Koala Habitat Rehabilitation Monitoring Report 7th 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:	K. Leopold, Dr M.N. Runkovski, J. Pittard, B. Steinrücken, K. Richardt
Date:	10 August 2021

Natura Pacific – Document Control Sheet

Project	
Title:	**Habitat Rehabilitation Management Report – Koala Habitat Area 7th Monitoring Period**
Authors:	**Dr M.N. Runkovski, J. Pittard, B. Steinrücken, M. Brett, K. Richardt, K. Leopold**
File reference:	**NCO11-0011_Yarrabilba**
Project leader:	**Kieran Richardt**
Phone:	**+(61) 7 5576 5568, +(61) 4 1541 3408**
Email:	**info@natura-pacific.com**
Client:	**Lendlease**
Client contact:	**Graeme Knox (Graeme.Knox@lendlease.com)**
DCR #:	**NCO_PRJ_210806_Q00069**

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1 Executive summary

Natura Pacific has developed this *Habitat Rehabilitation Monitoring Report* for the 7th 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 report is to provide 7th 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 7th monitoring period data for the rehabilitation of these areas, with all 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, to document and assess rehabilitation through time. All final locations of the monitoring sites (currently 62 in total) have been mapped. Monitoring includes photo point monitoring along with 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 current condition against the benchmark values. Several 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 weed infestations including *Pinus elliottii,* particularly in those areas where highest weed cover has been recorded.

A total of 29 sites (47%) met a benchmark for canopy tree cover (same as 6th monitoring period), 32 sites (52%) met a benchmark for canopy tree height (up from 28 sites in 6th monitoring period), 62 sites (100%) meet a benchmark for small tree cover (up from 58 sites in 6th monitoring period). The

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same number of sites meet a benchmark for small tree height (up from 58 sites in 6th monitoring period). For shrub cover, 55 sites (89%) met a benchmark (up from 52 sites in 6th monitoring period). For shrub height, 58 sites (94%) met a benchmark (up from 56 sites in 6th monitoring period). For ground cover, 59 sites (95%) meet a benchmark (up from 57 sites in 6th monitoring period). There was also an improvement for weed cover, with 29 sites (47%) now meeting the <5% cover benchmark of the ground-layer (up from 23 sites in the 6th monitoring period).

Overall, this assessment supports findings of the 5th and 6th monitoring period - that management actions are proving successful, with several 6th monitoring priority sites showing improvement and being replaced by new priority management areas, indicating the management recommendations provided in these reports are being responded to. Recommended management actions for this report are mostly consistent with previous monitoring rounds, including assisted natural regeneration with continued weed control for a range of target species alongside infill planting to improve native species richness and cover predominantly in the shrub and ground layers. There is some variation in priority HRU based on monitoring results and changes to benchmark attainment across sites and variables.

Rehabilitation works need to continue prioritising weed control of the ground-layer 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 FPC, and so these sites will need to be prioritised for rehabilitation within the next 6 months to facilitate attainment of the IMO-3 year benchmark at minimum. Management of *Pinus elliotti* has shown good results and is recommended to continue through strategic removal across all strata in addition to management for priority sites.

Based on the results of this monitoring period, there are 14 sites currently 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 the percentage of weed cover also taken into consideration. Of these, **there are 11 top priority rehabilitation units** most urgently requiring management actions for improving multiple benchmarks (predominantly species richness, T2 cover, shrub height and cover, ground cover and weed cover). These are **HRU1 (sites 1, 4), HRU9 (site 35), HRU15 (site 71), HRU17 (sites 95, same as 6th monitoring and 96), HRU18 (site 87 same as 6th monitoring), HRU22 (site 93), HRU23 (site 89, same as 6th monitoring), HRU28 (sites 116, 117, 118), HRU29 (sites 141, same as 6th monitoring and 142), CRU7 (sites 139, 140, same as 6th monitoring) and CRU12 (site 12). One additional rehabilitation unit, HRU3 (site 6), is recommended specifically for weed removal as it contains the highest weed cover of any site.**

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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 livestock 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 (approx. 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 Pacific has developed this *Habitat Rehabilitation Monitoring Report – 7h 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 7th monitoring period for the rehabilitation of Koala Habitat Areas within the development site, with all 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 7th 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 7th monitoring period results
- assess whether rehabilitation is on-track to meet the next interim performance indicator

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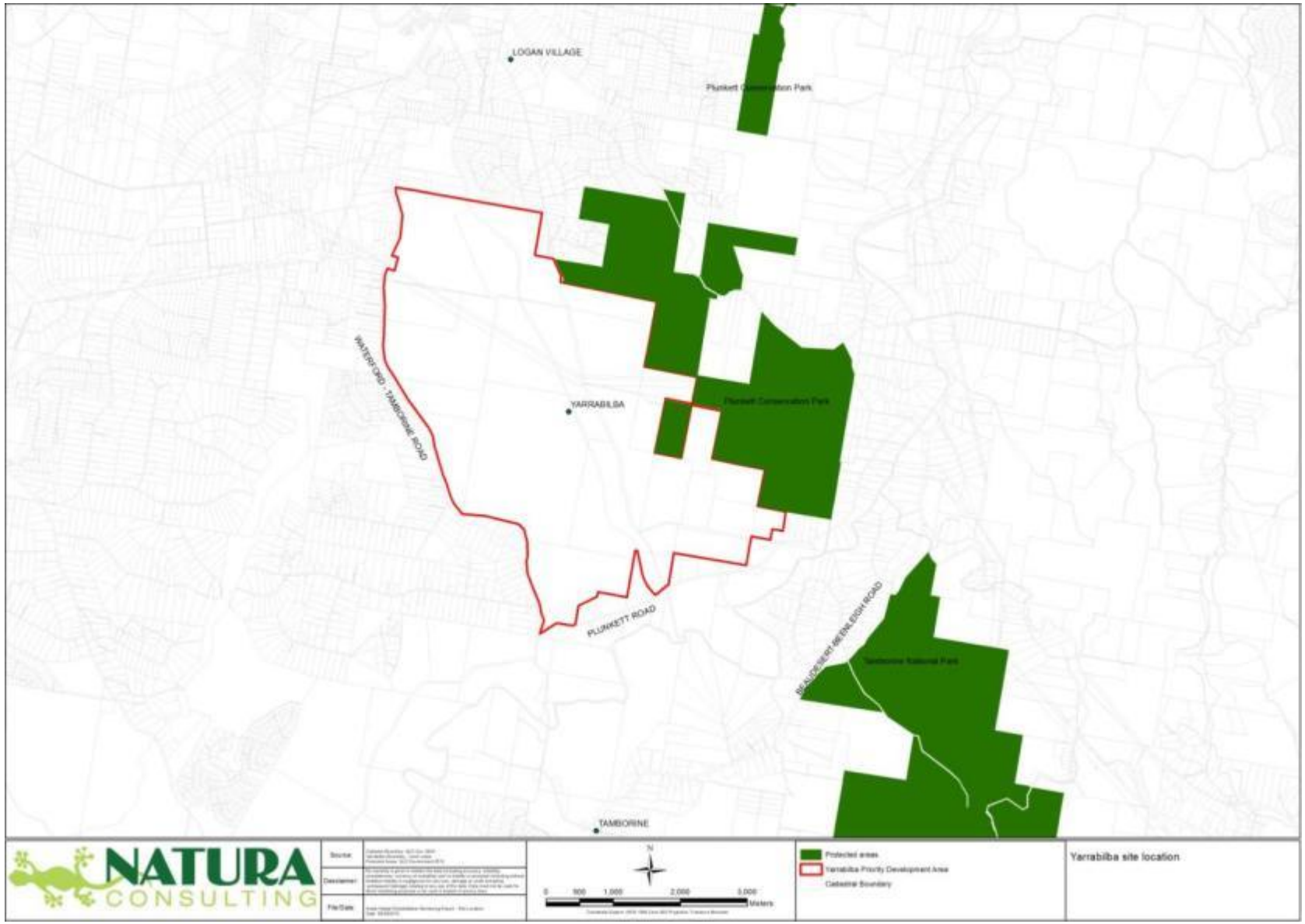

Figure 1 Yarrabilba site location

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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 are also being undertaken where road and infrastructure traverses a Habitat Rehabilitation Unit. These areas are known as Crossing Rehabilitation 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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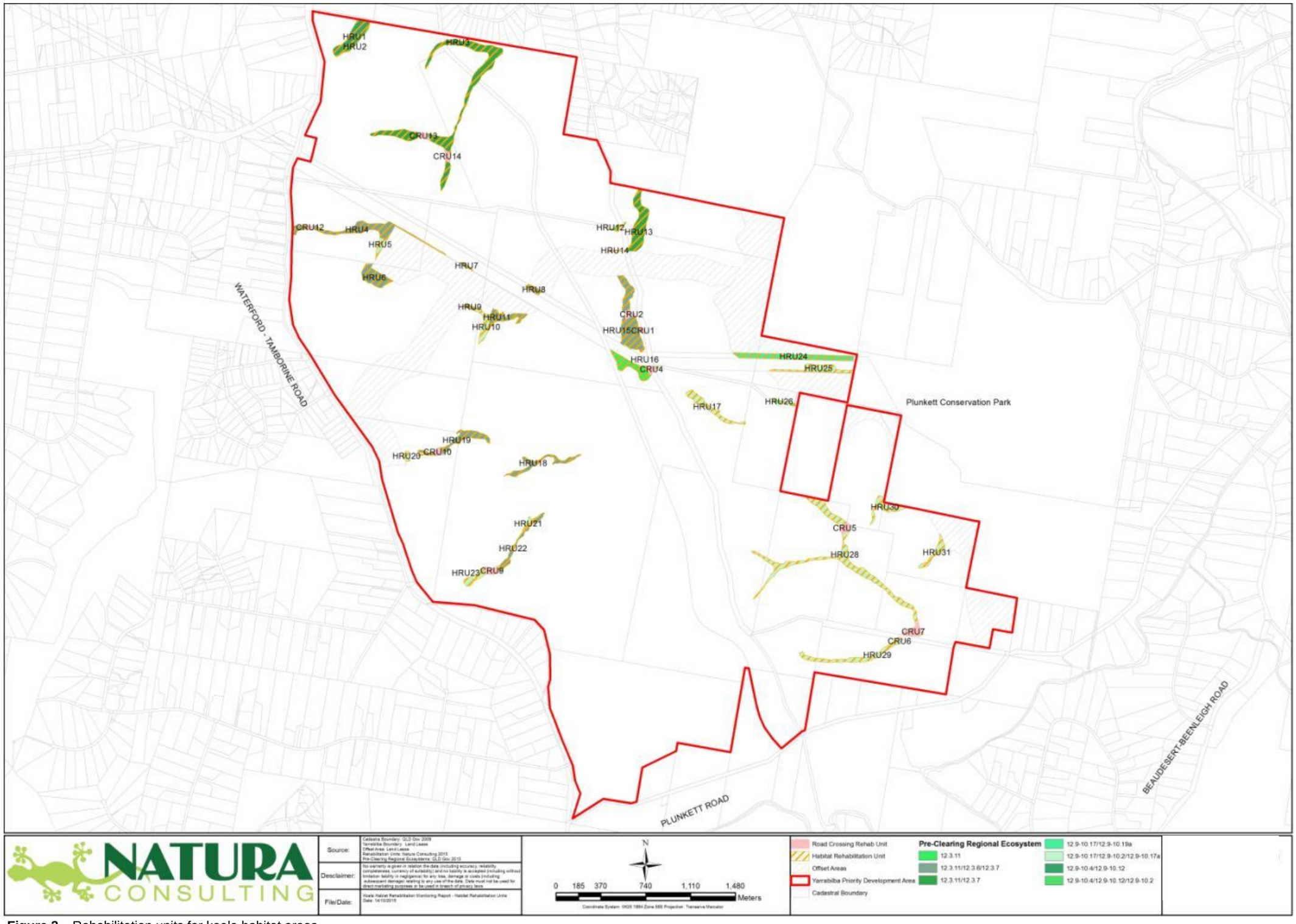

Figure 2 Rehabilitation units for koala habitat areas

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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

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Rehab. Unit	Area (m^2)	Corridor Type	RE Code(s)	Landzone / Geology
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
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**			

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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 'snapshot' 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 7th monitoring period occurred in all 62 sampling 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 50 m apart. 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 7th monitoring period.

The following methodology is 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 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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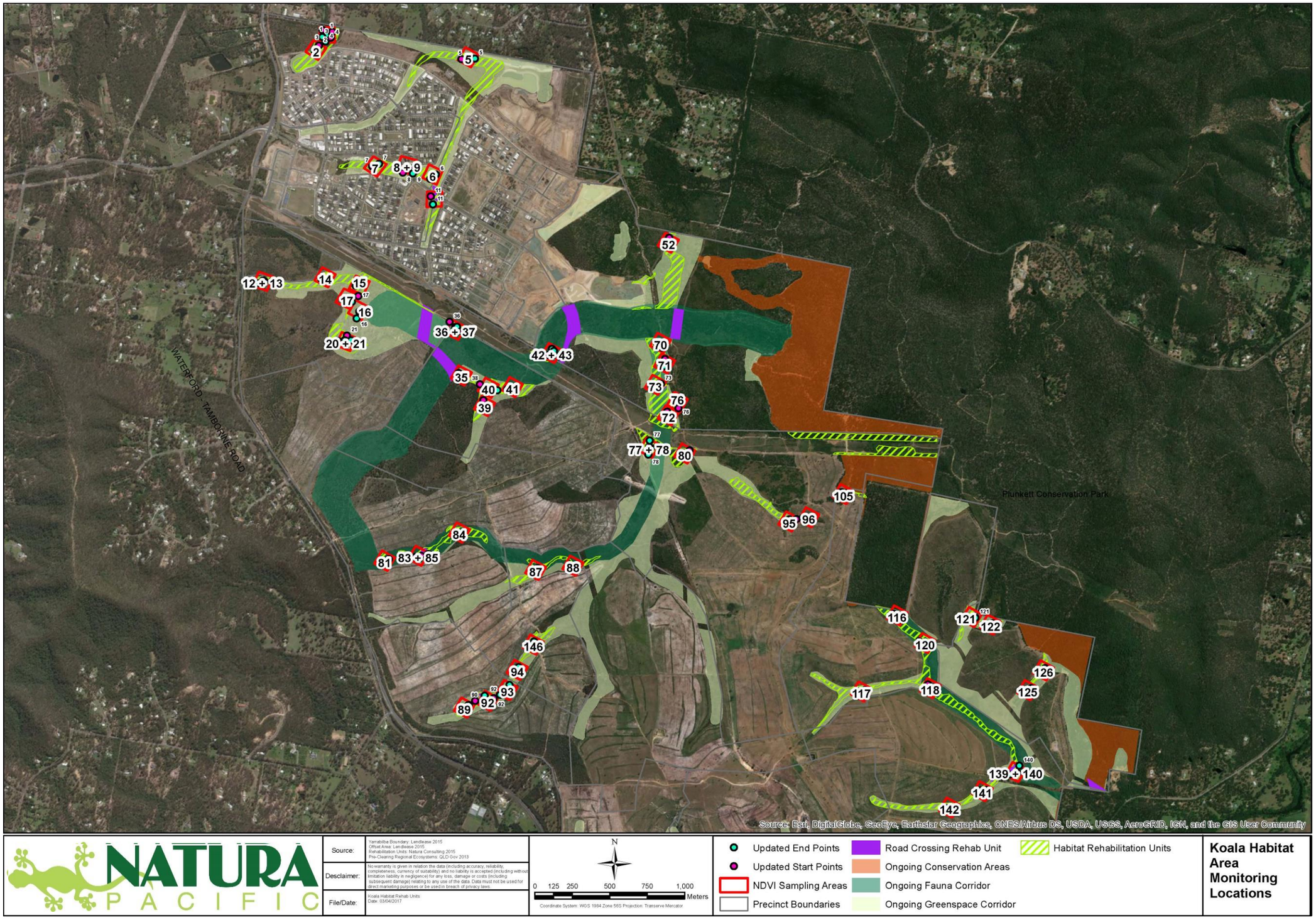

Figure 3 Koala Habitat Rehabilitation Units, habitat monitoring permanent transect locations and NDVI sampling areas

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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 right 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.

- When recording data, reference height ranges were used for allocating vegetation to different strata layers according to dominant pre-clearing RE allocated for the different rehabilitation units (ORU and HRU) and crossing rehabilitation units (CRU) (Table 5).

Table 5 Example reference height ranges used for classifying RE vegetation to respective strata layers

RE Type	Pre clearing height ranges (m)			
	Canopy (T1)	Small trees (T2-T3)	Shrub layer (S1)	Ground Layer (G1)
12.3.11	>19.1	5.1-19	1.26-5	<1.25
12.9-10.17	>13.1	6.1-13	0.76-6	<0.75
12.9-10.4	>14.1	6.6-14	1.25-6.5	<1.25

Given the above, each monitoring site had the information collected, as detailed in (Table 6). This benchmark monitoring process has also been undertaken at 1 year, 18 months, 2 years, 2.5 years, 3 years (current monitoring period) and will continue at 6 monthly intervals until significant progress has been achieved towards RE benchmark values at which point monitoring can be reduced to annual events. Reporting from each of the monitoring events shall be provided to the Department of Environment within 4 weeks of completion of monitoring.

Table 6 Data collected at monitoring sites

Method of collection	Data collected
50 m x 10 m quadrat (plot)	Species richness
50 m transect	Canopy species cover (% Foliage Projected Cover (FPC) and height Shrub % FPC and height)
Five 1 x 1 m quadrats (subplot)	Percentage cover in ground layer (including regenerating native canopy cohorts)

Percent Foliage Projected Cover calculation:

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

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6 Results

6.1 Photo-point monitoring

Photo monitoring results are reported in the following table (Table 7), showing the variety of vegetation types and their condition. The vegetation varies from exotic grass pasture dominated by species such as *Chloris gayana* and *Setaria sphacelata* with sparse native regenerating shrubs and trees, to eucalypt forest with intact canopy and native species composition across multiple strata. The partial inundation of site 71 can be observed. This presented as a barrier to collecting the full suite of data across the site.

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Table 7 Photo monitoring images

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Site 2 (23/07/2020)

Site 3 (23/07/2020)

Site 4 (29/07/2020)

Site 5 (19/08/2020)

Site 6 (19/08/2020)

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Site 7 (29/07/2020)

Site 8 (29/07/2020)

Site 9 (30/07/2020)

Site 11 (29/07/2020)

Site 12 (12/08/2020)

Site 13 (12/08/2020)

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Site 14 (12/08/2020)

Site 15 (12/08/2020)

Site 16 (12/08/2020)

Site 17 (12/08/2020)

Site 20 (12/08/2020)

Site 21 (12/08/2020)

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Site 35 (13/08/2020)

Site 36 (20/08/2020)

Site 37 (20/08/2020)

Site 38 (13/08/2020)

Site 39 (13/08/2020)

Site 40 (13/08/2020)

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Site 41 (13/08/2020)

Site 42 (20/08/2020)

Site 43 (20/08/2020)

Site 52 (19/08/2020)

Site 70 (19/08/2020)

Site 71 (19/08/2020)

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Site 72 (26/08/2020)

Site 73 (19/08/2020)

Site 77 (20/08/2020)

Site 78 (20/08/2020)

Site 80 (26/08/2020)

Site 81 (23/07/2020)

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Site 83 (23/07/2020)

Site 84 (22/07/2020)

Site 85 (23/07/2020)

Site 87 (13/08/2020)

Site 88 (13/08/2020)

Site 89 (30/07/2020)

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Site 90 (30/07/2020)

Site 92 (30/07/2020)

Site 93 (30/07/2020)

Site 94 – No new image (taken 27/05/2019)

Site 95 (06/08/2020)

Site 96 (06/08/2020)

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Site 105 (06/08/2020)

Site 116 (06/08/2020)

Site 117 (06/08/2020)

Site 118 (06/08/2020)

Site 120 (06/08/2020)

Site 121 (05/08/2020)

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Site 122 (05/08/2020)

Site 125 (05/08/2020)

Site 126 (05/08/2020)

Site 139 (05/08/2020)

Site 140 (05/08/2020)

Site 141 (05/08/2020)

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info@natura-pacific.com www.natura-pacific.com

Site 142 (05/08/2020)

Site 146 (30/07/2020)

PO Box 2959, Burleigh BC, QLD 4220 Australia Tel: +61 (0)7 55 765 568 Mob: +61(0)415 413 408
info@natura-pacific.com www.natura-pacific.com

6.2 Transect and quadrat monitoring

6.2.1 Species richness

At baseline in May 2016, a total of 339 species were recorded within the 59 surveyed monitoring sites in the koala habitat areas (Habitat Area). In successive monitoring periods, there has been variability in the total species richness, with the lowest number of species recorded to date in the 6th monitoring period. In the current monitoring period, a total of 338 species were recorded across 62 sites, an increase of 34 since the 6th monitoring period. Table 8 provides a summary of total species richness for all monitoring periods to date.

Table 8 Summary of total species richness recorded in monitoring periods.

Monitoring period	Baseline	1st	2nd	3rd	4th	5th	6th	7th
Species Richness	339	313	334	310	359	343	304	338
No. of sites monitored	59	64	59	62	62	61	59	62

Species richness within sites ranged from 18 to 53 species, with an average of 36.9 species per site (2.9 species more than 6th monitoring period). The largest number of species was observed in sites 9 (Precinct 13), 11 (P1), 36 (P13), 41 (P6) and 6 (P1) (from lowest to highest in species richness), ranging between 50-53 species. This varied slightly from the 6th monitoring period, where the largest number of species was observed in sites 41 (Precinct 6), 8 (P1), 6 (P1), 12 (P13) and 120 (P14).

The lowest number of species was observed in sites 71 and 89 (18 species, which was same for site 71 and a decrease of 3 species for site 89 since the 6th monitoring period). Site 71 is located in the Greenspace Corridor of Precinct 3, whereas site 89 is in the southern reaches of the Greenspace Corridor in Precinct 11 to the south west of the site. Site 89 had previously been recorded as one of the sites with lowest species richness.

Canopy tree species (T1 stratum) common across the Habitat Area were consistent with 6th monitoring period and included *Eucalyptus tereticornis, Eucalyptus siderophloia, Angophora leiocarpa* and *Corymbia trachyphloia* (from highest to lower abundance). *Angophora woodsiana* was no longer among the native canopy tree species that were most rare (found only at one site) across the Habitat Area. These were mostly consistent with the findings in the previous monitoring period and included *Corymbia citriodora* subsp*. variegata, C. henryi, C. tesselaris, Eucalyptus acmenoides, E. carnea, Glochidion ferdinandi* and *Lophostemon suaveolens. E. fibrosa* subsp*. fibrosa,* previously rare, was not recorded in the T1 layer during this monitoring period.

Small tree species (T2-T3) common across the Habitat Area only varied slightly to those recorded in the 6th monitoring period and include *Lophostemon suaveolens, Melaleuca linariifolia, Eucalyptus seeana, Melaleuca quinquenervia, E. tereticornis* and *Angophora leiocarpa* (from highest to lower abundance). There were nine small native tree species that were rare across the Habitat Area, including *Acacia falcata, Allocasuarina torulosa*, *Angophora subvelutina, E. propinqua, E, racemosa,* and *E. resinifera* which varied slightly from the 15 rare species recorded in the 6th monitoring period.

Shrub species (S1 stratum) that were commonly observed across the Habitat Area were consistent with those recorded in the 6th monitoring period and include *Acacia disparrima, A. leiocalyx, Alphitonia excelsa, Leptospermum polygalifolium* and *Lantana camara* (exotic weed) (from highest to lower abundance). A number of native species (4 species) were rare in the shrub layer within the Habitat Area and found only at one site, with some variation to those that were rare in the 6th monitoring round.

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Of all the species recorded, 63 were exotic (2 less species than 6th monitoring period). Several of these had significant representation across the Habitat Areas, being present at many sites within multiple levels of strata. In the ground layer, exotic herbs and graminoids were most highly represented. This includes *Ageratum houstonianum* (42 sites; 10 more than previous), *Lantana camara* (36 sites), *Andropogon virginicus* (33 sites; 2 more), *Emilia sonchifolia* (33 sites; 10 more), *Richardia brasiliensis* (28 sites; 4 more), *Conyza bonariensis* (21 sites), *Megathursus maximus* (21 sites; 2 more) and *Passiflora suberosa* (21 sites; 13 more).

6.2.2 Tree canopy cover and height (T1)

Of the sites with canopy trees present (T1 stratum), tree canopy overlapping % Foliage Projected Cover (FPC) varied from 4% to 94% cover, with average canopy cover of 34.3% (up 1.9% from 6th monitoring period). The canopy species with highest FPC cover in the T1 stratum varied slightly from those recorded in the 6th monitoring period, including *Eucalyptus tereticornis, E. siderophloia, Corymbia trachyphloia* subsp. *trachyphloia, Angophora leiocarpa* and *E. moluccana* (in order of highest to lower). The exotic tree *Pinus elliottii,* was still present in the T1 layer at site 121.

The number of sites containing T1 canopy trees had increased since the 6th monitoring period from 35 to 41 sites. This indicates continued improvement in the direction of attaining the benchmarks for T1 canopy cover. This is represented in Table 9, which indicates sites with no T1 layer for the current monitoring round and previous two monitoring rounds for comparison.

Table 9 7th Monitoring round sites with canopy absent for current and two previous monitoring rounds. Orange highlight indicates sites not surveyed in current monitoring rounds.

Site and Rehabilitation Unit	T1 Canopy trees absent 5th mon	T1 Canopy trees absent 6th mon	T1 Canopy trees absent 7th mon
1 (HRU1)		X	
6 (HRU3)	X	X	X
7 (CRU13)	X	X	X
8 (CRU13)	X	X	
9 (CRU13)	X	N/A	X
11 (CRU14)	X	X	X
12 (CRU12)	X	X	X
13 (CRU12)	X	X	X
15 (HRU4)	X	N/A	
16 (HRU5)	X		
35 (HRU9)	X	X	X
36 (HRU7)		X	X
37 (HRU7)	X	X	X
40 (HRU11)	X		
41 (HRU11)	X		X
52 (HRU13)	X	X	X
70 (HRU15)	X	X	X
71 (HRU15)	X	X	X
72 (HRU15)	X	X	X

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Site and Rehabilitation Unit	T1 Canopy trees absent 5th mon	T1 Canopy trees absent 6th mon	T1 Canopy trees absent 7th mon
73 (HRU15)	X	X	
78 (HRU16)	X		
81 (HRU20)		X	
83 (HRU20)	X	X	X
87 (HRU18)	X	X	X
88 (HRU18)	X	X	
89 (HRU23)	X	X	X
92			X
93 (HRU22)	X	X	X
94 (HRU22)	X	N/A	X
95 (HRU17)	X		
118 (HRU28)	X	X	
120 (CRU8)	X		
140 (CRU8)	X	X	
141 (CRU8)	X	X	X
142 (HRU29)	X		
146 (HRU21)	X	X	
TOTAL	**32**	**25**	**21**

T1 canopy tree height varied from 14.8 m to 23 m, with the average tree height 17.8 m (up 0.4 m since 6th monitoring period). Species with high average T1 canopy height were *Eucalyptus moluccana E. tereticornis, E. siderophloia, E. resinifera* and *Angophora leiocarpa* (in order of highest to lowest average T1 canopy height), which was mostly consistent with tallest species in the 6th monitoring period.

6.2.3 Small tree cover and height (T2-T3)

In this monitoring period, all 62 of the surveyed sites contained a small tree layer (T2 –T3 stratum), which is 4 more than the 6th monitoring period, where a small tree layer was recorded in 58 sites. Overlapping % FPC varied from 2% to 141%, with average cover 49.2% (down 1.4% from 6th monitoring period). The top five small tree species with high net cover in the T2-T3 layer were consistent with those recorded in the 5th and 6th monitoring period and included *Lophostemon suaveolens, Melaleuca linariifolia, Eucalyptus tereticornis, M. quinquenervia* and *E. siderophloia* (from highest to lower). *Pinus elliottii* occurrence remained consistent, with 5 sites containing the species. These are indicated for comparison with the previous two monitoring rounds in Table 10. Small tree height varied from 6 m to 15 m high, with an average of 9.3 m (same as 6th monitoring period).

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Table 10 Sites containing *Pinus elliotti* in the small tree layer this monitoring round and previous two monitoring rounds

Site and Rehabilitation Unit	X = Pinus elliotti present in small tree layer		
	5th mon	6th mon	7th mon
12 (CRU12)	X	X	X
17 (HRU5)		X	X
20 (HRU6)	X	X	X
40 (HRU11)	X	X	X
41 (HRU11)	X	X	X
TOTAL	**4**	**5**	**5**

6.2.4 Shrub cover and height (S1)

Of the 58 sites with shrubs present, overlapping % FPC varied from 1% to 86% with an average FPC of 22.3% (decreased 4.9% from 6th monitoring period). Shrub species with highest net FPC in the shrub layer across sites were mostly consistent with those recorded in the 6th monitoring period, including *Acacia leiocalyx, Lantana camara, Leptospermum polygalifolium, Acacia disparrima* and *Alphitonia excelsa* (in order of highest to lower average cover). Shrub height varied from 0.9 m to 5 m with an average height of 2.8 m (same as 6th monitoring period). Four sites did not have any shrubs present (two more than 6th monitoring period). This included sites 77 and 78 (HRU16) as well as 118 (HRU28) and 139 (CRU7), which were both absent of shrubs in the 6th monitoring round.

6.2.5 Ground cover (G1)

Consistent with the previous four monitoring periods, all of the sites surveyed have a living ground layer, varying in average ground cover across the 5 quadrats per site from 0.8% (site 81 (HRU20), same as previous four monitoring periods, with a decrease of 0.4% since 6th monitoring round) to 62.4% (site 139 (CRU7)), different from 6th monitoring period, where the highest cover was observed at site 117 (HRU28)). Average ground cover was 23.6% (down 5% from 6th monitoring period). Ground cover was dominated by native graminoids, a mat-rush as well as two exotic species. Species varied only slightly from the 6th monitoring period and included *Imperata cylindrica* (which had a minimum of 2 times higher cover overall than any other species), *Lomandra longifolia, Cynodon dactylon, Leersia hexandra, Lantana camara* (exotic herb), *Andropogon virginicus* (exotic grass), *Pteridium esculentum* and *Ageratum houstonianum* (exotic herb) (from highest to lower abundance).

The extent of regenerating *Pinus elliottii* (exotic weed tree) cover in the ground layer continued to decline, with a 44% reduction since the 6th monitoring period (decreasing from 96% to 52% FPC), despite a greater number of sites being surveyed in this monitoring period. The results indicate that targeted removal is continuing to have a positive result**. Six sites were detected where *P. elliottii* remains** in the ground layer component of the survey, **these included site 2 (HRU3), 39 (HRU10), 84 (HRU19), 87 (HRU18), 116 (HRU28) and 146 (HRU21).** It is anticipated that the management of *P. elliottii* in the ground layer will facilitate continued reduction in total cover across all strata, working towards the goal to eradicate the species completely from the Yarrabilba footprint area. This approach should continue to combine with efforts to manage and reduce other exotic species including *Lantana camara* and high cover exotic grasses such as *Andropogon virginicus* and *Paspalum urvillei* within the ground-layer to support and improve the long-term regeneration habitat within these areas.

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PO Box 2959, Burleigh BC, QLD 4220 Australia Tel: +61 (0)7 55 765 568 Mob: +61(0)415 413 408
info@natura-pacific.com www.natura-pacific.com

6.2.6 Weed incursion

There was a total of 63 species of weeds identified in different strata across sites (8 more than 6th monitoring period). Weeds were recorded in the ground layer at 53 sites surveyed in this monitoring period (4 more than 6th monitoring period).

In sites where weed ground cover was recorded, weed cover in the ground layer varied from 0.4% to 35.6%, with average cover 8.3% (5.2% less than 6th monitoring period). The top 5 sites with highest weed cover included site 6 (HRU3, 35.6%), 87 (HRU18, 24.8%), 116 (HRU28, 19.6%), 1 (HRU1, 18.4%) and 140 (CRU7, 18.4%). The composition of weed species in the ground layer with highest cover differed from the 6th monitoring period, were predominantly graminoids and herbs including *Lantana camara, Andropogon virginicus, Paspalum urvillei, Ageratum houstonianum* and *Axonopus compressus* (from highest to lower abundance).

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Table 11 7th Monitoring period species richness, average canopy height within the canopy (T1), sub-canopy (T2-T3) and shrub layer (S1) and Foliage Projected Cover within the canopy (T1), sub-canopy (T2-T3), shrub layer (S1) and ground layer (G1). All 62 sites were surveyed in this monitoring round.

	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	7	1	7	22	37	11	0	10.4	2.7	0	20	86	28	106	14.4	18.4
2	3	5	7	19	34	8	16	9.1	2.8	16	50	49	0	115	10	0.4
3	1	2	11	25	39	13	18	9.8	3	10	46	45	14	101	14.8	18
4	7	4	9	17	37	8	16.3	10.8	2.9	94	29	54	0	177	8.8	1.2
5	1	3	9	22	35	11	19	7.8	3.9	18	9	27	0	54	45.2	6
6	0	2	2	46	50	17	0	9.5	2.6	0	18	9	0	27	23.2	35.6
7	0	9	8	27	44	8	0	9.8	2.8	0	137.4	25	0	162.4	10	1.6
8	1	8	12	21	42	7	0	8.4	2.6	0	75	24	0	99	15.6	1.2
9	0	7	3	43	53	11	0	8.3	3.2	0	48	16	0	64	42.8	9.2
11	0	3	5	44	52	13	0	15	3.8	0	11	53	0	64	21.2	8
12	0	3	4	33	40	18	0	12.8	5.0	0	69	4.6	32	73.6	23.6	6.8
13	0	4	6	29	39	10	0	9.1	2.7	0	31	42	12	73	19.6	2
14	3	1	6	32	42	11	20.4	5.5	2.2	68	2	22	5	92	24.4	8
15	2	6	10	31	49	10	16.5	10	2	20	78.6	17	7	115.6	22	16.4
16	1	1	2	24	28	3	15.7	7.9	2.6	26	30	14	0	70	9.6	2
17	1	4	5	21	31	9	15	9.1	3.6	8	41	36	19	85	11.6	7.6
20	1	6	5	21	33	7	20	14.3	2.3	4	65	10	2	79	16	2.4
21	1	3	5	25	34	7	20	9.8	2.2	14	16	3.0	0	33	19.6	4
35	0	4	7	27	38	14	0	7.7	4.8	0	23	15	0	38	21.2	12
36	0	10	7	34	51	11	0	10.6	3.7	0	141	29	1	170	27.6	2.4
37	0	4	6	28	38	9	0	12.1	2.8	0	89	23	0	112	22	2.8
38	3	0	3	21	27	8	17	6.2	2.9	24	8	11	0	43	20	8.4
39	1	1	3	23	28	10	18.5	7.3	2.9	26	36	23	4	85	18.8	8.4
40	1	5	6	20	32	6	16	10.7	2.7	64	19	6	5	89	23.6	4
41	0	6	6	38	50	10	0	12.4	2.6	0	70	32	17	102	27.6	1.6
42	2	12	6	21	41	11	21.5	9.7	2.2	18	70	27	25	115	11.6	6.4
43	3	4	3	26	36	4	22.3	7.7	3.3	68	15	14	0	97	12	8.8
52	0	10	6	23	39	3	0	9.4	2.6	0	51	13	0	64	31.6	0
70	0	6	8	25	39	4	0	8.7	2.7	0	65	41	0	106	21.2	0.4
71	0	5	3	10	18	2	0	6.2	3.5	0	76	2	0	78	28	0
72	0	5	4	16	25	3	0	10.4	2.1	0	114	31	0	145	9.2	0
73	2	4	4	39	49	11	0	10.5	2.4	0	125	10	0	135	30	4
77	1	3	1	16	21	4	23	9.7	0	50	24	0	0	74	20.8	0
78	2	3	1	21	27	6	22	8.7	0	16	52	0	0	68	24	0.4
80	2	3	3	25	33	7	19.5	12	2.7	36	87	15	0	138	18.4	0.4
81	3	5	3	16	27	9	15	8.0	2.6	18	60	24	10	102	0.8	3.2
83	0	3	6	43	52	17	0	12.1	2.4	0	114	13	4	127	26	10.8
84	2	2	5	39	48	12	20	12.7	1.6	4	48	13	6	65	45.6	3.2
85	2	4	3	31	40	11	17.2	11.9	3.2	45	50	21.4	0	116.4	23.2	4.4

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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**
87	0	3	4	35	42	15	0	8.7	2.9	0	101	8	0	109	37.6	24.8
88	1	3	6	36	46	13	0	9.2	3.1	0	55	10	0	65	22.4	9.6
89	0	0	1	17	18	10	0	7.6	3.1	0	33	12	7	45	12	9.6
90	2	2	0	23	27	4	0	8.1	2.4	0	24	41	27	65	43.2	17.2
92	0	3	3	20	26	7	17.5	9.9	2.8	14	49	22	11	85	30.8	14.4
93	0	2	1	29	32	11	0	7.5	4.8	0	12	20	15	32	17.2	14
94	0	1	3	25	29	8	0	8.0	2.7	0	12	21	1	33	36.8	4.4
95	2	3	2	32	39	10	0	7.9	0.9	0	31	11	5	42	9.6	13.6
96	3	1	0	26	30	9	15	8.2	3.1	28	34	16	0	78	17.2	6
105	5	0	3	21	29	3	14.8	9.5	1.7	71	30	11	0	112	15.6	0.4
116	1	2	4	35	42	13	16.9	9.7	1.7	36	77	11	7	124	42.8	19.6
117	1	3	2	34	40	19	16	9.0	0	4	64	0	0	68	44	10.4
118	1	2	1	31	35	12	0	9.0	4.5	0	103	2	0	105	23.6	9.2
120	2	4	7	29	42	15	18.3	9.1	2.3	28	49	2	0	79	57.2	18
121	4	1	5	27	37	6	16.4	6.0	2.1	60	4	32	7	96	14.4	0
122	6	2	9	23	40	6	15.8	9.6	2.1	38	23	44	0	105	24.4	5.6
125	2	1	5	31	39	5	15.2	6.4	2.6	70	10	56	0	136	12.4	0.4
126	4	5	7	30	46	4	16.6	10.2	2.2	88	26	15	0	129	15.6	0
139	1	3	1	26	31	12	17	6.5	0	14	2	0	0	16	62.4	14.8
140	2	3	2	33	40	15	0	8.5	3.0	0	15	1	0	16	32.8	18.4
141	0	3	4	20	27	12	0	7.9	2.9	0	58	9	0	67	13.6	8
142	1	3	1	28	33	14	0	10.3	2.6	0	103	6	0	109	23.2	3.2
146	1	2	6	37	46	15	0	7.9	3.5	0	21	43	20	64	41.2	12.8
7th Mon.	**2.2**	**3.7**	**4.8**	**27.3**	**37**	**9.5**	**17.8**	**9.3**	**2.8**	**34.3**	**49.2**	**22.3**	**11.6**	**87.7**	**23.6**	**8.3**
6th Mon.	**1.9***	**4.4***	**5.5***	**23.3***	**34***	**8.4***	**17.4***	**9.3***	**2.8***	**32.4***	**50.6***	**27.2***	**11.4***	**93.6***	**28.6***	**13.5***
5th Mon.	**2.1***	**3.3***	**4.4***	**30.2***	**38.5***	**9.5***	**16.9***	**9.4***	**2.4***	**32***	**49.5***	**20.5***	**6.2***	**85.6***	**34***	**11.8***
4th Mon.	**1.9***	**3.8***	**3.8***	**32.8***	**40.8***	**10.6***	**16.8***	**9.2***	**2.5***	**28.7***	**46***	**20.2***	**9***	**81.5***	**31.8***	**11.5***
3rd Mon.	**4.2***	**3.1***	**3***	**28***	**36***	**7.6***	**17. 6***	**8.9***	**2.5***	**25.2***	**42.4***	**5***	**2.4***	**56.8***	**32.3***	**9.5***
2nd Mon.	**2***	**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.	**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	**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 1: Total average values for 7th Monitoring period (7th Mon.), 6th Monitoring period (6th Mon.), 5th Monitoring period (5th Mon.), 4th Monitoring period (4th Mon.) and 3rd Monitoring period (3rd Mon.) are calculated across sites, only including sites where each respective strata were present and not including sites where they were absent (value = 0). ** Note 2: 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.

NATURA PACIFIC
PO Box 2959, Burleigh BC, QLD 4220 Australia Tel: +61 (0)7 55 765 568 Mob: +61(0)415 413 408
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6.3 Normalised Difference Vegetation Index (NDVI) monitoring

During the 7th monitoring period, the normal process of carrying out an additional NDVI assessment to determine the health and condition of the native vegetation across the Fauna Corridors, Greenspace and Environmental Protection Zones could not be conducted due to restrictions around the impacts of COVID-19. Therefore, the NDVI section of this report is omitted. For previous results of this assessment for Koala Habitat Areas, please refer to the 5th monitoring period report.

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7 Discussion

An assessment of site vegetation species richness (SR) and structure was undertaken to determine the 7th monitoring period condition against the benchmark, 2nd, 3rd, 4th, 5th and 6th monitoring periods and baseline values. In this monitoring period, IMO-3 year target, 97% of the surveyed sites (same as 6th monitoring period) met this minimum benchmark for at least four of the benchmark parameters. It should be noted that while results may have been attributed to seasonal variation, observer variation and response to management, comparisons must also consider the variation in number of sites surveyed and slight reactive changes to the methodology. It is therefore expected that there would be some non-natural 'decline / decrease' between monitoring periods.

Benchmark values for surveyed benchmark parameters at each site are provided in Table 12.

7.1 Overview

None of the sites met the benchmark of IMO-3 or greater for all 9 categories (including weed cover), however two sites (sites 15 and 116) met the IMO-3 benchmark of 3 or greater for 8 categories (excluding weed cover), which differed from the 6th monitoring round. This indicates that these sites are the most balanced and progressing in terms of achieving benchmarks in the desired 15 year time frame. The sites with the lowest number of any benchmarks met in the previous monitoring period all improved, with site 81 making the greatest improvement, increasing from 4 benchmarks to 7 benchmarks across categories. Sites 89 (HRU23) and 118 (HRU28) both met 5 benchmarks in this monitoring round (an increase from 4 in the 6th monitoring period). **Site 117 had the lowest number of any benchmarks met (4 only) in this monitoring period,** and the previously lowest, site 81 improved, increasing from 4 to 7 parameters meeting a benchmark.

Most sites (97%) meet the FINAL benchmark for at least one benchmark parameter (consistent with the two previous monitoring period) and 37% of sites (an improvement, with 4% more than 6th monitoring period) meet the FINAL benchmark for at least four (50%) of the benchmark variables. There was a slight decrease in the number of sites meeting consistently high benchmarks (5 or more variables with FMO-15 or FINAL), with 28 sites (45%, 4% less than 6th monitoring period) including sites 2, 3, 4, 7, 8, 9, 11, 13, 14, 15, 20, 21, 36, 37, 40, 41, 42, 43, 52, 70, 72, 73, 77, 80, 83, 84, 85, and 120. Sixteen of these sites are located in Greenspace Corridors (sites 2, 3, 4, 7, 8, 9, 11, 13, 14, 15, 20, 21, 40, 41, and 52), with 13 sites (sites 36, 37, 42, 43, 70, 72, 73, 77, 80, 83, 84, 85, and 120) located in Fauna Corridors (Figure 3).

There was a continued trend of improvement, or no change observed for many benchmark categories across sites, often exceeding the IMO-3 benchmark minimum where a benchmark has been met. For canopy tree cover, a total of 29 sites (47%, same as 6th monitoring period) met a benchmark of IMO-3 or greater. For canopy tree height 32 sites (52%, 5% more than 6th monitoring period) exceed the IMO-3 target, with a benchmark of IMO-10 or greater. For small tree cover 59 sites (95%, same proportion as 6th monitoring period) exceed the IMO-3 target benchmark, with a benchmark of IMO-5 or greater. For small tree height, 62 sites (100%, 2% more than 6th monitoring period) exceed the IMO-3 target benchmark, with a benchmark of IMO-5 or greater. For shrub cover, 50 sites (88%, 8% more than 6th monitoring period) met the IMO-3 benchmark or greater. There was also an improvement for weed cover, with 29 sites (47%, 9% more than 6th monitoring period) now meeting the <5% cover benchmark. Declines were observed in two areas including shrub height, where 57 sites (92%, 3% less than 6th monitoring period) met the IMO-3 benchmark or greater. Ground cover fared poorest in terms of reaching the benchmark target for this monitoring period, with 42 sites (68%, 7% less than 6th monitoring period) meeting the IMO-3 benchmark or greater.

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There are 14 sites (8 less than 6th monitoring period) that consistently met lower than the IMO-3 target benchmarks (IMO-1, IMO-2, or no benchmark), in four or more benchmark categories. **These sites are regarded as being in the poorest condition in terms of lowest benchmark values for species richness, native height, native cover and weed cover and are primarily consistent with those of poorest condition in the 6th monitoring period, including sites 1, 12, 35, 71, 87, 89, 93, 95, 117, 118, 139, 140, 141 and 142.** Sites 9, 11, 13, 15, 73, 81, 88, 94 and 146 had improved and were no longer amongst those considered to be of poorest condition.

7.1.1 Species richness

For species richness, there has been a significant increase in total diversity with 28 sites (45% of sites, 10% more than 6th monitoring period) reaching Final benchmark (7 more sites than 5th monitoring period). This increase, however, may be attributed to seasonal variation. In terms of regional ecosystems, RE12.9-10.4 declined, with none of the five sites in this ecosystem meeting the Final benchmark for species richness (same as previous monitoring). Within RE 12.9-10.17, 14 out of 24 sites (58%, 4% more than 6th monitoring period) now meet the final benchmark, whilst in RE12.3.11, 14 out of 33 sites (42%, 17% more than 6th monitoring period) meet the final benchmark for this parameter.

Due to the high number of sites still failing to meet the benchmark for species richness, the proportion of native species was reviewed to indicate the highest priority sites in this category. Overall, the number of native species recorded within sites is improving, with most sites containing at least 60% native species richness. The four sites with the highest proportion of native species compared to weeds was different to the 6th monitoring period, containing ≥90% native species and included sites 52, 126, 70 and 105 (in order from highest to lower). **There were 4 sites containing less than 60% native species richness and therefore regarded as the poorest (sites 12 and 117, 141 and 142).** This was different to the 6th monitoring period, where sites 12 and 139 contained less than 60% native species richness.

7.1.2 Canopy layer (T1)

The number of sites that fail to meet any benchmarks for T1 cover increased to 33 sites (53%), up from 21 (36%) in 6th monitoring period. A lower number of sites (28) had maintained the 'same' (S) status of 'failure to meet a benchmark', with 7 sites declining (D) in canopy cover (sites 2, 17, 39, 40, 90, 92 and 142) and one site declining in canopy height (site 90) since the 6th monitoring period, which varied from those declining in the previous monitoring period. **Only one site that had met a benchmark had a lower than IMO-3 result for canopy height (site 17, IMO-1), with a benchmark of IMO-10 or greater met for all 32 sites that had reached a benchmark for canopy height.**

7.1.3 Small tree layer (T2)

None of the 62 sites surveyed in this monitoring period failed to meet a benchmark for T2 cover and height, an improvement since the 6th monitoring round, where one site (site 39) failed to meet a benchmark. In this monitoring round, site 39 met the FINAL benchmark for T2 cover and IMO-5 benchmark for T2 height, which indicates the 6th monitoring round result may be attributable to observer error or missing data. The majority of sites were above the target benchmark of IMO-3 for T2 cover (59 sites) and T2 height (all 62 sites). **Sites in the small tree layer that have not yet met the IMO-3 benchmark for T2 cover and are therefore in need of most improvement include sites 14, 121 and 139.**

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7.1.4 Shrub layer (S)

There were 7 sites that fail to meet any benchmarks for shrub cover and 3 for shrub height (same as 6th monitoring period). There were 11 sites that failed to meet a benchmark of IMO-3 or greater for shrub cover, with 8 of these declining (D) since the 6th monitoring period (sites 12, 21, 38, 40, 71, 77, 78 and 141). There were 4 sites that failed to meet the benchmark of IMO-3 or greater for shrub height, with 3 of these declining (D) since the 6th monitoring period (sites 77, 78 and 95). **Therefore, sites in the small shrub layer in need of attention for future benchmark improvement include sites 12, 21, 38, 40, 71, 77, 78, 95 and 141.**

7.1.5 Ground layer (G)

There were 3 sites that fail to meet any benchmarks for ground cover (one more than 6th monitoring period), however there were 20 sites that failed to meet the benchmark of IMO-3 or greater. Of these, **10 had declined (D) since the 6th monitoring period and are therefore highest priority for benchmark improvement in the ground layer (sites 4, 16, 38, 39, 95. 96. 105, 118, 122 and 142).**

7.1.6 Weed cover

There were 33 sites (same as 6th monitoring period) that did not meet the benchmark for exotic weed cover (<5% cover). **Sites with the highest % cover of weeds varied slightly from the 6th monitoring period and include sites 6, 87, 116 and 1 (from highest to lower % cover). These sites are not amongst those considered highest priority for rehabilitation** as they have achieved IMO-3 or greater benchmarks in several other areas. On a positive note, the average weed cover overall has declined considerably to 8.1% (5.4% less than 6th monitoring round).

It is recognised that increases in weed incursion at Yarrabilba may involve several variables, including seasonal variation, human induced edge effects and the increasing isolation of 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. Considering that exotic species often have a competitive advantage with rapid growth and shorter time to seed maturity, it is expected that there will be observed improvements in native species richness, ground cover and shrub cover over time, where targeted management to reduce weed cover is applied.

To continue improving the number of sites meeting this important benchmark, **recommendations for future rehabilitation efforts include continued assisted natural regeneration with weed control across all sites that fail to meet the benchmark, with particular focus on targeting sites with the highest % weed cover (see above) that are infiltrated with the most dominant weed species:** *Ageratum houstonianum* (exotic herb), *Lantana camara* (exotic herb)*, Emilia sonchifolia* (exotic herb), *Andropogon virginicus* (exotic grass)*, Conyza bonariensis* (exotic herb), *Megathyrsus maximus* (exotic grass), *Passiflora suberosa* (exotic herb), *Ambrosia artemisiifolia* (exotic herb) and *Paspalum urvillei* (exotic grass) (from highest to lower number of sites). Additional species should be assessed in-situ and may include *Baccharis halimifolia* (exotic shrub) and *Setaria sphacelata* (exotic grass).

***Pinus elliottii* (exotic tree) is still present at a large number of sites within all layers of strata at different life stages, including the ground and canopy layers at sites 2, 3, 12, 17, 20, 39, 40, 41, 87, 116, 146, mostly consistent with the 6th monitoring round.** *P. elliottii* was also recorded in the general species list at a number of other sites, including sites, 1, 4, 5, 7, 11, 35, 36, 42, 71, 73, 81-86, 94, 121, 122 and 140. Continued targeted management of *P. elliottii* should be considered when planning rehabilitation management activities. Considering that many of these sites have already achieved high benchmarks (IMO3 or greater) across multiple categories, they are not included in the

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top priority sites for rehabilitation. **It is therefore suggested that further management of *P. elliottii* within these areas is done strategically over time with staged removal to reduce invasion of the ground-layer by exotic species.**

7.2 Summary and conclusions

In summary, there are 14 sites considered amongst those of highest priority requiring prompt management actions to improve benchmark conditions to a minimum of IMO-3 across all variables in preparation for moving forward to the new IMO-5 target in August 2021. There are a further 14 sites that may be targeted for improvement in specific benchmark areas, primarily % native cover in the shrub and ground layers. **These improvements are to be achieved primarily through assisted natural regeneration in combination with targeted weed control at the sites regarded to be in poorest condition and other priority high weed sites. Weed management is to incorporate reduction of weed cover for dominant species recorded this monitoring round (listed above), as well as others detected in-situ, and finally, the continued felling of *Pinus elliottii* where possible at the sites discussed above.** This will continue to open up more space for species from all strata layers to regenerate naturally through seed bank propagation. Opportunities for complementary infill planting may also be assessed and carried out if deemed necessary at sites that fail to meet the benchmark for ground and or shrub cover.

Using combined information from the above discussion, including poorest benchmark achievement, and weed prevalence, **there are 11 top priority rehabilitation units most urgently requiring management actions for improving multiple benchmarks** (predominantly species richness, T2 cover, shrub height and cover, ground cover and weed cover). A summary of these results is provided in Table 13. **One rehabilitation unit, HRU3 (site 6), is recommended as the highest priority, specifically for weed removal as it contains highest weed cover of any site, though overall this site is doing well in benchmark achievement in other areas. Additional top priority rehabilitation units are HRU18 (site 87 same as 6th monitoring), HRU22 (site 93), HRU17 (sites 95, same as 6th monitoring), HRU28 (sites 116, 117, 118), HRU9 (site 35), CRU7 (sites 139, 140, same as 6th monitoring), HRU1 (sites 1, 4), HRU23 (site 89, same as 6th monitoring), CRU12 (site 12), HRU29 (sites 141, same as 6th monitoring and 142) and HRU15 (site 71).** Site 146 (HRU21) now meets the IMO-10 benchmark for ground cover and has improved in all benchmark areas removing it from the top priority sites. Table 10 can be used to determine additional sites to be targeted for benchmark improvements in species richness, ground cover and weed control where possible following management actions within top priority sites.

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Table 12 7th Monitoring period benchmark values for species richness, canopy height within the canopy (T1), sub-canopy (T2-T3) and shrub layer (S1) and cover within the canopy (T1), sub-canopy (T2-T3), shrub 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)	FINAL (S)	FINAL (S)	FINAL (S)	FMO-15 (I)	IMO-2 (S)	N (S)
2	HRU1	12.9-10.4/12.9-10.12	X (S)	IMO-10 (D)	FMO-15 (S)	FINAL (S)	FINAL (S)	FINAL (S)	FMO-15 (I)	IMO-2 (S)	Y (S)
3	HRU3	12.9-10.4/12.9-10.12/12.9-10.2	X (S)	IMO-3 (S)	FMO-15 (S)	FINAL (S)	FINAL (S)	FINAL (S)	FMO-15 (S)	IMO-2 (I)	N (S)
4	HRU1	12.9-10.4/12.9-10.12	X (S)	FINAL (S)	FMO-15 (I)	FINAL (S)	FINAL (S)	FINAL (S)	FMO-15 (S)	IMO-1 (D)	Y (S)
5	HRU3	12.9-10.4/12.9-10.12/12.9-10.2	X (S)	IMO-10 (S)	FMO-15 (S)	IMO-10 (I)	IMO-10 (D)	FINAL (I)	FMO-15 (S)	FMO-15 (S)	N (S)
6	HRU3	12.3.11/12.3.7	FINAL (S)	X (S)	X (S)	IMO-10 (D)	FMO-15 (S)	IMO-10 (D)	FMO-15 (D)	FINAL (S)	N (S)
7	CRU13	12.3.11/12.3.7	FINAL (S)	X (S)	X (S)	FMO-15 (S)	FINAL (S)	FINAL (S)	FINAL (S)	FMO-15 (D)	Y (S)
8	CRU13	12.3.11/12.3.7	FINAL (S)	X (S)	X (S)	IMO-10 (S)	FINAL (S)	FINAL (S)	FINAL (S)	FMO-15 (D)	Y (S)
9	CRU13	12.3.11/12.3.7	FINAL	X	X	IMO-10	FINAL	FMO-15	FINAL	FINAL	N
11	CRU14	12.3.11/12.3.7	FINAL (I)	X (S)	X (S)	FINAL (I)	IMO-10 (D)	FINAL (S)	FINAL (S)	FINAL (S)	N (S)
12	CRU12	12.3.11/12.3.6/12.3.7	X (S)	X (S)	X (S)	FINAL (S)	FINAL (S)	IMO-2 (D)	FINAL (S)	FINAL (S)	N (S)
13	CRU12	12.3.11/12.3.6/12.3.8	X (S)	X (S)	X (S)	IMO-10 (S)	FINAL (S)	FINAL (S)	FINAL (I)	FINAL (S)	Y (I)
14	HRU4	12.3.11/12.3.6/12.3.7	X (S)	FINAL (S)	FMO-15 (S)	IMO-5 (S)	IMO-1 (D)	FINAL (S)	FMO-15 (S)	FINAL (S)	N (S)
15	HRU4	12.3.11/12.3.6/12.3.7	FINAL	IMO-5	IMO-10	FMO-15	FINAL	FMO-15	FMO-15	FINAL	N
16	HRU5	12.9-10.17/12.9-10.2	FINAL (I)	IMO-10 (I)	IMO-10 (I)	IMO-5 (S)	FMO-15 (S)	IMO-5 (D)	IMO-10 (D)	X (D)	Y (S)
17	HRU5	12.9-10.17/12.9-10.2	FINAL (S)	IMO-1 (D)	IMO-10 (S)	IMO-10 (I)	FINAL (S)	FMO-15 (D)	FMO-15 (S)	IMO-1 (S)	N (S)
20	HRU6	12.3.11/12.3.6/12.3.7	X (S)	X (S)	FMO-15 (S)	FINAL (S)	FINAL (S)	IMO-10 (D)	FMO-15 (S)	FMO-15 (D)	Y (S)
21	HRU6	12.3.11/12.3.6/12.3.7	X (S)	IMO-3 (S)	FMO-15 (S)	FMO-15 (S)	FMO-15 (S)	IMO-1 (D)	FMO-15 (I)	FINAL (S)	Y (I)
35	HRU9	12.3.11/12.3.6/12.3.7	X (S)	X (S)	X (S)	IMO-5 (S)	FMO-15 (S)	FMO-15 (D)	FINAL (S)	FINAL (S)	N (S)
36	HRU7	12.3.11/12.3.6/12.3.7	FINAL (I)	X (S)	X (S)	FMO-15 (S)	FINAL (S)	FINAL (S)	FINAL (I)	FINAL (S)	Y (S)
37	HRU7	12.3.11/12.3.6/12.3.7	X (S)	X (S)	X (S)	FINAL (I)	FINAL (S)	FINAL (S)	FINAL (S)	FINAL (S)	Y (S)
38	HRU10	12.9-10.17/12.9-10.2	X (D)	IMO-10 (S)	IMO-10 (S)	IMO-5 (S)	IMO-5 (S)	IMO-3 (D)	FMO-15 (S)	IMO-2 (D)	N (S)
39	HRU10	12.9-10.17/12.9-10.2	X (D)	IMO-10 (D)	FMO-15 (I)	IMO-5 (I)	FINAL (I)	FMO-15 (S)	FMO-15 (I)	IMO-1 (D)	N (S)
40	HRU11	12.3.11/12.3.6/12.3.7	X (D)	FINAL (I)	IMO-10 (I)	FMO-15 (I)	FMO-15 (D)	IMO-3 (D)	IMO-10 (D)	FINAL (S)	Y (I)

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PO Box 2959, Burleigh BC, QLD 4220 Australia Tel: +61 (0)7 55 765 568 Mob: +61(0)415 413 408
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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%)
41	HRU11	12.3.11/12.3.6/12.3.7	FINAL (S)	X (S)	X (S)	FINAL (S)	FINAL (S)	FINAL (S)	IMO-10 (D)	FINAL (S)	Y (S)
42	HRU8	12.3.11/12.3.6/12.3.7	X (S)	IMO-5 (D)	FMO-15 (S)	FMO-15 (S)	FINAL (S)	FINAL (S)	FMO-15 (S)	FMO-15 (D)	N (S)
43	HRU8	12.3.11/12.3.6/12.3.7	X (S)	FINAL (S)	FMO-15 (S)	IMO-5 (D)	FMO-15 (D)	FMO-15 (D)	FINAL (I)	FMO-15 (D)	N (S)
52	HRU13	12.3.11/12.3.6/12.3.7	FINAL (S)	X (S)	X (S)	IMO-10 (D)	FINAL (S)	FMO-15 (D)	IMO-10 (D)	FINAL (S)	Y (S)
70	HRU15	12.3.11/12.3.6/12.3.7	FINAL (I)	X (S)	X (S)	IMO-10 (S)	FINAL (S)	FINAL (S)	FINAL (S)	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 (D)	FINAL (S)	FINAL (S)	Y (S)
72	HRU15	12.3.11/12.3.6/12.3.7	X (S)	X (S)	X (S)	FMO-15 (S)	FINAL (S)	FINAL (S)	FMO-15 (S)	FMO-15 (S)	Y (S)
73	HRU15	12.3.11/12.3.6/12.3.7	FINAL (I)	X (S)	X (S)	FMO-15 (S)	FINAL (S)	IMO-10 (S)	FMO-15 (S)	FINAL (S)	Y (I)
77	HRU16	12.3.11	X (S)	FMO-15 (S)	FMO-15 (S)	FMO-15 (S)	FINAL (S)	X (D)	X (D)	FINAL (S)	Y (S)
78	HRU16	12.3.11	X (S)	IMO-3 (S)	FMO-15 (I)	IMO-10 (I)	FINAL (S)	X (D)	X (D)	FINAL (I)	Y (S)
80	CRU4	12.3.11	X (S)	FMO-15 (S)	FMO-15 (S)	FINAL (S)	FINAL (S)	FMO-15 (D)	IMO-10 (D)	FINAL (S)	Y (S)
81	HRU20	12.9-10.17/12.9-10.2	X (S)	IMO-5 (I)	IMO-10 (I)	IMO-5 (D)	FINAL (S)	FMO-15 (S)	IMO-10 (D)	X (S)	Y (I)
83	HRU20	12.3.11/12.3.6/12.3.7	FINAL (S)	X (S)	X (S)	FINAL (S)	FINAL (S)	FMO-15 (S)	FMO-15 (S)	FINAL (S)	N (S)
84	HRU19	12.3.11/12.3.6/12.3.7	FINAL (I)	X (S)	FMO-15 (S)	FINAL (S)	FINAL (S)	FMO-15 (S)	IMO-10 (D)	FINAL (S)	Y (I)
85	CRU10	12.3.11/12.3.6/12.3.7	X (D)	FMO-15 (I)	FMO-15 (S)	FINAL (S)	FINAL (S)	FMO-15 (D)	FINAL (D)	FINAL (S)	Y (S)
87	HRU18	12.3.11/12.3.6/12.3.7	X (S)	X (S)	X (S)	IMO-10 (D)	FINAL (S)	IMO-5 (D)	FINAL (S)	FINAL (S)	N (S)
88	HRU18	12.3.11/12.3.6/12.3.7	FINAL (I)	X (S)	X (S)	IMO-10 (D)	FINAL (S)	IMO-10 (D)	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)	FINAL (S)	IMO-3 (I)	FMO-15 (D)	IMO-1 (S)	N (S)
90	CRU9	12.9-10.17/12.9-10.2	FINAL (I)	X (D)	X (D)	IMO-5 (S)	FMO-15 (S)	FINAL (I)	IMO-10 (D)	IMO-10 (I)	N (S)
92	HRU22	12.9-10.17/12.9-10.2	X (S)	IMO-3 (D)	IMO-10 (S)	IMO-10 (S)	FINAL (S)	FMO-15 (I)	FMO-15 (S)	IMO-5 (D)	N (S)
93	HRU22	12.3.11/12.3.6/12.3.7	X (S)	X (S)	X (S)	IMO-5 (S)	IMO-10 (S)	FMO-15 (D)	FINAL (I)	FINAL (S)	N (S)
94	HRU22	12.3.11/12.3.6/12.3.7	X	X	X (S)	IMO-5	IMO-10	FMO-15	FINAL	FINAL	Y
95	HRU17	12.9-10.17/12.9-10.2	FINAL (I)	X (S)	X (S)	IMO-5 (S)	FINAL (S)	IMO-3 (I)	IMO-1 (D)	X (D)	N (S)
96	HRU17	12.9-10.17/12.9-10.2	X (D)	FMO-15 (I)	IMO-10 (S)	IMO-5 (D)	FINAL (S)	IMO-10 (S)	FMO-15 (I)	IMO-1 (D)	N (S)
105	HRU26	12.9-10.17/12.9-10.19	FINAL (S)	FINAL (S)	IMO-10 (S)	IMO-10 (S)	FMO-15 (S)	IMO-3 (D)	IMO-5 (S)	IMO-1 (D)	Y (S)
116	HRU28	12.9-10.17/12.9-10.2	FINAL (S)	FMO-15 (S)	IMO-10 (S)	IMO-10 (S)	FINAL (S)	IMO-3 (I)	IMO-3 (D)	IMO-10 (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%)
117	HRU28	12.9-10.17/12.9-10.2	X (D)	X (S)	IMO-10 (S)	IMO-10 (I)	FINAL (S)	X (S)	X (S)	FMO-15 (S)	N (S)
118	HRU28	12.9-10.17/12.9-10.2	FINAL (S)	X (S)	X (S)	IMO-10 (S)	FINAL (S)	X (S)	FINAL (I)	IMO-2 (D)	N (S)
120	CRU8	12.9-10.17/12.9-10.2	FINAL (S)	FMO-15 (S)	FMO-15 (I)	IMO-10 (I)	FINAL (S)	X (S)	IMO-10 (I)	FMO-15 (S)	N (S)
121	HRU30	12.9-10.17/12.9-10.2	FINAL (S)	FINAL (S)	IMO-10 (S)	IMO-5 (S)	IMO-2 (S)	FMO-15 (D)	IMO-10 (S)	IMO-1 (S)	Y (S)
122	HRU30	12.9-10.17/12.9-10.2	FINAL (I)	FMO-15 (S)	IMO-10 (S)	IMO-10 (S)	FMO-15 (S)	FINAL (S)	IMO-5 (D)	IMO-2 (D)	N (D)
125	HRU31	12.9-10.17/12.9-10.2	FINAL (S)	FINAL (S)	IMO-10 (S)	IMO-5 (S)	IMO-5 (S)	FINAL (S)	IMO-10 (D)	IMO-1 (I)	Y (S)
126	HRU31	12.9-10.17/12.9-10.2	FINAL (S)	FINAL (S)	IMO-10 (S)	IMO-10 (S)	FMO-15 (S)	IMO-5 (I)	IMO-10 (I)	IMO-1 (S)	Y (S)
139	CRU7	12.9-10.17/12.9-10.2	X (S)	IMO-3 (S)	IMO-10 (S)	IMO-5 (S)	IMO-1 (D)	X (S)	X (S)	FMO-15 (S)	N (S)
140	CRU7	12.9-10.17/12.9-10.2	FINAL (S)	X (S)	X (S)	IMO-5 (S)	FMO-15 (S)	X (S)	FMO-15 (S)	IMO-5 (S)	N (S)
141	HRU29	12.9-10.17/12.9-10.2	X (S)	X (S)	X (S)	IMO-5 (S)	FINAL (S)	IMO-2 (D)	FMO-15 (I)	IMO-1 (S)	N (S)
142	HRU29	12.9-10.17/12.9-10.2	X (S)	X (D)	X (S)	FMO-15 (I)	FINAL (S)	IMO-1 (I)	IMO-10 (S)	IMO-2 (D)	Y (S)
146	HRU21	12.9-10.17/12.9-10.2	FINAL (I)	X (S)	X (S)	IMO-5 (S)	FMO-15 (S)	FINAL (S)	FMO-15 (S)	IMO-10 (I)	N (S)
Total meeting a benchmark			**28**	**29**	**32**	**62**	**62**	**55**	**58**	**59**	**29**
Total meeting a benchmark (6th mon.)			**21**	**28**	**28**	**58**	**58**	**52**	**56**	**57**	**23**
Total meeting a benchmark (5th mon.)			**31**	**29**	**32**	**61**	**61**	**55**	**59**	**60**	**28**
Total meeting a benchmark (4th mon.)			**34**	**26**	**31**	**62**	**62**	**53**	**57**	**61**	**23**
Total meeting a benchmark (3rd mon.)			**28**	**15**	**25**	**62**	**56**	**19**	**55**	**61**	**28**
Total meeting a benchmark (2nd mon.)			**3**	**19**	**21**	**57**	**57**	**12**	**29**	**57**	**20**
Total meeting a benchmark (baseline survey)			**65**	**45**	**49**	**60**	**61**	**47**	**62**	**65**	**12**
Total improving (since 6th mon.)			**11**	**5**	**7**	**10**	**1**	**8**	**14**	**5**	**6**
Total declining (since 6th mon.)			**6**	**7**	**1**	**7**	**6**	**22**	**17**	**17**	**1**
Total same (since 6th mon.)			**40**	**46**	**50**	**40**	**50**	**27**	**28**	**35**	**50**
Overall trend			**≥**	**=**	**≥**	**≥**	**=**	**≤**	**=**	**≤**	**≥**
Total sites surveyed (excl. removed) = 59											

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

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Table 13 Summary of 7th Monitoring top priority sites for management from highest to lowest priority based on % weed cover. Indicates variables that have failed to meet the IMO-3 or greater benchmark and therefore classified the management unit among top priority sites

HRU	Sites	Poorest Condition	Fails to meet target benchmark (≥IMO-3)							
			Native Species Richness	Canopy Cover (T1)	Canopy Height (T1)	Small Tree Cover(T2-T3)	Shrub Cover (S1)	Shrub Height (S1)	Native Ground Cover (G1)	Weed cover (>5%)
HRU3	6			X	X					X
HRU18	87	X	X	X	X					X
HRU22	93	X	X	X	X					X
HRU17	95	X		X	X			X	X	X
HRU28	116, 117, 118	X	X (1)*	X (2)*	X (1)*		X (2)*	X (1)*	X (1)*	X
HRU9	35	X	X	X	X					X
CRU7	139, 140	X	X (1)*	X (1)*	X (1)*	X (1)*	X	X (1)*		X
HRU1	1, 4	X	X	X	X				X	X
HRU23	89	X	X	X	X					X
CRU12	12	X	X	X	X		X			X
HRU29	141, 142	X	X	X	X		X		X	X (1)*
HRU15	71	X	X	X	X		X			

* Indicates number of sites failing to meet ≥IMO-3 target, where not all sites within the management unit fail

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