2 layer entirely *(Acacia fimbriata, Banksia integrifolia, Eucalyptus acmenoides, E. racemosa),* and others becoming more widespread *(E. microcorys and E. resinifera)* since the 3rd monitoring period.

Shrub species (S1 stratum) that were commonly observed across the Habitat Area include *Acacia leiocalyx, Leptospermum polygalifolium, A. disparrima, Alphitonia excelsa* and *Glochidion ferdinandi* (from highest to lower abundance). A number of native shrub species (20 species) were rare across the Habitat Area and found only at one site, including some that were consistent with the 3rd monitoring period such as *Melaleuca nodosa* and *M. thymifolia,* while one species that was rare in the 3rd monitoring period, *Daviesia umbellulate,* became more widespread. Some of the species that were rare in the 3rd monitoring period appeared to be absent from all sites in the 4th monitoring period including *Dillwynia retorta, Persoonia media* and *P. virgata*

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Of the species recorded, 56 are exotic (10 more species than 3rd monitoring period and 5 less than baseline). Several of these were significant across the habitat areas, being present at a large number of sites within multiple levels of strata. In the ground layer, where exotic herbs and graminoids were most highly represented, this includes *Andropogon virginicus* (41 sites, down 5), *Lantana camara* (40 sites, same), *Ageratum houstonianum* (37 sites; down 1), *Paspalum urvillei* (32 sites, up 7) *Emilia sonchifolia* (27 sites), *Passiflora suberosa* (25 sites), Conyza bonariense (22 sites, down 7), *Megathursus maximus* (21 sites), *Setaria sphacelata* (21 sites, same), *Sporobolus africanus* (20 sites), *Digitaria didactyla* (19 sites), *Richardia brailiensis* (19 sites), *Lantana montevidensis* (18 sites), *Sida cordifolia* (18 sites; down 6). *Pinus elliottii,* which was previously present at 38 sites, is now present at 34 sites in at least one layer of strata.

6.2.2 Tree canopy cover and height (T1)

Of the sites with canopy trees present (T1 stratum), tree canopy overlapping % cover varied from 0.4% to 86% cover, with average canopy cover of 28.7% (up 3.5% from 3rd monitoring period). The canopy species with highest net cover in the T1 stratum were *Eucalyptus tereticornis, Corymbia trachyphloia* subsp. *trachyphloia, E. moluccana, E. resinifera, Lophostemon suaveolens* and *Angophora leiocarpa* (in order of highest to lower). Most of these species were also in the top list for the 3rd monitoring period, with the exception of *A. leiocarpa*. *Pinus elliottii, which* was previously not recorded in the T1 stratum, was present (1 tree) in the T1 stratum at site 17.

The number of sites containing canopy trees improved since the 3rd monitoring period. Half of the sites (31 sites, 8 less than 3rd monitoring period) did not have any canopy trees present, including sites 1 (HRU1), 2 (HRU1), 3 (HRU3), 6 (HRU3), 7 (CRU13), 8 (CRU13), 9 (CRU13), 11 (CRU14), 12 (CRU12), 13 (CRU12), 35 (HRU9), 37 (HRU7), 40 (HRU11), 41 (HRU11), 52 (HRU13), 70 (HRU15), 71 (HRU15), 72 (HRU15), 73 (HRU15), 80 (HRU16), 83 (HRU20), 87 (HRU18), 88 (HRU18), 89 (HRU23) (canopy present in baseline), 90 (CRU9), 93 (HRU22) (canopy present in baseline), 94 (HRU22), 118 (HRU28), 140 (CRU8), 141 (CRU8) and 146 (HRU21). 19 (61%) of these were also missing T1 canopy strata in the 3rd monitoring period. HRU15 was the most highly represented, with all four associated sites having no T1 canopy layer.

T1 canopy tree height varied from 12.0 m to 23.0 m, with the average tree height 17.4 m (down 0.2 m since 3rd monitoring period). Canopy species with high average canopy height were *Corymbia tesselaris, C. intermedia, Eucalyptus moluccana, E. siderophloia, E. tereticornis* and *Angophora leiocarpa* (in order of highest to lowest average canopy height), the latter four of which were also the highest species in the 3rd monitoring round.

6.2.3 Small tree cover and height (T2-T3)

Of the sites with small trees present (T2 –T3 stratum), overlapping % cover varied from 2% to 151%, with average cover 46% (up 3.6% from 3rd monitoring period). The top five small tree species with high net cover in the T2-T3 strata were identical to those recorded in the 3rd monitoring period and included *Melaleuca linariifolia, Lophostemon suaveolens, Eucalyptus siderophloia, E. tereticornis* and *M. quinquenervia* (from highest to lower). Note that whilst *Pinus elliottii* remained absent in the 3rd monitoring period, in the current monitoring period, 7 sites contained at least one individual. These included sites 12, 41, 70, 40, 73, 20 and 121 (from highest to lowest cover). Small tree height varied from 4.8 m to 14.0 m high, with an average of 9.2 m (up 0.3 m from 3rd monitoring period).

All sites contained a small tree layer in this monitoring period, which is an improvement since the last monitoring period, where 1 site, site 94 (HRU22) did not have any small trees present, and the 2nd

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monitoring period, where 2 different sites did not contain small trees, (sites 16 (HRU5) and 121 (HRU30)).

6.2.4 Shrub cover and height (S1)

Of the sites with shrubs present, overlapping % shrub cover varied from 0.4% to 64.8% with an average cover 20.2% (increased 15.2% from 2nd monitoring period). Shrub species with highest net cover in the shrub layer across sites were the same as those recorded in the 3rd monitoring period *Acacia leiocalyx, Lantana camara, Acacia disparrima, Leptospermum polygalifolium* and *Alphitonia excelsa* (in order of highest to lower average cover). Shrub height varied from 1.3 m to 6.4 m with an average height of 2.5 m (same as 3rd monitoring period).

Several of the sites (5 sites, 2 less than 3rd monitoring period) did not have any shrubs present including sites 77 (HRU15), 78 (HRU16), 117 (HRU28), 139 (CRU7) and 140 (HRU29) Most of these sites also had shrubs absent in the 3rd monitoring round with the exception of site 117 (HRU28).

6.2.5 Ground cover (G1)

Consistent with the 3rd monitoring period results, all of the sites surveyed have a living ground layer, varying in average ground cover across the 5 quadrats per site from 2.8% (site 81 (HRU20), same as 2nd and 3rd monitoring period) to 70% (site 118 (HRU28), different from 3rd monitoring period where the highest cover was observed in the same HRU at site 117), with an average cover of 31.8% (down 0.5% from 3rd monitoring period). Ground cover was dominated by native graminoid, fern, mat-rush and exotic herb and gramonoid species with high cover within sites. Species varied only slightly from the 3rd monitoring period and included *Imperata cylindrica* (which had 2.5 times higher cover across sites than any other species), *Leersia hexandra, Pteridium esculentum, Paspalum urvillei* (exotic weed grass), *Lantana camara* (exotic weed herb), *Andropogon virginicus* (exotic weed grass), *Lomandra longifolia, Cynodon dactylon* and *Cymbopogon refractus.*

Note that regenerating *Pinus elliottii* comprises a smaller portion of vegetative cover across sites than previously recorded, indicating that targeted removal is having a postive result. A continued focus should include removal of *P. elliottii* in the ground layer to minimise regeneration of the species, with a goal to eradicate them completely from the Yarrabilba footprint area. This approach should be combined with efforts to manage and reduce other exotic species including *L. camara* and high cover exotic grasses such as *Andropogon virginicus* and *Paspalum urvillei* within the ground-layer to continue improving and supporting the long-term regeneration of these habitat areas.

6.2.6 Weed incursion

There were a total of 58 species of weeds identified in different strata across sites (7 more than 3rd monitoring period). Weeds were present at all 62 sites recorded for this monitoring period (2% more than the 3rd monitoring period).

In sites where weed ground cover was recorded, weed cover in the ground layer varied from 0.8% (sites 72 (HRU15), 77 (HRU16) and 80 (CRU4) to 72.8% (site 120 (CRU8)) with average cover 23% (4% more than 3rd monitoring period). Weed species in the ground layer with high cover were predominantly graminoids including *Lantana camara, Paspalum urvillei, Andropogon virginicus, Sporobolus africanus* and *Pinus elliottii* saplings (from highest to lower abundance).

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Table 7 4th Monitoring period species richness, average canopy height within the canopy (T1), sub-canopy (T2-T3) and shub layer (S1) and total overlapping cover within the canopy (T1), sub-canopy (T2-T3), shrub layer (S1) and ground layer (G1).

	Species Richness						Average Height (m)			Total Crown Cover (% overlapping cover)					Ground Cover (%)	
Site	Canopy (T1)	Sub - Canopy (T2 and T3)	Shrubs (S1)	Ground Layer (G1)	Total	Total weeds	Canopy (T1)	Sub - Canopy (T2 and T3)	Shrubs (S1)	Canopy (T1)	Sub - Canopy (T2 and T3)	Shrubs (S1)	Total Weed Crown Cover	Total Native Crown Cover	Av. Native Shrub and Ground Layer (S1-G1)	Total Weed Ground Cover
1	0	6	4	34	44	15	0	7.8	6.4	0	31	57.2	16	88.2	13.2	19.6
2	0	5	3	27	35	7	0	8.8	2.6	0	58.6	64.8	0	123.4	18	4.8
3	0	3	5	34	42	11	0	8.8	2.9	0	45	34.2	7	79.2	20.8	31.6
4	1	4	2	26	33	5	18.0	10.7	2.7	8	93	46.0	0	147.0	20.8	6.8
5	2	0	6	27	35	11	21.0	4.8	2.7	20	19	3.0	0	42.0	46.4	24
6	0	2	2	35	39	11	0	13.0	2.7	0	11	15.0	0	26.0	39.2	17.6
7	0	7	6	36	49	12	0	9.2	2.6	0	151	22.6	0	173.6	20.4	2.8
8	0	6	6	33	45	9	0	7.9	2.6	0	63	10.6	0	73.6	29.6	2.8
9	0	5	5	40	50	13	0	7.4	3.1	0	37	13.4	0	50.4	25.2	9.2
11	0	2	7	28	37	8	0	9.5	2.8	0	8	48.0	0	56.0	47.2	3.2
12	0	2	2	60	64	24	0	12.0	2.7	0	54	7.0	0	61.0	50.4	10
13	0	2	1	37	40	10	0	8.5	2.5	0	26.2	22.6	8	48.8	40.8	5.2
14	2	0	4	39	45	14	20.4	5.0	2.2	74	2	32.4	7	108.4	36.4	10.8
15	1	7	6	47	61	12	20.0	10.7	2.3	6	73.8	8.2	7	88.0	30.4	20
16	1	0	1	34	36	9	17.0	8.6	2.6	2	24.6	13.6	0	40.2	16.4	2
17	3	4	3	37	47	13	12.7	7.3	2.6	14	20	49.0	24	83.0	11.6	22.8
20	2	7	3	44	56	10	20	14.0	1.8	0.4	56	7.0	0	63.4	36.4	0.8
21	0	4	1	41	46	10	20.0	9.7	1.5	14	16	5.6	2	35.6	29.2	5.2
35	0	1	4	49	54	16	0	7.0	3.2	0	17	8.0	0	25.0	32.4	19.6
36	0	7	3	41	51	12	19.0	10.2	2.0	8	103	28.6	0	139.6	35.6	4.8
37	0	7	6	51	64	14	0	11.4	2.3	0	76	20.6	0	96.6	43.2	4.4
38	1	6	2	37	46	13	16.0	5.9	2.0	24	9	7.0	0	40.0	30.4	8.8
39	2	1	3	37	43	11	15.0	10.4	2.2	32	33	13.8	1	78.8	33.2	15.6
40	0	3	8	27	38	6	0	11.5	2.2	0	90.4	4.0	0	94.4	32	2.4
41	0	5	4	59	68	14	0	12.6	1.9	0	68	26.4	0	94.4	30.4	3.2
42	2	6	6	29	43	15	21.5	9.2	2.1	18	60	35.8	19	113.8	12.8	15.2
43	3	3	6	24	36	9	22.0	10.4	1.7	56	23	17.8	0	96.8	16.2	10
52	0	7	4	27	38	5	0	9.8	2.8	0	51	21.0	0	72.0	24	2.4
70	0	5	4	28	37	5	0	8.9	2.3	0	58.6	37.0	0	95.6	22.4	2.4
71	0	2	2	16	20	4	0	6.8	2.8	0	63.6	2.4	0	66.0	55.6	2
72	0	5	1	16	22	4	0	9.3	2.2	0	83.2	30.0	0	113.2	8	0.4
73	0	5	1	37	43	12	0	9.8	2.1	0	108	6.2	0	114.2	31.2	13.2
77	1	2	1	14	18	5	23.0	9.2	0	50	38.6	0.0	0	88.6	14.4	0.4
78	1	3	2	20	26	5	22.0	8.6	0	24	58	0.0	0	82.0	15.6	0
80	0	4	2	14	20	3	0	13.4	2.1	0	103	12.4	0	115.4	18	0.4
81	0	5	6	32	43	12	16.0	7.3	3.1	6	32	29.6	9	67.6	2.8	10.8
83	1	3	8	48	60	20	0	11.4	1.8	0	91	2.6	0.4	93.6	42	16.8
84	2	5	7	34	48	13	18.5	12.8	2.6	19	13.6	9.0	2	41.6	46	4

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	Species Richness						Average Height (m)			Total Crown Cover (% overlapping cover)					Ground Cover (%)	
Site	**Canopy (T1)**	**Sub - Canopy (T2 and T3)**	**Shrubs (S1)**	**Ground Layer (G1)**	**Total**	**Total weeds**	**Canopy (T1)**	**Sub - Canopy (T2 and T3)**	**Shrubs (S1)**	**Canopy (T1)**	**Sub - Canopy (T2 and T3)**	**Shrubs (S1)**	**Total Weed Crown Cover**	**Total Native Crown Cover**	**Av. Native Shrub and Ground Layer (S1-G1)**	**Total Weed Ground Cover**
85	3	3	9	45	60	14	19.8	12.6	2.2	30	62	20.2	1	112.2	31.2	3.6
87	0	3	1	26	30	10	0	9.9	2.6	0	81	5.0	0	86.0	56.4	19.6
88	0	3	1	30	34	13	0	10.5	3.0	0	55	9.0	0	64.0	23.6	15.2
89	0	3	1	8	12	6	0	7.1	3.4	0	25.16	16.0	10	41.2	22.4	9.6
90	1	3	5	28	37	6	0	7.4	2.5	0	22	52.8	31.4	74.8	48.6	23.6
92	3	0	4	37	44	14	13.8	8.8	2.4	33	35	24.8	8.8	92.8	29.2	24.8
93	0	4	4	32	40	12	0	7.5	2.0	0	12	8.4	5	20.4	51.6	14
94	0	3	2	30	35	7	0	7.6	2.9	0	11	18.4	0	29.4	59	13.6
95	1	4	1	30	36	10	17.0	7.4	2.2	1	29	15.8	4	45.8	24.8	22.4
96	3	2	5	39	49	10	16.2	8.1	2.6	36	37.4	37.0	0	110.4	24.4	4.8
105	5	1	3	24	33	3	13.8	9.7	2.2	70	26	6.0	0	102.0	17.6	5.6
116	2	0	4	31	37	12	15.9	9.3	1.3	50	66.6	0.8	0.4	117.4	44.4	9.2
117	1	3	2	58	64	23	12.0	8.5	0	3	44	0.0	0	47.0	47.6	18
118	0	3	1	36	40	10	0	8.9	4.5	0	91	0.4	0	91.4	70	13.6
120	2	5	6	32	45	14	18.3	9.2	2.5	32	39.6	3.0	0	74.6	56.4	36.4
121	1	4	4	17	26	5	17.1	10.0	2.4	62	4	15.4	0	81.4	28.8	1.2
122	2	4	8	16	30	4	16.5	12.1	2.9	20	38	29.2	0	87.2	18.4	2.8
125	2	1	3	22	28	4	14.9	5.3	3.1	68	3.6	45.6	0	117.2	18	0
126	2	4	7	16	29	2	14.2	11.5	2.0	86	24	4.4	0	114.4	16	8.8
139	1	2	0	22	25	9	16.0	6.5	0	10	2	0.0	0	12.0	53.6	26.8
140	0	3	0	34	37	11	0	8.3	0	0	14	0.0	0	14.0	36.4	24.4
141	0	1	6	30	37	16	0	7.6	2.8	0	50.4	11.8	0	62.2	29.6	20
142	0	4	0	44	48	21	13.0	8.9	2.7	12	87	7.0	0	106.0	39.2	5.2
146	0	3	3	48	54	18	0	7.0	2.7	0	24.6	46.2	16.6	70.8	46.4	30.4
4th Mon. Average	**1.9***	**3.8***	**3.8***	**32.8***	**40.8***	**10.6***	**16.8***	**9.2***	**2.5***	**28.7***	**46.0***	**20.2***	**9.0***	**81.5***	**31.8***	**11.5***
3rd Mon. Average	**4.2***	**3.1***	**3.0***	**28***	**36.0***	**7.6***	**17. 6***	**8.9***	**2.5***	**25.2***	**42.4***	**5***	**2.4***	**56.8***	**32.3***	**9.5***
2nd Mon. Average	**2.0***	**4.7***	**3.7***	**24.2***	**34.6***	**7.7***	**15.9***	**9.9***	**4.5***	**35.2***	**56.8***	**6.4***	**0**	**70.8****	**31.1***	**12.5***
1st Mon. Average	**2.6***	**3.6***	**5.9***	**25.6***	**37.8***	**16.7***	**16.5***	**10.2***	**3.9***	**33***	**19.4***	**4.2***	**6.4****	**79****	**34***	**14.4***
Baseline Average	**1.8***	**2.3***	**5.1***	**20.5***	**29.6***	**6.5***	**17.2***	**10.2***	**2.8***	**45***	**20.2***	**6.2***	**16****	**84.8****	**41.1***	**10***

* Note total average values for 4th Monitoring period (4th Mon.), 3rd Monitoring period (3rd Mon.), 2nd Monitoring period (2nd Mon.), 1st Monitoring period (1st Mon.) and Baseline, are calculated across sites, only including sites where each respective strata was present and not including sites where they were absent (value = 0).
** Note total average values for 2nd Monitoring period (2nd Mon.), 1st Monitoring period (1st Mon.) and Baseline for Total Weed Crown Cover and Total Native Crown Cover are calculated across all sites, irrespective of presence/absence.

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7 Discussion

An assessment of site species richness and structure was undertaken to determine the 4th monitoring period condition against the benchmark, 2nd and 3rd monitoring periods and baseline values (Table 8). In this monitoring period, IMO-3 year target, 98% of sites met this minimum benchmark for at least four of the benchmark parameters, with only one site having only met IMO-3 or greater for three parameters (site 139). Four sites meet IMO-3 or greater in all benchmark categories, including sites 21, 39, 84 and 85. The number of sites failing to meet an IMO-3 benchmark in two or more categories is declining, with only 48% of sites failing to meet IMO-3 benchmarks in at least 2 or more categories. The site with the lowest number of benchmarks met in this monitoring period was site 139. The majority of sites (97%) already meet the Final benchmark for at least one benchmark parameter and 16% of sites meet the Final benchmark for at least four (50%) of the benchmark variables. The number of sites meeting consistently high benchmarks (FMO-15 or FINAL) is increasing, with 13 sites (21%, 11% more than 3rd monitoring period, which had 6 sites meeting this standard), including sites 3, 4, 7, 9, 12, 14, 20, 21, 42, 80, 84, 120 and 122. The majority of these sites are located in Greenspace Corridors, with three sites (sites 42, 84 and 120) located in Fauna Corridors (Figure 3).

For species richness, there has been a continued increase in total diversity with 34 sites (55% of sites, 10% more than 3rd monitoring period) reaching final benchmark (6 more sites than 3rd monitoring period). In terms of regional ecosystems, RE12.9-10.4 improved, with one of the five sites (site 3) in this ecosystem now reaching the FINAL benchmark for species richness. Within RE 12.9-10.17, 18 out of 24 sites (75%) now meet the final benchmark, whilst in RE12.3.11, 15 out of 33 sites (45%) meeting the final benchmark for species richness. The number of native species recorded within sites is improving, with all except three sites (sites 89, 141 and 142) containing at least 60% natives in the species composition. The sites with the highest proportion of native species compared to weeds contained ≥86% native species and included sites 126, 105, 122, 52, 125 and 70 (in order from highest to lower). Despite this, the number of sites that had higher than acceptable cover of exotic weeds (>5% cover) had increased from 34 to 39 sites (8% increase since 3rd monitoring period). Sites with the highest % cover of weeds include sites 120, 3, 146, 139 and 92 (from highest to lower % cover), however, a number of these are not considered highest priority at this time as they are overall doing well in terms of achieving benchmark targets, with at least 6 benchmarks of IMO-3 or greater across categories, with the exception of site 139. **To continue improving the number of sites meeting this important benchmark, recommendations for future rehabilitation efforts include assisted natural regeneration with continued weed control across all sites that fail to meet the benchmark, with particular focus on targeting sites with the highest % weed cover (see above), which are largely infiltrated with the most dominant weed species *Lantana camara* (exotic herb), *Paspalum urvillei* (exotic grass), *Andropogon virginicus* (exotic grass), *Sporobolus africanus* (exotic grass) and *Pinus elliottii* (exotic tree) saplings as well as continued efforts to eliminate mature *Pinus elliottii*.** This may also include continued replanting with a suite of species represented in the pre-clearing Regional Ecosystem species lists for each rehabilitation unit being planted where possible as part of an assisted regeneration effort.

Overall, there is a trend of improvement within benchmark categories across sites. A total of 26 sites (42%) meet a benchmark for canopy tree cover (up from 15 sites (24%) in 3rd monitoring period), with 92% of these meeting the IMO-3 benchmark or greater. 31 sites (50%) meet a benchmark for canopy tree height (up from 25 sites (40%) in 3rd monitoring period), with 100% of these meeting the IMO-3 benchmark or greater. 62 sites (100%) meet a benchmark for small tree cover (up from 56 sites (90%) in 3rd monitoring period), with 94% of these meeting the IMO-3 benchmark or greater. 62 sites (100%) meet a benchmark for small tree height (up from 61 sites (98%) in 3rd monitoring period), with 100% of these meeting the IMO-3 benchmark or greater. Perhaps the greatest improvement was seen in shrub cover, where 53 (85%) sites meet a benchmark (up from 19 sites (31%) in 3rd monitoring period), with 87% of these meeting the IMO-3 benchmark or greater. 57 sites (92%) meet a

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benchmark for shrub height (up from 55 sites (89%) in 3rd monitoring period), with 98% of these meeting the IMO-3 benchmark or greater. 61 sites (98%) meet a benchmark for ground-cover (same as 3rd monitoring period), with 82% of these meeting the IMO-3 benchmark or greater and 23 sites (37%) meet the <5% cover benchmark for weed cover of the ground-layer (down from 28 (45%) in 3rd monitoring period). **Considering that the ground cover variable had the lowest number of sites meeting the IMO-3 benchmark minimum, it is recommended that rehabilitation efforts incorporate assisted natural regeneration in combination with targeted weed control to open up more space for ground cover species to regenerate naturally. Opportunities for complementary infill planting may also be assessed and carried out if deemed necessary. Top priority sites to target for ground cover improvement to IMO-3 standard include those that also fail to meet the weed cover benchmark, which are sites 81, 17, 105, 126, 122, 95, 1 and 8.**

In this monitoring period, a slight adjustment was made to the way % cover is reflected, and this value is now calculated as % overlapping cover. These calculations have also been applied to averages (Table 7) for previous monitoring periods for accurate comparison:

$$\%\ overlapping\ cover = \frac{total\ cover\ (m)}{transect\ length\ (m)} \times 100$$

In terms of general trends of average values across all sites, compared to baseline surveys, canopy tree cover remains decreased while height is similar. As discussed in previous reports, this decrease has been attributed to the removal of *Pinus* trees which comprised a significant part of the canopy layer in baseline surveys. Since the removal of mature *Pinus*, space has opened up as well as increased sunlight, which may be attributed to significant increases in cover both in the small tree and shrub layers since the baseline study. Small tree cover has increased significantly to 46% (25.7% more than baseline), while height remains close to the baseline value. Shrub cover has also increased significantly to 20.2% (14% more than baseline) and shrub height remains stable. Total ground-cover has seen a trend of decline, and the proportion of weeds has increased slightly overall since baseline. Overall average native species richness has improved steadily.

Overall, this assessment reveals that considering the average cover of weeds in the ground layer continues to increase, **rehabilitation needs to prioritise continued targeted widespread weed removal in the ground layer across a large number of sites that do not yet fall within the acceptable benchmark limit of <5% total weed cover in the ground layer (refer to table 8).** Recent wet weather may have contributed to the accelerated growth of weeds in the ground layer and the results indicate management actions including ground-layer weed control should be targeted in rehabilitation areas that do not yet meet the benchmark. This will in turn reduce the overall average cover. In this monitoring period, only 23 sites meet the benchmark value for weed cover in the ground layer, therefore, 63% of sites fall outside of this target.

Looking forward, effective management will ensure that all sites meet the benchmark value before the IMO-5 year benchmark target in August 2020. The remaining prevelance of weeds across these 39 sites has likely contributed to declines in native species richness and shrub cover, considering that they often have a competitive advantage with rapid growth and shorter time to seed maturity. It is recognised that increases in weed incursion may be a result of the increasing isolation of the HRUs as clearing of the surrounding land-use matrix has intensified for pastoral and arable agriculture as well as new clearing in the development precincts. **Primary weed species needing to be targeted are highlighted in paragraph two of the discussion. Additional species include *Baccharis halimifolia* (exotic shrub), *Setaria sphacelata* (exotic grass), *Ageratum houstonianum* (exotic herb), *Cenchrus ciliaris* (exotic grass), *Ambrosia artemisifolia* (native shrub), *Conyza bonariensis* (exotic herb) and *Megathyrsus maximus* (exotic grass) among others.**

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The felling removal of *Pinus elliottii* on a whole-of-site scale has been a major target, with high success in significantly reducing the presence and cover of this species as an invasive in the canopy and sub-canopy strata, however, it was noted that there is still a varying (low-high) density of *Pinus elliotti* juvenile regrowth across a large number of sites (25 sites, 40% of sites). Overall however, average cover and the number of sites this species is present, continues to decline. **Currently, *P. elliottii* is present at 42 sites (68% of sites) in total, in one, two or rarely three layers of strata, including for the canopy, sites 5, 17, 83 and 85; for the small tree layer, sites 1, 12, 15, 20, 36, 38, 40, 41, 70, 73, 84, 93, 95, 117, 121; for the shrub layer, sites 3, 7, 11, 35, 37, 39, 42, 71, 90, 122, 146 and for the ground layer, sites 2, 4, 13, 52, 81, 87, 88, 94, 96, 116, 120, 125 and 146. It is suggested that further felling of *P. elliottii* is done strategically over time with staged removal of the canopy to reduce invasion of the ground-layer by exotic species** (which in turn reduces native species richness and compromises shrub parameter benchmarks) due to the increased light penetration and competitive environmental conditions. This will also help reduce the prevalence of regenerating *Pinus* seedlings.

A lower number of sites (31 (50%) down from 34 (54%) since 3rd monitoring period) are lacking a canopy (T1) layer. Furthermore, there is also a marked decreased in the number of sites that fail to meet any benchmarks for canopy height (35 (56%) down from 37 (60%) in 3rd monitoring period) and cover (17 (26%), down from 47 (76%) in 3rd monitoring period). Additionally, whilst a large number of sites remain in the same (S) status of failure to meet a benchmark, a smaller number of **sites are declining in canopy cover (sites 6 and 12) or canopy height (2, 6, 16 and 37) since the 3rd monitoring period. Considering that the canopy strata has a much lower number of sites meeting a benchmark for height and canopy when compared to other layers of strata, these sites should be included in those for priority natural assisted regeneration, with particular attention during future monitoring periods to determine if canopy layers are 'recovering' and if the height and composition of the small tree layer is increasing in a way that would indicate growth of canopy species and future recruitment into the canopy layer.**

A number of sites that were included in poorest condition in the 3rd monitoring report have improved and no longer require priority attention, including site 36 (HRU7), 70 (HRU15), 81 (HRU20), 93 and 94 (HRU22), 95 (HRU17), 118 (HRU28) and 141 (HRU29). Furthermore, a number of priority HRU's have significantly improved since the last monitoring period and are no longer regarded amongst those most urgently requiring action, including HRU7, HRU22, HRU28 and HRU29. This confirms the success of targeting specific HRU's with recommended management actions in these areas.

There are seven sites (2 less than 3rd monitoring period) that consistently meet lower than the IMO-3 target benchmarks (IMO-1, IMO-2, or no benchmark), in four or more categories across canopy, shrub and ground-layers. These sites are regarded as being in the poorest condition in terms of benchmark values for species richness, height and cover and they include sites 1 and 2 (HRU1), 40 (HRU11), 71 (HRU15), 89 (HRU23), 139 and 140 (CRU7). **Four of the poorest benchmark sites also fail to meet the <5% requirement for weed cover and are therefore considered to be top priority for natural assisted regeneration combined with active weed control measures. These include sites 1 (HRU1), 89 (HRU23), 139 and 140 (CRU7).**

In summary, a number of sites are considered amongst those of highest priority requiring prompt management actions to improve benchmark conditions through assisted natural regeneration of the ground layer, reduction in weed cover and improving sites to a minimum of IMO-3 across all variables in preparation for moving forward to the new IMO-5 target in August 2020. Using combined information from the above discussion, based on a combination of benchmark achievement and weed prevalence, **there are 4 top rehabilitation units most urgently requiring management actions for improving multiple benchmarks and weed cover, including sites 1 (HRU1), 89 (HRU23), 139 and 140 (CRU7 same as 3rd monitoring) and HRU15 (same as 3rd monitoring) and a further 6**

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rehabilitation units requiring targeted management for overall ground cover improvement, including sites 81 (HRU20), 17 (HRU5), 105 (HRU26), 126 (HRU31), 122 (HRU30) and 95 (HRU17). Primary weed species needing to be targeted include the most dominant weed species *Lantana camara* (exotic herb), *Paspalum urvillei* (exotic grass), *Andropogon virginicus* (exotic grass), *Sporobolus africanus* (exotic grass) and *Pinus elliottii* (exotic tree at various life stages). Additional species include *Baccharis halimifolia* (exotic shrub), *Setaria sphacelata* (exotic grass), *Ageratum houstonianum* (exotic herb), *Cenchrus ciliaris* (exotic grass), *Ambrosia artemisifolia* (native shrub), *Conyza bonariensis* (exotic herb) and *Megathyrsus maximus* (exotic grass) among others.

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Table 8 4th Monitoring period benchmark values for species richness, canopy height within the canopy (T1), sub-canopy (T2-T3) and shub layer (S1) and cover within the canopy (T1), sub-canopy (T2-T3), shub layer (S1) and ground layer (G1) as well as indicative weed cover benchmarks.

Site	Rehabilitation Unit	Pre-Clearing Regional Ecosystem	Native Species Richness	Canopy Cover (T1)	Canopy Height (T1)	Small Tree Height (T2-T3)	Small Tree Cover (T2-T3)	Shrub Cover (S1)	Shrub Height (S1)	Native Ground Cover (G1)	Weed Cover (<5%)
1	HRU1	12.9-10.4/12.9-10.12	X (S)	X (S)	X (S)	IMO-10 (D)	FINAL (S)	FINAL (I)	FINAL (I)	IMO-2 (D)	N (S)
2	HRU1	12.9-10.4/12.9-10.12	X (S)	X (S)	X (D)	FINAL (I)	FINAL (S)	FINAL (I)	FMO-15 (I)	IMO-3 (D)	Y (I)
3	HRU3	12.9-10.4/12.9-10.12/12.9-10.2	FINAL (I)	X (S)	X (S)	FINAL (I)	FINAL (S)	FINAL (I)	FMO-15 (S)	IMO-5 (S)	N (S)
4	HRU1	12.9-10.4/12.9-10.12	X (S)	IMO-2 (I)	FMO-15 (S)	FINAL (S)	FINAL (S)	FINAL (I)	FMO-15 (S)	IMO-5 (I)	N (D)
5	HRU3	12.9-10.4/12.9-10.12/12.9-10.2	X (S)	IMO-10 (I)	FMO-15 (S)	IMO-3 (S)	FINAL (I)	IMO-1 (I)	FMO-15 (I)	FMO-15 (S)	N (S)
6	HRU3	12.3.11/12.3.7	X (S)	X (D)	X (D)	FINAL (S)	IMO-10 (I)	FMO-15 (I)	FINAL (I)	FINAL (S)	N (S)
7	CRU13	12.3.11/12.3.7	FINAL (S)	X (S)	X (S)	IMO-10 (S)	FINAL (S)	FINAL (I)	FMO-15 (D)	FINAL (I)	Y (S)
8	CRU13	12.3.11/12.3.7	FINAL (I)	X (S)	X (S)	IMO-5 (S)	FINAL (I)	IMO-10 (I)	FMO-15 (D)	FINAL (S)	Y (S)
9	CRU13	12.3.11/12.3.7	FINAL (I)	X (S)	X (S)	IMO-5 (S)	FINAL (I)	FMO-15 (I)	FINAL (S)	FINAL (S)	N (S)
11	CRU14	12.3.11/12.3.7	X (S)	X (S)	X (S)	FMO-15 (S)	IMO-5 (I)	FINAL (I)	FINAL (I)	FINAL (S)	Y (S)
12	CRU12	12.3.11/12.3.6/12.3.7	FINAL (S)	X (D)	X (S)	FINAL (S)	FINAL (I)	IMO-5 (I)	FINAL (I)	FINAL (S)	N (S)
13	CRU12	12.3.11/12.3.6/12.3.8	X (S)	X (S)	X (S)	IMO-10 (I)	FINAL (I)	FINAL (I)	FMO-15 (D)	FINAL (S)	N (D)
14	HRU4	12.3.11/12.3.6/12.3.7	X (D)	FINAL (I)	FMO-15 (S)	IMO-3 (D)	IMO-1 (D)	FINAL (I)	FMO-15 (S)	FINAL (S)	N (S)
15	HRU4	12.3.11/12.3.6/12.3.7	FINAL (S)	X (S)	FMO-15 (I)	FMO-15 (I)	FINAL (S)	IMO-5 (I)	FMO-15 (S)	FINAL (S)	N (S)
16	HRU5	12.9-10.17/12.9-10.2	FINAL (I)	X (S)	IMO-10 (D)	IMO-5 (S)	FMO-15 (S)	IMO-3 (I)	IMO-10 (S)	IMO-1 (S)	Y (S)
17	HRU5	12.9-10.17/12.9-10.2	FINAL (S)	IMO-3 (I)	IMO-10 (S)	IMO-5 (S)	FMO-15 (I)	FINAL (I)	IMO-10 (S)	IMO-1 (S)	N (S)
20	HRU6	12.3.11/12.3.6/12.3.7	FINAL (I)	X (S)	FMO-15 (I)	FINAL (I)	FINAL (I)	IMO-5 (I)	IMO-10 (S)	FINAL (S)	Y (I)
21	HRU6	12.3.11/12.3.6/12.3.7	FINAL (I)	IMO-3 (I)	FMO-15 (S)	FMO-15 (I)	FMO-15 (I)	IMO-3 (I)	IMO-10 (S)	FINAL (S)	N (D)
35	HRU9	12.3.11/12.3.6/12.3.7	FINAL (I)	X (S)	X (S)	IMO-5 (S)	FMO-15 (I)	IMO-5 (I)	FINAL (S)	FINAL (S)	N (S)
36	HRU7	12.3.11/12.3.6/12.3.7	FINAL (I)	IMO-1 (I)	FMO-15 (S)	FMO-15 (I)	FINAL (S)	FINAL (I)	FMO-15 (I)	FINAL (S)	Y (S)
37	HRU7	12.3.11/12.3.6/12.3.7	FINAL (I)	X (S)	X (D)	FINAL (S)	FINAL (I)	FMO-15 (I)	FMO-15 (D)	FINAL (S)	Y (S)
38	HRU10	12.9-10.17/12.9-10.2	FINAL (S)	IMO-10 (I)	IMO-10 (I)	IMO-5 (S)	IMO-5 (D)	IMO-2 (I)	IMO-5 (S)	IMO-5 (D)	N (S)
39	HRU10	12.9-10.17/12.9-10.2	FINAL (S)	FMO-15 (I)	IMO-10 (S)	FMO-15 (S)	FINAL (I)	IMO-3 (I)	IMO-10 (I)	IMO-5 (D)	N (S)

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Site	Rehabilitation Unit	Pre-Clearing Regional Ecosystem	Native Species Richness	Canopy Cover (T1)	Canopy Height (T1)	Small Tree Height (T2-T3)	Small Tree Cover (T2-T3)	Shrub Cover (S1)	Shrub Height (S1)	Native Ground Cover (G1)	Weed Cover (<5%)
40	HRU11	12.3.11/12.3.6/12.3.7	X (D)	X (S)	X (S)	FINAL (S)	FINAL (S)	IMO-2 (I)	FMO-15 (S)	FINAL (S)	Y (S)
41	HRU11	12.3.11/12.3.6/12.3.7	FINAL (S)	X (S)	X (S)	FINAL (I)	FINAL (I)	FINAL (I)	FMO-15 (S)	FINAL (S)	Y (S)
42	HRU8	12.3.11/12.3.6/12.3.7	X (S)	IMO-5 (I)	FMO-15 (S)	IMO-10 (S)	FINAL (S)	FINAL (I)	FMO-15 (I)	FMO-15 (D)	N (S)
43	HRU8	12.3.11/12.3.6/12.3.7	X (S)	FINAL (I)	FMO-15 (S)	FMO-15 (S)	FMO-15 (I)	FMO-15 (I)	IMO-10 (S)	FMO-15 (D)	N (S)
52	HRU13	12.3.11/12.3.6/12.3.7	FINAL (I)	X (S)	X (S)	FMO-15 (I)	FINAL (I)	FMO-15 (I)	FINAL (I)	FINAL (S)	Y (S)
70	HRU15	12.3.11/12.3.6/12.3.7	X (D)	X (S)	X (S)	IMO-10 (I)	FINAL (I)	FINAL (I)	FMO-15 (I)	FINAL (S)	Y (S)
71	HRU15	12.3.11/12.3.6/12.3.7	X (S)	X (S)	X (S)	IMO-5 (S)	FINAL (S)	IMO-1 (I)	FINAL (S)	FINAL (S)	Y (S)
72	HRU15	12.3.11/12.3.6/12.3.7	X (S)	X (S)	X (S)	IMO-10 (S)	FINAL (S)	FINAL (I)	FMO-15 (S)	IMO-10 (D)	Y (S)
73	HRU15	12.3.11/12.3.6/12.3.7	X (D)	X (S)	X (S)	FMO-15 (S)	FINAL (S)	IMO-3 (I)	FMO-15 (D)	FINAL (S)	N (S)
77	HRU16	12.3.11	X (S)	FMO-15 (I)	FMO-15 (S)	IMO-10 (S)	FINAL (I)	X (S)	X (S)	FMO-15 (S)	Y (S)
78	HRU16	12.3.11	X (S)	IMO-10 (I)	FMO-15 (S)	IMO-10 (S)	FINAL (S)	X (S)	X (S)	FMO-15 (S)	Y (S)
80	CRU4	12.3.11	X (S)	X (S)	X (S)	FINAL (S)	FINAL (S)	FMO-15 (I)	FMO-15 (I)	FINAL (S)	Y (S)
81	HRU20	12.9-10.17/12.9-10.2	FINAL (I)	IMO-1 (I)	IMO-10 (I)	IMO-5 (S)	FINAL (I)	FMO-15 (I)	FMO-15 (S)	X (S)	N (S)
83	HRU20	12.3.11/12.3.6/12.3.7	FINAL (S)	X (S)	X (S)	FINAL (S)	FINAL (S)	IMO-1 (I)	IMO-10 (I)	FINAL (S)	N (S)
84	HRU19	12.3.11/12.3.6/12.3.7	FINAL (S)	IMO-5 (I)	FMO-15 (S)	FINAL (S)	IMO-10 (S)	IMO-10 (I)	FMO-15 (D)	FINAL (S)	Y (I)
85	CRU10	12.3.11/12.3.6/12.3.7	FINAL (S)	FMO-15 (I)	FMO-15 (I)	FINAL (S)	FINAL (S)	FMO-15 (I)	FMO-15 (S)	FINAL (S)	Y (S)
87	HRU18	12.3.11/12.3.6/12.3.7	X (S)	X (S)	X (S)	FMO-15 (I)	FINAL (S)	IMO-3 (I)	FINAL (I)	FINAL (S)	N (S)
88	HRU18	12.3.11/12.3.6/12.3.7	X (D)	X (S)	X (S)	FMO-15 (I)	FINAL (S)	IMO-10 (I)	FINAL (I)	FINAL (S)	N (S)
89	HRU23	12.9-10.17/12.9-10.2	X (S)	X (S)	X (S)	IMO-5 (S)	FMO-15 (I)	IMO-10 (I)	FMO-15 (I)	IMO-2 (D)	N (S)
90	CRU9	12.9-10.17/12.9-10.2	X (S)	X (S)	X (S)	IMO-5 (S)	FMO-15 (I)	FINAL (I)	IMO-10 (S)	FMO-15 (S)	N (S)
92	HRU22	12.9-10.17/12.9-10.2	X (S)	FMO-15 (I)	IMO-10 (S)	IMO-5 (D)	FINAL (I)	FMO-15 (I)	IMO-10 (I)	IMO-3 (I)	N (S)
93	HRU22	12.3.11/12.3.6/12.3.7	X (S)	X (S)	X (S)	IMO-5 (S)	IMO-10 (I)	IMO-5 (I)	FMO-15 (S)	FINAL (S)	N (S)
94	HRU22	12.3.11/12.3.6/12.3.7	X (S)	X (S)	X (S)	IMO-5 (I)	IMO-10 (I)	FMO-15 (I)	FINAL (I)	FINAL (S)	N (D)
95	HRU17	12.9-10.17/12.9-10.2	FINAL (S)	X (S)	IMO-10 (I)	IMO-5 (S)	FMO-15 (S)	IMO-5 (I)	IMO-10 (S)	IMO-2 (I)	N (S)
96	HRU17	12.9-10.17/12.9-10.2	FINAL (S)	FMO-15 (I)	IMO-10 (S)	IMO-5 (S)	FINAL (I)	FMO-15 (I)	IMO-10 (S)	IMO-2 (D)	Y (S)
105	HRU26	12.9-10.17/12.9-10.19	FINAL (S)	FINAL (I)	IMO-10 (S)	IMO-10 (D)	FMO-15 (S)	IMO-1 (I)	IMO-10 (I)	IMO-1 (S)	N (D)

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116	HRU28	12.9-10.17/12.9-10.2	FINAL (S)	FMO-15 (I)	IMO-10 (S)	IMO-10 (S)	FINAL (I)	X (S)	IMO-2 (D)	FMO-15 (S)	N (S)
117	HRU28	12.9-10.17/12.9-10.2	FINAL (S)	X (S)	IMO-10 (I)	IMO-5 (S)	FINAL (I)	X (S)	X (D)	FMO-15 (S)	N (S)
118	HRU28	12.9-10.17/12.9-10.2	FINAL (I)	X (S)	X (S)	IMO-10 (I)	FINAL (S)	X (S)	FINAL (I)	FMO-15 (S)	N (S)
120	CRU8	12.9-10.17/12.9-10.2	FINAL (S)	FMO-15 (I)	FMO-15 (I)	IMO-10 (I)	FINAL (I)	X (S)	IMO-10 (I)	FMO-15 (S)	N (S)
121	HRU30	12.9-10.17/12.9-10.2	X (D)	FINAL (I)	IMO-10 (S)	IMO-10 (I)	IMO-2 (I)	IMO-5 (I)	IMO-10 (S)	IMO-3 (D)	Y (S)
122	HRU30	12.9-10.17/12.9-10.2	FINAL (S)	IMO-5 (I)	IMO-10 (S)	FMO-15 (S)	FINAL (I)	FMO-15 (I)	FMO-15 (I)	IMO-1 (D)	Y (I)
125	HRU31	12.9-10.17/12.9-10.2	FINAL (S)	FINAL (I)	IMO-10 (S)	IMO-3 (D)	IMO-2 (D)	FINAL (I)	FMO-15 (S)	IMO-1 (D)	Y (S)
126	HRU31	12.9-10.17/12.9-10.2	FINAL (S)	FINAL (I)	IMO-10 (S)	FMO-15 (S)	FMO-15 (I)	X (S)	IMO-5 (D)	IMO-1 (D)	N (D)
139	CRU7	12.9-10.17/12.9-10.2	X (S)	IMO-2 (I)	IMO-10 (S)	IMO-5 (S)	IMO-1 (I)	X (S)	X (S)	FMO-15 (I)	N (S)
140	CRU7	12.9-10.17/12.9-10.2	FINAL (I)	X (S)	X (S)	IMO-5 (S)	IMO-10 (I)	X (S)	X (S)	IMO-10 (I)	N (S)
141	HRU29	12.9-10.17/12.9-10.2	X (S)	X (S)	X (S)	IMO-5 (S)	FINAL (I)	IMO-3 (I)	FMO-15 (I)	IMO-3 (I)	N (D)
142	HRU29	12.9-10.17/12.9-10.2	FINAL (S)	IMO-3 (I)	IMO-10 (I)	IMO-10 (S)	FINAL (S)	IMO-2 (I)	IMO-10 (S)	IMO-10 (D)	N (D)
146	HRU21	12.9-10.17/12.9-10.2	FINAL (S)	X (S)	X (S)	IMO-5 (S)	FMO-15 (I)	FINAL (I)	IMO-10 (S)	FMO-15 (S)	N (S)
Total meeting a benchmark			**34**	**26**	**31**	**62**	**62**	**53**	**57**	**61**	**23**
Total meeting a benchmark (3rd monitor. Period)			**28**	**15**	**25**	**62**	**56**	**19**	**55**	**61**	**28**
Total meeting a benchmark (2nd monitor. period)			**3**	**19**	**21**	**57**	**57**	**12**	**29**	**57**	**20**
Total meeting a benchmark (in baseline survey)			**65**	**45**	**49**	**60**	**61**	**47**	**62**	**65**	**12**
Total improving (since 3rd monitor. period)			**13**	**26**	**9**	**35**	**16**	**53**	**23**	**7**	**4**
Total declining (since 3rd monitor. period)			**6**	**2**	**4**	**3**	**4**	**0**	**9**	**13**	**8**
Total same (since 3rd monitor. period)			**41**	**32**	**48**	**22**	**41**	**9**	**30**	**41**	**49**
Overall trend			**≥**	**≥**	**≥**	**=**	**≥**	**≥**	**≥**	**=**	**≥**
Total sites surveyed (excl. removed) = 62											

Note: the site meets the following benchmarks: IMO - 1 year; IMO – 2 year, IMO – 3 year, IMO- 4 year, IMO – 5 year, IMO – 10 year, FMO – 15 year, FINAL Benchmark condition, and X – does not meet any benchmark i.e. poorer than IMO-1 year condition.
* D = Decrease, S = Same, I = Increase in all values

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