



Native Vegetation Clearing Permit Offset Proposal

*We're working for
Western Australia.*

**Mitchell Freeway Principal Shared
Path Gaps Proposal (Ocean Reef
Road to Hepburn Avenue)**

Contents

1	INTRODUCTION	3
1.1	Proposal background.....	3
1.2	Purpose.....	3
1.3	Proposal Location.....	3
1.4	Clearing Principles Likely to be at Variance.....	4
1.5	Residual Impacts Associated with Specific Clearing Principles	6
2	OFFSET PROPOSAL REQUIREMENTS.....	8
2.1	Offset guide inputs and justification.....	8
2.2	Summary of Offsets Proposed.....	9
3	COUNTERBALANCE OF SIGNIFICANT RESIDUAL IMPACTS.....	13
4	APPLICATION OF ENVIRONMENTAL OFFSET POLICY PRINCIPLES	17
5	REFERENCES	19
6	APPENDICES	20
	Appendix A: Offset Calculations.....	21
	Appendix B: EPBC Offset Calculator Tool Worksheets	26
	Appendix C: AECOM (2016) Lake Clifton Biological Survey	27
	Appendix D: AECOM (2020) Lake Clifton Tuart TEC Assessment	28

Amendments

Report Compilation & Review	Name and Position	Document Revision	Date
Author:		Rev A	17/02/21
Reviewer:		Rev A	23/02/2021
Author:		Rev B	26/02/2021

1 INTRODUCTION

1.1 Proposal background

Main Roads Western Australia (Main Roads) proposes to construct a shared path (or Principle Shared Path (PSP)) and noise walls along the eastern side of the Mitchell Freeway at various sections between Ocean Reef Road and Hepburn Avenue, in the northern suburbs of Perth, Western Australia (WA) (Proposal).

The Proposal includes:

- The installation of a new PSP along the eastern side of the Mitchell Freeway, including the upgrading of existing PSPs to current design standards.
- The construction of noise walls to mitigate freeway noise on nearby residential areas, stretching from Hepburn Avenue to Ocean Reef Road.
- Verge side emergency stopping bays.
- The modification of freeway on-ramps to accommodate Intelligent Transport Systems (ITS) works.
- Drainage works on the Mitchell Freeway.

The works include the installation of a new PSP along the Mitchell Freeway, and the upgrading of existing PSPs to current design standards. The works also include the construction of noise walls to mitigate noise to residential properties for the upgrades of the freeway and nearby residential areas, stretching from Hepburn Avenue to Ocean Reef Road, verge side emergency stopping bays and the modification of on-ramps, Intelligent Transport Systems (ITS) works and drainage on the Mitchell Freeway to accommodate the works. These works are required to improve the safe and efficient use of this route.

The Proposal involves the construction of a continuous PSP along Mitchell Freeway between Ocean Reef Road and Hepburn Avenue in order to improve the efficiency of the Perth bicycle network and potentially increase the uptake of cycling as a method of commuting. Noise walls will also be constructed in order to improve the amenity of the adjacent residential properties as there is currently no noise mitigation from the traffic noise of the Mitchell Freeway. Works will also include the upgrade of Ocean Reef Road and Whitfords Avenue on-ramps to the Mitchell Freeway and the construction of new emergency stopping bays, which is required to improve the safe and efficient use of the freeway.

1.2 Purpose

The areas of native vegetation to be cleared for the Proposal will require a native vegetation clearing permit under the *Environmental Protection Action 1986* (EP Act). Main Roads operates on a hierarchy of avoid, minimise, reduce, rehabilitate and offset environmental impacts. This hierarchy is achieved primarily through changes in scope and design, development and implementation of avoidance and mitigation measures and finally, an offset proposal.

The purpose of this document is to outline the offset proposed for the native vegetation clearing permit in accordance with the WA Environmental Offsets Guidelines (GoWA 2011), as a response to the residual impacts remaining.

1.3 Proposal Location

The Proposal includes the installation of a PSP and noise walls along the Mitchell Freeway between Ocean Reef Avenue, in the northern suburbs of Perth, Western Australia (Proposal area) (Figure 1). The Proposal area is 13.68 ha in size, with 3.02 ha of native vegetation.

1.4 Clearing Principles Likely to be at Variance

Schedule 5 of the EP Act defines the Ten Clearing Principles for native vegetation clearing. These principles aim to ensure that all potential impacts resulting from removal of native vegetation can be assessed in an integrated way. Clearing required for construction of the Proposal has been assessed against the Ten Clearing Principles, with each principle being assessed in accordance with the Department of Water and Environmental Regulation's (DWER) A Guide to the Assessment of Applications to Clear Native Vegetation (DER 2014) to determine whether the application is at variance to the principles. The assessment indicates may be or is likely to be at variance with principles a and b (Table 1).

Table 1. Principles at variance

PRINCIPLE	ASSESSMENT	OUTCOME
<p>a Native vegetation should not be cleared if it comprises a high level of biological diversity.</p>	<p>The Proposal involves the clearing of up to 3.02 ha of remnant native vegetation comprised of the following mapped vegetation units:</p> <ul style="list-style-type: none"> • Tuart Forest 2: <i>Eucalyptus gomphocephala</i> mid open to closed forest over <i>Eucalyptus marginata</i> (<i>Banksia attenuata</i>, <i>Allocasuarina fraseriana</i>, <i>Corymbia calophylla</i>) mid to low woodland to open woodland over <i>Xanthorrhoea preissii</i> (<i>Acacia rostellifera</i>, <i>Jacksonia sternbergiana</i>, <i>Allocasuarina humilis</i>) mid shrubland to isolated shrubs over <i>Mesomelaena pseudostygia</i> and <i>Lepidosperma calcicola</i> sparse sedgeland over an introduced tussock grassland. • Jarrah Woodland 2: <i>Eucalyptus gomphocephala</i> isolated trees to isolated clumps of trees over <i>Eucalyptus marginata</i> (+/- <i>Banksia attenuata</i> and/or <i>Allocasuarina fraseriana</i>) woodland to open woodland over +/- <i>Acacia rostellifera</i> +/- <i>Calothamnus quadrifidus</i>, +/- <i>Melaleuca nesophila</i> tall shrubland to tall open shrubland over <i>Xanthorrhoea preissii</i> mid sparse to open shrubland over closed tussock grassland of introduced grasses. <p>The vegetation proposed to be cleared is in 'Completely Degraded' to 'Good' condition with the majority (1.68 ha; 55.6%) in 'Completely Degraded' condition. The Proposal area presents poorer quality native vegetation in comparison to that in the surrounding area. Vegetation within the Proposal area comprises a linear fragment, separated from surrounding patches by main roads and residential land use. The northern section of the Proposal is adjacent to Woodvale Nature Reserve, which exhibits high quality, intact vegetation.</p> <p>The Proposal will impact on 2.93 ha of native vegetation representative of the EPBC Act listed 'Tuart (<i>Eucalyptus gomphocephala</i>) woodlands and forests of the Swan Coastal Plain' Threatened Ecological Community (Critically Endangered) (Tuart TEC) and DBCA listed 'Tuart woodlands of the Swan Coastal Plain' Priority Ecological Community (P3) (Tuart PEC).</p> <p>The Tuart TEC/PEC mapped within the Proposal area presents only 0.4% of that within the surrounding local area (10 km), based on the current extent of remnant vegetation included in the DBCA Tuart Woodlands mapping (DBCA-048). Of the Tuart TEC/PEC within the Proposal area, 2.88 ha (98%) is in 'Completely Degraded' to 'Degraded' condition.</p> <p>Tuart TEC/PEC patch TP12 occurs both within the road reserve (Proposal area) and outside of the Proposal area, within Woodvale Nature Reserve. Currently the occurrence of TP12 in this section is separated by the existing PSP and a fire break within the reserve. Within the Proposal area the vegetation representing TP12 is between 10 – 25 m wide, clearing as result of the Proposal will remove this narrow strip. The Proposal will not result in the splitting of</p>	<p>May be at variance to this Principle.</p>

PRINCIPLE	ASSESSMENT	OUTCOME
	<p>the occurrence of TP12, as it is removing the western edge, nor significantly increase the separation between it and other patches of the TEC that currently exist, given the narrow extent of the clearing.</p> <p>Mapped patches of the Tuart TEC/PEC exist within Woodvale Nature Reserve as well as within Bush Forever site 303 to the west of the Proposal area. The removal of 2.93 ha of Tuart TEC/PEC within the current Mitchell Freeway road reserve is not expected to have a significant negative impact on the survival of the community given there is currently 733.35 ha within 10 km of the Proposal area of which 186.13 ha (25.4%) is protected within DBCA managed land.</p> <p>Whilst Astron (2020) reported that the Jarrah Woodland 2 vegetation type had similarities to the Banksia Woodland Threatened Ecological Community (TEC)/Priority Ecological Community (PEC) (FCT 28 and FCT24), the vegetation was found to be non-representative of this TEC/PEC. This was due to the vegetation being in 'Degraded' to 'Completely Degraded' condition and having small patch sizes. One Priority flora species, <i>Grevillea olivacea</i> (P4) was recorded within the Proposal area (Astron 2020). This individual was considered to have been established via seed mix during previous works within the Proposal area. This is due to the natural range of <i>G. olivacea</i> being approximately 120 km north of the Proposal area, and the species being commonly used in horticulture in the Metropolitan region.</p> <p>Astron (2020) observed the presence of three conservation significant fauna species within the survey area, including the Forest Red-tailed Black Cockatoo (foraging evidence), Carnaby's Cockatoo (foraging individuals), and Quenda (roadkill and diggings).</p> <p>The Proposal area is within the known distribution range of the Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo, but outside of the modelled breeding range of Carnaby's Cockatoo. A total of 3.02 ha of remnant native vegetation that is potentially suitable foraging habitat for Black Cockatoo species was recorded by Astron (2020) in the current Proposal area. The area was found unlikely to support quality foraging habitat under the referral guidelines (DSEWPac 2012) due to its highly degraded state and the sporadic, isolated distribution of known foraging species. However, it is noted that the presence of a known breeding site approximately 1 km away and potential breeding trees in close vicinity (Kirby 2020), increases the value of the foraging habitat proposed to be cleared.</p> <p>There are 107 suitable DBH (>500 mm) trees located within the proposed native vegetation clearing area (Astron 2020), of which two contain potentially suitable hollows (Kirby 2020). All suitable DBH trees identified by Astron (2020) were inspected by Tony Kirby with two trees of interest (Tree ID 190, 290) occurring within the proposed</p>	

PRINCIPLE	ASSESSMENT	OUTCOME
	<p>clearing area. The trees were found to have potentially suitable hollows for Black Cockatoo use, with chew marks at the entrance. While chew marks were observed, it was not possible to confirm usage even after investigation with pole and camera. In personal communication, Kirkby stated that the hollows could be occupied by either Galah (<i>Cacatua roseicapilla</i>) or Little Corella (<i>Cacatua sanguinea</i>).</p> <p>Assessment Outcome: While overall biodiversity values of the Proposal area are low, with Completely Degraded condition and the presence of similar remnant vegetation and fauna habitat in the local area, the presence of Tuart TEC and Black Cockatoo habitat increase its significance. The clearing of the small area of remnant vegetation may be at variance to this principle.</p>	
<p>b Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.</p>	<p>Native vegetation contained within the Proposal area is predominantly (1.68 ha; 55.6%) in 'Completely Degraded' condition, and is separated from surrounding habitat patches by roads, pathways and residential land use. As such, the vegetation to be cleared is not considered likely to provide significant habitat for most fauna species in the local area, however does contain specific value important for the Carnaby's Cockatoo (<i>Calyptorhynchus latirostris</i>), Forest red-tailed Black Cockatoo (<i>Calyptorhynchus banksii naso</i>) and Quenda (<i>Isodon fusciventer</i>).</p> <p>Black Cockatoos</p> <p>The Proposal area falls within the known distribution range of the Carnaby's Cockatoo and Forest Red-tailed Black Cockatoos, but outside of the modelled breeding range of Carnaby's Cockatoo (DSEWPac 2012). Individuals of Carnaby's Cockatoo were recorded within the survey area (Astron 2020), while Kirkby (2020) recorded foraging residue associated with Carnaby's Cockatoo from Marri and banksia.</p> <p>Within the local area approximately 290 ha of suitable foraging habitat exists within conservation reserves, in close proximity to the Proposal area (less than 5 km) with Woodvale Nature Reserve immediately adjacent to the Proposal area. These reserves, listed below, are considered to provide significantly higher quality habitat for Black Cockatoos:</p> <ul style="list-style-type: none"> • Hepburn Heights Conservation area (20 ha). • Shepherds Bushland Reserve (20 ha). • Craigie Open Space (Bushland) (215 ha). • Woodvale Nature Reserve (35 ha). • Joondalup Regional Park (19.0 ha). 	<p>Likely to be at variance to this Principle.</p>

PRINCIPLE	ASSESSMENT	OUTCOME
	<p>Within the proposed clearing area, habitat suitable for Carnaby's Cockatoo and Forest Red-tailed Black Cockatoos comprises of 3.02 ha and 0.62 ha of potentially suitable foraging habitat respectively and 107 suitable DBH trees, two of which contain hollows suitable for Black Cockatoos (Kirkby 2020). All suitable DBH trees were inspected by Tony Kirby with two trees of interest (Tree ID 190, 290) occurring within the clearing area and additional tree of interest (Tree ID 103) adjacent to the Proposal area. Trees 190 and 290 contain single hollows suitable for Black Cockatoos, both with chew marks at the entrance. While chew marks were observed, it was not possible to confirm usage even after investigation with pole and camera. In personal communication, Kirkby stated that the hollows could be occupied by either Galah (<i>Cacatua roseicapilla</i>) or Little Corella (<i>Cacatua sanguinea</i>). Tree 103 has a small hollow with a chewed entrance but is probably not a Black Cockatoo breeding hollow (Kirkby 2020).</p> <p>While the Proposal area comprises suitable foraging species and potential breeding habitat, the quality of this habitat is 'Low' (Astron 2020) and is outside of the modelled breeding range for Carnaby's Cockatoo, with no evidence of current or historic breeding observed (Astron 2020). However, Kirkby (2020) noted that Carnaby's Cockatoo is known to breed at the Edith Cowan University Campus, approximately 1 km east of the north section of the Proposal area. At this site, 8-9 pairs breed each year, utilising a mix of natural and artificial hollows. Kirkby (2020) notes that the closest known breeding site for Forest Red-tailed Black Cockatoo is approximately 30 km northeast in the Darling Range. Given the presence of breeding Carnaby's Cockatoos nearby, the vegetation, though not in pristine condition may provide foraging habitat for these breeding birds (Kirkby 2020). Research satellite tracking data of Black Cockatoos from Murdoch University indicates that the general area surrounding the Proposal area is an occasional transit corridor for Carnaby's Cockatoo (J. Shephard 2020, per comms, 7 October). However, the data suggests that individuals are frequently utilising habitat north of the Proposal area within Neerabup National Park where higher quality foraging habitat exists, with occasional trips transiting the area surrounding the Proposal area. This indicates a preference for higher quality foraging habitat north of the Proposal area, which is more likely to support the Carnaby's breeding individuals at Edith University Campus.</p> <p>Within 6 km and 12 km of the Proposal area, there is approximately 1,511 ha and 6,454.9 ha of potential foraging habitat (DBCA 2020). Clearing of potential foraging habitat as a result of the Proposal represents 0.19% and 0.04% respectively of the foraging habitat within 6 and 12 km of the Proposal area. With regards to roosting, the nearest confirmed roost for Carnaby's Cockatoo is approximately 1 km to the west and for Forest Red-tailed Black Cockatoo approximately 6 km to the south of the Proposal area. No evidence of roosting within the Proposal area was recorded and is unlikely to occur. Within the Perth-Peel region, foraging and water resources within 6 km, as</p>	

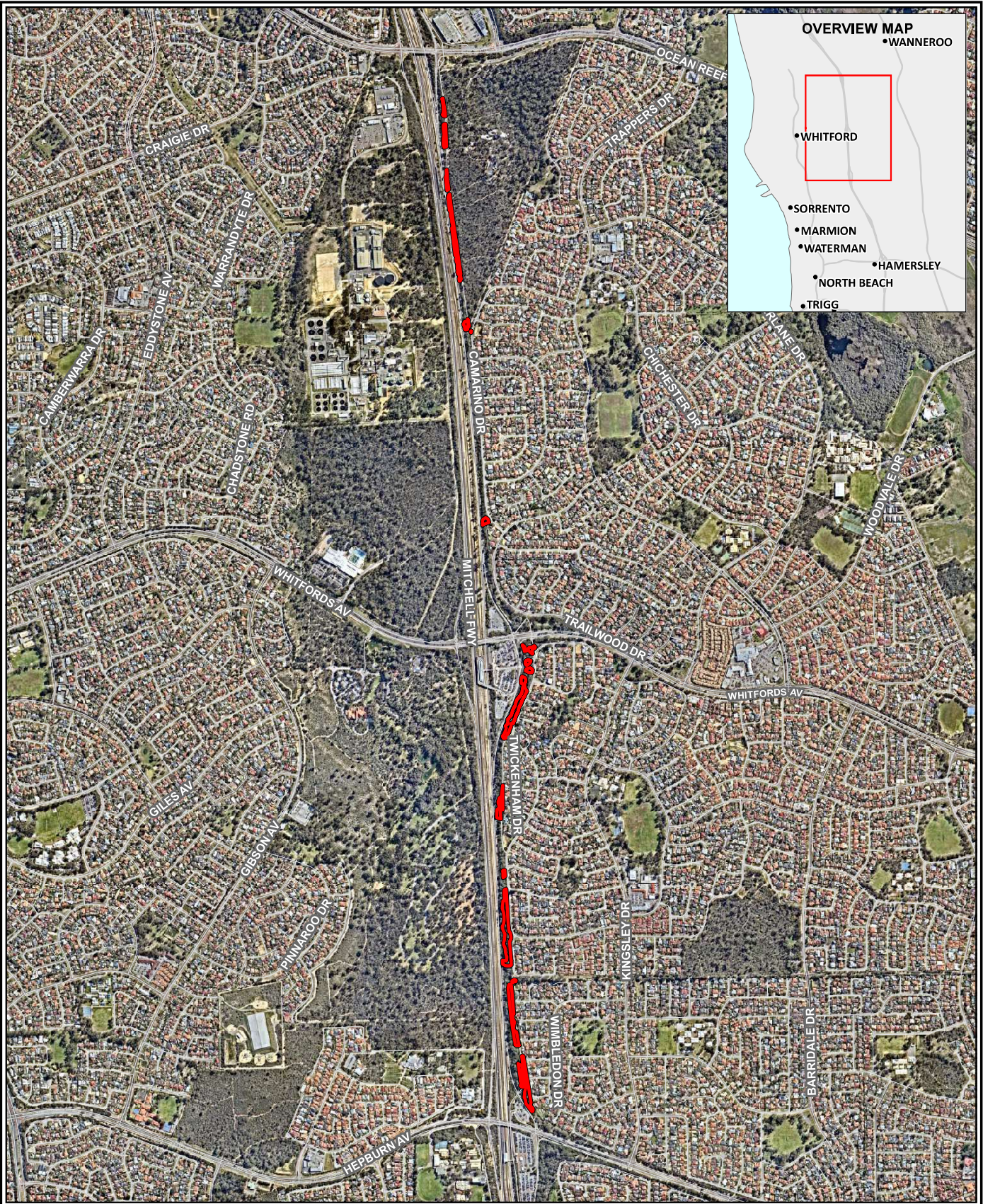
PRINCIPLE	ASSESSMENT	OUTCOME
	<p>well as overlapping foraging within 12 km, are required to support roosting and breeding sites and maintain habitat connectivity so that movement can be facilitated through the landscape (EPA 2019). Within the local area, there are a number of habitat patches that are considered likely to provide higher quality foraging habitat and are associated with water bodies. For this reason, the Proposal area is considered of poorer habitat value within the context of the local area.</p> <p>Flocks of Black Cockatoos move through the landscape by following vegetated corridors whilst actively avoiding cleared or open areas including dense urban areas. Ecological linkages are therefore required to facilitate this movement between habitat nodes. The Proposal area is located within a Regional Ecological Linkage and 'Conceptual' Gnaragara Mound Ecological Linkage within the City of Joondalup.</p> <p>Given the disturbance caused by the existing Mitchell Freeway, and maintenance of the ecological linkage to the east and west through Woodvale Nature Reserve, Craigie Bushland and Hepburn Heights Conservation area, the proposed clearing is considered unlikely to have a significant impact on the available foraging habitat within 6 km of nearby roosting sites or impede the movement of individuals through the landscape. However, in recognition of the close proximity (within 1 km) of foraging habitat to a known breeding site, the significance of this foraging habitat is increased. As a result, clearing is likely to be at variance to this principle.</p> <p>Other Significant Species</p> <p>The Quenda was identified within the Astron (2020) survey area (roadkill and diggings), however was outside of the Proposal area within planted vegetation (Astron 2020). This record is expected to form part of a population within Woodvale Nature Reserve. Whilst individuals may be found within vegetation within road reserves, it is considered unlikely that the small area of vegetation to be cleared as a result of the Proposal constitutes significant habitat for the species. Quenda are more likely to inhabit larger pockets of native vegetation associated with the reserves listed above. Furthermore, given the existing alignment of Mitchell Freeway, the additional clearing for the Proposal is unlikely to constitute a significant increase in impact to the Quenda.</p> <p>Assessed Outcome: Although the proposed small and degraded clearing area is unlikely to provide significant habitat for most native fauna in the local context, it does contain habitat potentially significant for Carnaby's Cockatoo. Therefore, clearing for this Proposal is likely to be at variance to this principle.</p>	



1.5 Residual Impacts Associated with Specific Clearing Principles

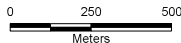
The residual impacts associated with the Proposal include the loss of 3.02 ha of native vegetation. Native vegetation was mainly in Completely Degraded (56%) and Degraded to Completely Degraded (37%) condition, with sections of Degraded (6%) and Good (2%) condition vegetation. This reflects on the high levels of disturbance of the site, which is located adjacent to the Mitchell Freeway within the road reserve.


Clearing impacts will include the loss of up to:

- 3.02 ha of native vegetation in Completely Degraded to Good condition
- 2.93 ha of Tuart Woodlands TEC (also representing the EPBC listed Tuart Woodlands and Forests of the Swan Coastal Plain TEC)
- 3.02 ha of foraging habitat for Black Cockatoos, as well as 107 suitable DBH trees



Legend:
 Proposal area
 Local and regional roads

Scale 1:22,000 at A4 
 Meters

Coord. Sys. GDA 1994 MGA Zone 50 

Job No: 58540

Client: Main Roads

Version: A Date: 27-Oct-2020

**Mitchell Freeway
Perth, WA**

PROPOSAL AREA

FIGURE 1



2 OFFSET PROPOSAL REQUIREMENTS

Main Roads has pursued a number of options in developing a package of offsets to counterbalance residual impacts. The options investigated have comprised acquisition of land and the installation of artificial hollows. The proposed offset site will address the requirement for more than one offset attribute, including provision of Tuart PEC and habitat for Black Cockatoos.

Table 2 provides an overview of the offset package under consideration, with the offset property location (Offset 1) presented in Figure 2.

Table 2. Overview of proposed offset package

NO.	OFFSET TYPE	OFFSET SUMMARY	PROPERTY LOCATION	EXISTING TENURE
1	Land Acquisition	29 ha of existing native vegetation providing: <ul style="list-style-type: none"> • Tuart PEC • Black Cockatoo habitat 	Preston Beach Road	DBCA managed freehold land owned by the State of WA
2	Installation of Artificial Hollows	Four artificial hollows providing nesting habitat for Black Cockatoos	To be determined in consultation with DBCA	TBD

2.1 Offset guide inputs and justification

The EPBC offset calculator tool was used to evaluate impacts from the Proposed Action to MNES. Appendix A provides a summary of the calculations used to offset impacts to Tuart Woodlands TEC and Black Cockatoos and the offset calculator inputs are provided in Appendix B.

2.2 Summary of Offsets Proposed

Offset 1 – Lake Clifton Property Acquisition

The principle offset for the Proposal relates to residual impacts to the Tuart Woodlands and of the Swan Coastal Plain Priority Ecological Community (PEC) (Priority 3) and Black Cockatoo Habitat. The offsets calculation has determined that 12 ha of land is required to offset this residual impact for the NVCP. While only 12 ha is required to offset the NVCP, a total of 29 ha of native vegetation will be offset for this Proposal to meet the requirements of the EBPC Act approval.

For the purposes of providing an offset for this Proposal, a portion of previously acquired land within a 1000 ha property located on Preston Beach Road, Lake Clifton (Lake Clifton site) (Figure 2) will be used to offset impacts from this Proposal. This land parcel has already been transferred to the Department of Biodiversity, Conservation and Attractions (DBCA). Not all of the land within the Lake Clifton site has been utilised as an offset, with some land banked for future offsets. Main Roads proposes to use 29 ha of vegetation within the Lake Clifton site (Proposed offset area) to offset impacts from the Proposal for the NVCP. The vegetation within the Proposed offset area contains vegetation representative of the Tuart PEC and habitat for Carnaby's Cockatoo and FRTBC. At the Lake Clifton Site, a biological survey, which included a Black Cockatoo assessment was conducted by AECOM in 2016 (Appendix C) and an additional targeted Tuart woodlands survey was conducted by AECOM in 2020 (Appendix D).

The AECOM (2020) assessment identified approximately 135 ha of vegetation community 'AfXpHh' described as "*Agonis flexuosa* and *Eucalyptus gomphocephala* over *Xanthorrhoea preissii*, *Hakea lissocarpa* and *Hardenbergia comptoniana* low to tall open shrubland over **Hypochaeris glabra* and **Lysimachia arvensis* low sparse forbland" within the Lake Clifton site. The vegetation community is in 'Excellent' condition (AECOM 2020) and is representative of the state listed Tuart Woodlands PEC and the federally listed Tuart Woodlands (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain Threatened Ecological Community (Tuart Woodlands TEC). The area of Tuart Woodlands PEC within the Proposed Offset Area is in 'Very High' condition (AECOM 2020), as per the condition criteria in the Conservation Advice for the TEC (DotEE 2019).

The Proposed offset area also contains foraging habitat for Carnaby's Cockatoo in vegetation types 'AfXpHh' and 'MsTd' and foraging habitat for FRTBC in vegetation type 'MsTd'. Vegetation community 'MsTd' is described as "mid to tall heathland to closed heathland of *Melaleuca systema*, *Hibbertia cuneiformis* and *Templetonia retusa* over **Trachyandra divaricata*, **Hypochaeris glabra* and **Arctotheca calendula* low forbland. AECOM (2016) identified this community as containing up to 10% of *Hakea* species which are foraging species for FRTBC (Johnstone 2011).

Vegetation community 'AfXpHh' was classed as 'Valued' breeding habitat. Valued breeding habitat was defined as habitat that contained scattered Tuarts (DBH >500mm and potentially suitable breeding hollows) at a moderate density across a vegetation unit. Approximately 500 potential breeding trees are estimated to be within the Proposed offset area (AECOM 2016). AECOM (2016) also noted that there is a confirmed Carnaby's Cockatoo breeding site approximately 3 km to east of the Lake Clifton site.

Main Roads proposes to allocate 29 ha of vegetation in 'Excellent' condition from vegetation communities 'AfXpHh' and 'MsTd', containing approximately 500 potential breeding trees to offset 2.93 ha of impact to the Tuart PEC and 3.02 ha of impact to Black Cockatoos (Figure 2).

Offset 2 – Installation of Artificial Hollows

Main Roads proposes to install four artificial hollows to offset the significant residual impact to two suitable hollows for Black Cockatoo nesting. The hollows will be installed at a site suitable for Black Cockatoo breeding, on land vested with DBCA, with the location determined in consultation with DBCA. Initial consultation with DBCA has commenced and DBCA is currently proposing a site in the Moora district, in proximity to an existing breed site. DBCA has advised that it does not support the installation of artificial hollows in the Metropolitan region. The design and placement of the artificial hollows will be based on DBCA's guidelines for installing Black Cockatoo hollows (DPaW 2015). Main Roads will monitor and maintain the installed artificial hollows for a period of ten years.

Installation

Main Roads is intending to procure and install artificial hollows known as Cockatubes. These are constructed by Landcare and the current design has been developed over a period of 10 years with the assistance of DBCA and the Western Australian Museum. Cockatubes are used extensively throughout the south west of Western Australia, including ones that have been installed by Main Roads along the Great Northern Highway in the Bindoon area. Recent monitoring of the hollows show they have been used successfully for breeding (Johnstone et al 2010; Phoenix Environmental Sciences 2020).

Appropriate trees will be identified by taking in to consideration the following parameters:

- Trees should be within DBCA-managed land to facilitate ease of access for monitoring and maintenance
- Located in proximity to an existing nesting hollow
- Located within or adjacent to foraging habitat
- Located in proximity to water
- Trees should be mature and well shaded
- Trees should be accessible with a cherry picker, without requiring additional disturbance, to allow installation of the artificial hollows.

Monitoring

The artificial hollows will be surveyed in September / October each year to coincide with the peak breeding season for Carnaby's Cockatoos. The first survey will occur during the breeding season following the installation of artificial hollows. Surveys will be undertaken by a suitably qualified person. Surveys will identify:

- If hollows are currently in use or show evidence of previous use
- Maintenance requirements for artificial hollows
- If hollows are no longer to be used by Carnaby's Cockatoos, for example if they have been invaded by feral bees.

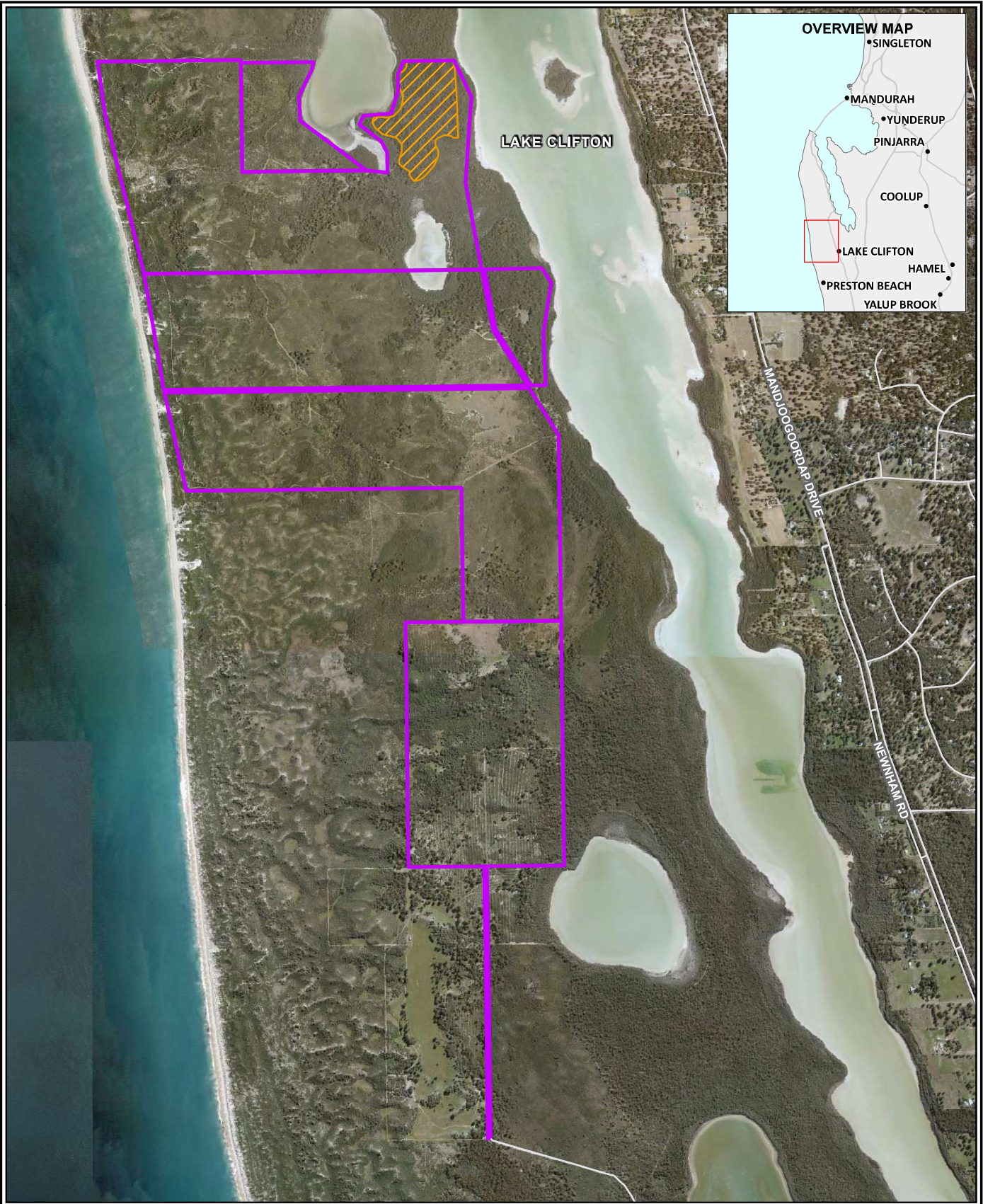
The results of the monitoring surveys will be provided to DBCA in order to contribute to broader research into the species.

Maintenance

Maintenance of artificial hollows will be scheduled outside of the breeding season. Maintenance may include:

- Replacement of sacrificial chewing post
- Replacement/repair of attachment points
- Repairs to the base of hollows

- Repairs of cracks in the artificial hollow. If cracks form that are too large to be repaired, the hollow may need to be replaced
- Removal of pest species, such as feral bees.



Legend:

- Lake Clifton Site
- Offset 1 – Proposed Offset Area
- Local and regional roads

Scale 1:35,152 at A4 0 250 500
Meters

Coord. Sys. GDA 1994 MGA Zone 50 ↑

Job No: 58540

Client: Main Roads

Version: A Date: 16-Feb-2021

Mitchell Freeway Principal Shared Path Gaps Project (Ocean Reef Road to Hepburn Avenue)

PROPOSED OFFSET SITE

FIGURE 2



3 COUNTERBALANCE OF SIGNIFICANT RESIDUAL IMPACTS

The EPBC Offset Calculator Tool was used to evaluate Proposal impacts for biodiversity clearing principles (Principles a and b) with significant residual impacts in accordance with the requirements of the WA Environmental Offsets Guidelines (GoWA 2014). Table 3 provides a summary of the offset package calculations which counterbalance the significant impacts to Tuart PEC and Black Cockatoos (for Principles a and b).

As presented in Table 3, the offset package is expected to provide adequate compensation for significant residual impacts to Tuart PEC and Black Cockatoos. The offset package for the NVCP exceeds the requirements of a 7 ha offset required for Tuart PEC and 12 ha offset required for Black Cockatoos. The areas required to be offset are larger for the Commonwealth process, as the Tuart PEC (Tuart TEC at the Commonwealth level) extends into planted vegetation in the Proposal area.

Table 3. Summary of residual impacts, offset type, size of offset and percentage of residual impact offset

RESIDUAL IMPACT	DETAILS	TEMPORARY CLEARING REVEGETATION	RESIDUAL IMPACT (HA)	OFFSET TYPE	NVCP OFFSET REQUIRED (HA)	TOTAL OFFSET (HA)	% OF RESIDUAL IMPACT OFFSET
1	Loss of high biodiversity vegetation (Principle a)	<ul style="list-style-type: none"> 3.02 ha of vegetation ranging from Completely Degraded to Good condition 2.93 ha of Tuart PEC 	3.02 ha (2.93 ha Tuart PEC)	Land acquisition	7 ha	29 ha	429.10%
2	Loss of habitat necessary for the maintenance of indigenous fauna (Principle b)	<ul style="list-style-type: none"> 3.02 ha of foraging habitat for Carnaby's Cockatoo and 0.63 ha of Forest Red-tailed Black Cockatoo, as well as 107 Suitable DBH trees, with two potentially suitable breeding hollows 	3.02 ha	Land acquisition and installation of artificial hollows	12 ha	29 ha	260.23%

4 APPLICATION OF ENVIRONMENTAL OFFSET POLICY PRINCIPLES

The Western Australian Offsets Policy (GoWA 2011) states that environmental offsets are to be used as a last resort, and details six principles to be applied in the assessment and decision making with respect to offset.

The application of the environmental offset policy principles to the Offset Proposal is provided in Table 4.

Table 4. Application of the WA Environmental Offset Policy Principles to the Offset Proposal

PRINCIPLE No.	PRINCIPLE	COMMENT
1.	Environmental offsets will only be considered after avoidance and mitigation options have been pursued.	<p>All strategies to avoid and mitigate environmental impacts have been explored and implemented, including the following:</p> <ul style="list-style-type: none"> • The Proposal has been designed within the existing road reserve to avoid higher quality vegetation in adjacent Nature Reserves • The Proposal has been designed to avoid native vegetation in Good or better condition where possible <p>The following will be considered during the Proposal design:</p> <ul style="list-style-type: none"> • Steepening of barriers to ensure that clearing does not extend outside of the Proposal footprint • Widening of the on-ramps will utilise previously disturbed verges. • Cleared areas to be used for access tracks, construction storage and stockpiling <p>The existing PSP will be upgraded in-situ rather than being relocated.</p>
2.	Environmental offsets are not appropriate for all proposals.	Environmental offsets are considered an appropriate form of mitigation for biological impacts including the clearing of native vegetation.
3.	Environmental Offsets will be cost effective, as well as relevant and proportionate to the significance of the environmental value being impacted.	Main Roads believes that the proposed offset represents a cost-effective solution that is relevant and proportionate to the environmental value being impacted by the Proposal. The area of land purchased for an offset at Lake Clifton has been adequately surveyed and contains environmental values that are equal or of higher value than the vegetation proposed to be cleared within the Proposal footprint.
4.	Environmental offsets will be based on sound environmental information and knowledge.	The Lake Clifton site has been adequately surveyed. The selection and management of the land purchased has been based on sound environmental information and knowledge.
5.	Environmental offsets will be applied within a framework of adaptive management.	The land to be used for this offset has been added to the conservation estate and will continue to be managed within an adaptive management framework utilising the State's environmental knowledge and understanding.

PRINCIPLE No.	PRINCIPLE	COMMENT
6.	Environmental offsets will be focussed on longer term strategic outcomes.	Land acquired by Main Roads, to be used as an offset for the Proposal, has been added to the conservation estate. The Lake Clifton offset property closes a 'gap' in the Yalgorup National Park and protects the western boundary of Lake Clifton and its stromalite TEC from adverse development in perpetuity.

5 REFERENCES

AECOM (2016). Biological Assessments of Lot 1000, 2240, 2275, 2657 and 3045 Preston Beach Road Lake Clifton. Unpublished report for Main Roads Western Australia.

AECOM (2020). Targeted Tuart Woodlands TEC Survey, Lake Clifton. Unpublished report prepared for Main Roads Western Australia.

Astron (2020). Mitchell Freeway Widening Biological Survey. Unpublished report by Astron Environmental Pty Ltd for Main Roads Western Australia.

Department of Environment Regulation (DER) (2014). A Guide to the Assessment of Applications to Clear Native Vegetation. Government of Western Australia, Perth.

Department of Parks and Wildlife (DPaW) (2015). Fauna notes: Artificial hollows for Carnaby's Cockatoos. Government of Western Australia.

Department of Sustainability, Environment, Water, Populations and Communities (DSEWPaC) (2012). EPBC Act referral guidelines for three Black Cockatoo species, Carnaby's cockatoo (*Calyptorhynchus latirostris*), Baudin's cockatoo (*Calyptorhynchus baudinii*) and the Forest Red-tailed black cockatoo (*Calyptorhynchus banksii naso*). Available from: <https://www.environment.gov.au/system/files/resources/895d4094-af63-4dd3-8dffad2b9b943312/files/referral-guidelines-wa-black-cockatoo.pdf>.

Environmental Protection Authority (EPA) (2019). EPA Technical Report: Carnaby's Cockatoo in Environmental Impact Assessment in the Perth and Peel Region – Advice of the Environmental Protection Authority under Section 16(j) of the Environmental Protection Act 1986. EPA, Perth.

Government of Western Australia (GoWA) (2011). (WA Environmental Offset Policy (September 2011). Perth, WA. Available online: <http://www.epa.wa.gov.au/EPADocLib/WAEnvOffsetsPolicy-270911.pdf>

Johnstone, R. E. (2011). Black Cockatoos on the Swan Coastal Plain. Western Australia: Department of Planning.

Johnstone, RE, Johnstone, C & Kirkby, T (2010). Carnaby's Cockatoo nest box monitoring, Bindoon region 2009-2010, unpublished report prepared for Access Alliance/Main Roads Western Australia, Perth.

Kirby, T (2020). Black Cockatoo Breeding, Feeding and Roosting Habitat Assessment, Mitchell Freeway. Prepared for Main Roads Western Australia.

Phoenix Environmental Sciences (2020). Black Cockatoo breeding activity census 2019-2020 for Muchea North Great Northern Highway, Muchea to Wubin Upgrade Stage 2 Project, unpublished memorandum prepared for the GNH IPT, Phoenix Environmental Sciences Pty Ltd, Perth.

6 APPENDICES

Appendix	Title
Appendix A	Offset Calculation Values
Appendix B	EPBC Offset Calculator Tool Worksheets
Appendix C	AECOM (2016) Lake Clifton Biological Survey
Appendix D	AECOM (2020) Lake Clifton Tuart TEC Assessment

Appendix A: Offset Calculations

Values that were input into the EPBC Calculator Tool – Residual Impact to Clearing Principle a:

ATTRIBUTE	VALUE	JUSTIFICATION
Area of community/habitat impacted	2.93 ha	Total amount of native PEC clearing required for the Proposal.
Vegetation/Habitat quality of the impacted area	3	<p>An overall quality score was obtained by weighting the vegetation condition across the Proposal area:</p> <ul style="list-style-type: none"> • Pristine: score 10 – 0% of PEC area • Excellent: score 9 – 0% of PEC area • Excellent – Very Good: score 8 – 0% of the PEC area • Very Good: score 7 – 0% of PEC • Very Good - Good: score 6 – 0% of the PEC area • Good: score 5 - 2% of the PEC area • Good – Degraded: score 4 – 0% of the PEC area • Degraded: score 3 – 6% of the PEC area • Degraded – Completely Degraded: score 2 – 38% of the PEC area • Completely Degraded: score 1 – 54% of the PEC area <p>The PEC ranges from Completely Degraded to Good condition. The majority of the PEC impacted is in Completely Degraded condition. A weighted score of 2 was identified.</p>
Start quality Vegetation/habitat Quality of the offset area (takes into account the regional context and stocking rate)	9	Rating for excellent condition vegetation based on Keighery (1994). The land purchased with funds provided under s51i (2b) of the EP Act (1986) has been mapped by AECOM (2016) as Excellent condition.
Future Quality without offset	8	Quality of land could decline if not purchased as an offset.
Future Quality with Offset	9	Acquisition only, therefore no change is expected in future quality
Time Horizon over which loss is averted (security of land tenure)	20 years	Land purchased with financial contributions has been added to the conservation estate so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	1 year	Short time frame as land has already been purchased and placed into the conservation estate.
Risk of loss without offset	30%	Moderate risk of loss.
Risk of loss with offset	10%	Minimal risk. Offset placed into secure tenure managed by the State (i.e. conservation estate). Ten percent allows for ongoing management of the offset site.

ATTRIBUTE	VALUE	JUSTIFICATION
Confidence in result	90%	High degree of confidence. Land purchased has been added to the conservation estate through a State guaranteed scheme.
Hectares of offset required	7 ha	-
Percentage of impact offset	429.10%	-

Values that were input into the EPBC Calculator Tool – Residual Impact to Clearing Principle b:

ATTRIBUTE	VALUE	JUSTIFICATION
Area of community/habitat impacted	3.02 ha	3.02 ha of foraging habitat for Black Cockatoos was applied to this factor. It is assumed that Black Cockatoo habitat is also representative of habitat for other conservation significant species.
Vegetation/Habitat quality of the impacted area	3	<p>An overall quality score was obtained by considering habitat quality across the Proposal area, taking into account site condition, site context and species stocking rate.</p> <p>Site condition</p> <ul style="list-style-type: none"> • Pristine: score 10 – 0% of Black Cockatoo habitat area • Excellent: score 9 – 0% of Black Cockatoo habitat area • Excellent – Very Good: score 8 – 0% of Black Cockatoo habitat area • Very Good: score 7 – 0% of Black Cockatoo habitat area • Very Good - Good: score 6 – 0% of the Black Cockatoo habitat area • Good: score 5 - 2% of Black Cockatoo habitat area • Good – Degraded: score 4 – 0% of Black Cockatoo habitat area • Degraded: score 3 – 6% of Black Cockatoo habitat area • Degraded – Completely Degraded: score 2 – 37% of Black Cockatoo habitat area • Completely Degraded: score 1 – 56% of Black Cockatoo habitat area <p>A weighted score of 2 was identified.</p> <p>Site context</p> <p>A moderate score was applied to reflect the location of the Proposal, along the edge of the road within a road reserve. The Proposal area has been subject to degradation through edge effects and large areas of the habitat were historically cleared as part of the Mitchell Freeway construction in the 1980’s. Astron (2020) identified that the natural flora assemblage in the DE has been altered to an extent that there is a reduced number and quality of foraging species for Black Cockatoos. Higher quality habitat exists adjacent to the Proposal area in reserves such as Woodvale Nature Reserve.</p> <p>The Proposal represents approximately 0.19% of Black Cockatoo habitat remaining within 6 km of the Proposal area (estimated to be 1,511 ha).</p> <p>A Carnaby’s Cockatoo breeding site exists approximately 1 km north of the Proposal area.</p> <p>A score of 4 was applied to reflect this context.</p> <p>Stocking rate</p> <p>A moderate score is provided as the Proposal area is known to support foraging and occupation by the species, but has an absence of actual breeding and roosting evidence. While a Carnaby’s Cockatoo breeding site exists approximately 1 km</p>

ATTRIBUTE	VALUE	JUSTIFICATION
		<p>north of the Proposal area, the Proposal is expected to have a minor role in sustaining the overall species population viability as the species forages and migrates across the Swan Coastal Plain each year.</p> <p>The score reflects the presence of 3.02 ha of foraging habitat and 107 trees with two potentially suitable hollows.</p> <p>A Carnaby's Cockatoo breeding site exists approximately 1 km north of the Proposal area. A score of 3 was applied.</p> <p>An average score of 3 was obtained for habitat quality.</p>
Start quality Vegetation/habitat Quality of the offset area (takes into account the regional context and stocking rate)	8	Rating for excellent condition vegetation based on Keighery (1994) and 'Valued' breeding habitat mapping by AECOM (2016). The land purchased with funds provided under s51i (2b) of the EP Act (1986) has been mapped by AECOM (2016) as 'Valued' breeding habitat and is in 'Excellent' condition.
Future Quality without offset	7	Quality of the land could decline if not purchased as an offset.
Future Quality with Offset	8	Acquisition only, therefore no change is expected in future quality.
Time Horizon over which loss is averted (security of land tenure)	20 years	Land purchased with financial contributions has been added to the conservation estate so long term protection is afforded. Twenty years is the maximum value that can be input.
Time until ecological benefit	1 year	Short time frame as land has already been purchased and placed into the conservation estate.
Risk of loss without offset	30%	Moderate risk of loss.
Risk of loss with offset	10%	Minimal risk. Offset placed into secure tenure managed by the State (i.e. conservation estate). Ten percent allows for ongoing management of the offset site.
Confidence in result	90%	High degree of confidence. Land purchased has been added to the conservation estate through a State guaranteed scheme.
Hectares of offset required	12 ha	-
Percentage of impact offset	260.23%	-

Appendix B: EPBC Offset Calculator Tool Worksheets

Appendix C: AECOM (2016) Lake Clifton Biological Survey

Biological Assessments Lot 1000, 2240, 2275, 2657 & 3045 Preston Beach Road Lake Clifton

Biological Assessments Lot 1000, 2240, 2275, 2657 & 3045 Preston Beach Road Lake Clifton

Client: Main Roads Western Australia



26-Sep-2016

Job No.: 60100953

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

© AECOM Australia Pty Ltd (AECOM). All rights reserved.

AECOM has prepared this document for the sole use of the Client and for a specific purpose, each as expressly stated in the document. No other party should rely on this document without the prior written consent of AECOM. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. This document has been prepared based on the Client's description of its requirements and AECOM's experience, having regard to assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified. Subject to the above conditions, this document may be transmitted, reproduced or disseminated only in its entirety.

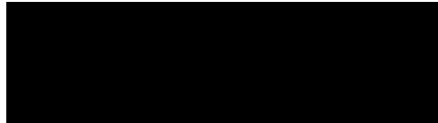
Quality Information

Document Biological Assessments Lot 1000, 2240, 2275, 2657 & 3045 Preston
Beach Road Lake Clifton

Ref 60100953

Date 26-Sep-2016

Prepared by



Reviewed by

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	28-Jul-2016	Draft for Internal Review		
B	29-Jul-2016	Draft for Client Review		
C	08-Aug-2016	Revised Draft for Internal Review		
E	19-Aug-2016	Re-issued to Client for Review		
0	20-Sep-2016	Final for Client Issue		
1	25-Oct-2016	Final with client comments		

Table of Contents

Executive Summary		i
1.0	Introduction	1
	1.1 Background and scope	1
	1.2 Location	1
2.0	Legislative Framework	3
	2.1 Overview	3
3.0	Existing Environment	4
	3.1 Climate	4
	3.2 IBRA region	4
	3.3 Vegetation	5
	3.3.1 Pre-European vegetation	5
	3.4 Wetlands	5
	3.4.1 Ramsar site	5
	3.4.2 Geomorphic Wetlands of the Swan Coastal Plain	6
	3.5 Conservation estates, Bush Forever and Environmentally Sensitive Areas	6
4.0	Methodology	9
	4.1 Desktop assessment	9
	4.1.1 Previous surveys	9
	4.2 Flora and vegetation assessment	10
	4.3 Fauna assessment	11
	4.3.1 Fauna habitats	12
	4.4 Black Cockatoos	14
	4.4.1 Breeding habitat	14
	4.4.2 Roosting habitat	15
	4.4.3 Foraging habitat	15
	4.5 Wetlands	19
	4.5.1 Geomorphic Wetlands dataset of the Swan Coastal Plain	19
	4.5.2 Riparian vegetation	20
	4.6 Limitations	22
5.0	Desktop Results	26
	5.1 Threatened and Priority Ecological Communities	26
	5.1.1 Commonwealth	26
	5.1.1 State	26
	5.2 Threatened and Priority flora	29
	5.3 Threatened and Priority fauna	31
	5.4 Black Cockatoos	38
	5.4.1 Carnaby's Black Cockatoos	38
	5.4.2 Forest Red-tailed Black Cockatoos	38
	5.4.3 Baudin's Black Cockatoo	39
6.0	Field Results	40
	6.1 Vegetation	40
	6.1.1 Threatened and Priority Ecological Communities	40
	6.1.2 Commonwealth	40
	6.1.3 State	40
	6.1.4 Vegetation communities	40
	6.1.5 Condition	53
	6.2 Flora	55
	6.2.1 Threatened and Priority flora	55
	6.2.2 Diversity	55
	6.2.3 Weeds	56
	6.3 Fauna	58
	6.3.1 Fauna species	58
	6.3.2 Fauna habitat	58
	6.3.3 Black Cockatoos	67
	6.3.4 Black Cockatoo foraging habitat quality	69

	6.3.5	Breeding habitat	73
	6.3.6	Roosting sites	78
	6.3.7	Fauna habitat linkages	78
6.4		Wetlands	78
	6.4.1	Riparian vegetation	78
	6.4.2	Boundary mapping	79
7.0		References	80
Appendix A		Conservation Categories	A
Appendix B		Biosecurity and Agriculture Management Act 2007 Classifications	B
Appendix C		Curriculum Vitae for Botanists	C
Appendix D		Desktop Fauna Assessment	D
Appendix E		Vascular Flora Species by Community Recorded, Lake Clifton 2016	E
Appendix F		Lake Clifton Quadrat Data	F
Appendix G		Vascular Flora Species List, 2016	G
Appendix H		Weed Species and their Significance Recorded at Lake Clifton, 2016	H
Appendix I		Fauna Species Recorded during the Field Survey	I
Appendix J		Black Cockatoo Foraging Assessment	J
Appendix K		Black Cockatoo Trees Quadrat Raw Data	K
Appendix L		Lake Clifton Wetlands Assessment Forms	L

List of Plates

Plate 1	Conservation significant species from left to right: EPBC Act-listed Threatened <i>Eucalyptus argutifolia</i> ; Priority 3 <i>Stylidium maritimum</i>	56
Plate 2	Declared Pests from left to right: <i>Gomphocarpus fruticosus</i> , <i>Solanum linnaeanum</i> and <i>Zantedeschia aethiopica</i>	56
Plate 3	Weed invasion from top to bottom left to right: * <i>Trachyandra divaricata</i> invasion in cleared area; typical weed understorey of <i>Agonis flexuosa</i> woodlands; * <i>Solanum nigrum</i> juvenile with * <i>Lysimachia arvensis</i> .	57
Plate 4	Potential Ring-tailed Possum drey	64
Plate 5	Parrot Bush foraged on by Carnaby's Black Cockatoo	69
Plate 6	Invertebrate foraged from <i>Banksia</i> cone, most likely by Carnaby's Black Cockatoo	69
Plate 7	High quality Carnaby's Black Cockatoo foraging habitat	70
Plate 8	High quality Forest Red-tailed Black Cockatoo foraging habitat	71
Plate 9	High quality breeding habitat for Baudin's Black Cockatoo	74
Plate 10	Valued breeding habitat	77
Plate 11	Low quality breeding habitat	77

List of Tables

Table 1	Relevant legislation and regulations	3
Table 2	Beard (1981) vegetation types mapped within the Survey Area	5
Table 3	Heddle <i>et al.</i> (1980) vegetation complexes mapped within the Survey Area and the extent remaining using the Perth @ 3.5 million document (EPA, 2015)	5
Table 4	Wetlands within the Survey Area	6
Table 5	Categories of likelihood of occurrence for species and communities	9
Table 6	Bushland condition ratings (Keighery, 1994)	11
Table 7	Breeding habitat for the three Western Australian Threatened Black Cockatoo species	15
Table 8	Suitable roosting trees for the three Threatened Black Cockatoos	15
Table 9	Foraging species utilised by the three Western Australian Threatened Black Cockatoo species	16
Table 10	Black Cockatoo foraging assessment scoring	16
Table 11	Quality of foraging habitat assessment tool for the three Western Australian Threatened Black Cockatoo species	17
Table 12	Management Categories and Objectives for the Geomorphic Wetlands of the Swan Coastal Plain	19
Table 13	Condition classes for a detailed assessment of foreshore condition	20
Table 14	Limitations associated with the biological surveys	22
Table 15	Threatened and Priority Ecological Communities identified as occurring in the Study Area	26
Table 16	Desktop flora results showing species, conservation code (Commonwealth and State), habitat description and likelihood of occurrence	30
Table 17	Threatened Fauna species likely to occur within the Survey Area	32
Table 18	Vegetation communities	42
Table 19	Vegetation condition mapped within the Survey Area	53
Table 20	Declared Pests	57
Table 21	Conservation Significant Fauna Recorded during the Field Survey	59
Table 22	Fauna habitats of the Survey Area	65
Table 23	Carnaby's Black Cockatoo observations	67
Table 24	Potential Carnaby's Black Cockatoo foraging evidence	69
Table 25	Carnaby's Black Cockatoo foraging habitat	70
Table 26	Forest Red-tailed Black Cockatoo foraging habitat	71
Table 27	Black Cockatoo breeding habitat assessment	73

List of Figures

Figure 1	Survey Area	2
Figure 2	Rainfall graph, data obtained from Pinjarra Refinery Station 9891, BOM (2016)	4
Figure 3	Wetlands associated with the Survey Area	7
Figure 4	Conservation estates and ESAs	8
Figure 5	Fauna survey assessment locations	13
Figure 6	Foreshore condition assessment used to assess riparian vegetation condition	21
Figure 7	Desktop assessment results	28
Figure 8	Vegetation Communities	52
Figure 9	Vegetation Condition	54
Figure 10	Conservation significant fauna records and fauna habitat mapping	63
Figure 11	Potential foraging habitat and observations for Carnaby's Black Cockatoo	68
Figure 12	Potential foraging habitat for the Red-tailed Black Cockatoo	72
Figure 13	Potential foraging habitat for Baudin's Black Cockatoo	75
Figure 14	Potential breeding habitat for Black Cockatoos	76

Executive Summary

Main Roads Western Australia commissioned AECOM Australia Pty Ltd (AECOM) to undertake biological assessments for a proposed offset property. The objective of the assessment was to describe the environmental values associated with wetlands and riparian vegetation, flora and vegetation, fauna, and Black Cockatoo potential breeding, roosting and foraging habitat. To meet this objective, a Level 1 Flora and Vegetation Assessment, Level 1 Fauna Assessment, targeted Black Cockatoo Survey, and a Wetlands Assessment were undertaken.

A detailed desktop assessment was undertaken incorporating results (where relevant) from the Department of Parks and Wildlife (DPAW) database, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST) and historical surveys available in the public domain. One Threatened and four Priority Ecological Communities are known to occur within the Survey Area, one Commonwealth-listed Threatened flora species and one Priority 1 flora species are known to occur. Sixty three conservation significant fauna species could potentially occur. Of these 63 fauna species; 12 species are likely to occur, 31 species may occur and 20 species are unlikely to occur.

Field surveys were undertaken by two botanists and an ecologist in June 2016 over a ten-day period. Flora and vegetation data was captured at 63 relevés which informed the development of a vegetation map and vegetation condition map. The Level 1 fauna survey primarily focused on recording observations of fauna (particularly conservation significant species), which included evidence of fauna activity such as scats, tracks, burrows, foraging evidence and diggings. Microhabitat searches of leaf litter, bark, fallen logs and rocks were also conducted opportunistically when appropriate areas were located. Eleven microhabitat searches were conducted, and motion activated cameras were installed at five locations to observe fauna, particularly nocturnal fauna. Eighteen detailed habitat assessments were also completed. For Black Cockatoos, a breeding habitat assessment was conducted at 19 sites and foraging assessments were conducted across 35 sites. Roosting sites were assessed opportunistically when appropriate areas were located.

One State-listed Threatened Ecological Community (TEC) was recorded, as identified in the desktop assessment. This community is a State-listed ecological community known as 'SCP26a *Melaleuca huegelii-Melaleuca acerosa (systema)* Shrublands on Limestone Ridges and was recorded extensively. This TEC is represented by vegetation code MsTd and was recorded in predominantly 'Very Good' condition, extending over 202 ha.

Four Priority Ecological Communities (PECs) may occur within the Survey Area, including:

- SCP25 – Southern *Eucalyptus gomphocephala-Agonis flexuosa*
- SCP30b – Quindalup *E. gomphocephala* and/or *A. flexuosa* woodlands
- SCP29a – Coastal shrublands on shallow sands
- SCP29b – Acacia shrublands on taller dunes.

Quadrat data captured over multiple seasons would be required to accurately determine and define the presence of these PECs by undertaking data analysis to infer the appropriate Floristic Community Type.

One Threatened flora species listed under the EPBC Act, *Eucalyptus argutifolia* occurs within the Survey Area. The 2016 survey combined with previous surveys shows more than 200 individuals occur within three populations. Furthermore, the Priority 3 *Stylidium maritimum* occurs throughout the western sand dune vegetation community. This species has been previously extensively mapped with more than 2,800 individuals located.

Forty-two fauna species were recorded. This comprised 31 bird, eight mammal, one reptile and two amphibian species. Of the 42 fauna species, 11 species were of conservation significance and six were introduced fauna species. The European Wild Rabbit (*Oryctolagus cuniculus*) and the Red Fox (*Vulpes vulpes*) were both recorded and are listed as Declared Pests under the *Biosecurity and Agricultural Management Act 2007* (BAM Act).

Five fauna habitats (including Cleared Areas) have been defined and mapped. The most common fauna habitat was the mid to tall shrubland / heathland at approximately 57% of the Survey Area. This is a quite varied habitat that would generally support many of the common species of the area and would potentially also be utilised by many of the conservation significant fauna species recorded such as Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) and the Quenda (*Isoodon obesulus fusciventer*). The Survey Area provides an important and ecologically valuable linkage between the north and south sections of Yalgorup National Park, ensuring a contiguous corridor of habitat throughout this area.

The Black Cockatoo foraging assessments determined that the property contains approximately 632 ha of Carnaby's Black Cockatoo foraging habitat, approximately 214 ha of Forest Red-tailed Black Cockatoo foraging habitat and approximately 45 ha of Baudin's Black Cockatoo foraging habitat. Carnaby's Black Cockatoo was heard and / or observed five times during the field survey. They were observed either flying over, foraging on *Banksia sessilis* in the Survey Area, or heard in close proximity. The Project Area contains significant amounts of mature Tuarts, with approximately 294 ha of Black Cockatoo breeding habitat.

The Survey Area intersects four Conservation Category Wetlands, including a small portion of Lake Clifton and an unnamed wetland which represent the Harvey-Yalgorup Ramsar Site. One unnamed wetland is situated entirely within the Survey Area and includes water, riparian vegetation and adjacent fringing vegetation. A total of approximately 65 ha of Conservation Category Wetlands (CCW) was mapped. The field assessment showed that existing geomorphic wetlands of the Swan Coastal Plain mapping depict the accurate boundaries of all wetlands.

1.0 Introduction

1.1 Background and scope

Main Roads Western Australia (MRWA) required biological surveys for three defined areas to determine their suitability as offset sites for current and future projects. Three offset sites located on the Swan Coastal Plain south of Perth were defined and a suite of field surveys undertaken to assess the environmental values of the areas.


The Lake Clifton Survey Area (the Survey Area) was subject to ecological investigations including:

- Verifying whether existing information is still relevant and an accurate depiction of environmental values
- A Wetlands Assessment to verify and map Conservation Category Wetland (CCW) boundaries
- Mapping and assessment of Black Cockatoo foraging habitat
- Mapping of potential Black Cockatoo breeding and roosting trees
- Identification of areas requiring rehabilitation (addressed in the Land Acquisition Management Plan [LAMP]).

1.2 Location

The proposed offset property (the Survey Area) is situated on the border between the City of Mandurah and the Shire of Waroona, 110 km south of Perth in Western Australia. The Survey Area is bordered by Lake Clifton on the east, the foredunes and beach on the west, and by Yalgorup National Park on the north, east and south sides. The Survey Area is comprised of Lots 1000, 2240, 2275, 2657, and 3045 (Figure 1).



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY FDW LAST MODIFIED 19 AUG 2016</p>	<p>AECOM www.aecom.com</p> <p>LEGEND  Survey Area</p>	<p>Survey Area</p>	
<p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 380 760 1,140 1,520</p> <p>metres</p> <p>1:50,000 when printed at A4</p>	<p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Geotrapping, AerGRID, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>MAIN ROADS</p> <p>LAKE CLIFTON BIOLOGICAL ASSESSMENT</p>	<p>Figure</p> <p>1</p>

2.0 Legislative Framework

2.1 Overview

Table 1 summarises the key legislation governing the protection and management of Western Australia's environment, discussed further below and in **Appendix A**.

Table 1 Relevant legislation and regulations

Legislation	Purpose
Commonwealth of Australia	
<i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i>	Provides for the protection of the environment and the conservation of biodiversity.
Western Australia	
<i>Wildlife Conservation Act 1950 (WC Act)</i>	Provides for the conservation and protection of Western Australia's wildlife.
<i>Environmental Protection Act 1986 (EP Act)</i>	Preventing, controlling and abating environmental harm and conserving, preserving, protecting, enhancing and managing the environment.
<i>Biosecurity and Agriculture Management Act 2007 (BAM Act)</i>	Provides for the management, control and prevention of certain plants and animals, and for the protection of agriculture and related resources generally. (Appendix B)
<i>Land Administration Act 1997 (LAA)</i>	An Act to consolidate and reform the law about Crown land and the compulsory acquisition of land generally, to repeal the <i>Land Act 1933</i> and to provide for related matters. The Act allows for the
<i>Rights in Water and Irrigation Act 1914 (RIWI Act)</i>	An Act relating to rights in water resources, to make provision for the regulation, management, use and protection of water resources, to provide for irrigation schemes, and for related purposes.

3.0 Existing Environment

3.1 Climate

The Swan Coastal Plain has a warm Mediterranean climate, characterised by hot dry summers and cool to mild wet winters. The closest meteorological recording station to the Survey Area with comprehensive data is Pinjarra Refinery (BOM Station 9891), located 30 km east of the Survey Area. The weather station has been collecting data since 1984.

Rainfall in the 12 months preceding the field survey is shown in Figure 2, and shows higher than average rainfall in March to May. The mean annual rainfall is 828.5 mm at Pinjarra refinery. In the twelve months prior to conducting the field survey, the recording station had received 682.4 mm of rainfall. The 'drying' climate in south-western Australia has been well documented (Climate Commission, 2011) and is likely to continue having minor impacts on the survey results. For this project, it is unlikely to have affected the outcomes of the Level 1 assessment.

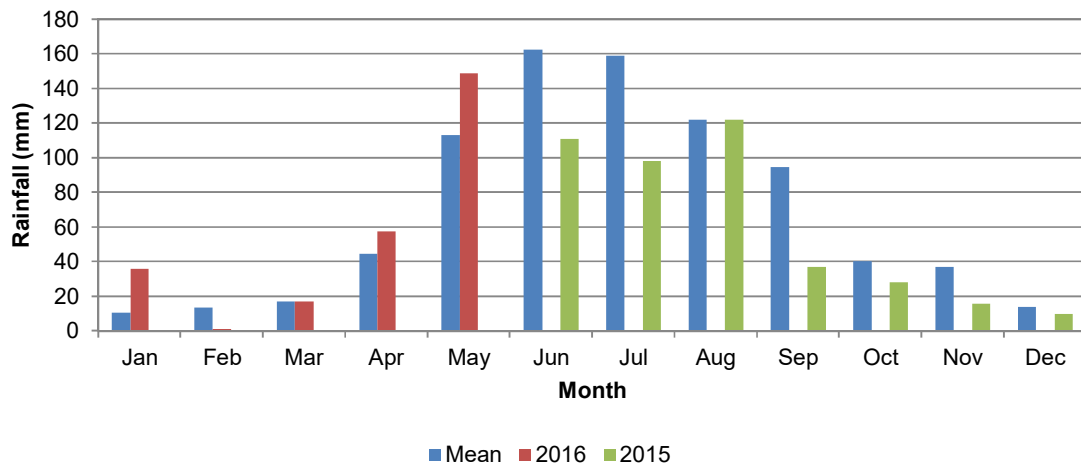


Figure 2 Rainfall graph, data obtained from Pinjarra Refinery Station 9891, BOM (2016)

3.2 IBRA region

There are 89 recognised Interim Biogeographic Regionalisation for Australia (IBRA) regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (Commonwealth of Australia, 2013a). The Survey Area lies within the Swan Coastal Plain IBRA region and, at a finer scale, within the Perth subregion (Mitchell *et al.*, 2002).

The Survey Area is located on the Swan Coastal Plain bioregion described in CALM (2002), includes Perth and the outer suburbs (excluding the Hills suburbs). The Swan Coastal Plain consists of the Dandaragan Plateau and the Perth Coastal Plain and is comprised of a narrow belt less than 30 km wide of Aeolian, alluvial and colluvial deposits of Holocene or Pleistocene age incorporating a complex series of seasonal fresh water wetlands, alluvial river flats, coastal limestone and several offshore islands. Younger sandy areas and limestone are dominated by heath and/or Tuart woodlands, while *Banksia* and Jarrah-*Banksia* woodlands are found on the older dune systems.

The Swan Coastal Plain subregion, described by Mitchell *et al.* (2002), is a low-lying coastal plain covered with woodlands dominated by *Banksia* or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. The area includes a complex series of seasonal wetlands and includes Rottnest, Carnac and Garden Islands. Land use is predominantly cultivation, conservation, urban and rural residential. The area contains a number of rare features including Holocene dunes and wetlands and a large number of threatened species and ecological communities.

3.3 Vegetation

3.3.1 Pre-European vegetation

The pre-European vegetation association mapping completed by Beard (1981) shows two vegetation associations are present in the Survey Area including a medium woodland of Tuart and shrubland mosaic (Table 2).

Heddle *et al.* (1980) mapping is used to determine the current extent of remnant vegetation when compared to pre-European vegetation extent. The Environmental Protection Authority's (EPA) objective is to retain at least 30% of all pre-European ecological communities, which is consistent with recognised retention levels (EPA, 2000; EPA, 2015).

Heddle *et al.* (1980) mapped four vegetation complexes within the Survey Area (Table 3). None of the vegetation complexes are reduced to less than 30% extent remaining.

Table 2 Beard (1981) vegetation types mapped within the Survey Area

Vegetation Association	Description
998	Medium woodland; Tuart
1007	Mosaic: Shrublands; <i>Acacia lasiocarpa</i> & <i>Melaleuca acerosa</i> heath / Shrublands; <i>Acacia rostelifera</i> & <i>Acacia cyclops</i> thicket

Table 3 Heddle *et al.* (1980) vegetation complexes mapped within the Survey Area and the extent remaining using the Perth @ 3.5 million document (EPA, 2015)

Vegetation association	Description	Extent Remaining
Cottesloe Complex – Central and South	Mosaic of woodland of <i>Eucalyptus gomphocephala</i> and open forest of <i>Eucalyptus gomphocephala</i> – <i>Eucalyptus marginata</i> – <i>Corymbia calophylla</i> ; closed heath on the limestone outcrops	33%
Yoongarillup Complex	Woodland to tall woodland of <i>Eucalyptus gomphocephala</i> with <i>Agonis flexuosa</i> in the second storey. Less consistently an open forest of <i>Eucalyptus gomphocephala</i> – <i>Eucalyptus marginata</i> and <i>Corymbia calophylla</i>	38%
Quindalup	Coastal dune complex consisting mainly of two alliances – the strand and foredune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of <i>Melaleuca lanceolata</i> – <i>Callitris preissii</i> and the closed scrub of <i>Acacia rostelifera</i>	55%
Vasse Complex	Estuarine and marine deposits.	35.9%

3.4 Wetlands

3.4.1 Ramsar site

Lake Clifton is located adjacent to the Peel-Yalgorup Ramsar site. The Peel-Yalgorup site comprises the estuarine Peel Inlet and Harvey Estuary, the freshwater wetlands of lakes McLarty and Mealup, and the Yalgorup National Park (including the saline lakes system with sections of fringing upland). The system stretches for 60 km north to south and approximately 10 km east to west.

The Ramsar site was recognised as a wetland of international importance in 1990 and is considered to be representative of wetlands of the Swan Coastal Plain forming a chain of diverse habitat types which in turn support an array of ecologically important species and communities (Peel-Harvey Catchment Council, 2009).

3.4.2 Geomorphic Wetlands of the Swan Coastal Plain

Lake Clifton intersects four Conservation Category Wetlands (CCW), including UFI 3096 (in its entirety), UFI 3089 (edge only), UFI 3094 (edge only) and UFI 3100 (small sliver). All four wetlands, their extent within the Survey Area, and comments regarding vegetation present and condition, are outlined in Table 4. All four wetlands are part of the consanguineous suite of Clifton (DPaW, 2013).

Table 4 Wetlands within the Survey Area

Unique Feature Identifier	Extent within Survey Area	Vegetation Present, Condition and Additional Comments
3096	51.38 ha	The area represents the entire wetland system including water, riparian vegetation and adjacent <i>Agonis flexuosa/Eucalyptus gomphocephala</i> woodland. Majority of wetland vegetation is mapped as 'Excellent' with some fringing vegetation considered 'Very Good'.
3089	6.46 ha	The Survey Area intersects with fringing vegetation of Lake Clifton, representing the Peel-Yalgorup Ramsar Site. Vegetation is in 'Excellent' condition.
3094	7.49 ha	Vegetation includes AfXpHhTp and MrGtTd in excellent condition. This wetland represents the Peel-Yalgorup Ramsar Site.
3100	0.02 ha	Representing the eastern edge of vegetation associated with a wetland southeast of the Survey Area.

3.5 Conservation estates, Bush Forever and Environmentally Sensitive Areas

Lake Clifton is located wholly within an Environmentally Sensitive Area (ESA) which is associated with the Peel-Yalgorup Ramsar site and the Yalgorup National Park. The Yalgorup National Park is located adjacent to the Survey Area along its north, south and eastern borders. Yalgorup National Park represents the largest coastal reserve on the Swan Coastal Plain, and includes coastal wetlands that are part of the Peel-Yalgorup wetland system recognised as a "Wetland of National Importance" under the Ramsar convention.

There are no Bush Forever Sites at Lake Clifton. The conservation estates and Environmentally Sensitive Areas are shown on Figure 4.



PROJECT ID 60100953
 CREATED BY DGF
 APPROVED BY FDW
 LAST MODIFIED 19 AUG 2016

AECOM
 www.aecom.com

DATUM GDA 1994, PROJECTION MGA ZONE 50
 0 380 760 1,140 1,520
 metres
 1:50,000 when printed at A4

LEGEND

- Survey Area
- Peel-Yalgorup System Ramsar

Geomorphic Wetlands

- Conservation
- Multiple Use
- Resource Enhancement

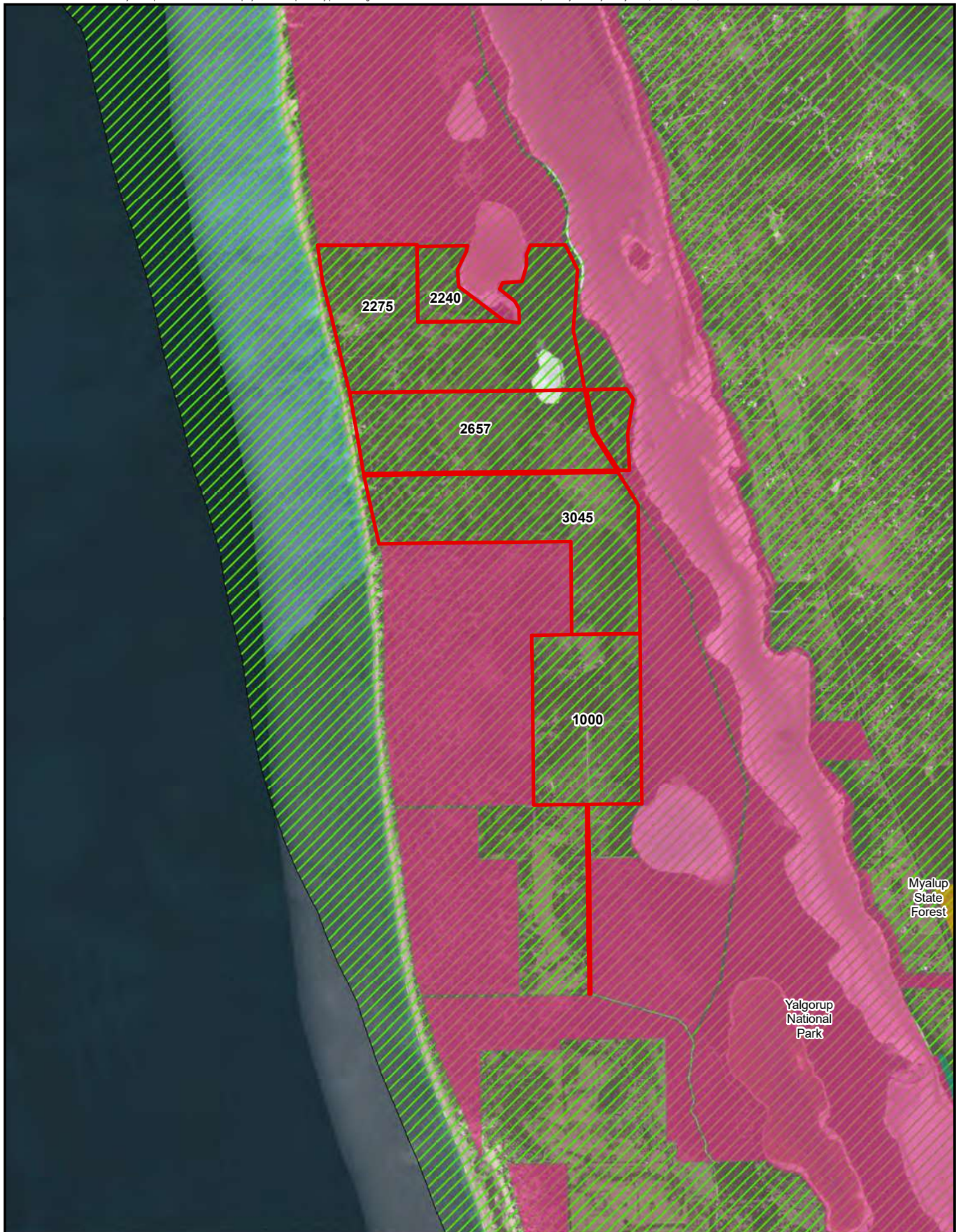
Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroX, Geotrapping, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community

Wetlands

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure
3



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY FDW LAST MODIFIED 24 AUG 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 380 760 1,140 1,520 metres</p> <p>1:50,000 when printed at A4</p>	<p>LEGEND</p> <ul style="list-style-type: none"> Survey Area Environmentally Sensitive Areas <p>DPAW Managed Lands and Water</p> <ul style="list-style-type: none"> 5(1)(g) Reserve National Park Nature Reserve State Forest <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Geotrapping, AerGRID, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Conservation Estates and ESAs</p> <hr/> <p>MAIN ROADS</p> <p><i>LAKE CLIFTON BIOLOGICAL ASSESSMENT</i></p>	<p>Figure 4</p>
---	--	---	----------------------------

4.0 Methodology

4.1 Desktop assessment

The desktop assessment included compilation of relevant information for conservation significant matters from a variety of sources including publicly available literature, DPaW databases (including additional Black Cockatoo observational data), EPBC Protected Matters Search Tool (online resource) and Naturemap. The literature review was undertaken in May 2016 prior to the June field surveys. Data searches were conducted in May 2016 prior to the 2016 Spring field survey.

A total of 12 historical studies that are directly relevant to this Study Area were identified, listed below. Of the significant survey effort, three reports were available for review prior to conducting the field survey, including the latest ENV (2009) Public Environmental Review (PER) report incorporating the entire Survey Area. Particularly the flora and vegetation technical appendix of the ENV (2009) PER was used for informing the survey sample plan.

The search results were reviewed to assess the potential presence of conservation significant environmental values. All conservation significant matters including flora, fauna and communities were reviewed and a likelihood of occurrence was completed based on the categories outlined in Table 5.

Table 5 Categories of likelihood of occurrence for species and communities

Likelihood Category	Flora	Fauna	Communities
Likely to occur	Habitat is present in the Survey Area and the species has been recorded in close proximity to the Survey Area	Survey Area is within the known distribution of the species, habitat is present in the Survey Area and the species has been recorded in close proximity to the Survey Area	Known occurrences of the community in close proximity to the Survey Area. Vegetation looks the same within the known occurrence and Study area based on aerial imagery. Geographic location is similar to the Survey Area
May occur	Habitat may be present and/or the species has been recorded in close proximity to the Survey Area	Survey Area is within the known distribution of the species, marginal habitat may be present and/or the species has been recorded in close proximity to the Survey Area	Known occurrence of the community in the local area, and/or vegetation looks the same within known occurrence and Survey Area based on aerial imagery. Geographic location is similar to the Survey Area
Unlikely to occur	No suitable habitat is present and the species has not been recorded in close proximity to the Survey Area	Survey Area is outside the known distribution for the species, or no suitable habitat is present and the species has not been recorded in close proximity to the Survey Area	Known occurrence of the community in close proximity to the project area however geographic location does not occur in Survey Area

4.1.1 Previous surveys

A number of studies have been undertaken in, or within the vicinity, of Lake Clifton, that are directly relevant to this assessment. Relevant studies include:

- Bamford 2003 Fauna Values of Cape Bouvard Investments Pty Ltd
- ENV 2009 Clifton Beach Fauna Assessment
- ENV 2009 Clifton Beach Flora and Vegetation Assessment
- Trudgen 1991 Flora and Vegetation Survey of the Coast of the City of Mandurah
- Freeman *et al.* 2009 Flora and Vegetation of the Dawesville to Binningup Region

- Trudgen 1997 Occurrences and Potential Occurrences of Rare and Priority Flora on Access Options to the Cape Bouvard Investments Block
- Weston 1998a Vegetation survey of eastern park of Lake Clifton: Location 4185 and parts of 2240, 2275, 2657, 3045, 4981 and 5182
- Weston 1998b Potential Rare Flora in the proposed White Hill Road to Lake Clifton West Access Road Corridor
- Weston 1998c Floristic Community Types and Comparable Vegetation Units in the Proposed White Hill Road to Lake Clifton West Access Corridor
- Weston 1998d Comparisons of Vegetation, Flora and Rare Flora of Proposed Exchange Areas in Lake Clifton West and Yalgorup National Park
- Weston 2003 Vegetation and Flora of Cape Bouvard Land Holding Lake Clifton West
- Ecoscape 2003 An Atlas of Tuart Woodlands on the Swan Coastal Plain in Western Australia

Of these reports, three including the Freeman *et al.*, (2009) ENV (2009) and Ecoscape (2003) reports were available in the public domain.

4.2 Flora and vegetation assessment

A Level 1 Flora and Vegetation survey was undertaken, as outlined by the EPA in Guidance Statement 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment*, and DPaW and EPA (2015) *Technical Guide for Terrestrial Flora and Vegetation Surveys*. This included a site reconnaissance, and low-level sampling to verify existing mapping already available for Lake Clifton.

Historically, the Survey Area has been traversed on foot and vegetation mapped using transects. Following this, Floristic Community Types (FCTs) were inferred and two permanent 10 x 10m quadrats established within each FCT. In addition, relevés were used to sample other vegetation communities. This field survey aimed to verify existing vegetation mapping and undertake vegetation condition mapping, and collect floristic data representative of the broad vegetation groups present. Due to the level of detail in the previous mapping available for Lake Clifton, a new vegetation map was produced to represent the broad vegetation types present.

The flora and vegetation survey was undertaken by two botanists [REDACTED] [REDACTED] between 20 and 30 June 2016 (Appendix C). The sample plan was informed by the vegetation map published in ENV (2009), review of aerial imagery, and a site reconnaissance inspection undertaken on the first day of commencing the field surveys.

Sample point locations were selected to document the floristics, vegetation composition and structure, condition, and other identifying features of the vegetation community. A total of 63 relevés were completed to capture flora and vegetation data. These data were used to inform the vegetation map and condition map. Despite there already being a vegetation map available for Lake Clifton, on-ground observations indicated that the map is outdated, and no longer adequately represents vegetation communities present. A new vegetation map was produced, with communities described using the National Vegetation Information System framework (Australian Government, 2013).

Any species unable to be identified in the field were collected for identification in AECOM's in-house herbarium and the specimens and taxonomic references and keys at the Western Australian Herbarium (WAH). Naming of species followed the convention of the WAH.

Vegetation condition mapping was reviewed and updated as required using the scale developed by M.E. Trudgen (1991) and published by the Wildflower Society WA (Keighery, 1994) condition scale (Table 6). The scale is based on disturbance (e.g. grazing, erosion), degree of alteration to community and habitat structure and site ecology.

Table 6 Bushland condition ratings (Keighery, 1994)

Descriptor	Explanation
Pristine	Pristine or nearly so, no obvious signs of disturbance
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species
Very Good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance of vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as “parkland cleared” with the flora comprising weed or crop species with isolated native trees or shrubs

4.3 Fauna assessment

The survey primarily focused on recording observations of fauna at Lake Clifton, which included evidence of fauna activity such as scats, tracks, burrows, foraging evidence and diggings. This survey was undertaken in accordance with EPA (2002) Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection, and EPA (2004b) Guidance Statement No. 56 Guidance for the Assessment of Environmental Factors – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Particular attention was given to locating species of conservation significance that have the potential to occur at Lake Clifton, as identified in the desktop assessment. All observations were made during daylight hours of 0730 and 1700.

Scats unable to be identified in the field were collected in paper bags, dried whilst in the field and then identified by specialist Barbara Triggs.

Microhabitat searches of leaf litter, bark, fallen logs and rocks were also conducted opportunistically when appropriate areas were located. Eleven microhabitat searches were conducted (refer to Figure 5 for locations).

Motion activated cameras (Scoutguard Zeroglow 10M) were also installed to observe fauna, particularly nocturnal fauna. These cameras were placed in five locations in habitats assessed as potentially containing conservation significant fauna, and were generally left out for three nights in each location. Figure 5 illustrates these locations.

The taxonomy and nomenclature of vertebrate species for mammals, reptiles and amphibians is consistent with the Western Australian Museum’s Checklist of Vertebrates of Western Australia (2010) and for bird species the Bird’s Australia Checklist of Australian Birds by Christidis and Boles (2008).

4.3.1 Fauna habitats

The fauna habitats were mapped during the field survey, in conjunction with the vegetation mapping. Eighteen detailed habitat assessments were completed in habitats throughout Lake Clifton. Fauna habitats were assessed for specific habitat components in order to determine the potential for these habitats to support conservation significant species. Information collected included:

- Location
- General habitat description
- Habitat condition and disturbance types
- Dominant / characteristic flora species and vegetation layers
- Presences and abundance of hollows (large / small), fallen logs (<10 cm / 10-30 cm / >30 cm), litter (course / fine), decorticated bark, bare ground, grass, stones and boulders (<20 cm / 20-60 cm / 60 cm – 2 m / >2 m), rock crevices, soil cracks, cryptogamic crust, vines, mistletoe, dense shrubs, water bodies etc.
- Presence of animal signs (e.g. scats, digging, tracks, burrows, egg shell, bones, feathers etc)
- Fauna observations
- Connectivity and potential significance of habitat.



PROJECT ID 60100953
 CREATED BY DGF
 APPROVED BY FDW
 LAST MODIFIED 19 AUG 2016

AECOM
 www.aecom.com

DATUM GDA 1994, PROJECTION MGA ZONE 50

0 260 520 780 1,040
 metres

1:33,809 when printed at A4

LEGEND

- Survey Area
- Black Cockatoo Breeding Trees Quadrat
- Microhabitat Assessment Locations
- Black Cockatoo Foraging Assessment Quadrats
- Habitat Assessment Locations
- Camera Locations

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Geotrapping, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community

Fauna Survey Assessment Locations

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure 5

4.4 Black Cockatoos

A targeted Black Cockatoo assessment was conducted to identify potential breeding, roosting and foraging habitat for the three threatened Black Cockatoo species that occur in Western Australia. These are Carnaby's Black Cockatoo (*Calyptorhynchus latirostris* [Endangered under the EPBC Act and Vulnerable under the WC Act]), Baudin's Black Cockatoo (*Calyptorhynchus baudinii* [Vulnerable under the EPBC Act and under the WC Act]), and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii* subsp. *naso* [Vulnerable under the EPBC Act and under the WC Act]). Refer to Section 6.3.3 for further information on these species.

The field survey was conducted in accordance with DSEWPaC (2012) Referral Guidelines for the three species of Black Cockatoos. The field survey was conducted by [REDACTED] who has more than four years' experience conducting Black Cockatoo assessments), [REDACTED]. [REDACTED] The field survey was conducted between 20-25 June 2016.

The ENV (2009) vegetation community mapping, Tuart condition mapping and fauna habitat maps were utilised to identify potentially suitable habitat for the three Black Cockatoo species, and to inform the sample plan. The sample plan was then refined in the field, with the following assessments conducted at relevant sample points:

- foraging quality assessment
- breeding habitat including potential and actual breeding trees
- roosting habitat.

4.4.1 Breeding habitat

A Black Cockatoo breeding habitat assessment was conducted which focussed on quantifying potential breeding trees and associated habitat. Table 7 defines breeding habitat and identifies those trees that Black Cockatoos will utilise as breeding trees, according to the DSEWPaC (2012). Vegetation communities were assessed for their potential to provide breeding habitat by installing a 50 x 50 m quadrat as a sample point. All trees within this quadrat were then assessed for their suitability as a breeding tree. A total of 19 quadrats were assessed (refer to Figure 5). These quadrats were used to provide a representative sample to determine the total amount of breeding habitat (and approximate number of trees). Opportunistic records of trees with a DBH >500 mm were also made within the Survey Area, where time permitted. The following information was collected for all potential breeding trees with a DBH >500 mm:

- location
- fire scarring present
- tree species
- DBH
- height
- presence and number of hollows
- potential suitability of hollows.

Photographs were also taken of each tree

Table 7 Breeding habitat for the three Western Australian Threatened Black Cockatoo species

	Baudin's	Carnaby's	Forest Red-Tailed
Specific breeding habitat for the three Cockatoos	Nest in hollows in live or dead trees of <i>Eucalyptus diversicolor</i> , <i>Corymbia calophylla</i> , <i>E. wandoo</i> and <i>E. gomphocephala</i> .	Nest in hollows in live or dead trees of <i>E. salmonophloia</i> , <i>E. wandoo</i> , <i>E. gomphocephala</i> , <i>E. marginata</i> , <i>E. rudis</i> , <i>E. loxophleba</i> subsp. <i>loxophleba</i> , <i>E. accedens</i> , <i>E. diversicolor</i> and <i>Corymbia calophylla</i> .	Nest in hollows in live or dead trees of <i>E. diversicolor</i> and <i>Corymbia calophylla</i> , <i>E. wandoo</i> , <i>E. megacarpa</i> , <i>E. patens</i> , <i>E. gomphocephala</i> and <i>E. marginata</i> .
Definition of breeding habitat	'Breeding habitat' is defined in these referral guidelines as trees of species known to support breeding within the range of the species which either have a suitable nest hollow OR are of a suitable DBH to develop a nest hollow. For most tree species, suitable DBH is 500 mm.		

Source: DSEWPaC (2012).

4.4.2 Roosting habitat

Table 8 defines the suitable trees that the three Western Australian Black Cockatoo species may utilise as roosting trees. Both white-tailed Black Cockatoo species roost in or near riparian environments or near other permanent water sources. The Forest Red-Tailed Cockatoos prefers the edges of forests for roosting (DSEWPaC, 2012). Potential roosting trees were searched for and assessed during the field survey.

Table 8 Suitable roosting trees for the three Threatened Black Cockatoos

Baudin's	Carnaby's	Forest Red-Tailed
<i>Corymbia calophylla</i> , <i>E. marginata</i> , <i>E. rudis</i> , <i>E. patens</i> , and <i>E. gomphocephala</i> .	<i>E. salmonophloia</i> , <i>E. wandoo</i> , <i>Corymbia calophylla</i> , <i>Eucalyptus diversicolor</i> , <i>E. patens</i> , and <i>E. gomphocephala</i> .	<i>Corymbia calophylla</i> , <i>E. marginata</i> , and <i>E. gomphocephala</i> .

Source: DSEWPaC (2012).

4.4.3 Foraging habitat

Foraging species for the three Western Australian Black Cockatoo species is presented in Table 9 as reported in various literature.

Table 9 Foraging species utilised by the three Western Australian Threatened Black Cockatoo species

Baudin's (DSEWPaC, 2012)	Carnaby's (DSEWPaC, 2012)	Forest Red-tail (Johnstone et al. 2013 and DSEWPaC, 2012)
Eucalypt woodlands and forests, proteaceous woodland and heath. During breeding season feed primarily on native vegetation, particularly Marri. Outside breeding season they can feed on fruit orchards (apple and pear, also persimmon) and tips of <i>Pinus</i> species. Common food items also include insects and insect larvae, and pith of kangaroo paw <i>Anigozanthos flavidus</i> .	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species (e.g. <i>Banksia</i> sp., <i>Hakea</i> sp. and <i>Grevillea</i> sp.) as well as eucalypt woodland and forest that is dominated by foraging species. Also will feed on Callistemon, seeds of introduced species such as <i>Pinus</i> species and <i>Erodium</i> species, wild radish, canola, almonds and pecan nuts and occasionally apples and persimmons.	The principal foods of the FRTBC are the seeds of Marri and Jarrah. Other less important foods include Blackbutt <i>E. patens</i> , <i>E. wandoo</i> , Sheoak <i>A. fraseriana</i> , Snottygobble <i>P. longifolia</i> , <i>Hakea</i> spp., also introduced species (including Cape Lilac <i>Melia azedarach</i> , Spotted Gum <i>C. maculata</i> , Lemon-scented Gum <i>C. citriodora</i> , Silver Princess <i>E. caesia</i> , Illyarrie <i>E. erythrocorys</i> and Kaffir Plum <i>Harpephyllum caffrum</i>) and in southern forests Albany Blackbutt <i>E. staeri</i> and Karri <i>E. diversicolor</i> . Rarely observed grubbing for insect larvae on <i>Allocasuarina</i> spp.

The quality of foraging habitat not only reflects the availability of food sources, but also the proximity to reliable water sources, connectivity to other suitable habitat, presence of potential breeding trees, and proximity to confirmed roost and breeding sites (amongst others). These parameters were utilised by the DotE to produce a draft quality of foraging habitat scoring system. AECOM has amended this system and this is presented in Table 11. This scoring system was utilised to assess potential foraging habitat for each Black Cockatoo species. Initially a desktop assessment was conducted to select sample point locations in varying representative habitats throughout the Survey Area, and these sites were then refined in the field. 50 x 50 m quadrats were established in the field at each of these 35 sites and the scoring assessment tool utilised.

The scoring tool is used by initially defining the quality of the overall habitat present (i.e. High, Quality, Valued, Low) and then adding or subtracting points from this depending on the ecological values of the habitat (i.e. proximity to water, proximity to a known roost site, evidence of foraging material etc.). This determines an overall quantitative rating. These scores were then used as representative scores for that vegetation unit. Table 10 defines the levels of foraging habitat quality used during the assessment.

Table 10 Black Cockatoo foraging assessment scoring

Score	Foraging Quality
1 - 3	Low
4 - 6	Valued
7 - 9	Quality
10	High

Table 11 Quality of foraging habitat assessment tool for the three Western Australian Threatened Black Cockatoo species

Score	Carnaby's	Baudin's	Forest Red-tailed
≥10 High	Quality foraging habitat that is being managed for Black Cockatoos, including successful rehabilitation, and/or has some level of protection from clearing, and / or is Quality habitat described below with attributes contributing to meet a score of 10 or greater	Quality foraging habitat that is being managed for Black Cockatoos, including successful rehabilitation, and/or has some level of protection from clearing, and / or is Quality habitat described below with attributes contributing to meet a score of 10 or greater	Quality foraging habitat that is being managed for Black Cockatoos, including successful rehabilitation, and/or has some level of protection from clearing, and / or is Quality habitat described below with attributes contributing to meet a score of 10 or greater
7 Quality	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species (e.g. <i>Banksia</i> sp., <i>Hakea</i> sp. and <i>Grevillea</i> sp.) as well as eucalypt woodland and forest that is dominated by foraging species. Does not include orchards, canola, or areas under a RFA	Eucalypt (not mallee) woodlands and forest, and proteaceous woodland and heath, particularly Marri. Does not include orchards or areas under a RFA	Jarrah and Marri woodlands and forest, and edges of Karri forests, including Wandoo and Blackbutt, within the range of the subspecies. Does not include areas under a RFA
5 Valued	Pine plantation or introduced eucalypts	Pine plantation or introduced eucalypts	Introduced eucalypts as well as the introduced Cape lilac (<i>Melia acedarach</i>)
1 Low	Individual foraging plants or small stand of foraging plants (≤2 ha)	Individual foraging plants or small stand of foraging plants (≤2 ha)	Individual foraging plants or small stand of foraging plants (≤2 ha)
Additions: Context adjustor – attributes improving habitat quality			
+3	Is within the Swan Coastal Plain	Is within the known foraging area	Jarrah and/or Marri shows good recruitment (i.e. evidence of young trees)
+3	Contains trees known to be used for breeding	Contains trees known to be used for breeding	Contains trees known to be used for breeding
+2	Primarily comprises Marri	Primarily contains Marri	Primarily contains Marri and/or Jarrah
+2	Contains trees with potential to be used for breeding (DBH ≥500 mm or ≥300 mm for Salmon Gum and Wandoo)		
+2	Known to be a large or key roosting site		
+1	Is <12 km from known breeding location		
+1	Is <2 km from a watering point		
+1	Is used for roosting		

Score	Carnaby's	Baudin's	Forest Red-tailed
Subtractions: Context adjustor – attributes reducing habitat quality			
-2	No other foraging habitat within 6 km		
-1	Is >12 km from known breeding location		
-1	Is >2 km from watering point		
-1	Disease present (e.g. <i>Phytophthora cinnamomi</i> or Marri canker)		

Source: 2016 DotE workshop

4.5 Wetlands

The vegetation within wetland boundaries, as mapped in the Geomorphic Wetlands dataset, was investigated to determine the extent of riparian vegetation, as well as vegetation condition. A wetland evaluation was completed for wetlands located entirely, or mostly within the Survey Area, inclusive of riparian vegetation, water, and fringing vegetation that grades from riparian to adjacent floodplain woodlands. Wetlands where only a small area intersected with the Survey Area, i.e. slivers and edges, were not considered.

The wetland evaluation methodology for the Swan Coastal Plain is a two tiered approach. This approach has been adopted to avoid detailed evaluations being undertaken where it may not be necessary. The two tiers of evaluation are as follows:

1. Preliminary Evaluation – if any one of the preliminary evaluation criteria is met the wetland is automatically to be assigned a Conservation management category and no further evaluation is required
2. Secondary Evaluation – if the wetland does not meet the preliminary evaluation criteria the secondary evaluation should be conducted to determine the wetland's management category.

The Preliminary evaluation was undertaken using the information contained in the *Wetland evaluation and desktop and site assessment form*. In accordance with DPaW (2013) methodology, if a wetland met any one of the Preliminary evaluation criteria then it was assigned a Conservation management category.

4.5.1 Geomorphic Wetlands dataset of the Swan Coastal Plain

The Geomorphic Wetlands of the SCP dataset displays the location, boundary, geomorphic classification (wetland type) and management category of wetlands on the SCP. The mapping, classification and evaluation of wetlands on the SCP was initially conducted by Hill *et al.* in 1996 and then subsequently conducted in accordance with EPA Bulletin 686: *A Guide to Wetland Management in the Perth and Near Perth Swan Coastal Plain Area* (EPA, 1993). These mapping and evaluation results have been digitised into the *Geomorphic Wetlands of the SCP dataset* administered by DPaW. Geomorphic classifications are determined based on the duration of wetland inundation and associated landform.

In addition to geomorphic classifications, evaluation of wetlands is undertaken to assign the relevant management categories. EPA Guidance Statement 33 outlines the three key management categories which have been applied on the SCP, along with guidance on management objectives for each category (Table 12).

Table 12 Management Categories and Objectives for the Geomorphic Wetlands of the Swan Coastal Plain

Management Category	General Description	Management Objectives
Conservation (CC or CCW)	Wetlands which support a high level of attributes and functions.	Highest priority wetlands. Objective is to preserve and protect the existing conservation values of the wetlands through various mechanisms including: <ul style="list-style-type: none"> • reservation in national parks, crown reserves and State owned land protection under Environmental Protection Policies • wetland covenanting by landowners. No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate.
Resource Enhancement (RE)	Wetlands which may have been partially modified but still support substantial ecological attributes and functions	Priority wetlands. Ultimate objective is to manage, restore and protect towards improving their Conservation value. These wetlands have the potential to be restored to Conservation Category. This can be achieved by restoring wetland function, structure and biodiversity. Protection is recommended through a number of mechanisms.

Management Category	General Description	Management Objectives
Multiple Use (MU)	Wetlands with few remaining important attributes and functions	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare.

4.5.2 Riparian vegetation

Riparian vegetation condition was assessed using the Water & Rivers Commission (1999) foreshore condition scale, developed for application in farming areas of south-west Australia. It takes into account vegetation health, presence of weeds and erosion (Waters & Rivers Commission, 1999). The categories and sub-categories for a detailed foreshore assessment are presented in Table 13.

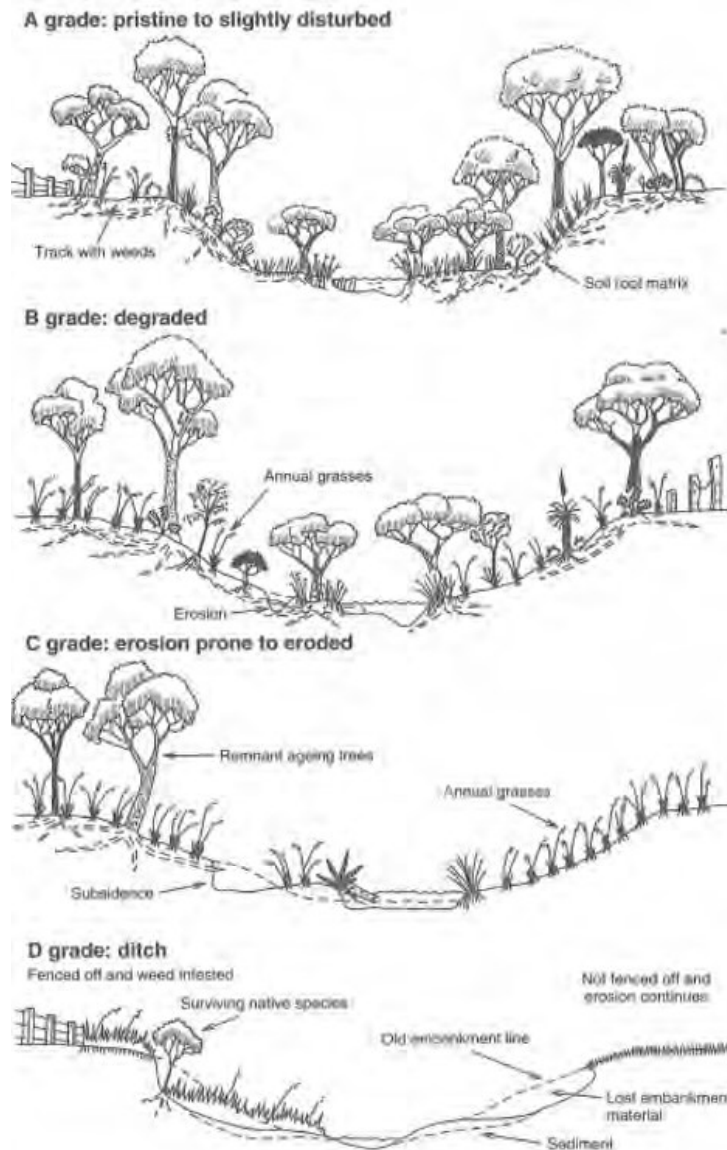
The extent of the riparian vegetation was mapped using on-ground observations and aerial imagery.

Table 13 Condition classes for a detailed assessment of foreshore condition

Category	Sub-category	Description
A	A1	Pristine. The river embankments and floodway are entirely vegetated with native species, and there is no evidence of human presence or livestock damage.
	A2	Near pristine. Native vegetation dominates. Some introduced weeds may be present in the understorey, but not to the extent that they displace native species. Otherwise there is no evidence of human impact. (A river valley in this condition is as good as will be found today)
	A3	Slightly disturbed. Native vegetation dominates, but there are some areas of human disturbance where soil may be exposed and weeds are relatively dense (such as along tracks). The native vegetation would quickly recolonise the disturbed areas if human activity declined.
B	B1	Degraded - weed infested. Weeds have become a significant component of the understorey vegetation. Although native species are dominant, a few have been replaced by weeds.
	B2	Degraded - heavily weed infested. In the understorey, weeds are about as abundant as native species. The regeneration of some tree and large shrub species may have declined.
	B3	Degraded - weed dominated. Weeds dominate the understorey, but many native species remain. Some trees and large shrub species may have declined or disappeared altogether.
C	C1	Erosion prone. Trees remain, and possibly some large shrubs or tree grasses, but the understorey consists entirely of weeds, mainly annual grasses. The trees are generally resilient or long lived species but there is little or no evidence of regeneration. The shallow-rooted weedy understorey provides no support to the soil, and only a small increase in physical disturbance will expose the soil and make the river embankments and floodway vulnerable to erosion.
	C2	Soil exposed. Older trees remain, but the ground is virtually bare. Annual grasses and other weeds have been removed by livestock trampling or grazing, or through over use by humans. Low-level soil erosion has begun, by the action of either wind or water.
	C3	Eroded Soil is washed away from between tree roots, trees are being undermined and unsupported embankments are subsiding into the river valley.

Category	Sub-category	Description
D	D1	Ditch – eroding. There is not enough fringing vegetation to control erosion. Some trees and shrubs remain and act to retard erosion in certain spots, but are doomed to be undermined eventually.
	D2	Ditch - freely eroding. No significant fringing vegetation remains and erosion is completely out of control. Undermined and subsided embankments are common, and large sediment plumes are visible along the river channel.
	D3	Drain - weed dominated. The highly eroded river valley has been fenced off, preventing control of weeds by stock. Perennial (long lived) weeds have become established. The river has become a simple drain, similar or identical to a typical major urban drain.

Source: Water & Rivers Commission, 1999.



Source: Water & Rivers Commission, 1999.

Figure 6 Foreshore condition assessment used to assess riparian vegetation condition

4.6 Limitations

The objective of the assessment was to verify existing information on ecological values of the defined Survey Area. Field surveys were completed as a Level 1 investigation. This requires a desktop study and reconnaissance survey to verify desktop results, delineate and characterise flora and the range of vegetation units and fauna habitats present (EPA, 2004a; EPA 2004b). The limitations were therefore addressed based on this objective.

Table 14 Limitations associated with the biological surveys

Limitation	Constraints	
	Flora and Vegetation Assessment	Fauna / Black Cockatoo Assessment
Competency/experience of consultant conducting survey	Nil. The flora and vegetation assessment was led by Floora de Wit who has 8 years' experience addressing similar scopes on the Swan Coastal Plain.	Nil. Floora has four years' experience conducting Black Cockatoo assessments. Jared is an ecologist with over 14 years' experience in the environmental industry and has conducted fauna surveys in a range of bioregions within Western Australia. Jared has also conducted multiple Black Cockatoo assessments.
Scope (i.e. what life forms were sampled)	Nil. Effort was spent on documenting all vascular flora species. Sterile juvenile forbs were sometimes difficult to identify to species level and were therefore named to genus only. As a Level 1 survey, this is not considered a limitation as it is unlikely to have influenced the overall results.	Nil. The level 1 fauna survey: <ul style="list-style-type: none"> Assessed all fauna habitats within the Survey Area Documented secondary evidence (scats, diggings, burrows etc.) and fauna sightings Conducted microhabitat searches at appropriate sites Utilised motion activated cameras. Although reptiles would generally have been in brumation and not sampled effectively, it is not the objective of a Level 1 survey to trap or sample for fauna groups extensively.
Proportion of flora/fauna identified, recorded and/or collected (based on sampling, timing and intensity)	Nil. Sterile juvenile forbs were sometimes difficult to identify to species level and were therefore named to genus only. Sampling effort included 63 relevés and numerous additional observations recorded on field maps.	Nil. Information gained for a Level 1 Fauna survey was sufficient. Fauna were observed (through direct or indirect evidence) during daylight hours (0700 and 1730hrs). Therefore nocturnal species were only predominantly observed through indirect evidence, although three motion activated cameras were installed in appropriate habitats. Although reptiles would generally have been in brumation and not sampled effectively, it is not the objective of a Level 1 survey to trap or sample for fauna groups extensively.

Limitation	Constraints	
	Flora and Vegetation Assessment	Fauna / Black Cockatoo Assessment
Sources of information	<p>Minor.</p> <p>The latest published survey for Lake Clifton was used to inform this assessment. This was further supported by DPaW database searches.</p>	<p>Moderate.</p> <p>DPaW database (with additional Black Cockatoo observational data), Naturemap and EPBC Act Protected Matters Search Tool were utilised. Numerous studies have also been undertaken in the Study Area, however only three reports are available in the public domain. Information within these historical reports (e.g. vegetation mapping) were utilised to aid in the selection of Black Cockatoo foraging assessment sites for the survey. However, the on-ground observations indicated that these maps are outdated, and no longer adequately represents vegetation communities present. The location of the Black Cockatoo foraging assessment sites was refined in the field.</p>
Completion (is further work needed)	<p>Nil.</p> <p>For the purpose of meeting the objective of this assessment, no further work is required.</p>	<p>Nil.</p> <p>The objectives of the assessment were completed and no further work is required.</p>
Timing, weather, season, cycle	<p>Nil.</p> <p>The survey was conducted in winter, outside the ideal detection period for Swan Coastal Plain vegetation. For the purposes of undertaking a Level 1 Flora and Vegetation Assessment, this is not considered a limitation. It was considered that enough information was able to be captured at this time to provide an understanding of the ecological values of the Survey Area.</p>	<p>Minor</p> <p>The survey was conducted during the colder months when some fauna groups (reptiles in particular) are not as active. This assessment was also limited to one survey period during one year. However, this does not significantly impact a Level 1 fauna survey.</p>

Limitation	Constraints	
	Flora and Vegetation Assessment	Fauna / Black Cockatoo Assessment
Disturbances (e.g. fire flood, accidental human intervention) which affected results of the survey	Minor. Historical clearing and weed invasion has affected the condition of the Survey Area. Partial clearing of rows in the southern portion of the Survey Area led to cryptic vegetation mosaics present between rows.	Nil. The fauna survey was not disrupted or impacted.
Intensity (was the intensity adequate)	Nil. A total of 63 relevés were completed over ten field days to assess the floristic values of the Survey Area. This is considered suitable for meeting a Level 1 Assessment requirement as stipulated by EPA (2004a).	Nil. The Survey Area was surveyed over a five day period. It enabled sufficient time to conduct the Black Cockatoo foraging, breeding and roosting assessments. It also enabled sufficient time to assess the fauna habitats present, search for and collect opportunistic records for conservation significant species. The fauna survey was conducted in accordance with EPA Guidance Statement 56 (EPA, 2004b).
Resources (degree of expertise available in plant/animal identification)	Nil. Sufficient time was allocated for the survey. Plant identification was undertaken by Floora de Wit and Lyn van Gorp at the WA Herbarium.	Nil. Sufficient time was allocated for the survey and equipment utilised (e.g. motion activated cameras) were above that required for a Level 1 fauna survey. Floora has four years' experience conducting Black Cockatoo assessments, and Jared is an ecologist with over 14 years' experience in the environmental industry who has also conducted multiple Black Cockatoo assessments.
Remoteness and/or access problems	Nil. Multiple tracks dissect the Survey Area, enabling access to all vegetation communities encountered.	Minor. Not all of the Survey Area was covered on-ground due to the size of the project Area and the availability of tracks. However, this minor limitation was not deemed significant as the requirements of a Level 1 fauna survey were met.

Limitation	Constraints	
	Flora and Vegetation Assessment	Fauna / Black Cockatoo Assessment
Availability of contextual information on the region	Minor. Publicly available resources such as Beard (1981), Hedde (1980), and historical reports including ENV (2009) informed the report. Many historical biological reports relevant for this Survey Area are not available in the public domain and were therefore not able to be further considered.	Minor. Many historical biological reports relevant for this Survey Area are not available in the public domain and were therefore not able to be further considered.

5.0 Desktop Results

5.1 Threatened and Priority Ecological Communities

5.1.1 Commonwealth

Lake Clifton is located within the buffer of one Commonwealth-listed Threatened Ecological Community (TEC) (Figure 7). The Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton) is listed as Critically Endangered under the EPBC Act, and Critically Endangered under the WC Act (where it is listed as Stromatolite like Freshwater Microbialite Community of Coastal Brackish Lakes). This TEC incorporates Lake Clifton and the stromatolites present in the Lake. Despite the buffer of this community encompassing the Survey Area, this TEC is not present within the Survey Area.

5.1.1 State

Two State-listed TECs and five Priority Ecological Communities (PECs) were identified in the desktop assessment as occurring in the vicinity of Lake Clifton. Of the seven communities, five are known to occur, one may occur, and one is unlikely to occur (Table 15; Figure 7).

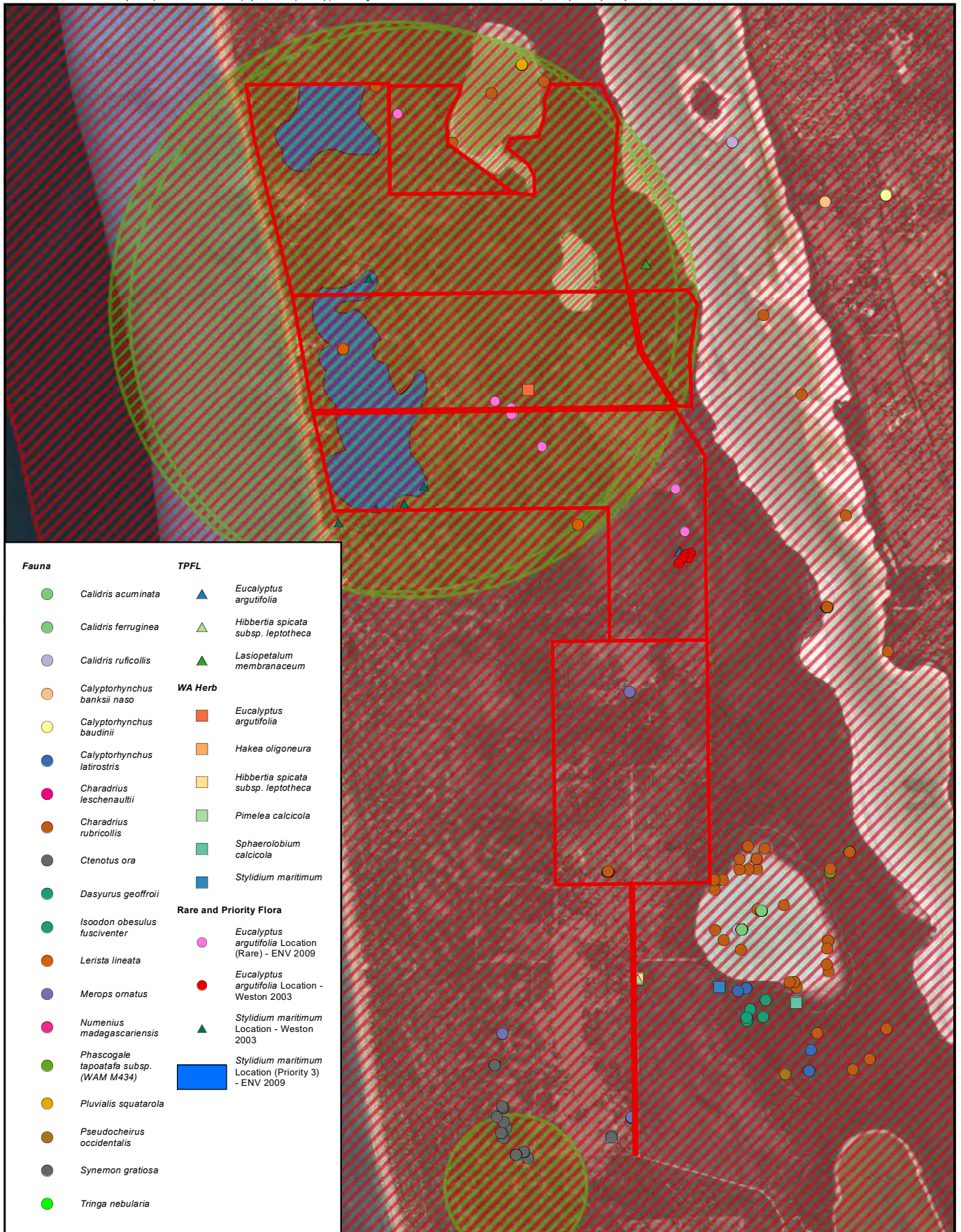
The TEC, FCT26a – *Melaleuca huegelii* – *Melaleuca acerosa* (*systema*) Shrublands on Limestone Ridges, is listed as Endangered (EN) by DPaW and endorsed by the Minister of the Environment. Gibson *et al.* (1994) characterised this community as including *Acacia lasiocarpa*, *Banksia sessilis*, *Grevillea thelemanniana* subsp. *preissii*, *Melaleuca acerosa*, *Melaleuca huegelii* and *Trymalium albicans* with numerous herbs. FCT26a is restricted to large limestone ridges north of Perth and those in the Yalgorup area on skeletal soils of ridge slopes and ridge tops dominated by heath vegetation. This community has been identified as occurring in the Survey Area in ENV (2009). The DPaW database has no records of this community at this location, but does show a known location 2.7 km east of the Survey Area.

Similarly, the TEC, FCT18 Shrublands on Calcareous Silts was recorded by ENV (2009) however the DPaW databases show no records of this community in the Survey Area. Gibson *et al.* (1994) recorded this community in Yalgorup National Park and describes it as a very species-rich community characterised by open low scrubs with rich annual flora. Common taxa include *Acacia saligna*, *Leptomeria lehmannii*, *Xanthorrhoea preissii*, *Gahnia trifida* and *Melaleuca teretifolia* on damplands.

Table 15 Threatened and Priority Ecological Communities identified as occurring in the Study Area

	Cons. Status	Presence
FCT18 Shrublands on calcareous silts	WC Act: Vulnerable	May occur. There are no DPaW database records however ENV (2009) identified it as potentially occurring at one location following FCT analysis of field survey results.
SCP25 – Southern <i>Eucalyptus gomphocephala</i> – <i>Agonis flexuosa</i> woodlands	Priority 3	Known. Mapped by ENV (2009) however no DPaW database records in the Survey Area with the nearest record 4 km east of Lake Clifton.
SCP29a – Coastal shrublands on shallow sands	Priority 3	Known from DPaW database 2016 and mapped by ENV (2009).
SCP29b – <i>Acacia</i> shrublands on taller dunes	Priority 3	Known from DPaW database 2016 and mapped by ENV (2009).
SCP30b – Quindalup <i>Eucalyptus gomphocephala</i> and / or <i>Agonis flexuosa</i> woodlands	Priority 3	Known from DPaW database 2016 and mapped by ENV (2009).

	Cons. Status	Presence
Elongate Fluvial Delta System – Peel-Harvey inlet	Priority 1	Unlikely. Associated with Peel-Harvey inlet located 5km east of the Survey Area on the east side of Lake Clifton.
FCT26a – <i>Melaleuca huegelii</i> – <i>Melaleuca acerosa (systema)</i> shrublands on limestone ridges	WC Act: Endangered	Known. Mapped by ENV (2009) however no DPaW database records in the Survey Area, with the nearest record 2.7 km east of Lake Clifton.



Fauna		TPFL	
	<i>Calidris acuminata</i>		<i>Eucalyptus argutifolia</i>
	<i>Calidris ferruginea</i>		<i>Hibbertia spicata subsp. leptotheca</i>
	<i>Calidris ruficollis</i>		<i>Lasiopetalum membranaceum</i>
	<i>Calyptorhynchus banksii naso</i>	WA Herb	
	<i>Calyptorhynchus baudinii</i>		<i>Eucalyptus argutifolia</i>
	<i>Calyptorhynchus latirostris</i>		<i>Hakea oligoneura</i>
	<i>Charadrius leschenaultii</i>		<i>Hibbertia spicata subsp. leptotheca</i>
	<i>Charadrius rubricollis</i>		<i>Pimelea calcicola</i>
	<i>Ctenotus ora</i>		<i>Sphaerolobium calcicola</i>
	<i>Dasyurus geoffroi</i>		<i>Stylidium maritimum</i>
	<i>Isoodon obesulus fusciventer</i>	Rare and Priority Flora	
	<i>Lerista lineata</i>		<i>Eucalyptus argutifolia</i> Location (Rare) - ENV 2009
	<i>Merops ornatus</i>		<i>Eucalyptus argutifolia</i> Location - Weston 2003
	<i>Numenius madagascariensis</i>		<i>Stylidium maritimum</i> Location - Weston 2003
	<i>Phascogale tapoatafa subsp. (WAM M434)</i>		<i>Stylidium maritimum</i> Location (Priority 3) - ENV 2009
	<i>Pluvialis squatarola</i>		
	<i>Pseudocheirus occidentalis</i>		
	<i>Synemon gratusa</i>		
	<i>Tringa nebularia</i>		

PROJECT ID 60100953
 CREATED BY DGF
 APPROVED BY FDW
 LAST MODIFIED 19 AUG 2016

DATUM GDA 1994, PROJECTION MGA ZONE 50
 0 270 540 810 1,080
 metres
 1:35,000 when printed at A4

LEGEND

- Survey Area
- TEC/PEC
- Priority 3
- Critically Endangered

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Geotrapping, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community

Desktop Assessment Results

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure 7

5.2 Threatened and Priority flora

The desktop assessment identified ten flora species of conservation significance, including two species listed under the EPBC Act and WC Act, and eight species listed as Priority by DPaW and endorsed by the Minister for Environment.

Of the ten species, five species are known to occur within the Survey Area based on ENV (2009) which includes a figure showing Weston (2003) Threatened flora locations, and DPaW database search results. Furthermore, one species is considered likely to occur, three may occur, and one is considered unlikely to occur.

Details of all ten species are provided in Table 16 and historical locations shown in Figure 7.

Table 16 Desktop flora results showing species, conservation code (Commonwealth and State), habitat description and likelihood of occurrence

Species	Conservation code ¹	Habitat ²	Flowering Period	Likelihood
<i>Eucalyptus argutifolia</i> , Yanchep Mallee, Wabbling Mallee	VU, VU	Grows on slopes and gullies near coast and close to summits of limestone ridges. Soils are shallow, well drained and grey with outcrops of limestone. Commonly associated with heath and thicket species.		Known , ENV (2009) mapped three populations with more than 200 individuals. Weston (2003) mapped one population. DPaW database shows ten records from two distinct populations.
<i>Caladenia huegelii</i> Grand Spider Orchid	EN, CR	Grows in deep sandy soil in <i>Banksia-Eucalyptus marginata</i> woodland	Sep-late Oct	Unlikely , no suitable habitat present.
<i>Caladenia swartziorum</i>	P1	Winter wet areas.	Unknown	May , suitable habitat present but no known occurrences in the Study Area.
<i>Stylidium maritimum</i>	P3	Sand over limestone. Dune slopes and flats. Coastal heath and shrubland, open <i>Banksia</i> woodland	Sep-Nov	Known , more than 2,800 records (ENV (2009) in the western sand dune communities. No DPaW database records in the Study Area.
<i>Hakea oligoneura</i>	P4	Limestone. Known only from Mandurah and Waroona. Recorded by Weston (2003) in Yalgorup National Park in <i>Banksia sessilis</i> woodlands	Unknown	Known , recorded by Weston (2003) and suitable habitat present. No known occurrences from DPaW or ENV (2009).
<i>Hibbertia spicata</i> subsp. <i>leptotheca</i>	P3	Near-coastal limestone ridges, outcrops and cliffs.	Jul-Oct	Known , recorded by Weston (2003) and one DPaW database record near the access road.
<i>Lasiopetalum membranaceum</i>	P3	Sand over limestone.	Sep-Dec	Known , one DPaW database record located in the northeast of Lake Clifton.
<i>Platysace ramosissima</i>	P3	Sandy soils.	Oct-Nov	Likely , suitable habitat present and one DPaW database record in close proximity.
<i>Pimelea calcicola</i>	P3	Coastal limestone ridges, sand.	Sep-Nov	May , suitable habitat present but no records in the Study Area.
<i>Sphaerolobium calcicola</i>	P3	White-grey-brown sand, sandy clay over limestone, black peaty sandy clay. Tall dunes, winter-wet flats, interdunal swamps, low-lying areas.	Jun or Sep	May , suitable habitat present but no records in the Study Area.

1. Shows EPBC Act listing and WC Act listing based on categories described in Appendix A and Section 2.0. P refers to Priority flora listed by DPaW.

2. Information obtained from DotE (2016) Species Profiles Database (SPRAT) or WA Herbarium Florabase (1998)

5.3 Threatened and Priority fauna

The desktop assessment identified 63 conservation significant fauna species that could potentially occur within the Survey Area. Of these:

- 12 species are likely to occur (Table 17)
- 31 species may occur
- 20 species are unlikely to occur.

The species likely to occur in the Survey Area include eight bird, two mammal, one reptile and one invertebrate species. The likelihood of occurrence of fauna species was determined by assessing the presence of suitable habitat in the Survey Area, and reviewing the recent records and distribution of the species. Table 17 identifies the 12 species likely to occur. The conservation significant categories as defined by DPaW, the WC Act and EPBC Act are defined in **Appendix A**.

The full desktop assessment for all 63 fauna species and their likelihood of occurrence are presented in **Appendix D**.

Table 17 Threatened Fauna species likely to occur within the Survey Area

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
Birds				
<i>Calidris ruficollis</i>	Red-necked Stint	Migratory / Marine	IA	The Red-necked Stint is a small Calidridinae approximately 13–16 cm in length and is the smallest shorebird in Australia (Geering <i>et al.</i> 2007). The Red-necked Stint has been recorded in all coastal regions, and found inland in all states when conditions are suitable. The Red-necked Stint breeds in Siberia and sporadically in north and west Alaska. In Australasia, the Red-necked Stint is mostly found in coastal areas. The Red-necked Stint mostly forages on bare wet mud on intertidal mudflats or sandflats, or in very shallow water; mostly in areas with a film of surface water and mostly close to edge of water. During high tides they sometimes forage in non-tidal wetlands (DotE, 2016b). Within Australia, there are a number of threats common to most migratory shorebirds, including habitat loss, habitat degradation, disturbance and direct mortality (DotE, 2016b).
<i>Calyptrorhynchus latirostris</i>	Carnaby's Black Cockatoo	E	EN	Carnaby's Black Cockatoo is endemic to the southwest of Western Australia and is a large black cockatoo with a white patch on its cheek, white bands on its tail and a strong short curved bill. This species display strong pair bonds and nest in the hollows of live or dead Eucalypts. On the Swan Coastal Plain, the birds feed on a large variety of plants, preferring proteaceae species and Marri nuts, and some introduced species (e.g. <i>Pinus</i> sp.). Carnaby's Black Cockatoo has undergone a dramatic decline in recent years, declining by 50 percent in the past 45 years, one of the main contributing factors being land clearing (DotE, 2016). Refer to Section 6.3.3.1 for further detail.

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
<i>Charadrius rubricollis</i>	Hooded Plover	Marine	P4	Hooded Plovers are small to medium-sized, stocky shorebirds with short bills, large eyes and rounded heads. The Hooded Plover is pale-coloured, 19 - 23 cm in length with a wingspan of 26 - 44 cm. Hooded Plovers utilise sandy ocean beaches, tidal bays and estuaries, rock platforms and rocky or sand-covered reefs near sandy beaches, small beaches in lines of cliffs, near-coastal saline and freshwater lakes and lagoons. In south-west Western Australia the Hooded Plover is not restricted to the coast, and can also live and breed around inland salt lakes (OEH, 2016). Threats to the Hooded Plover include disturbance, predation of eggs and chicks by foxes, dogs, and cats, Australian ravens, silver gulls and raptors, habitat modification (OEH, 2016).
<i>Charadrius ruficapillus</i>	Red-capped Plover	Marine	-	The Red-capped Plover is a small grey-brown plover that is white underneath and has a red-brown crown. The Red-capped Plover is the most common of Australia's beach-nesting shorebirds. It is widespread throughout Australia and is found in wetlands, especially in arid areas, and prefers saline and brackish waters. They usually inhabit wide, bare sandflats or mudflats at the margins of saline, brackish or freshwater wetlands where they forage by taking small invertebrates from the surface (http://www.birdlife.org.au/bird-profile/red-capped-plover).

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	Marine	-	The White-bellied Sea-Eagle is a large raptor that has long, broad wings and a short, wedge-shaped tail. It measures 75–85 cm in length, and has a wingspan of 180–220 cm. This species is distributed along the Australian coastline, and it also extends inland along some of the larger waterways. The White-bellied Sea-Eagle is found in coastal habitats (especially those close to the sea-shore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands (DotE, 2016b). Potential threats to the White-bellied Sea-Eagle are the loss of habitat due to land development, disturbance of nesting pairs by human activity, poisoning, shooting, competition with Wedge-tailed Eagles, and the deterioration of inland water resources (DotE, 2016b).
<i>Merops ornatus</i>	Rainbow Bee-eater	Marine	-	The Rainbow Bee-eater is a common species which occupies numerous habitats including open woodlands with sandy loamy soil, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests (Morcombe, 2003). The Rainbow Bee-eater breeds in monogamous pairs and nests are usually concentrated together in loose colonies with other pairs. In Australia the breeding season begins in August and carries through until January. Nests are constructed in a chamber at the end of a long burrow that is excavated by the pair. Burrows are typically recorded in flat or sloping ground in a variety of locations where suitable sandy loam substrate occurs (DotE, 2016b).

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
<i>Numenius madagascariensis</i>	Eastern Curlew	CE	VU & IA	The Eastern Curlew is a large wader with a long neck, long legs, and a heavy bill that curves downwards. Within Australia, the Eastern Curlew has a primarily coastal distribution and is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. The birds are also found in saltworks and sewage farms (Marchant & Higgins 1993). Threats to the Eastern Curlew include human disturbance, habitat loss and modification, pollution and hunting (DoTE, 2016b).
<i>Tringa nebularia</i>	Common Greenshank	Migratory / Marine	IA	The Common Greenshank is a heavily built, elegant wader, 30–35 cm in length, with a wingspan of 55–65 cm and weight up to 190 g. The Common Greenshank does not breed in Australia, but does occur in all types of wetlands and has the widest distribution of any shorebird in Australia (DoTE, 2016). Within Australia, threats to the Common Greenshank include loss and modification of habitat; silt, weeds or pest invasion; disturbance and introduced species (DoTE, 2016b).

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
Mammals				
<i>Isoodon obesulus fusciventer</i>	Quenda, Southern Brown Bandicoot	-	P4	The Quenda or Southern Brown Bandicoot is a small marsupial with coarse dark grey / yellow brown fur above, creamy-white below and a short, tapered, dark brown tail (DPaW, 2016). It is found in woodland, heath and shrub communities on the Swan Coastal Plain and prefers a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan 2008). Key threatening processes for the Quenda include habitat loss and degradation, road trauma and predation by introduced carnivores.
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	V	EN	The Western Ringtail Possum is a medium sized nocturnal marsupial, up to 1.3 kg in weight and approximately 40 cm in body length. Its fur is dark brown above with cream to grey fur underneath, with a strong prehensile tail (Van Dyck & Strahan 2008). The Western Ringtail Possum has a patchy distribution in predominantly two areas: near Bunbury to Leeuwin-Naturaliste National Park (with a small translocated subpopulation near Dawesville); and near Albany. Habitat parameters affecting the distribution of the subpopulation on the Swan Coastal Plain are associated with stands of myrtaceous trees (usually <i>Agonis flexuosa</i>) growing near swamps, water courses or floodplains, and at topographic low points which provide cooler, often more fertile, conditions (DoTE, 2016). The main threats to the Western Ringtail Possum include climate change and extreme weather events, predation by the European Red Fox (<i>Vulpes vulpes</i>) and the Cat (<i>Felis catus</i>), inappropriate fire regimes, and habitat loss and fragmentation (Woinarski <i>et al.</i> , 2014).

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
Reptiles				
<i>Lerista lineata</i>	Lined Skink	-	P3	<i>Lerista lineata</i> is a small reptile growing to 11 cm long, with characteristic dark brown ventral stripes (Storr <i>et al.</i> , 1999). This burrowing species is found in loose sand beneath logs and termite mounds and inhabits coastal heath and shrubland areas in the southwest and midwest coast of Western Australia (Wilson & Swan, 2010).
Invertebrates				
<i>Synemon gratiosa</i>	Graceful Sunmoth	-	P4	The Graceful Sunmoth is a medium-sized diurnal flying sunmoth that is similar in appearance to a butterfly. It has a wingspan of 25–35 mm with females generally larger than males. The upper surface of the forewings is dark grey, whereas the upper surface of the hind wings and the entire underside of all the wings are bright orange, with some dark grey markings (TSSC, undated). The Graceful Sunmoth is found only in southwest Western Australia, along a narrow strip of approximately 630 km of coastal habitat, from Kalbarri to Binningup (DEC, 2012). The main threats to this species are clearing of habitat for urban, rural and industrial development, particularly in the greater Perth to Peel urban area (Yanchep to Dawesville), and inappropriate management of habitat (TSSC, undated).

Note: Species listed as Marine under the EPBC Act are only considered conservation significant when in a Commonwealth marine reserve.

5.4 Black Cockatoos

5.4.1 Carnaby's Black Cockatoos

Carnaby's Black Cockatoo is endemic to the southwest of Western Australia, extending from the Murchison River to Esperance, and inland to Coorow, Kellerberrin and Lake Cronin (DotE, 2016). This black cockatoo has a white patch on its cheek, white bands on its tail, and a strong curved bill.

Carnaby's Black Cockatoo feed on seeds, nuts and flowers of a variety of native and exotic plants. Feed plants include the various proteaceous species (e.g. *Banksia*, *Grevillea* and *Hakea*), *Corymbia calophylla* (Marri), *Eucalyptus* (e.g. Jarrah [*Eucalyptus marginata*]), and seeds from the cones of Pine trees (*Pinus* sp.).

Carnaby's Black Cockatoo display strong pair bonds and nest in the hollows of live or dead mature eucalypts including Salmon Gum (*Eucalyptus salmonophloia*), York Gum (*Eucalyptus loxophleba* subsp. *loxophleba*), Flooded Gum (*Eucalyptus rudis*), Karri (*Eucalyptus diversicolor*), Marri (*Corymbia calophylla*), Wandoo (*Eucalyptus wandoo*) and Tuart (*Eucalyptus gomphocephala* [DSEWPaC, 2012]). Nest hollows generally range from 2.5-12 m above ground, size of entrance from 23-30 cm and depth of hollows from 1-2.5 m (Johnstone & Storr, 1998). On the SCP, Carnaby's Black Cockatoo are known to breed in small numbers at Regans Ford, Yancheep, Gingin, Mandurah and Bunbury (Johnstone & Johnstone, 2004). The species appears to be expanding its current breeding range westward and south into the Jarrah-Marri forests of the Darling Range and into the Tuart forests of the SCP (Johnstone & Kirkby, 2006). After breeding, Carnaby's Black Cockatoo disperse to the higher rainfall coastal areas of the south-west of Western Australia to feed in late December to July (DEC, 2009). Breeding has been recorded from early July to mid-December.

Carnaby's Black Cockatoo has undergone a dramatic decline of approximately 50 percent in the past 45 years, with the main contributing factors the clearing of core breeding habitat in the wheatbelt, the deterioration of nesting hollows, and clearing of foraging habitat.

Under the Perth-Peel strategic assessment, it is proposed that a minimum of 116,000 ha of additional conservation reserves be created that supports suitable Carnaby's habitat including the replacement of 5,000 ha of pines (Government of Western Australia, 2015).

5.4.2 Forest Red-tailed Black Cockatoos

The Forest Red-tailed Black Cockatoo is endemic to the south-west humid and semi-humid zones of Western Australia, where it inhabits dense Jarrah, Karri and Marri forests which receive more than 600 mm average annual rainfall (DSEWPaC, 2012). The species has a pair of black central tail feathers and a bright red, orange or yellow barring on the tail.

This species predominantly feeds in eucalypt forests, preferring Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) seeds, but also feeding in Blackbutt (*Eucalyptus patens*), Albany Blackbutt (*Eucalyptus staeri*), Karri (*Eucalyptus diversicolor*), Sheoak (*Allocasuarina fraseriana*) and Snottygobble (*Persoonia longifolia*) (Johnstone, 2016 pers. comm.). Forest Red-tailed Black Cockatoos are monogamous and pairs nest in tree hollows from 6.5–33 m above ground. Most nests are in very large and very old, mature Marri (*Corymbia calophylla*) (Johnstone, Kirkby & Sarti, 2013), though they will nest in other eucalypts such as Tuart (Johnstone, 2016 pers. comm.).

The modelled distribution of Forest Red-Tailed black Cockatoos in the *Referral Guidelines for three threatened black cockatoo species* (DSEWPaC, 2012) ranges from Perth to Albany encompassing the south west of the state. Formerly common, but now rare to uncommon and patchily distributed, the Forest Red-tailed Black Cockatoo has disappeared from about 30% of its former range. It has suffered a marked decline in numbers over the past 60 years because of the destruction and fragmentation of habitat (especially Jarrah-Marri forest), the apparent decline in Marri along the eastern side of the Darling Scarp (possibly due to climate change), logging, the impact of competitors for nest hollows, and fire (Chapman, 2008).

According to Johnstone *et al.* (2013) the foraging ecology of the Forest Red-tail is changing as their range is expanding. New foraging species, including introduced species, are being added to their diet. Lack of food and the discovery of new food sources is leading this change in foraging range. Sedentary flocks are now becoming regular visitors to the Swan coastal Plain, particularly for breeding. Principal foods are Marri and Jarrah with less important foods including Blackbutt, Sheoak, *Hakea*, introduced eucalypts and cape lilac.

Habitat mapping for the Forest Red-tail was undertaken as part of the Strategic Assessment for the Perth and Peel Regions (Government of Western Australia, 2015). In the Strategic Assessment the following plant species were included as target species for the feeding habitat layer for the Forest Red-tailed Black Cockatoo and are also used by Carnaby's Cockatoo: Marri (*Corymbia calophylla*), Jarrah (*Eucalyptus marginata*), Parrot Bush (*Banksia sessilis*), Wandoo (*E. wandoo*), Flooded Gum (*E. rudis*) and Tuart (*E. gomphocephala*). The majority of the Survey Area was mapped as Forest Red-tailed Black Cockatoo habitat in the *Draft EPBC Act Strategic Impact Assessment Report Part D: MNES Assessment*.

The potential for Flooded Gum (*E. rudis*) and Tuart (*E. gomphocephala*) as forage species was discussed with Johnstone as part of this survey and he confirmed that these species were not foraging species. Contradictions regarding foraging species for the Forest Red-tailed Black Cockatoo have caused difficulty with determining foraging habitat at the Survey Area. Species ultimately used to define habitat for this report were those as listed in Table 9.

5.4.3 Baudin's Black Cockatoo

Baudin's Black Cockatoo is distributed throughout the south-western humid and subhumid zones, from the northern Darling Range and adjacent far east of the SCP (south of the Swan River), south to Bunbury and across to Albany (Johnstone & Storr 1998). It is a large black cockatoo with rectangular white patches in the tail. Males have a pink eye ring, the female a dark eye ring.

Baudin's Black Cockatoo forages primarily in eucalypt forest, where it feeds on seeds, flowers, nectar and buds from Marri (*Corymbia calophylla*), and seeds of *Eucalyptus* and proteaceous species (e.g. *Banksia* and *Hakea*), as well as orchard fruits and Pines (*Pinus* sp.). It also takes insect larvae and insects (including beetle, wasp and moth larvae) from under bark and in wood of live and dead trees, from galls and from flower spikes of *Xanthorrhoea* and the pith of *Anigozanthos flavidus* (Johnstone & Kirkby, 2008).

This black cockatoo primarily nests in tree hollows in live or dead Karri (*Eucalyptus diversicolor*), Marri (*Corymbia calophylla*), Wandoo (*Eucalyptus wandoo*) and Tuart (*Eucalyptus gomphocephala* [DSEWPac, 2012]). Baudin's Black Cockatoo nests in spring in the deep southwest of Western Australia. It has suffered a substantial decline in numbers in the past 50 years. Direct causes of population decline include large numbers shot by orchardists, fragmentation of habitat and the impact of hollow competitors.

6.0 Field Results

6.1 Vegetation

6.1.1 Threatened and Priority Ecological Communities

6.1.2 Commonwealth

No EPBC Act listed vegetation communities occur within the Survey Area.

6.1.3 State

One State-listed TEC occurs within the Survey Area, as identified in the desktop assessment. The TEC FCT26a – *Melaleuca huegelii* – *Melaleuca acerosa* (*systema*) Shrublands on Limestone Ridges occurs at two distinct locations in the Survey Area. This community was confirmed by the presence of the two keystone species *Melaleuca huegelii* and *M. systema*, and the limestone outcropping. The results coincide with ENV (2009) results. This TEC is mapped as MsTd, and was rated as being in predominantly 'Very Good' condition. This community extends over 202 ha and is described in more detail in Table 18.

The TEC FCT18 Shrublands on calcareous silts may have been recorded during the 2016 field survey. ENV (2009) mapped this as potentially occurring within the 2016 mapping code MrGtHg. This community is dominated by *Melaleuca teretifolia* and *M. raphiophylla* over *Gahnia trifida*, which is consistent with some of the species characterising FCT18. A Level 2 flora and vegetation survey incorporating permanent quadrats sampled over multiple seasons would be required to ascertain the presence of this TEC. Quadrat data could then be used to infer a FCT by undertaking data analysis such as similarity indices and hierarchical clustering methods.

The Priority 3 PEC SCP25 – Southern *Eucalyptus gomphocephala*-*Agonis flexuosa* woodlands were recorded on the Cottesloe Complex – central and south (part of the Spearwood complex) at Lake Clifton. This PEC corresponds to parts of AfHcEp, AfXpHg, AfXpHh and EgMhAp where these communities intersect with the Cottesloe or Quindalup complexes. Similarly, another Priority 3 PEC, SCP30b – Quindalup *E. gomphocephala* and/or *A. flexuosa* woodlands that are restricted to the Quindalup system also occur at Lake Clifton. This community corresponds to EgMhAp and parts of AfHcEp.

The Priority 3 PEC SCP29a – Coastal shrublands on shallow sands and SCP29b – *Acacia* shrublands on taller dunes are restricted to the Quindalup dunes system. These PECs are known to occur within the Survey Area (DPaW records) and potentially correspond to ArMsTd. A Level 2 flor and vegetation survey including quadrat sampling over multiple seasons would be required to undertake data analysis to infer these FCTs with confidence. Vegetation communities, their detailed descriptions, and inferred TEC or PEC are presented in Table 18.

6.1.4 Vegetation communities



Two vegetation community maps have previously been developed for the Survey Area including the Freeman *et al.* (2009) broadscale vegetation mapping and the ENV (2009) Clifton Beach Flora and Vegetation Assessments. A review of ENV (2009) indicates that their vegetation map was produced by someone prior to their assessment, however no reference is given and none of the other studies are available for consideration. The two available maps show two extremes of scale for mapping vegetation.



Freeman *et al.* (2009) mapped four broad vegetation groups at Lake Clifton, based on DPaW mapping and FCT mapping. This vegetation map generally coincides with the Heddle *et al.* (1980) vegetation association mapping.



ENV (2009) mapped 68 vegetation communities, capturing a level of detail considered unnecessary for this assessment. On-ground observations and floristic data captured in 63 relevés were used to produce an updated vegetation map at a 1:35,000 scale.


Following the field survey in June 2016, the floristic data captured in relevés were used to inform the vegetation mapping. Hierarchical clustering was undertaken to determine the relationships between relevés and illustrate groupings of similar sites. This led to 15 communities being described in Table 18 and mapped in Figure 8. These vegetation communities are similar to those described in ENV (2009) and Freeman *et al.* (2009).



Table 18 Vegetation communities

Community	Vegetation description	Photograph(s)
Woodland communities		
AfHcEp	<p><i>Agonis flexuosa</i> mid open forest with emergent <i>Eucalyptus gomphocephala</i> over <i>Hibbertia cuneiformis</i>, <i>Xanthorrhoea preissii</i> and <i>Clematis linearifolia</i> mid sparse shrubland over <i>Euphorbia peplus</i>, <i>Geranium molle</i>, and <i>Trachyandra divaricata</i> low sparse forbland.</p> <p>This community has pockets of rehabilitation. Soils of the community are sand or sandy loam and vegetation condition ranges from 'Good' to 'Very Good' Condition associated largely with the presence of understorey weeds, evidence of disturbance by rabbits and lack of native understorey vegetation in places.</p> <p>Area: 134.89 ha Sites: five relevés (including 2, 3, 4, 13, 39) Species richness: 10 native and 14 weed species Significance: Potential for portions of this community that occur on Cottesloe or Quindalup Complex to represent Priority 3 PECs SCP25 or SCP30b</p>	
AfXpHg	<p><i>Agonis flexuosa</i> and <i>Eucalyptus marginata</i> mid woodland with emergent <i>Eucalyptus gomphocephala</i> over <i>Xanthorrhoea preissii</i>, <i>Hakea lissocarpa</i> and <i>Hardenbergia comptoniana</i> low to tall open shrubland over <i>Hypochaeris glabra</i> and <i>Lysimachia arvensis</i> low sparse forbland.</p> <p>Soils of this community were recorded as dark brown sands with loam in places. Vegetation condition was 'Very Good', influenced by the presence of understorey weeds and evidence of previous human disturbance.</p> <p>Area: 11.87 ha Sites: two relevés (1, 62) Species richness: 24 native and six weed species Significance: Potential for portions of this community that occur on Cottesloe complex to represent Priority 3 PEC SCP25</p>	

Community	Vegetation description	Photograph(s)
<p>AfXpHh</p>	<p>Low to mid open to closed forest of <i>Agonis flexuosa</i>, <i>Eucalyptus gomphocephala</i> and occasional <i>Banksia grandis</i> over <i>Xanthorrhoea preissii</i>, <i>Templetonia retusa</i> and occasional <i>Banksia sessilis</i> var. <i>cygnorum</i> tall open shrubland over <i>Hibbertia hypericoides</i> and <i>Macrozamia riedlei</i> sparse to open low shrubland.</p> <p>This vegetation communities has areas of the Declared Pests <i>Gomphocarpus fruticosus</i> and <i>Zantedeschia aethiopica</i>. Within the community there are occasional <i>Banksia attenuata</i>, <i>Banksia littoralis</i> and <i>Banksia grandis</i> as well as <i>Eucalyptus petrensis</i> along ecotones and <i>Nuytsia floribunda</i>. The soil type within the community comprised white to brown sand and loam. Vegetation condition ranged between 'Very Good' and 'Excellent' reflecting generally relatively low intensity of weeds and also evidence of disturbance by rabbits.</p> <p>Area: 95.93 ha Sites: eight relevés (8, 9, 10, 11, 23, 24, 25, 30) Species richness: 51 native and 10 weed species Significance: Potential for portions of this community that occur on Cottesloe complex to represent Priority 3 PEC SCP25</p>	
<p>EgMhAp</p>	<p>Isolated tall trees of <i>Eucalyptus gomphocephala</i> over mid woodland of <i>Agonis flexuosa</i> and occasional <i>Santalum acuminatum</i> over <i>Melaleuca huegelii</i> subsp. <i>huegelii</i>, <i>Acacia rostellifera</i> and <i>Clematis linearifolia</i> tall shrubland over <i>Acanthocarpus preissii</i>, <i>Trachyandra divaricata</i> and <i>Euphorbia peplus</i> closed low forbland.</p> <p>Soil was a sandy loam, brown in colour reflecting the presence of organic matter. Vegetation condition was recorded as 'Good' due to the presence of weeds, a low diversity of plants and the absence of much native understorey stratum.</p> <p>Area: 17.53 ha Sites: one relevé (18) Species richness: 10 native and four weed species Significance: Potential for this community to represent Priority 3 PECs SCP25 or SCP30b</p>	


Community	Vegetation description	Photograph(s)
EgMsTd	<p><i>Eucalyptus gomphocephala</i> mid woodland over <i>Melaleuca systema</i>, <i>Hibbertia cuneiformis</i> and <i>Xanthorrhoea preissii</i> mid to tall shrubland over <i>*Trachyandra divaricata</i>, <i>*Geranium molle</i> and <i>*Trifolium campestre</i> low forbland.</p> <p>Isolated <i>Acacia rostelifera</i> thickets occur within this community and occasional <i>Eucalyptus platypus</i>.</p> <p>Soil type was brown sand with loam in places. Limestone was recorded at one of the sites within this community. Vegetation condition ranged from 'Good' to 'Very Good' primarily as a result of the presence of understorey weeds, lacking native understorey species in parts and the occasional presence of planted Eucalypts.</p> <p>Area: 6.50 ha Sites: three relevés (27, 28, 45) Species richness: 22 native and 12 weed species</p>	
EgXpTd	<p><i>Eucalyptus gomphocephala</i>, <i>Agonis flexuosa</i> and <i>Banksia attenuata</i> tall open forest over <i>Xanthorrhoea preissii</i>, <i>Macrozamia riedlei</i> and <i>Hibbertia cuneiformis</i> mid to tall shrubland over <i>*Trachyandra divaricata</i>, <i>*Solanum nigrum</i> and <i>*Geranium molle</i> low isolated forbs.</p> <p>Soils comprised sand with loam and limestone was present at one site. Vegetation condition was mapped as 'Very Good'. Condition was affected by the presence of understorey weeds.</p> <p>Area: 26.44 ha Sites: two relevés (15, 22), one opportunistic (20) Species richness: 12 native and six weed species</p>	


Community	Vegetation description	Photograph(s)
Heath and Shrubland communities		
MsTd	<p>Mid to tall heathland to closed heathland of <i>Melaleuca systema</i>, <i>Hibbertia cuneiformis</i> and <i>Templetonia retusa</i> over <i>*Trachyandra divaricata</i>, <i>*Hypochaeris glabra</i> and <i>*Arctotheca calendula</i> low forbland.</p> <p>Sandy loam soils with limestone outcrops. Vegetation condition ranged from 'Good' to 'Excellent', primarily affected by the presence of common weeds and the Declared Pest <i>*Gomphocarpus fruticosus</i>. In the southern portion of the Survey Area the vegetation condition reflects an altered structure resulting from historical linear row clearing. This community contains isolated pockets of mallee trees including <i>Agonis flexuosa</i>, <i>Hakea prostrata</i>, <i>Eucalyptus argutifolia</i> (Threatened), <i>Eucalyptus foecunda</i>, <i>Eucalyptus petrensis</i>, <i>Eucalyptus decipiens</i> and <i>Eucalyptus platypus</i> with occasional <i>Nuytsia floribunda</i>.</p> <p>Area: 202.47 ha Sites: 14 relevés (5, 6, 7, 17, 19, 29, 41, 42, 56, 57, 58, 59, 60, 61), two opportunistic (42b, 63) Species richness: 54 native and 15 weed species Significance: Likely to represent State-listed TEC FCT26a</p>	



Community	Vegetation description	Photograph(s)
ArMsTd	<p><i>Acacia rostellifera</i>, <i>Spyridium globulosum</i> and <i>Clematis linearifolia</i> tall shrubland over <i>Melaleuca systema</i>, <i>Phyllanthus calycinus</i> and <i>Acanthocarpus preissii</i> mid heathland to open heathland over low sparse to closed forbland of <i>*Trachyandra divaricata</i>, <i>*Solanum nigrum</i> and <i>*Geranium molle</i>.</p> <p>Emergent <i>Agonis flexuosa</i> and <i>Eucalyptus platypus</i> in places as well as areas of planted Eucalypts.</p> <p>Soils of this vegetation community were cream to brown sands. Condition ranged from 'Very Good' to 'Excellent'. Areas of lower condition were associated with understorey weeds.</p> <p>Area: 263.51 ha Sites: 13 relevés (sites 31, 32, 43, 54, 34, 35, 48, 49, 50, 52, 53, 46, 47), one opportunistic (site 51) Species richness: 50 native and eight weed species Significance: Potential for portions of this community located on Cottesloe or Quindalup complexes to represent Priority 3 PECs SCP29a and SCP29b, respectively</p>	
AfSgTd	<p>Isolated low trees of <i>Agonis flexuosa</i> over mid to tall shrubland of <i>Spyridium globulosum</i>, <i>Alyxia buxifolia</i> and <i>Acanthocarpus preissii</i> over low sparse forbland of <i>*Trachyandra divaricata</i> and other common annual weeds.</p> <p>Soils underlying this vegetation community are sands and limestone was evident at one site. Vegetation condition was rated as 'Excellent' with relatively minor weed incursion evident.</p> <p>Area: 17.68 ha Sites: two relevés (sites 36, 37) Species richness: 26 native and five weed species</p>	


Wetland communities	
MrGtD	<p><i>Melaleuca raphiophylla</i> and <i>Melaleuca cuticularis</i> low closed forest over <i>Gahnia trifida</i>, <i>Juncus kraussii</i> subsp. <i>australiensis</i> and <i>Lepyrodia drummondiana</i> mid to tall sedgeland over *<i>Trachyandra divaricata</i>, *<i>Geranium molle</i> and *<i>Lysimachia arvensis</i> low isolated forbs.</p> <p>This community captures three distinct zones of riparian vegetation associated with the wetland in the Survey Area. Adjacent to the open water the vegetation is characterised by <i>Melaleuca cuticularis</i> low closed forest over ?<i>Threlkeldia diffusa</i>, <i>Sarcocornia blackiana</i> and *<i>Lysimachia arvensis</i> low chenopod shrubland. This community grades to the MrGtD description as soils become less water where <i>M. cuticularis</i> is supplemented with <i>M. raphiophylla</i>. The third zone, furthest from the water becomes <i>Eucalyptus petrensis</i>, <i>Agonis flexuosa</i> and <i>Eucalyptus gomphocephala</i> mid closed forest over <i>Xanthorrhoea preissii</i>, <i>Templetonia retusa</i> and <i>Melaleuca systema</i> mid open shrubland over <i>Lepyrodia drummondiana</i> and <i>Gahnia trifida</i> tall sedgeland.</p> <p>The soils are black clay loam with some limestone present in places. Vegetation condition was rated as 'Excellent'. The condition is impacted by the presence of some weedy undergrowth and presence of the declared pest *<i>Zantedeschia aethiopica</i>.</p> <p>Area: 39.48 ha Sites: two relevés (12, 40) Species richness: 29 native and six weed species</p>

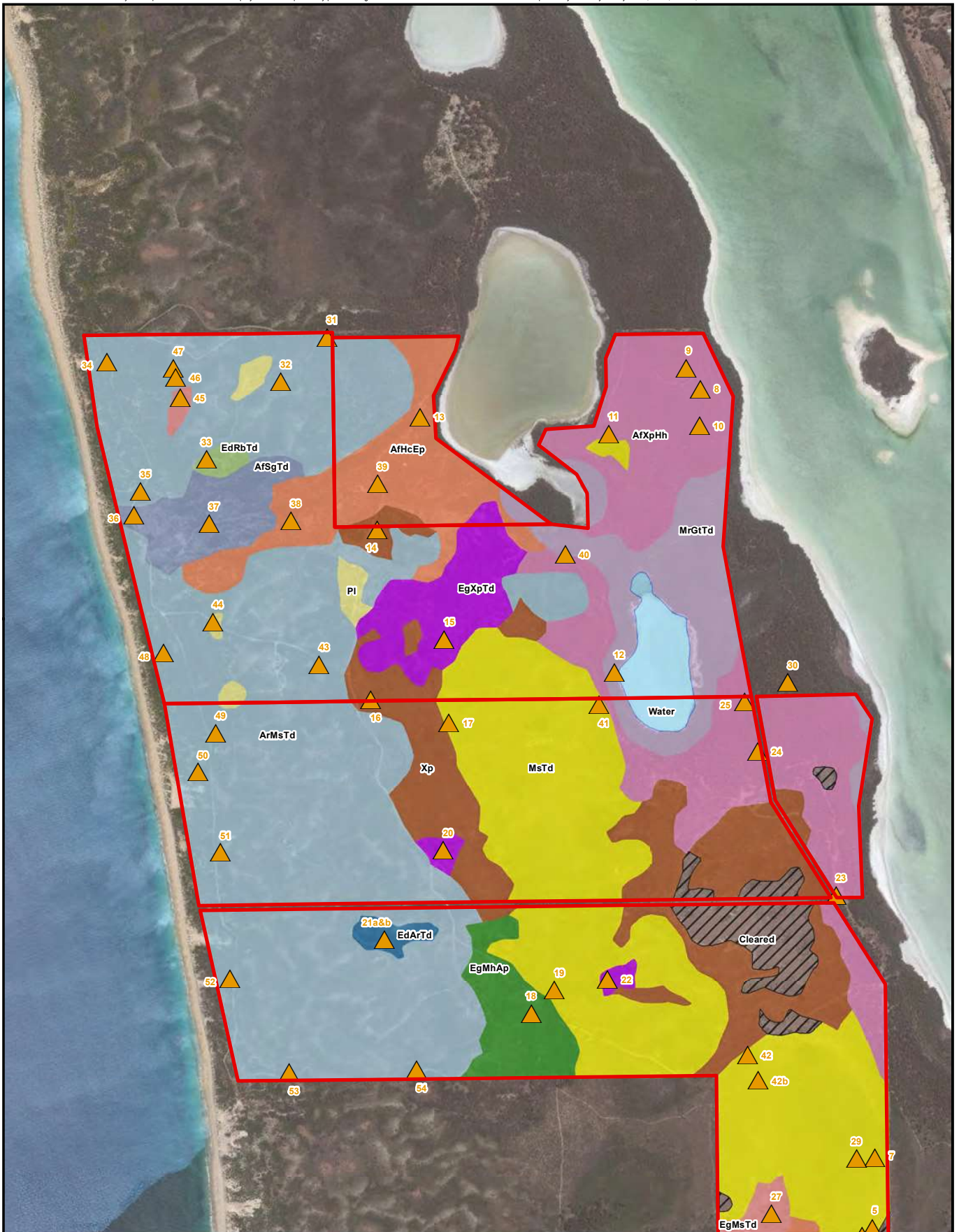


MrGtHg	<p><i>Melaleuca raphiophylla</i> and <i>Melaleuca teretifolia</i> low open forest with occasional <i>Melaleuca lanceolata</i> over <i>Gahnia trifida</i> tall sedgeland over <i>Hypochaeris glabra</i>, <i>Dittrichia graveolens</i> and <i>Lysimachia arvensis</i> low open forbland.</p> <p>This community includes occasional emergent <i>Eucalyptus gomphocephala</i> and <i>Agonis flexuosa</i>.</p> <p>Soil clay loam. Vegetation condition ranged from 'Degraded' to 'Excellent'. Areas of 'Degraded' condition are associated with historic clearing and weed incursion including the declared pest <i>Gomphocarpus fruticosus</i>.</p> <p>Area: 12.90 ha Sites: two relevés (26, 55) Species richness: nine native and 11 weed species Significance: Potential to represent the State-listed TEC FCT18</p>	
--------	---	--

EdArTd	<p>Wetland fringing vegetation comprising <i>Eucalyptus decipiens</i>, <i>Callitris preissii</i> and <i>Allocasuarina fraseriana</i> low open forest over <i>Acacia rostellifera</i>, <i>Xanthorrhoea preissii</i> and <i>Melaleuca huegelii</i> subsp. <i>huegelii</i> tall shrubland over <i>Trachyandra divaricata</i>, <i>Solanum nigrum</i> and <i>Trifolium campestre</i> low open forbland.</p> <p>Waterbody is a closed rushland dominated by <i>Typha sp.</i> and <i>Baumea juncea</i>. Some planted Eucalypts surrounding the wetland. Vegetation condition was rated as 'Good' as a result of weeds in the understorey. Soils are sand.</p> <p>Area: 3.37 ha Sites: two relevés (21a, 21b) Species richness: 17 native and four weed species</p>	
--------	---	--

EdRbTd	<p>Wetland fringing vegetation comprising <i>Eucalyptus decipiens</i>, <i>Callitris preissii</i> and <i>Melaleuca lanceolata</i> low open forest over <i>Rhagodia baccata</i> subsp. <i>baccata</i>, <i>Acacia rostellifera</i> and <i>Melaleuca huegelii</i> mid to tall shrubland over *<i>Trachyandra divaricata</i>, *<i>Solanum nigrum</i> and *<i>Geranium molle</i> low forbland.</p> <p>Wetland itself is a closed rushland of <i>Typha</i> sp. And <i>Baumea juncea</i> surrounded by <i>Melaleuca raphiophylla</i>, <i>Allocasuarina fraseriana</i> and Planted Eucalypts.</p> <p>Soil at the site is sand. Vegetation condition was rated as 'Very Good' due to the presence of weeds.</p> <p>Area: 2.11 Sites: one relevé (33) Species richness: 18 native and 3 weed species</p>	
AfDdLg	<p><i>Agonis flexuosa</i> mid woodland with emergent <i>Eucalyptus gomphocephala</i> over <i>Diplolaena dampieri</i>, <i>Alyxia buxifolia</i> and <i>Hibbertia cuneiformis</i> mid to tall open shrubland over <i>Lepidosperma gladiatum</i>, *<i>Trachyandra divaricata</i> and *<i>Geranium molle</i> tall closed sedgeland</p> <p>Area: 0.09 ha Sites: one relevé (38) Species richness: 11 native and five weed species</p>	

Modified communities		
Xp	<p><i>Xanthorrhoea preissii</i> tall shrubland over common weeds.</p> <p>Vegetation condition was rated as 'Good' due to the absence of an over storey and the presence of common weeds. Soils were sand and loam. Scattered limestone was observed in some areas.</p> <p>Area: 85.62 ha Sites: two relevés (14, 16), one opportunistic (59b) Species richness: 10 native and nine weed species</p>	
Cleared	<p>Cleared of native vegetation Area: 40.68 ha</p>	None available
PI	<p>Planted Eucalypts sometimes over sparse native and/or non-native shrubs over common annual weeds such as <i>*Trachyandra divaricata</i>.</p> <p>Area: 5.48 ha Sites: one opportunistic (44)</p>	None available
Water	<p>Water Area: 12.40 ha</p>	None available



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY FDW LAST MODIFIED 19 AUG 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50 0 150 300 450 600 metres 1:20,000 when printed at A4</p>		<p>LEGEND</p> <table border="0"> <tr> <td> Survey Area</td> <td> AfXpHh</td> <td> EgXpTd</td> </tr> <tr> <td> Relevés</td> <td> AfXpHhHg</td> <td> MrGtHg</td> </tr> <tr> <td>Community</td> <td> ArMsTd</td> <td> MrGtTd</td> </tr> <tr> <td> AfDdLg</td> <td> Cleared</td> <td> MsTd</td> </tr> <tr> <td> AfHcEp</td> <td> EdArTd</td> <td> Water</td> </tr> <tr> <td> AfSgTd</td> <td> EdRbTd</td> <td> Xp</td> </tr> <tr> <td> AfXpHg</td> <td> EgMhAp</td> <td></td> </tr> <tr> <td></td> <td> EgMsTd</td> <td></td> </tr> </table>		Survey Area	AfXpHh	EgXpTd	Relevés	AfXpHhHg	MrGtHg	Community	ArMsTd	MrGtTd	AfDdLg	Cleared	MsTd	AfHcEp	EdArTd	Water	AfSgTd	EdRbTd	Xp	AfXpHg	EgMhAp			EgMsTd		<p>Vegetation Community Mapping</p> <p>MAIN ROADS</p> <p>LAKE CLIFTON BIOLOGICAL ASSESSMENT</p>	
Survey Area	AfXpHh	EgXpTd																											
Relevés	AfXpHhHg	MrGtHg																											
Community	ArMsTd	MrGtTd																											
AfDdLg	Cleared	MsTd																											
AfHcEp	EdArTd	Water																											
AfSgTd	EdRbTd	Xp																											
AfXpHg	EgMhAp																												
	EgMsTd																												
			<p>Figure 8</p>																										

6.1.5 Condition

Vegetation condition varied from 'Excellent' to 'Completely Degraded'. A large portion of the vegetation was mapped as 'Excellent', extending over 333 ha (comprising 34 % of the Survey Area). The major contributing factors causing degradation are historical clearing, altered fire regimes and weed invasion.

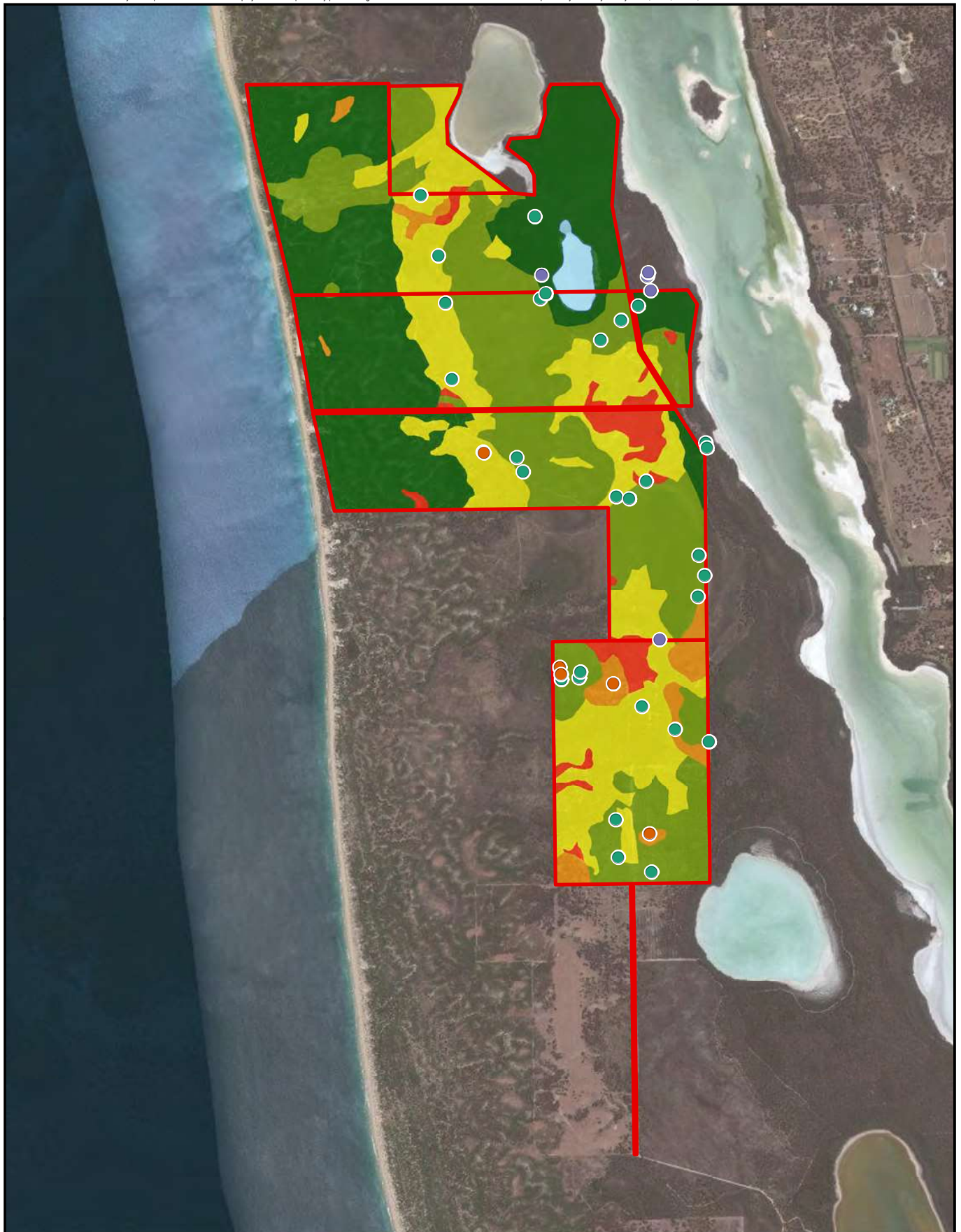
Altered fire regimes may have led to ecological change in Tuart forests within and adjacent to Yalgorup National Park (Bradshaw, 2000; Ward, 2000). Since the Yalgorup National Park was declared protected in 1968, fire frequency declined considerably as a fire exclusion zone was implemented (Longman & Keighery, 2002). Fires are essential for recruitment and persistence of obligate seeder plant species (i.e. *Banksia* species [Australian Government, 2011]).

Weed invasion, particularly invasive species that dominate and displace native vegetation put pressure on land environmental values and impact on biodiversity (Australian Government, 2011). A total of 20 weed species were recorded within 86% of relevés completed. Weeds are considered one of the major threats to the natural environment, destroying native habitats, threatening native plants and animals, and choking our natural systems including rivers and forests (Australian Government, 2016).

Vegetation condition has been mapped in Figure 9 and their relative extent shown in Table 19.

Table 19 Vegetation condition mapped within the Survey Area

Condition Rating	Area (ha)	Percentage of Survey Area (%)
Excellent	333.60	34.10
Very Good	314.87	32.19
Good	241.58	24.70
Degraded	35.13	3.59
Completely Degraded	40.63	4.15



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY FDW LAST MODIFIED 19 AUG 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 270 540 810 1,080 metres</p> <p>1:35,000 when printed at A4</p>	<p>LEGEND</p> <p> Survey Area</p> <p>Declared Pest Weeds Locations</p> <ul style="list-style-type: none"> ● <i>Gomphocarpus fruticosus</i> ● <i>Solanum linnaeanum</i> ● <i>Zantedeschia aethiopica</i> <p>Condition</p> <ul style="list-style-type: none"> Water Excellent Very Good Good Degraded Completely Degraded <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Geotraining, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Vegetation Condition Mapping</p> <hr/> <p>MAIN ROADS</p> <p>LAKE CLIFTON BIOLOGICAL ASSESSMENT</p> <p style="text-align: right;">Figure 9</p>
---	--	--

6.2 Flora

6.2.1 Threatened and Priority flora

One EPBC Act listed species, *Eucalyptus argutifolia*, was confirmed to occur within the Survey Area at one location. At the time of the field survey, no spatial data for *Eucalyptus argutifolia* as mapped by Weston (2003) and ENV (2009) was available, therefore only the DPaW location was visited.

The Priority 3 species *Stylidium maritimum* was confirmed to occur on the sand dunes that extend north to south along the western edge of the Survey Area. No flowers were present at the time of the survey, which affected detection rates. Their distinctive leaves and colour assisted in the accurate identification in the field in the vicinity of ENV (2009) records.

6.2.2 Diversity

A total of 131 species from 85 genera and 48 families were recorded. The total includes 110 (84%) locally native species and 20 (16%) introduced (exotic) or naturalised weed species. A number of planted species were observed however no effort was spent to identify these to species level.

Families with the highest representation are Myrtaceae (17 native, one planted), Fabaceae (14 taxa; 11 native and three introduced) and Proteaceae (11 taxa; nine native and two introduced). The full list of vascular flora species recorded and representative communities in which they occur in are presented in **Appendix E**. Qualitative data recorded from individual quadrats is presented in **Appendix F**.

Diversity for the 2016 survey was lower than previously recorded, with ENV (2009) recording 179 taxa from 53 families and Weston (2003) recording 202 taxa across 65 families. This could be representative of the survey timing and the disturbance of weed invasion.

The ENV (2009) species list was merged with the current species list to provide one comprehensive overview of floristic diversity within the Survey Area (**Appendix G**). Following the merge of species lists, a total of 223 species from 138 genera and 61 families have been recorded. The total includes 161 (72%) locally native species. Of note is the number of Poaceae (grass) species collected previously (22 species) compared to the 2016 survey (two species).



Plate 1 Conservation significant species from left to right: EPBC Act-listed Threatened *Eucalyptus argutifolia*; Priority 3 *Stylidium maritimum*

6.2.3 Weeds

A total of 21 weeds were recorded during the field survey. This included three species listed as Declared Pests under the BAM Act. Details of the three Declared Pests are provided in Table 20 and Plate 2.

Weeds were observed throughout the entire Survey Area. In particular, the extensive spread of *Trachyandra divaricata* and the Declared Pest *Gomphocarpus fruticosus* led to a lower rating of vegetation community condition. The most common weeds recorded within sample sites were *Trachyandra divaricata* (48 sites), *Lysimachia arvensis* (35 sites) and *Solanum nigrum* and *Hypochaeris glabra* (33 sites each). The impacts of weeds have been previously discussed in Section 6.1.5. Examples of weed infestations observed are shown in Plate 3.

A complete list of weeds, their common names, their WA weed strategy rating (CALM, 1999) and the Swan Priority rating (Bettink & Keighery, 2008) is provided in **Appendix H**.



Plate 2 Declared Pests from left to right: *Gomphocarpus fruticosus*, *Solanum linnaeanum* and *Zantedeschia aethiopica*

Table 20 Declared Pests

Taxon	Details	Reproduction and Dispersal ¹	BAM Act Category
<i>Gomphocarpus fruticosus</i> Narrow Leaf Cotton Bush	Widely dispersed throughout the area with only the sand dunes excluded. 30 locations recorded, representing 1,622 individuals. This is a conservative estimate as not all individuals were counted or recorded due to the extent of the infestation.	From seed and suckers from lateral roots closest to the soil surface. Seeds are commonly spread by wind and water.	Declared Pest – C3, s22(2) across entire State.
<i>Solanum linnaeanum</i> Apple of Sodom	Four populations recorded, representing 22 adult plants and two juveniles.	From seed. Seeds do not disperse far from parent plants but fruit may be dragged when prickly fruit get attached to animals.	Declared Pest – C3, s22(2) in Shire of Waroona and Shire of Mandurah
<i>Zantedeschia aethiopica</i> Arum Lily	Recorded at five locations representing 35 juvenile individuals. No flowers present at the time of the survey.	Reproduces from seed and vegetatively via rhizomes and tubers. Seeds dispersed via water movements, birds and other animals. Local spread occurs from rhizomes.	Declared Pest – C3, s22(2) across entire State

1. Details derived from Identic (2016).



Plate 3 Weed invasion from top to bottom left to right: *Trachyandra divaricata invasion in cleared area; typical weed understory of *Agonis flexuosa* woodlands; **Solanum nigrum* juvenile with **Lysimachia arvensis*.

6.3 Fauna

6.3.1 Fauna species

Forty-two fauna species were recorded during the field survey. This comprised 31 bird, eight mammal, one reptile and two amphibian species. The full species list is presented in **Appendix I**. Of the 42 fauna species, 11 species were of conservation significance. These 11 conservation significant fauna species comprised nine bird and two mammal species. These are listed and discussed in Table 21.

6.3.1.1 Introduced fauna

Six introduced fauna species were recorded at Lake Clifton. These comprised:

- Dog (*Canis lupis familiaris*)
- European Wild Rabbit (*Oryctolagus cuniculus*) Declared Pest - s22(2) (C3 Prohibited)
- House Mouse (*Mus musculus*)
- Red Fox (*Vulpes vulpes*) Declared Pest - s22(2) (C3 Exempt)
- Laughing Kookaburra (*Dacelo novaeguineae*)
- Laughing Turtle-dove (*Streptopelia senegalensis*).

The European Wild Rabbit and the Red Fox are both listed as Declared Pests under the BAM Act. Most species were recorded intermittently during the field survey, identified either by sight, call, scats, den or tracks.

6.3.2 Fauna habitat

Five main fauna habitats (including Cleared Areas) have been defined and mapped within the Survey Area (Table 22 and Figure 10). The delineation of fauna habitats considered the fauna habitat field assessments and the vegetation mapping.

The most common fauna habitat was the mid to tall shrubland / heathland at approximately 57% of the Survey Area. This is a varied habitat that would generally support many of the common species of the area, as recorded during the field survey. It would also be utilised by many of the conservation significant fauna species recorded at Lake Clifton such as Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), Quenda (*Isoodon obesulus fusciventer*), Nankeen Kestrel (*Falco cenchroides*) and Magpie-lark (*Grallina cyanoleuca*).

The second most common habitat was the *Agonis flexuosa* and Tuart forest. This habitat covered approximately 30% of the Lake Clifton Survey Area. This habitat was also varied but generally contained an open Tuart overstorey over an open to closed *Agonis flexuosa* layer over an open shrub layer. The conservation significant fauna species that would potentially utilise this habitat include Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), Quenda (*Isoodon obesulus fusciventer*), Western Ring-tail Possum (*Pseudocheirus occidentalis*), Whistling Kite (*Haliastur sphenurus*) and Southern Boobook (*Ninox novaeseelandiae*).

Table 21 Conservation Significant Fauna Recorded during the Field Survey

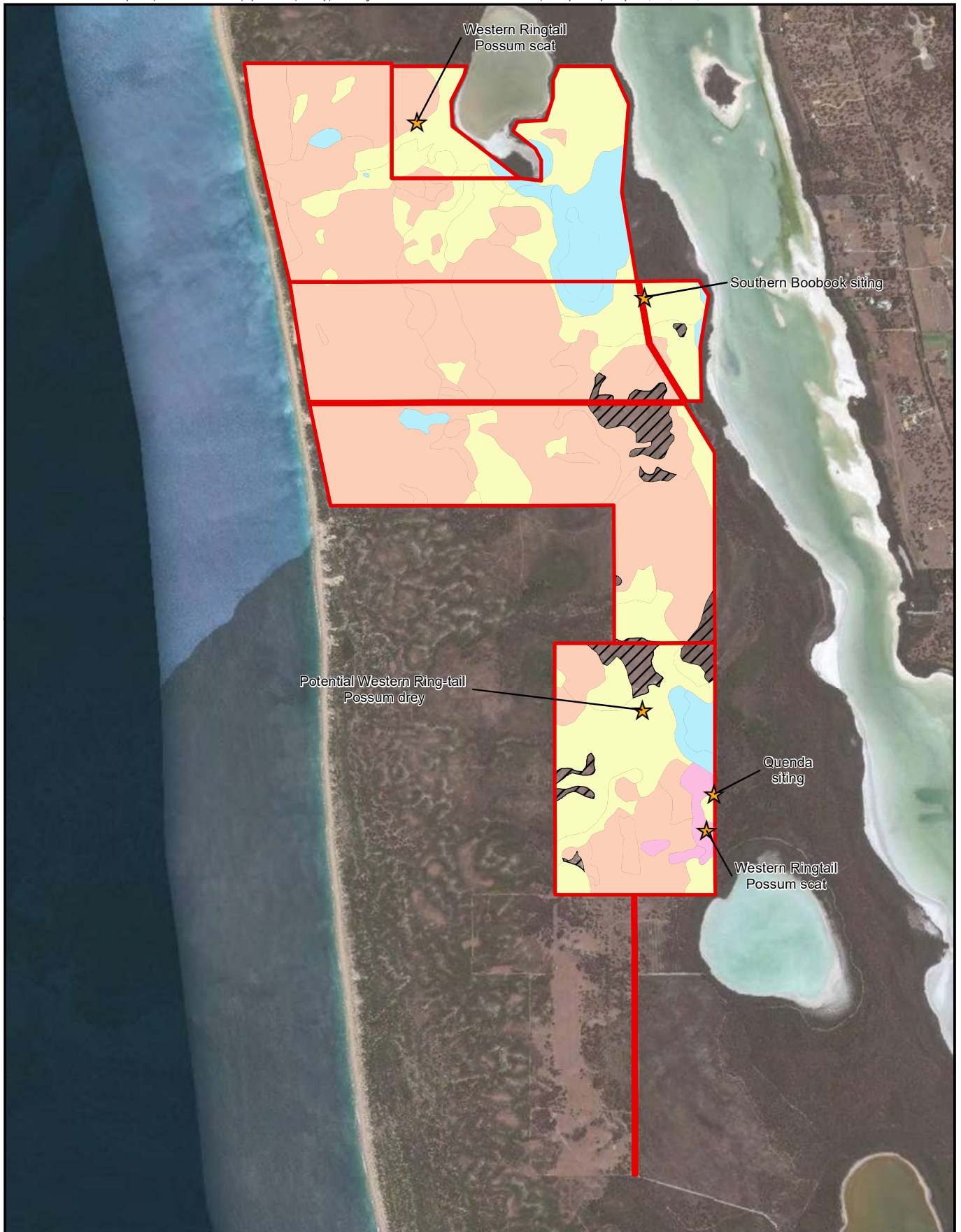
Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
Birds				
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	Marine	-	The Fan-tailed Cuckoo is a slender cuckoo with the adult having a yellow eye ring, dark slate-grey back and wings, with a boldly barred black and white under tail. Younger birds are duller and browner in colour. This species is found in all kinds of well wooded habitats from Karri forests to Acacia thickets (Johnstone and Storr, 1998), and can be found in eastern Australia, southern south Australia, Tasmania and the southwest of Western Australia (Pizzey & Knight, 2007). This bird was heard in the woodland habitats of the Project area.
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	E	EN	Refer to Sections 6.3.3.
<i>Circus approximans</i>	Swamp Harrier	Marine	-	The Swamp Harrier is a large slim-bodied raptor with long slender legs and a long, round-tipped tail, rounded at the tip. It is mainly dark brown above and the white rump is prominent. It has an owl-like face mask. The Swamp Harrier feeds mainly on birds and rats (Johnstone and Storr, 1998). The Swamp Harrier inhabits swamps and wetlands, tall grasslands, grain crops, coasts, islands, heathlands, saltmarshes, bracken and bore drains (Pizzey and Knight, 2010). At Lake Clifton this species was recorded flying over the unnamed wetland within the Project area. The Swamp Harrier is widespread in Australasia and the South Pacific.
<i>Falco cenchroides</i>	Nankeen Kestrel	Marine	-	The Nankeen Kestrel is a slender falcon and a relatively small raptor with the upper parts mostly rufous and some dark streaking. The wings are tipped with black and the underparts are pale buff, streaked with black. The under tail is finely barred with black, with a broader black band towards the tip. The Nankeen Kestrel's diet is varied, feeding mainly feeds on small mammals, reptiles, small birds and a variety of insects. Once prey is spotted, the bird drops nearer to the ground until it is close enough to pounce. Preferred habitats of the Nankeen Kestrel are lightly wooded areas and open agricultural areas. A pair of Nankeen Kestrels was observed several times during the survey in the cleared area of the Project area. Nankeen Kestrels are found in most areas of Australia.

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
<i>Grallina cyanoleuca</i>	Magpie-lark	Marine	-	The Magpie-lark is a distinctively marked black and white bird with a thin bill and pale irises. The Magpie-lark is predominantly ground-dwelling, where it forages for invertebrates. It utilises most habitats and will be found anywhere there are trees and mud for nest building (Pizzey and Knight, 2010). The Magpie-lark is likely to be found in most of the fauna habitats at Lake Clifton and was recorded multiple times. Magpie-larks are confined to Australasia and found throughout Australia.
<i>Haliastur sphenurus</i>	Whistling Kite	Marine	-	The Whistling Kite is a medium-sized raptor with an almost shaggy appearance. It has a light brown head and underparts, and dark sandy-brown wings with paler undersides. Whistling Kites have been observed feeding on carrion and small birds (Johnstone and Storr, 1998). The Whistling Kite is found in a variety of habitats, usually near water, including woodlands, open country and wetlands (Pizzey and Knight, 2010). It prefers tall trees for nesting. At Lake Clifton, the Whistling Kite was observed perching on a large stag above a Wedge-tailed Eagles nest, and is likely to utilise most of the fauna habitats present. The Whistling Kite is widespread over mainland Australia.
<i>Hirundo neoxena</i>	Welcome Swallow	Marine	-	The Welcome Swallow is blue-black above and light grey on the breast and belly, with rust coloured markings on the forehead, throat and upper breast. It has a long forked tail, with a row of white spots on the individual feathers. The Welcome Swallow feeds on a wide variety of insects, which it acrobatically catches in flight. Welcome Swallows congregate in large flocks when food is abundant. Welcome Swallows frequent a wide variety of habitats with the exception of heavily forested and drier inland areas. Welcome Swallows were observed foraging over the unnamed lake to the northeast of Lake Clifton. Welcome Swallows are widespread in Australia but are scarce in the arid zone (Pizzey and Knight, 2010).

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
<i>Ninox novaeseelandiae</i>	Southern Boobook	Marine	-	The Southern Boobook is the smallest and most common owl in Australia. It has dark brown plumage above and rufous-brown below, heavily streaked and spotted with white. The facial disc is brown and its eyes are large and yellowish. Feeding generally occurs at dusk and during the night when the owl flies from its perch to capture flying insects (Pizzey and Knight, 2010) and geckos and small mammals (Johnstone and Storr, 1998). The Southern Boobook is found in a variety of habitats from dense forest to open desert. This owl was recorded twice in the northern woodlands at Lake Clifton, where it was observed flying out of hollows in mature Tuart trees. It may potentially utilise the majority of the fauna habitats. Southern Boobooks are found throughout Australia.
<i>Petrochelidon nigricans</i>	Tree Martin	Marine	-	The Tree Martin is a small dark swallow which is stubbier than a Welcome Swallow, with dull white rump and short tail (Pizzey and Knight, 2010). Tree Martins eat insects which they mainly catch in flight. Tree Martins are found in the air above a range of habitats including open country with large trees, watercourses, rivers and wetlands (Pizzey and Knight, 2010). This bird was observed near the unnamed lake to the northeast of the Project area, and is likely to fly over the majority of the fauna habitats at Lake Clifton. The Tree Martin is widespread throughout Australia.

Name	Common Name	Conservation Status		Ecology
		Commonwealth	State	
Mammals				
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	V	EN	The Western Ringtail Possum is a medium sized nocturnal marsupial, weighing up to 1.3 kg and with a body length of approximately 40 cm. It has dark brown fur above with cream to grey fur underneath. This species strong prehensile tail grows to 41 cm long and ends in a white tip (Van Dyck & Strahan, 2008). The possum constructs dreys from fine to medium-sized material collected from overstorey and understorey vegetation. Dreys vary from flimsy or platform-like constructions providing minimal shelter, to elaborate constructions providing substantial protection (de Tores & Rosier, 1997). The Western Ringtail Possum has a patchy distribution in predominantly two areas: near Bunbury to Leeuwin-Naturaliste National Park (with a small translocated subpopulation near Dawesville); and near Albany (Woinarski <i>et al.</i> , 2014). The subpopulation of the Western Ringtail Possum on the SCP are associated with stands of myrtaceous trees (usually Peppermint Tree [<i>Agonis flexuosa</i>]) growing near swamps, water courses or floodplains (DoTE, 2016). The Western Ringtail Possum was indirectly recorded potentially three times, twice through scats collected (33,081.901 172,762.009; 35,048.152 167,945.240) and once through locating a potential drey. Refer to Plate 4 and Figure 10. The Western Ringtail Possum will potentially utilise the woodland habitats that contain <i>Agonis flexuosa</i> .
<i>Isoodon obesulus fusciventer</i>	Quenda, Southern Brown Bandicoot	-	P4	The Quenda has coarse dark grey or yellow brown fur above and creamy-white below, with a short, tapered, dark brown tail. The ears are short and rounded, and the tail is lightly furred. The Quenda is omnivorous, feeding on invertebrates, underground fungi, subterranean plant material, and occasionally on small vertebrates. The Quenda inhabits scrubby, often swampy, vegetation with dense cover up to one metre high. The Quenda was directly sited in the woodland habitat, and is also likely to utilise the heathland and wetland habitats present. The Quenda is widely distributed near the southwest coast from Guilderton north of Perth to east of Esperance. Quenda have a patchy distribution through the Jarrah and Karri forest, the SCP, and inland as far as Hyden (DPaW, 2012).

Note: Species listed as Marine under the EPBC Act are only considered conservation significant when in a Commonwealth marine reserve.











<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 19 AUG 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 260 520 780 1,040 metres</p> <p>1:33,809 when printed at A4</p>	<p>LEGEND</p> <p> Survey Area</p> <p>★ Fauna Siting</p> <p>Fauna Habitat</p> <ul style="list-style-type: none"> <i>Agonis flexuosa</i> and Jarrah woodland <i>Agonis flexuosa</i> and Tuart forest Cleared Riparian vegetation, constructed ponds and wetlands Shrubland heathland <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Geotrapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Fauna Habitat and Opportunistic Fauna Records</p> <p>MAIN ROADS</p> <p>LAKE CLIFTON BIOLOGICAL ASSESSMENT</p> <p style="text-align: right;">Figure 10</p>
--	--	--



Plate 4 Potential Ring-tailed Possum drey

Table 22 Fauna habitats of the Survey Area

Fauna Habitat	Description	Conservation Significant Species Potentially Utilising Habitat	Area (ha)	Percentage (%)	Photos	
Agonis flexuosa and Tuart forest	<p>This habitat was varied in density of Tuarts and understory, but generally contained an open Tuart overstorey over an open to closed <i>Agonis flexuosa</i> layer over an open shrub layer. Habitat features included:</p> <ul style="list-style-type: none"> • large mature trees were occasionally present, although there were pockets of significantly higher density large, mature trees • hollows within Tuarts were rare to occasionally present • fallen logs of varied sizes were generally common • bare ground was generally rare, as were soil cracks • coarse and fine litter were generally common • stone presence was varied depending on size, boulders were absent • a cryptogamic crust was generally rare and vines were occasionally present • dense shrubs were absent to occasionally present • proteaceous plant species were generally absent to occasionally present • no water bodies were present. 	Carnaby's Black Cockatoo (<i>Calyptorhynchus latirostris</i>), Quenda (<i>Isoodon obesulus fusciventer</i>), Western Ring-tail Possum (<i>Pseudocheirus occidentalis</i>), Whistling Kite (<i>Haliastur sphenurus</i>), Southern Boobook (<i>Ninox novaeseelandiae</i>), Rainbow Bee-eater (<i>Merops ornatus</i>) and Fan-tailed Cuckoo (<i>Cacomantis flabelliformis</i>).	286.42	29.28		
Agonis flexuosa and Jarrah woodland	<p>This habitat generally contained an open Jarrah overstorey over an open to closed <i>Agonis flexuosa</i> layer, over an open shrub / scrub layer. Habitat features included:</p> <ul style="list-style-type: none"> • large mature trees were rare to occasionally present • hollows were rare to occasionally present in mature Jarrah trees • fallen logs of varied sizes were common • bare ground was common, as were soil cracks • coarse and fine litter were abundant • stone and boulder presence was rare • a cryptogamic crust was generally absent and the presence of vines was occasional • dense shrubs were absent to occasionally present • proteaceous plant species were generally rare • no water bodies were present. 	Carnaby's Black Cockatoo (<i>Calyptorhynchus latirostris</i>), Quenda (<i>Isoodon obesulus fusciventer</i>), Western Ring-tail Possum (<i>Pseudocheirus occidentalis</i>), Whistling Kite (<i>Haliastur sphenurus</i>), Southern Boobook (<i>Ninox novaeseelandiae</i>), Rainbow Bee-eater (<i>Merops ornatus</i>) and Fan-tailed Cuckoo (<i>Cacomantis flabelliformis</i>).	11.80	1.21		
Mid to tall shrubland / heathland	<p>This habitat was varied and generally contained an open to closed shrub / scrub layer with a moderately open groundcover layer. Habitat features included:</p> <ul style="list-style-type: none"> • Large mature trees were generally absent, as were hollows • fallen logs with a diameter less than 30 cm were absent to common • bare ground was occasionally to commonly present, and soil cracks were absent to rare • coarse and fine litter were rare to common • stone and boulder presence was absent to occasionally present • a cryptogamic crust was generally common • vines were absent to occasionally present • dense shrub presence was absent to common • proteaceous plant species were absent to occasional • no water bodies were present. 	Carnaby's Black Cockatoo (<i>Calyptorhynchus latirostris</i>), Quenda (<i>Isoodon obesulus fusciventer</i>), Whistling Kite (<i>Haliastur sphenurus</i>), Rainbow Bee-eater (<i>Merops ornatus</i>), White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>), Lined Skink (<i>Lerista lineata</i>), Graceful Sunmoth (<i>Synemon gratiose</i>), Nankeen Kestrel (<i>Falco cenchroides</i>), Magpie-lark (<i>Grallina cyanoleuca</i>), Welcome Swallow (<i>Hirundo neoxena</i>), Southern Boobook (<i>Ninox novaeseelandiae</i>) and Tree Martin (<i>Petrochelidon nigricans</i>).	569.18	58.19		

Fauna Habitat	Description	Conservation Significant Species Potentially Utilising Habitat	Area (ha)	Percentage (%)	Photos	
Wetlands and riparian vegetation	<p>This habitat consisted of natural wetlands, constructed pond and associated riparian zones. Habitat features included:</p> <ul style="list-style-type: none"> • Large mature trees were generally absent, though some emergent Tuart trees were present in the ecotone areas • hollows were not present • various sized fallen logs were occasionally to commonly present • bare ground was common and soil cracks were rare to occasional • coarse and fine litter were occasional present • stone and boulders were either absent or common • cryptogamic crust presence was occasional • vines were absent to occasionally present • dense shrub presence was occasionally recorded • proteaceous plant species were generally absent • water bodies were present. <p>Note: ENV (2009) noted several other constructed ponds which were have not been represented on Figure 9.</p>	<p>Red-necked Stint (<i>Calidris ruficollis</i>), Hooded Plover (<i>Charadrius rubricollis</i>), Red-capped Plover (<i>Charadrius ruficapillus</i>), Eastern Curlew (<i>Numenius madagascariensis</i>), Common Greenshank (<i>Tinga nebularia</i>), Carnaby's Black Cockatoo (<i>Calyptorhynchus latirostris</i>), Quenda (<i>Isoodon obesulus fusciventer</i>), Whistling Kite (<i>Haliaeetus sphenurus</i>), Rainbow Bee-eater (<i>Merops ornatus</i>), White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>), Nankeen Kestrel (<i>Falco cenchroides</i>), Magpie-lark (<i>Grallina cyanoleuca</i>), Welcome Swallow (<i>Hirundo neoxena</i>), Southern Boobook (<i>Ninox novaeseelandiae</i>) and Tree Martin (<i>Petrochelidon nigricans</i>).</p>	70.35	7.19		
Cleared	Completely degraded and cleared areas.	<p>Whistling Kite (<i>Haliaeetus sphenurus</i>), Rainbow Bee-eater (<i>Merops ornatus</i>), Nankeen Kestrel (<i>Falco cenchroides</i>), Magpie-lark (<i>Grallina cyanoleuca</i>), Welcome Swallow (<i>Hirundo neoxena</i>), Southern Boobook (<i>Ninox novaeseelandiae</i>) and Tree Martin (<i>Petrochelidon nigricans</i>).</p>	40.46	4.16		

6.3.3 Black Cockatoos

6.3.3.1 Carnaby's Black Cockatoo

Carnaby's Black Cockatoo were heard and / or observed five times during the field survey. They were observed either flying over Lake Clifton, foraging on *Banksia sessilis* within the Lake Clifton Survey Area, or heard in close proximity. The details of these records are presented in Table 23 and locations illustrated on Figure 11.

Table 23 Carnaby's Black Cockatoo observations

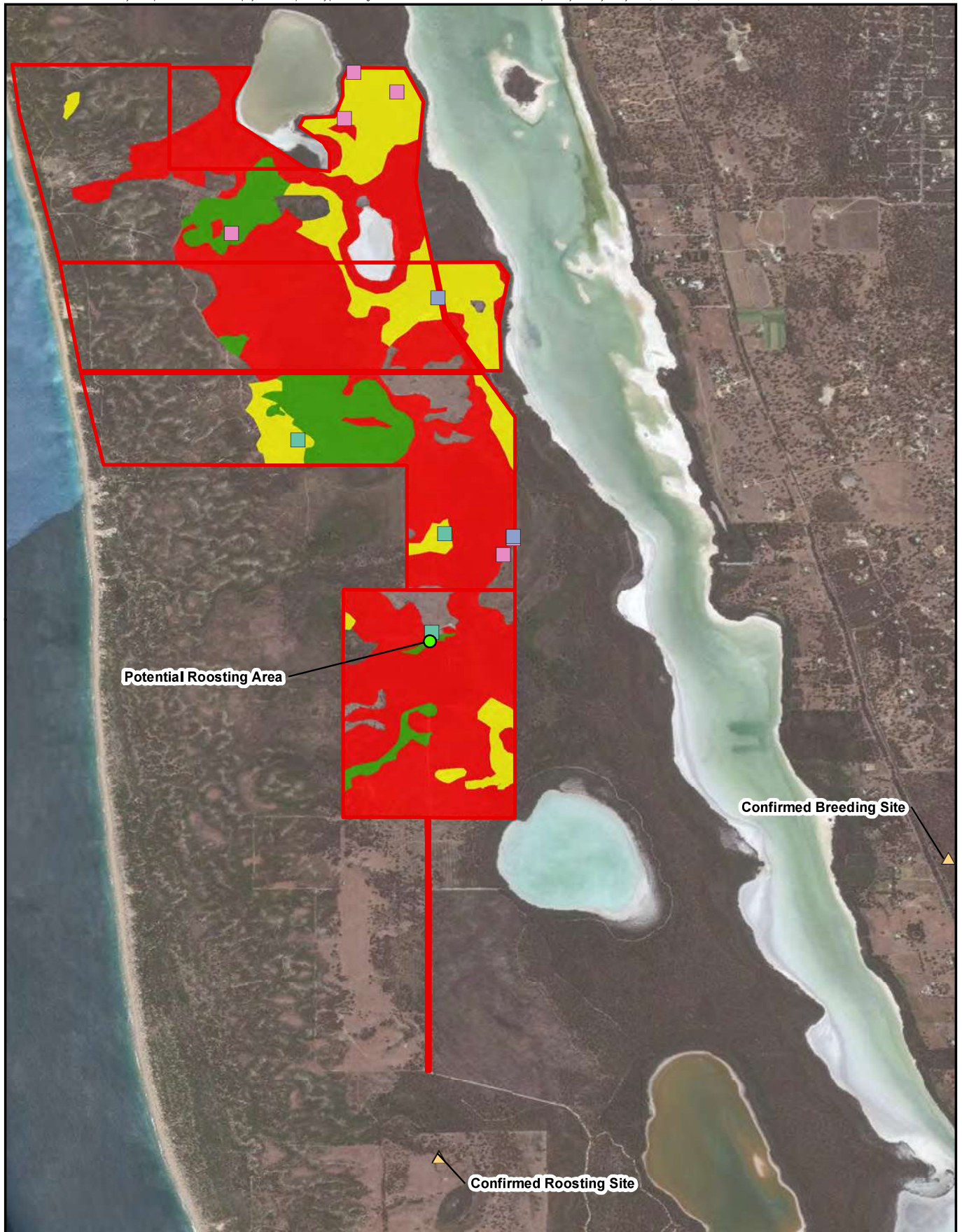
Record ID	Observation	Date	Location (m)	
Opp_13	Multiple birds heard towards the east	21 June 2016	34,578.405	168,899.646
Opp_19	Approx. 35 birds observed feeding on <i>Banksia sessilis</i> and then flying to the southeast	21 June 2016	35,122.715	169,518.519
Opp_43	Multiple birds heard towards the south	23 June 2016	33,728.387	170,338.712
Opp_50	Approx. 10 birds seen flying north	23 June 2016	34,615.686	171,412.419
Opp_55	Approx. 10 birds heard towards the east	24 June 2016	34,660.424	169,637.820

6.3.3.2 Baudin's Black Cockatoo

Baudin's Black Cockatoo was not recorded during the field survey.

6.3.3.3 Forest Red-tailed Black Cockatoo

The Forest Red-tailed Black Cockatoo was not recorded during the field survey or in other previous surveys.



PROJECT ID 60100953
 CREATED BY DGF
 APPROVED BY JL
 LAST MODIFIED 19 AUG 2016

AECOM
 www.aecom.com

DATUM GDA 1994, PROJECTION MGA ZONE 50
 0 290 580 870 1,160
 metres
 1:37,500 when printed at A4

LEGEND

- Survey Area
- ▲ Confirmed Black Cockatoo Breeding and Roosting Sites
- Carnaby's Black Cockatoo Foraging Habitat**
 - High (77.84 Ha)
 - Valued (129.06 Ha)
 - Low (424.85 Ha)
- Flock Heard
- Flock Observed Foraging
- Flock Seen
- Foraging Evidence

Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Geotrapping, AerGRID, IGN, IGP, swisstopo, and the GIS User Community

Carnaby's Black Cockatoo Foraging Habitat and Opportunistic Records

MAIN ROADS

LAKE CLIFTON BIOLOGICAL ASSESSMENT

Figure
11

6.3.4 Black Cockatoo foraging habitat quality

6.3.4.1 Carnaby's Black Cockatoo

Lake Clifton contains a significant amount of mature Tuart trees. It does not contain habitats dominated by proteaceous species but does contain moderate areas of Parrot Bush (*Banksia sessilis*) and *Banksia attenuata*, and large areas of non-principle foraging species such as *Xanthorrhoea preissii*. Carnaby's Black Cockatoo was observed foraging on Parrot Bush within the Survey Area on 21 June 2016 and recent evidence of Carnaby's Black Cockatoo foraging was recorded an additional five times during the field survey. Table 24 provides the details regarding these observations, locations illustrated on Figure 11.

Table 24 Potential Carnaby's Black Cockatoo foraging evidence

Record ID	Observation	Date	Location (m)		Plate
Opp_15	Recent torn <i>Banksia sessilis</i> branches	21 June 2016	35,033.239	169,481.237	Plate 5
Opp_28	Recent torn <i>Banksia sessilis</i> branches	22 June 2016	34,078.833	173,104.998	-
Opp_29	Recent torn <i>Banksia sessilis</i> branches and potentially chewed <i>Xanthorrhoea preissii</i> inflorescence	22 June 2016	34,354.716	172,955.873	-
Opp_30	Torn <i>Banksia sessilis</i> branches and potentially chewed <i>Xanthorrhoea preissii</i> inflorescence	22 June 2016	34,019.182	172,754.552	-
Opp_35	Grub foraged from <i>Banksia</i> cone	22 June 2016	33,303.378	171,889.622	Plate 6



Plate 5 Parrot Bush foraged on by Carnaby's Black Cockatoo



Plate 6 Invertebrate foraged from *Banksia* cone, most likely by Carnaby's Black Cockatoo

The Carnaby's Black Cockatoo foraging assessment determined that Lake Clifton contains approximately 632 ha of foraging habitat. This included 77.84 ha of High quality foraging habitat (Plate 7). The complete breakdown of the quality of the foraging habitat is detailed in Table 25 and illustrated on Figure 11. In general, Lake Clifton contains a significant area of Low to Valued Carnaby's Black Cockatoo foraging habitat.

Table 25 Carnaby's Black Cockatoo foraging habitat

Quality	Area (ha)
High	77.84
Quality	0
Valued	129.06
Low	424.85
Total	631.75

**Plate 7 High quality Carnaby's Black Cockatoo foraging habitat**

There is a confirmed Carnaby's Black Cockatoo breeding location within 12 km of the site and there is also a confirmed Carnaby's Black Cockatoo roosting site within 700 m of the southernmost point of the Survey Area (Figure 11). These sites provide further context as to the quality of the foraging habitat in the Survey Area, as per the foraging assessment scoring tool described in Section 4.4.3. The assessment has been included as **Appendix J**.

6.3.4.2 Forest Red-tailed Black Cockatoo

The Survey Area contains a significant number of mature Tuart trees, but does not contain Marri or significant areas of habitat containing Jarrah. No evidence of the Forest Red-tail Black Cockatoo utilising the Survey Area were observed during the field survey.

The Forest Red-tailed Black Cockatoo foraging assessment determined that the Survey Area contains approximately 11.88 ha of High quality foraging habitat (Plate 8). It also contains 202.47 ha of Low quality foraging habitat. The vegetation community MsTd contains up to 10% hakea species which are included in the list of foraging species for the Forest Red-tailed Black Cockatoo. Vegetation community MsTd contained foraging plants near a watering point and near potential breeding habitat. The lack of Marri means this habitat is Low Quality. The breakdown is detailed further in Table 25 and illustrated on Figure 12. The assessment has been included as **Appendix J**.

Table 26 Forest Red-tailed Black Cockatoo foraging habitat

Quality	Area (ha)
High	11.88
Quality	0
Valued	0
Low	202.47
Total	214.35

**Plate 8 High quality Forest Red-tailed Black Cockatoo foraging habitat**



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 19 AUG 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 270 540 810 1,080 metres</p> <p>1:35,000 when printed at A4</p>	<p>LEGEND</p> <p> Survey Area</p> <p>Forest Red-tailed Black Foraging Habitat</p> <p> High (11.88 Ha)</p> <p> Low (202.56 Ha)</p> <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Geotrapping, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Forest Red-tailed Black Cockatoo Foraging Habitat</p> <p>MAIN ROADS</p> <p>LAKE CLIFTON BIOLOGICAL ASSESSMENT</p> <p>Figure 12</p>
--	--	--

6.3.4.3 Baudin's Black Cockatoo

As discussed, Lake Clifton contains a significant amount of mature Tuart trees, but does not contain Marri. It also does not contain habitats dominated by proteaceous species but does contain moderate areas of Parrot Bush (*Banksia sessilis*) and *Banksia attenuata*. However, Lake Clifton is also out of the known foraging area for Baudin's Black Cockatoo and this reflects in the cumulative foraging assessment scores. The Baudin's Black Cockatoo foraging assessment determined that Lake Clifton contains approximately 45 ha of Valued foraging habitat. This is illustrated on Figure 13. The assessment has been included as **Appendix J**.

6.3.5 Breeding habitat

Breeding habitat has been defined as High, Valued or Low quality breeding habitat, depending on the density of mature eucalypt trees within the associated vegetation unit. In total, Lake Clifton contains approximately 294 ha of Black Cockatoo breeding habitat, with approximately 4,000 potentially suitable breeding trees.

High quality breeding habitat generally comprised dense stands of mature Tuart trees (with DBH > 500 cm and containing potentially suitable breeding hollows). Approximately 39 ha of High quality Black Cockatoo breeding habitat was mapped, which equates to approximately 1,400 trees (Plate 9).

Valued breeding habitat was defined as habitat that contained scattered Tuarts (with a DBH > 500 cm and potentially suitable breeding hollows) at a moderate density across a vegetation unit. Approximately 116 ha of Valued breeding habitat was mapped within the Survey Area, which equates to approximately 2,000 trees (Plate 10).

Low quality breeding habitat was defined as habitat that contained scattered Tuarts (with a DBH > 500 cm and potentially suitable breeding hollows) at a low density across a vegetation unit. Approximately 139 ha of Low quality breeding habitat within the Survey Area was mapped, which equates to approximately 400 trees (Plate 11).

Table 27 provides further detail on the breeding habitat assessment and a breeding habitat map has been produced in Figure 14 and raw data is available in **Appendix K**.

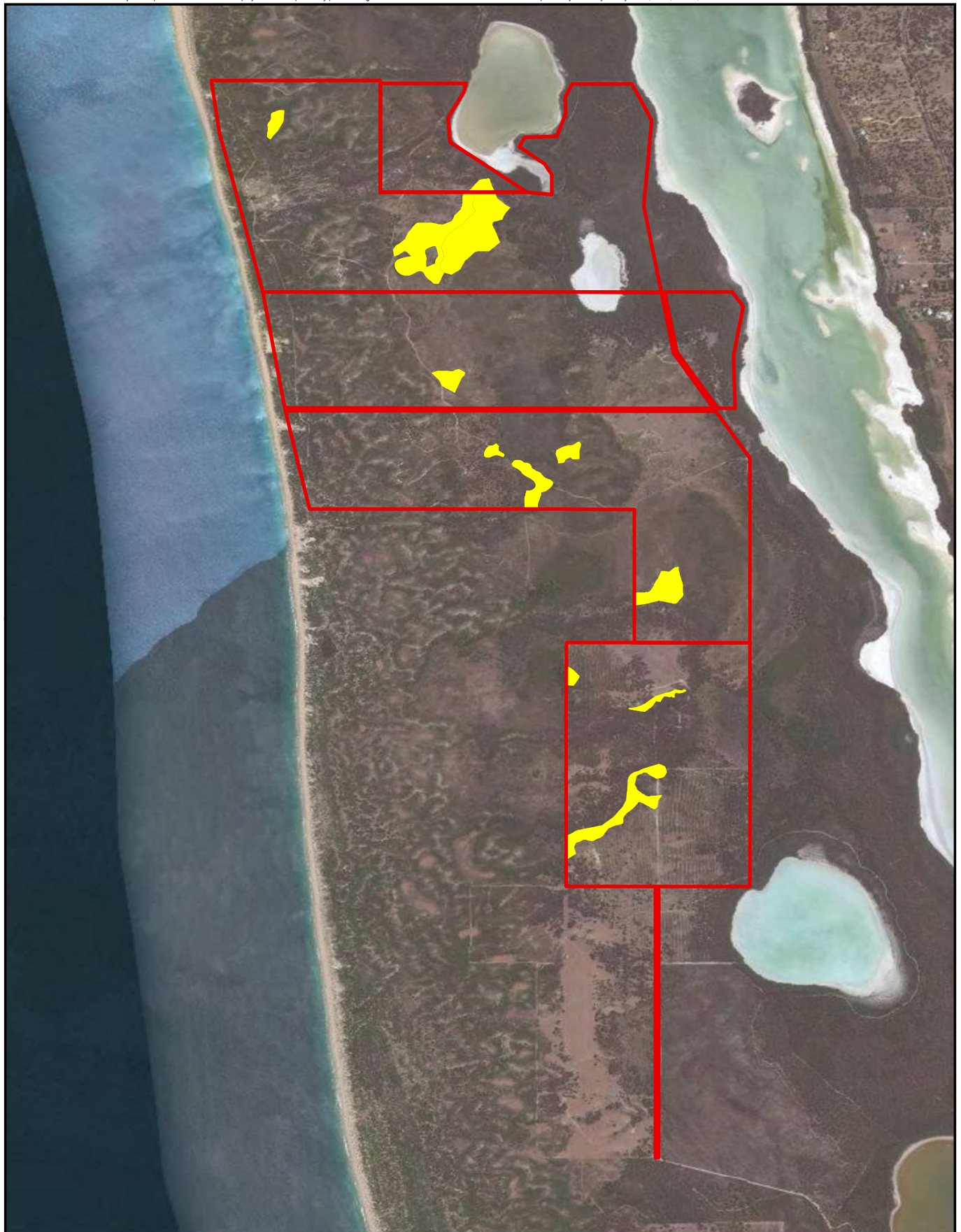
Table 27 Black Cockatoo breeding habitat assessment

Breeding Habitat	Vegetation Unit	Number of Breeding Tree Quadrats	Total Number of Trees within Quadrats	Total Area of Vegetation Units (Ha)	Approximate Number of Trees in Total Vegetation Units
High	Eg and EgXpTd	4	35	39.34	1,400
Valued	EgMsTd and AfXpHh	8	37	116.40	2,100
Low	AfXpHhHg and AfHcEp	7	7	138.63	400
Totals				294.37	3,900

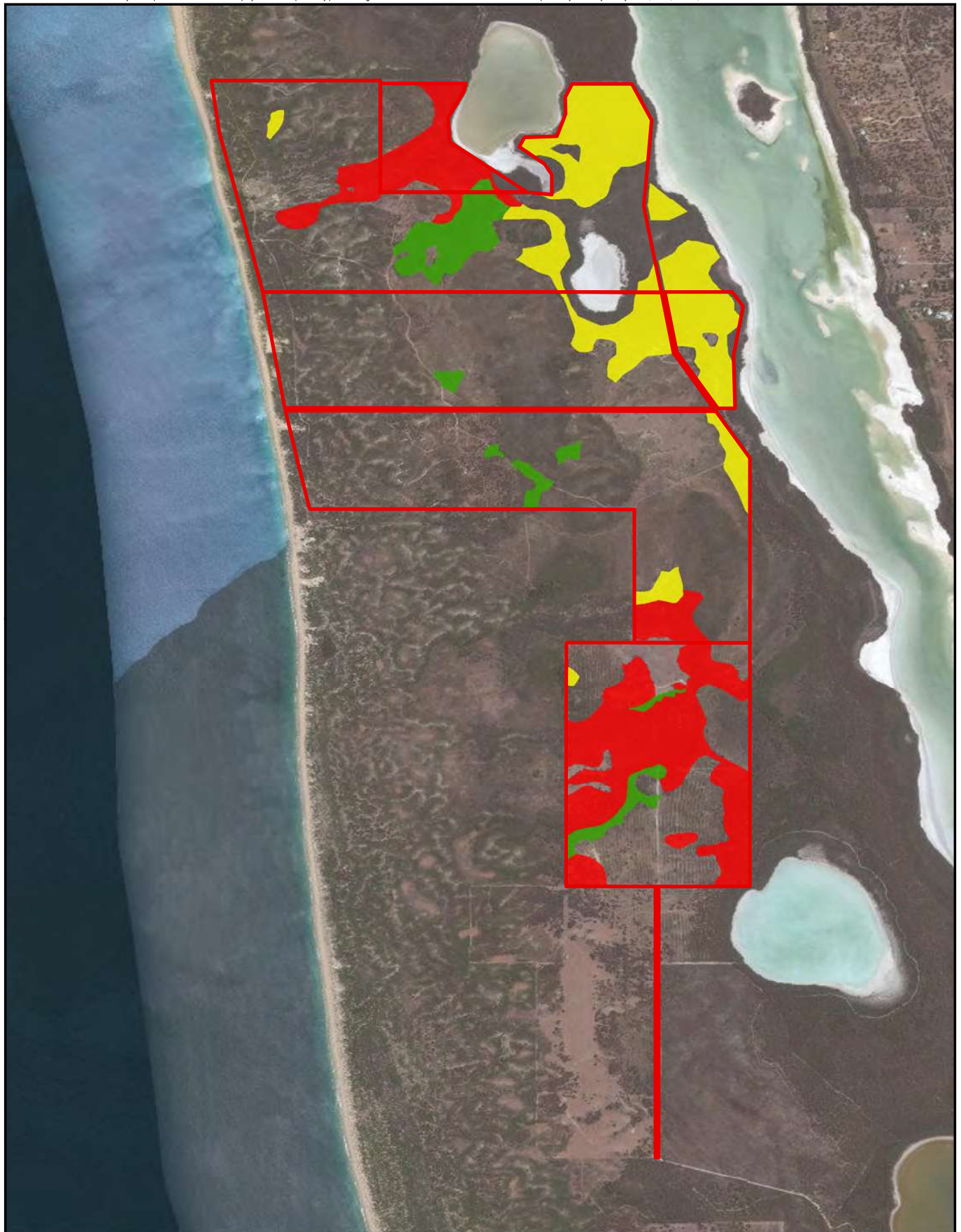
Note: Eg was not defined as a vegetation community during the biological assessments. These areas were stands of mature trees within broader vegetation units that were separated out during the post-field work analysis. This was completed to better represent the Black Cockatoo breeding habitat present at Lake Clifton.



Plate 9 High quality breeding habitat for Baudin's Black Cockatoo



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 19 AUG 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 270 540 810 1,080 metres</p> <p>1:35,000 when printed at A4</p>	<p>LEGEND</p> <p> Survey Area</p> <p> Baudin's Black Cockatoo Foraging Habitat</p> <p> Valued (45.09 Ha)</p> <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Geotrapping, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Baudin's Black Cockatoo Foraging Habitat</p> <p>MAIN ROADS</p> <p><i>LAKE CLIFTON BIOLOGICAL ASSESSMENT</i></p> <p>Figure 13</p>
--	--	--



<p>PROJECT ID 60100953 CREATED BY DGF APPROVED BY JL LAST MODIFIED 19 AUG 2016</p> <p>AECOM www.aecom.com</p> <p>DATUM GDA 1994, PROJECTION MGA ZONE 50</p> <p>0 270 540 810 1,080 metres</p> <p>1:35,000 when printed at A4</p>	<p>LEGEND</p> <ul style="list-style-type: none"> Survey Area Black Cockatoo Breeding Habitat High (38.59 Ha) Valued (116.39 Ha) Low (138.623 Ha) <p><small>Data sources: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroX, Geotrapping, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community</small></p>	<p>Potential Black Cockatoo Breeding Habitat</p> <hr/> <p>MAIN ROADS</p> <p><i>LAKE CLIFTON BIOLOGICAL ASSESSMENT</i></p>	<p>Figure 14</p>
--	---	---	------------------------------------



Plate 10 Valued breeding habitat



Plate 11 Low quality breeding habitat

In total, 181 *Eucalyptus* trees with a DBH >500 cm were recorded during the assessment. These were recorded either in the breeding habitat assessment quadrats, or opportunistically during the field survey. Of these 181 trees, 40 trees had potential hollows. Hollows are not always easy to identify and assess accurately from the ground. These 40 trees had a total of approximately 104 hollows, with 36 of these being potentially suitable hollows for Black Cockatoos. Some evidence of bees utilising these hollows was observed. Approximately 70% of these trees had little to no fire scarring.

6.3.6 Roosting sites

Both white-tailed Black Cockatoo species roost in or near riparian environments or near other permanent water sources and typically in the tallest trees in the landscape. The Forest Red-tailed Black Cockatoo prefers the edges of forests for roosting (DSEWPac, 2012). Evidence of roosting usually involves large amounts of bird scat beneath a large, mature tree, with a significant amount of broken branches on the ground. Searches for roosting evidence were undertaken alongside the other Black Cockatoo assessments and no confirmed Black Cockatoo roost sites were identified in the field. However, a potential roost area was identified (Figure 14), which contained large mature Tuarts that were very high in the landscape and with foraging habitat and a freshwater source located in close proximity.

6.3.7 Fauna habitat linkages

Habitat linkages are typically areas or corridors of vegetation that link (larger) areas of fauna habitat. Linkages are important as they enable fauna to move freely between remnant bushland patches, therefore increasing gene-flow between populations. A study conducted by Gilbert *et al.* (1998) found that corridors and/or linkages do maintain species richness in the fragmented landscapes.

The Lake Clifton Survey Area is bordered on the west by the coastline, on the east by Lake Clifton, and to the north and south by Yalgorup National Park. The area provides an important and ecologically valuable linkage between the north and south sections of Yalgorup National Park, ensuring a contiguous corridor of habitat throughout this area.

6.4 Wetlands

6.4.1 Riparian vegetation

Riparian vegetation grows along the banks of waterways extending to the edge of the floodplain (fringing vegetation), including emergent aquatic plants, ground cover plants, shrubs and trees (DoW, 2016). Riparian vegetation was recorded along the fringe of the CCW UFI 3,096.

The riparian vegetation condition was mapped as 'A grade: pristine to slightly disturbed' and 'A1 Pristine' as outlined in the preliminary and detailed assessment methods (Water & Rivers Commission, 1999). A vegetation relevé was completed, dividing the riparian vegetation into two zones including the partially submerged zone and the winter-wet zone.

The partially submerged zone was dominated by *Threlkeldia diffusa* groundcover on inundated clay soils with a fringe of *Melaleuca* paperbark species. The winter-wet zone includes *Gahnia trifida* sedges under a dense *Melaleuca* paperbark closed overstorey. Weeds that were present include low-impact species with cover of less than 0.1%.

A wetland assessment was undertaken in accordance with DPaw (2013) wetland assessment methodology. The preliminary wetland assessment triggered automatic consideration as a conservation wetland for the following parameters:

- Wetland supports breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, EPBC Act, migratory bird agreements (such as JAMBA, CAMBA and RoKAMBA) or the State
- Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale.

A secondary evaluation was undertaken which showed that 15 of the attributes scored High value. The outcome was that the Conservation management category is applicable based on the fauna, flora and wetland processes values, attributes and functions. The wetland assessment forms are provided in **Appendix L**.

6.4.2 Boundary mapping

The Survey Area intersects four geomorphic wetlands of the SCP, all considered Conservation Category Wetlands (CCWs). Wetland details are provided below. Vegetation within these wetland boundaries is considered in 'Very Good' to 'Excellent' condition. The geomorphic wetlands boundary mapping was considered accurate for depicting wetlands and associated riparian vegetation within the Survey Area.

A total of 65.35 ha of CCW wetland are located within the Survey Area.

7.0 References

- Australian Government, 2011. State of the Environment Report 2011. Chapter 5 – Land. Department of Sustainability, Environment, Water, Populations and Communities, Canberra, Australia.
- Australian Government, 2013. Australian Vegetation Attribute Manual – National Vegetation Information System, Version 6.0. Executive Steering Committee for Australian Vegetation Information, Department of the Environment and Heritage, 2003.
- Australian Government, 2016. Impact of Weeds. Online resource:
<http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/why/impact.html>.
- Beard JS 1981. Vegetation Survey of Western Australia - Swan 1:1000000 Vegetation Series. University of Western Australia Press.
- Bettink K & Keighery G, 2008. Environmental Weed Census and Prioritisation, Swan NRM Region. Swan Catchment Council and Department of Environment and Conservation, Kensington, Western Australia.
- Bradshaw FJ, 2000. Recommendations for the Regeneration and Maintenance of the Tuart Forest in the Yalgorup National Park. In: Longman VM & Keighery BJ, 2002. Tuart (*Eucalyptus gomphocephala*) and Tuart Communities. Perth Branch Wildflower Society of Western Australia (Inc.), Nedlands, Western Australia.
- Bureau of Meteorology, 2016. Climate Data Online. Australian Government Online Resource
<http://www.bom.gov.au/climate/data/>.
- Chapman T, 2008. Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Redtailed Black Cockatoo *Calyptorhynchus banksii naso*) Recovery Plan. Department of Environment and Conservation, Bentley, Western Australia.
- Christidis L & Boles WE, 2008. Systematics and Taxonomy of Australian Birds. CSIRO Publishing, Australia.
- Climate Commission, 2011. The Critical Decade: Western Australia Climate Change Impacts. Available at
<https://www.climatecouncil.org.au/uploads/e0d4e50478b96d1a50c821b7b2c022a4.pdf>.
- Department of Conservation and Land Management (CALM), 1999. Environmental Weed Strategy for Western Australia. DEC, Kensington, Western Australia.
- Department of Conservation and Land Management (CALM), 2002. Bioregional Summary of the 2002 Biodiversity Audit for Western Australia. Department of Conservation and Land Management, Perth, Western Australia.
- Department of the Environment (DotE), 2016a. Discussion Paper – Survey Guidelines for Black Cockatoos Workshop, attended by Jamie Shaw from AECOM on 24 May 2016
- DotE, 2016b. Threatened Species and Ecological Communities – Species Profile and Threats Database. Australian Government online resource <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>
- Department of Environment and Conservation (DEC) 2012. Nomination to delist *Synemon gratiosa* (graceful sun-moth).
- Department of Parks and Wildlife (DPaW) and Environmental Protection Authority (EPA), 2015. Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment. (eds. K Freeman, G Stack, S Thomas and N Woolfrey). Perth, Western Australia.
- DPaW, 2012. Fauna Profiles – Quenda.
https://www.dpaw.wa.gov.au/images/documents/conservation-management/pests-diseases/quenda_2012.pdf Accessed July 2016.
- DPaW, 2013. A Methodology for the Evaluation of Specific Wetland Types on the Swan Coastal Plain, Western Australia. DPaW, August 2013, Kensington Western Australia.

- DPaW, 2015. Conservation Codes for Western Australian Flora and Fauna. Department of Parks and Wildlife, Perth, WA.
- Department of Premier and Cabinet (DPC), 2015. Perth and Peel Green Growth Plan for 3.5 million, Draft EPBC Act Strategic Impact Assessment Report. Part B: Assessment Methodology. Part D: MNES Assessment – chapter 16. Perth WA.
- Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), 2012. EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species: Carnaby's Cockatoo, Baudin's Cockatoo and Forest Red-tailed Black Cockatoo. Canberra, Australian Capital Territory.
- Department of Water, 2016. Aquatic and Riparian Vegetation. Online resource: <http://www.water.wa.gov.au/water-topics/waterways/values-of-our-waterways/aquatic-and-riparian-vegetation>.
- Ecoscope, 2003. An Atlas of Tuart Woodlands on the Swan Coastal Plain in Western Australia. Report prepared for Department of Environment and Conservation, Bentley, Western Australia. Available online at: https://www.dpaw.wa.gov.au/images/documents/conservation-management/forests/tuart_atlas/tuart_atlas_full300.pdf
- ENV Australia Pty Ltd (ENV), 2009. Rural Subdivision, Lots 1000, 2240, 2274, 2675, and 3045 Preston Beach Road, Lake Clifton. Public Environmental Review. Prepared for Cape Bouvard Investment. EPA Assessment Number 1440.
- Environmental Protection Authority (EPA), 1993. A Guide to Wetland Management in the Perth and Near Perth Swan Coastal Plain Area. An update to EPA Bulletin 374, EPA Bulletin 686.
- EPA 2000. Environmental Protection of Native Vegetation in Western Australia. Clearing of Native Vegetation, with particular reference to the Agricultural Area. Position Statement No 2. Perth WA.
- EPA 2002. Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement 3. Environmental Protection Authority, Perth, Western Australia.
- EPA. 2004a. Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 51 Environmental Protection Authority, Perth, Western Australia.
- EPA. 2004b. Guidance for the Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 56. Environmental Protection Authority, Perth, Western Australia.
- EPA, 2008. Environmental Guidance for Planning and Development. Guidance Statement No. 33. Environmental Protection Authority, Perth, Western Australia.
- EPA 2015. Perth and Peel @ 3.5 Million Environmental Impacts, Risks and Remedies. Interim strategic advice of the EPA to the Minister for Environment under section 16(e) of the Environmental Protection Act 1986. Perth, Western Australia.
- Freeman K, Keighery B, Keighery G, Longman V, Black A, Molloy S, 2009. The Flora and Vegetation of the Dawesville to Binningup Region (Swan Coastal Plain). Prepared for the Environmental Protection Authority as part of the Swan Bioplan Project, Department of Environment and Conservation, Kensington, Western Australia.
- Geering, A., L. Agnew & S. Harding, eds. 2007. Shorebirds of Australia. Melbourne: CSIRO Publishing.
- Gibson N, Keighery B, Keighery G, Burbidge A, and Lyons M, 1994. *A Floristic Survey of the Southern Swan Coastal Plain*. Unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.).
- Government of Western Australia, 2015. Perth and Peel Green Growth Plan for 3.5 Million. December 2015. DRAFT.

- Heddle EM, Loneragan OW, Havell JJ, 1980. Atlas of Natural Resources, Darling System, Western Australia. Department of Environment and Conservation: Perth, Western Australia.
- Identic Pty Ltd (2016). Environmental Weeds of Australia for Biosecurity Queensland. Online resource: <http://keyserver.lucidcentral.org/weeds/data/media/Html/index.htm>.
- Johnstone RE, & Storr GM, 1998. *Handbook of Western Australian Birds, Volume 1 Non-passerines*. Western Australian Museum, Perth.
- Johnstone, RE. & Kirkby T, 2008. Distribution, status, social organisation, movements and conservation of Baudin's Cockatoo (*Calyptorhynchus baudinii*) in South-west Western Australia. *Records of the Western Australian Museum*. 25:107-118.
- Johnstone, Kirkby & Sarti, 2013. The breeding biology of Forest-Red-tailed Black Cockatoos *Calyptorhynchus banksii naso* Gould in south-western Australia. Breeding behaviour and diet. *Pacific Conservation Biology* Vol. 19: 145-155. Surrey Beatty and Sons, Sydney, 2013.
- Keighery BJ, 1994. Bushland Plant Survey - A Guide to Plant Community Survey for the Community Wildflower Society of WA (inc) Nedlands WA.
- Longman VM & Keighery BJ, 2002. Tuart (*Eucalyptus gomphocephala*) and Tuart Communities. Perth Branch Wildflower Society of Western Australia (Inc.), Nedlands, Western Australia.
- Marchant S, & Higgins PJ, eds. 1993. Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 - Raptors to Lapwings. Melbourne, Victoria: Oxford University Press.
- Mitchell D, Williams K, Desmond A, 2002. 'Swan Coastal Plain 2 (SWA2 – Swan Coastal subregion)' in CALM 2002. *Bioregional Summary of the 2002 Biodiversity Audit for Western Australia*. Department of Conservation and Land Management, Perth, Western Australia.
- Office of Environment & Heritage (OEH), 2016. Hooded Plover – Profile. Office of Environment and Heritage, NSW Government, August 2016.
- Peel Harvey Catchment Council, 2009. Peel-Yalgourup Ramsar Site Management Plan, Peel-Harvey Catchment Council, Mandurah.
- Pizzey G, & Knight F, 2007. The field guide to the birds of Australia. Harper Collins Publishers: Sydney, Australia.
- Storr GM, Smith LA, Johnstone RE, 1999. Lizards of Western Australia. I Skinks. Western Australian Museum, Perth, Western Australia.
- Tores P, & Rosier SR, 1997. Harvey Basin allocation plan: Western Ringtail Possum survey. Perth: Unpublished report prepared for the Waters and Rivers Commission.
- TSSC (undated) *Synemon gratiosa* (graceful sun moth) EPBC Act Listing Advice.
- Van Dyck, S. & R. Strahan, 2008. The Mammals of Australia, Third Edition. Page(s) 880. Sydney: Reed New Holland.
- Ward D, 2000. Trouble in the Tuart: A Brief Fire History. In: Longman VM & Keighery BJ, 2002. Tuart (*Eucalyptus gomphocephala*) and Tuart Communities. Perth Branch Wildflower Society of Western Australia (Inc.), Nedlands, Western Australia.
- Water and Rivers Commission, 1999. Planning and Management: Foreshore Condition Assessment in Farming Areas of South-west Western Australia. Water and Rivers Commission River Restoration Report No. RR3.
- Western Australian Herbarium (WAH), 1998-. Florabase – the Western Australian Flora, Department of Parks and Wildlife online resource <http://florabase.dpaw.wa.gov.au>
- Western Australian Museum (WA Museum), 2016. Checklist of Terrestrial Vertebrate Fauna of Western Australia. Online resource.
- Weston AS, 1998a. Vegetation survey of eastern park of Lake Clifton: Location 4185 and parts of 2240, 2275, 2657, 3045, 4981 and 5182.

Weston AS, 1998b. Potential Rare Flora in the proposed White Hill Road to Lake Clifton West Access Road Corridor

Weston AS, 1998c. Floristic Community Types and Comparable Vegetation Units in the Proposed White Hill Road to Lake Clifton West Access Corridor

Weston AS, 1998d. Comparisons of Vegetation, Flora and Rare Flora of Proposed Exchange Areas in Lake Clifton West and Yalgorup National Park

Weston AS, 2003. Vegetation and Flora of the Cape Bouvard Land Holding Lake Clifton West. City of Mandurah, WA.

Wilson S, & Swan G, 2010. *A Complete Guide to Reptiles of Australia*. New Holland Publishers: Sydney NSW

Woinarski J, Burbidge A, & Harrison P, 2014. The Action Plan for Australian Mammals 2012. CSIRO Publishing, Victoria, Australia.



Appendix A

Conservation Categories

Appendix A – Legislative Framework

1.0 Legislation

1.1 Commonwealth

1.1.1 Matters of National Environmental Significance

Matters of National Environmental Significance (MNES) include:

- listed threatened species and ecological communities
- migratory species protected under international agreements
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- world Heritage properties
- national Heritage places
- Great Barrier Reef Marine Park
- a water resource, in relation to coal seam gas development and large coal mining development
- nuclear actions.

If an action is likely to have a significant impact on a MNES this action must be referred to the Minister for the Environment for a decision on whether assessment and approval is required under the EPBC Act.

1.1.2 Flora and fauna

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is Australia’s central piece of environmental legislation which provides for the listing of nationally Threatened native species and ecological communities, native migratory species and marine species. Species at risk of extinction are recognised at a Commonwealth level and are categorised in one of six categories as outlined in Table 1.

Table 1 Categories of Species Listed under Schedule 179 of the EPBC Act (Commonwealth)

Conservation	Code Category
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time: <ol style="list-style-type: none"> a. the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered b. the following subparagraphs are satisfied: <ol style="list-style-type: none"> i. the species is a species of fish

Conservation	Code Category
	<ul style="list-style-type: none"> ii. the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised iii. the plan of management is in force under a law of the Commonwealth or of a State or Territory iv. cessation of the plan of management would adversely affect the conservation status of the species.

1.1.3 Vegetation communities

Communities can be classified as Threatened Ecological Communities (TECs) under the EPBC Act. The EPBC Act protects Australia’s ecological communities by providing for:

- identification and listing of ecological communities as threatened
- development of conservation advice and recovery plans for listed ecological communities
- recognition of key threatening processes
- reduction of the impact of these processes through threat abatement plans.

Categories of Commonwealth listed TECs are described in **Error! Reference source not found..**

Table 2 Categories of TECs that are listed under the EPBC Act

Conservation Code	Category
CE	Critically Endangered If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
E	Endangered If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
V	Vulnerable If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

1.2 Western Australia

1.2.1 EPA Policy and Guidelines

In Western Australia the Environmental Protection Authority represents a independent government authority that are governed by the EP Act. The objective of the EPA is to ‘use its best endeavours to a) protect the environment; and b) to prevent, control and abate pollution and environmental harm.

The EPA have released several guidance and position statements directly relevant to biological assessments undertaken in Western Australia, described in Table 3.

Table 3 EPA Policy and guidelines relevant to biological assessments in Western Australia

Document Title	Short Description
Environmental Protection Authority (EPA) Position Statement No. 2 Environmental Protection of Native Vegetation in Western Australia: Clearing of native vegetation, with particular reference to the agricultural area	Provides guidance on clearing of native vegetation, with particular reference to the agricultural area.
EPA Guidance Statement No. 51 Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia	Provides guidance on the standard of survey required to assist in collecting the appropriate data for decision-making associated with the protection of Western Australia’s terrestrial flora and vegetation and their ecosystems.

Document Title	Short Description
EPA Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection	Provides guidance on the requirements of biological surveys in Western Australia.
EPA Guidance Statement No. 56 Guidance for the Assessment of Environmental Factors – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia	Provides guidance on the standard of survey required to assist in collecting the appropriate data for decision-making associated with the protection of Western Australia's terrestrial fauna.
DPaW and EPA Technical Guide for undertaking Flora and Vegetation Assessments for Environmental Impact Assessment in Western Australia	Guide for ensuring adequate data of appropriate standard are obtained to inform environmental impact assessment applicable to terrestrial vascular flora and vegetation surveys.
DPaW Methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia	Provides a single methodology for evaluating wetlands on the Swan Coastal Plain.

1.2.2 Flora and fauna

Plants and animals that are considered threatened and need to be specially protected because they are under identifiable threat of extinction are listed under the *Wildlife Conservation Act (WC Act)*. These categories are defined in Table 1. Threatened species are published as Specially Protected under the Wildlife Conservation Act 1950, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora). The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as outlined in Table 1.

Species that have not yet been adequately surveyed to warrant being listed under Schedule 1 or 2 are added to the Priority Flora or Fauna Lists under Priority 1, 2 or 3. Species that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4 and require regular monitoring. Conservation Dependent species and ecological communities are placed in Priority 5. Categories and definitions of Priority Flora and Fauna species are provided in Table 2.

Table 4 Conservation codes for WA flora and fauna listed under the *Wildlife Conservation Act 1950* updated November 2015

Conservation Code	Category
CR	Critically endangered species Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EN	Endangered species Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
VU	Vulnerable species Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.
EX	Presumed extinct species Species which have been adequately searched for and there is no reasonable doubt that the

Conservation Code	Category
	last individual has died. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.
IA	<p>Migratory birds protected under an international agreement</p> <p>Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.</p>

Table 5 Conservation codes for WA flora and fauna (DPaW 2015)

Conservation Code	Category
P1	<p>Priority One – Poorly Known Species</p> <p>Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.</p>
P2	<p>Priority Two – Poorly Known Species</p> <p>Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.</p>
P3	<p>Priority Three – Poorly Known Species</p> <p>Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.</p>
P4	<p>Priority Four – Rare, Near Threatened and other species in need of monitoring</p> <ol style="list-style-type: none"> a. Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. b. Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. c. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5	<p>Priority Five: Conservation Dependent species</p> <p>Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.</p>

1.2.3 Vegetation communities

State listed TECs are not protected under any legislation, rather they are endorsed by the Environment Minister. Categories of TECs are defined in Table 6. Priority Ecological Communities are endorsed by the Environment Minister as having insufficient information available to be considered a TEC, or which are rare but not currently threatened. Categories are described in Table 7.

Table 6 Conservation codes for state-listed Threatened Ecological Communities

Conservation Code	Category
PD	<p>Presumed Totally Destroyed An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An Ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B) All occurrences recorded within the last 50 years have since been destroyed</p>
CR	<p>Critically Endangered An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i. geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).</p>

Conservation Code	Category
EN	<p>Endangered</p> <p>An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.</p> <p>An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C).</p> <p>A) The geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 70% and either or both of the following apply (i or ii):</p> <ol style="list-style-type: none"> i. the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 20 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 20 years) the community is unlikely to be capable of being substantially rehabilitated. <p>B) Current distribution is limited, and one or more of the following apply (i, ii or iii):</p> <ol style="list-style-type: none"> i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 20 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. <p>The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 20 years).</p>
VU	<p>Vulnerable</p> <p>An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatened processes continue or begin operating throughout its range.</p> <p>An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C).</p> <p>A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.</p> <p>B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.</p> <p>C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium or long term future because of existing or impending threatening processes.</p>

Table 7 Categories for Priority Ecological Communities

Conservation	Code Category
P1	<p>Priority One: poorly-known ecological communities Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤ 5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.</p>
P2	<p>Priority Two: poorly-known ecological communities Communities that are known from few occurrences with a restricted distribution (generally ≤ 10 occurrences or a total area of ≤ 200ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.</p>
P3	<p>Priority Three: poorly known ecological communities</p> <ul style="list-style-type: none"> i. Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation ii. communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat iii. communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. <p>Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.</p>
P4	<p>Priority Four: ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.</p> <ul style="list-style-type: none"> i. Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. ii. Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. iii. Ecological communities that have been removed from the list of threatened communities during the past five years.
P5	<p>Priority Five: Conservation Dependent ecological communities. Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.</p>



Appendix B

Biosecurity and
Agriculture Management
Act 2007 Classifications

Appendix B Weeds and their Classifications

1.1 The BAM Act

Biosecurity is the management of the risk of animal and plant pests and diseases entering, emerging, establishing or spreading in WA to protect the economy, environment and community. Biosecurity is managed under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) which came into effect 1 May 2013. Exotic animals and plants can become an invasive species if they can establish in new areas where local conditions are favourable for their growth. They usually invade as a result of human activities both accidental and deliberate. These invasive species can often have a damaging impact on the natural environment and agriculture, and therefore requires careful management. The Department of Agriculture and Food, Western Australia (DAFWA) has developed an Invasive Species Program which provides the strategic and operational management of serious weeds and pest animals.

The Minister for Agriculture and Food can declare invasive exotic plants and animals as pests under the BAM Act. These species are listed on the Western Australian Organism List (WAOL) and classified in four categories, explained in Table 1.

Table 1 Legal status of Declared Pests under the BAM Act

Category	Description
Declared Pest, Prohibited – s12	Prohibited organisms are declared pests by virtue of section 22(1), and may only be imported and kept subject to permits. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions.
Declared Pest – s22(2)	Declared pests must satisfy any applicable import requirements when imported, and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia.
Permitted – s11	Permitted organisms must satisfy any applicable import requirements when imported. They may be subject to an import permit if they are potential carriers of high-risk organisms.
Permitted, Requires Permit – r73	Regulation 73 permitted organisms may only be imported subject to an import permit. These organisms may be subject to restriction under legislation other than the Biosecurity and Agriculture Management Act 2007. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions.
Unlisted – s14	If you are considering importing an unlisted organism/s you will need to submit the name/s for assessment, as unlisted organisms are automatically prohibited entry into WA.

The Minister can declare an organism as a declared pest if there are reasonable grounds for believing that the organism:

- a. has or may have an adverse effect on
 - a. another organism in the area
 - b. human beings in the area
 - c. the environment or part of the environment in an area
 - d. agricultural activities, fishing or pearling activities, or related commercial activities carried on or intended to be carried on in the area.
- b. May have an adverse effect on any of those things if it were present in the area, or if it were present in the area in greater numbers or to a greater extent.

Under the BAM Act declared pests are placed in one of three categories, as explained in Table 2. Many of the declared pest plant species are also on the list of Weeds of National Significance. This list was compiled to prioritise future management and allocation of resources for weed control. Species were selected based on their

invasiveness and impact characteristics, potential and current area of spread and their environmental, industrial or socioeconomic impacts.

Under the BAM Act, local government authorities can prescribe any plant, other than a declared plant, to be a pest plant. Local law can be used to assist in pest plant management by enforcing that the owner or occupier of the land can be held financially responsible for the management of any pest plant.

Department of Parks and Wildlife (DPaW) recognise weeds as one of the most significant threats to biodiversity as they outcompete native species for resources, reduce natural diversity by smothering native plants, displace and replace native plants, and alter fire regimes. DPaW have prioritised their focus on infestations of species considered to be high impact, rapidly invasive and still at a population size that can feasibly be eradicated or contained to a manageable size. DPaW's rankings are provided to help landholders, community groups and private enterprises manage weeds that may impact on the natural environment. Weed species are listed according to the region they occur in and are ranked as very high, high, medium, low, negligible, or further assessment required. Furthermore, an example of management actions that may be appropriate for a species of that ranking is provided (DPaW, 2013b).

Table 2 Control categories for Declared Pests listed under the BAM Act

Category	Definition
C1 Exclusion	Organisms which should be excluded from part or all of Western Australia.
C2 Eradication	Organisms which should be eradicated from part or all of Western Australia.
C3 Management	Organisms that should have some form of management applied that will alleviate the harmful impact of the organism, reduce the numbers or distribution of the organism or prevent or contain the spread of the organism.
Unassigned	Unassigned: Declared pests that are recognised as having a harmful impact under certain circumstances, where their subsequent control requirements are determined by a Plan or other legislative arrangements under the Act.

1.2 Environmental Weeds Strategy of WA

The Environment Weed Strategy of WA (EWSWA) rating is shown along with the BAM Act classification and Environmental Weed Census. The EWSWA ratings identify weeds that pose significant environmental risk based on invasiveness, distribution and environmental impacts. The ratings include:

- High – have all three of the characteristics
- Moderate – have two of the characteristics
- Mild – have one of the characteristics
- Low – not deemed to have any of the characteristics.

1.3 Swan NRM Weed Prioritisation

In 2008 DPaW (at the time Department of Environmental Conservation), rated weeds species in Perth bushland conditions using eight ratings. They were rated according to the risk each species posed on environmental assets in the region based on invasiveness, ecological impact, current and potential distribution and priority for management (CALM, 2008). Ratings included:

- Very High
- High
- Further Assessment Required (FAR)/High
- Moderate/ High
- Moderate
- Low/ Moderate
- Low
- Further Assessment required (FAR).



Appendix D

Desktop Fauna Assessment

Appendix D Desktop Fauna Assessment

Name	Common Name	Conservation Code		DPAW Records		Likelihood
		Commonwealth	State	Year	Number	
Birds						
<i>Apus pacificus</i>	Fork-tailed Swift	Migratory / Marine	IA	-	-	May fly over
<i>Ardea alba</i>	Great Egret	Marine	-	-	-	May occur
<i>Ardea ibis</i>	Cattle Egret	Marine	-	-	-	May occur
<i>Arenaria interpres</i>	Ruddy Turnstone	Migratory / Marine	IA	-	-	May occur
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E	EN	-	-	May occur
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	Migratory / Marine	IA	2011	3	May occur
<i>Calidris canutus</i>	Red Knot	E	VU	-	-	May occur
<i>Calidris alba</i>	Sanderling	Migratory / Marine	IA	-	-	May occur
<i>Calidris canutus</i>	Red Knot	E / Migratory / Marine	IA	-	-	May occur
<i>Calidris ferruginea</i>	Curlew Sandpiper	CE / Migratory / Marine	VU / IA	2004	8	May occur
<i>Calidris melanotos</i>	Pectoral Sandpiper	Migratory / Marine	IA	-	-	Unlikely
<i>Calidris ruficollis</i>	Red-necked Stint	Migratory / Marine	IA	2013	72	Likely
<i>Calidris subminuta</i>	Long-toed Stint	Migratory / Marine	IA	-	-	May occur
<i>Calidris tenuirostris</i>	Great Knot	CE / Migratory / Marine	VU / IA	-	-	May occur
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	V	VU	2003	6	May occur
<i>Calyptorhynchus baudinii</i>	Baudin's Black Cockatoo	V	EN	1998	1	May occur
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	E	EN	2005	11	Likely
<i>Charadrius leschenaultii</i>	Greater Sand Plover	V	IA	2009	2	May occur
<i>Charadrius mongolus</i>	Lesser Sand Plover, Mongolian Plover	E / Migratory / Marine	EN / IA	-	-	Unlikely
<i>Charadrius rubricollis</i>	Hooded Plover	Marine	P4	2006	1,549	Likely
<i>Charadrius ruficapillus</i>	Red-capped Plover	Marine	-	-	-	Likely
<i>Diomedea epomophora (sensu stricto)</i>	Southern Royal Albatross	V / Migratory / Marine	IA	-	-	Unlikely

Name	Common Name	Conservation Code		DPaW Records		Likelihood
		Commonwealth	State	Year	Number	
<i>Diomedea sanfordi</i>	Northern Royal Albatross	E / Migratory / Marine	EN / IA	-	-	Unlikely
<i>Gallinago megala</i>	Swinhoe's Snipe	Migratory / Marine	IA	-	-	Unlikely
<i>Gallinago stenura</i>	Pin-tailed Snipe	Migratory / Marine	IA	-	-	May occur
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	M	-	-	-	Likely
<i>Himantopus himantopus</i>	Black-winged Stilt	Marine	-	-	-	May occur
<i>Leipoa ocellata</i>	Malleefowl	V	VU	-	-	Unlikely
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	Migratory / Marine	IA	-	-	Unlikely
<i>Limosa lapponica</i>	Bar-tailed Godwit	V	VU	-	-	Unlikely
<i>Limosa limosa</i>	Black-tailed Godwit	Migratory / Marine	-	-	-	Unlikely
<i>Merops ornatus</i>	Rainbow Bee-eater	Marine	-	2012	5	Likely
<i>Motacilla cinerea</i>	Grey Wagtail	Migratory / Marine	IA	-	-	May occur
<i>Natator depressus</i>	Flatback Turtle	V	VU	-	-	Unlikely
<i>Numenius madagascariensis</i>	Eastern Curlew	CE	VU & IA	1998	30	Likely
<i>Numenius minutus</i>	Little Curlew	Migratory / Marine	IA	-	-	May occur
<i>Numenius phaeopus</i>	Whimbrel	Migratory / Marine	IA	-	-	May occur
<i>Pachyptila turtur subantarctica</i>	Fairy Prion (southern)	V	-	-	-	Unlikely
<i>Pandion cristatus</i>	Osprey	Migratory / Marine	IA	-	-	May occur
<i>Philomachus pugnax</i>	Ruff (Reeve)	Migratory / Marine	IA	-	-	May occur
<i>Phascogale tapoatafa subsp. (WAM M434)</i>	South-western Brush-tailed Phascogale	-	VU	1991	1	May occur
<i>Pluvialis fulva</i>	Pacific Golden Plover	Migratory / Marine	-	-	-	Unlikely
<i>Pluvialis squatarola</i>	Grey Plover	Migratory / Marine	IA	2011	3	May occur
<i>Puffinus carneipes</i>	Flesh-footed Shearwater	Migratory / Marine	IA / VU	-	-	Unlikely
<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet	Marine	-	-	-	May occur
<i>Rostratula australis</i>	Australian Painted Snipe	E / Marine	EN	-	-	May occur

Name	Common Name	Conservation Code		DPaW Records		Likelihood
		Commonwealth	State	Year	Number	
<i>Sternula nereis nereis</i>	Australian Fairy Tern	V	VU	-	-	May occur
<i>Thalassarche cauta cauta</i>	Shy Albatross	V / Marine	VU	-	-	Unlikely
<i>Thalassarche cauta steadi</i>	White-capped Albatross	V / Marine	VU	-	-	Unlikely
<i>Tringa brevipes</i>	Grey-tailed Tattler	Migratory / Marine	IA / P4	-	-	Unlikely
<i>Tringa glareola</i>	Wood Sandpiper	Migratory / Marine	IA	-	-	May occur
<i>Tringa nebularia</i>	Common Greenshank	Migratory / Marine	IA	2011	16	Likely
<i>Tringa stagnatilis</i>	Marsh Sandpiper, Little Greenshank	Migratory / Marine	IA			May occur
<i>Tringa totanus</i>	Common Redshank	Migratory / Marine	IA	-	-	May occur
Mammals						
<i>Dasyurus geoffroii</i>	Chuditch, Western Quoll	V	VU	1996	2	May occur
<i>Isodon obesulus fusciventer</i>	Quenda, Southern Brown Bandicoot	-	P4	2007	6	Likely
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	V	EN	2011	3	Likely
Reptiles						
<i>Caretta caretta</i>	Loggerhead Turtle	E / Migratory / Marine	EN / IA	-	-	Unlikely
<i>Chelonia mydas</i>	Green Turtle	V / Migratory / Marine	VU / IA	-	-	Unlikely
<i>Ctenotus ora</i>	Coastal Plains Skink	-	P3	1980	2	Unlikely
<i>Dermochelys coriacea</i>	Leatherback Turtle	E / Migratory / Marine	VU / IA	-	-	Unlikely
<i>Lerista lineata</i>	Lined Skink	-	P3	2007	3	Likely
Invertebrates						
<i>Synemon gratiosa</i>	Graceful Sunmoth	-	P4	2011	27	Likely



Appendix E

Vascular Flora Species by
Community Recorded,
Lake Clifton 2016

Appendix E Vascular Species by Vegetation Community Recorded at Lake Clifton, 2016

Row Labels	AfDdLg	AfHcEp	AfSgTd	AfXpHh	AfXpHg	ArMsTd	EdArTd	EdRbTd	EgMhAp	EgMsTd	EgXpTd	MrGtHg	MrGtTd	MsTd	Xp
Weeds															
<i>?Daucus glochidiatus</i>						X									
<i>Arctotheca calendula</i>		X		X		X				X		X		X	X
<i>Avena barbata</i>														X	
<i>Brassica tournefortii</i>			X							X		X		X	X
<i>Dittrichia graveolens</i>												X		X	X
<i>Euphorbia peplus</i>	X	X							X	X		X		X	
<i>Euphorbia terracina</i>		X													
<i>Geranium molle</i>	X	X		X	X	X		X	X	X	X	X	X	X	X
<i>Hypochaeris glabra</i>		X		X	X	X				X	X	X	X	X	X
<i>Lotus subbiflorus</i>		X			X									X	
<i>Lupinus sp.</i>					X									X	
<i>Lysimachia arvensis</i>		X		X	X	X	X			X	X	X	X	X	X
<i>Poaceae sp.</i>										X					
<i>Solanum nigrum</i>	X	X	X	X		X	X	X	X	X	X	X		X	
<i>Sonchus oleraceus</i>		X													
<i>Trachyantha divaricata</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Trifolium campestre</i>		X	X	X		X	X			X	X	X	X	X	X
<i>Ursinia anthemoides</i>		X												X	X
Declared Pests															
<i>Gomphocarpus fruticosus</i>		X		X						X		X		X	X
<i>Solanum linnaeanum</i>										X					
<i>Zantedeschia aethiopica</i>	X			X									X		
Conservation Significant															
<i>Stylidium maritimum</i> (P3)						X									X
<i>Eucalyptus argutifolia</i> (T)															X
Other															
<i>?Hibbertia cuneiformis</i>						X									
<i>?Threlkeldia diffusa</i>													X		
<i>Acacia cochlearis</i>						X								X	
<i>Acacia cyclops</i>				X										X	X
<i>Acacia littorea</i>			X			X								X	
<i>Acacia pulchella</i>				X										X	
<i>Acacia rostellifera</i>			X	X		X	X	X	X	X				X	
<i>Acacia saligna</i>			X	X		X							X	X	
<i>Acacia truncata</i>			X												
<i>Acanthocarpus preissii</i>	X		X	X		X		X	X	X				X	
<i>Acrotriche cordata</i>			X			X									
<i>Agonis flexuosa</i>	X	X	X	X	X	X	X		X	X	X	X	X	X	X

Appendix E Vascular Species by Vegetation Community Recorded at Lake Clifton, 2016

Row Labels	AfDdLg	AfHcEp	AfSgTd	AfXpHh	AfXpHg	ArMsTd	EdArTd	EdRbTd	EgMhAp	EgMsTd	EgXpTd	MrGtHg	MrGtTd	MsTd	Xp
<i>Hibbertia cuneiformis</i>	x	x	x	x	x	x	x		x	x	x	x		x	
<i>Hibbertia hypericoides</i>				x	x									x	
<i>Hibbertia racemosa</i>				x										x	x
<i>Jacksonia furcellata</i>				x		x								x	
<i>Juncus kraussii</i> subsp. <i>australiensis</i>								x					x		
<i>Kennedia coccinea</i>													x		
<i>Lagenophora huegelii</i>				x									x	x	
<i>Lepidosperma gladiatum</i>	x														
<i>Lepidosperma squamatum</i>						x									
<i>Lepyrodia drummondiana</i>				x									x		
<i>Leucopogon nutans</i>				x		x									
<i>Leucopogon parviflorus</i>	x		x			x	x	x		x	x		x	x	
<i>Leucopogon propinquus</i>				x	x									x	x
<i>Lomandra maritima</i>						x	x							x	
<i>Lomandra micrantha</i>				x	x										x
<i>Loxocarya cinerea</i>														x	
<i>Macrozamia riedlei</i>				x	x						x				
<i>Melaleuca cuticularis</i>													x		
<i>Melaleuca huegelii</i>								x							
<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>			x	x		x	x		x	x			x	x	
<i>Melaleuca lanceolata</i>							x					x			
<i>Melaleuca raphiophylla</i>								x				x	x		
<i>Melaleuca</i> sp. (<i>huegelii</i> x <i>raphiophylla</i>)			x												
<i>Melaleuca systema</i>				x	x	x	x	x		x	x		x	x	x
<i>Melaleuca teretifolia</i>												x			
<i>Nuytsia floribunda</i>				x										x	
<i>Olearia axillaris</i>			x			x							x	x	
<i>Opercularia hispidula</i>				x		x							x		
<i>Orchid</i> sp.			x	x	x	x				x	x		x	x	
<i>Patersonia occidentalis</i>				x											
<i>Pentapeltis peltigera</i>		x													
<i>Phyllanthus calycinus</i>		x	x	x	x	x		x	x	x				x	x
<i>Pimelea ferruginea</i>						x									
<i>Pimelea</i> sp.															x
Planted <i>Callistemon</i>		x													x
<i>Poaceae</i> sp.			x	x	x	x									x
<i>Pterostylis sanguinea</i>				x											
<i>Pyrorchis nigricans</i>				x											
<i>Rhagodia baccata</i> subsp. <i>baccata</i>						x		x		x					

Appendix E Vascular Species by Vegetation Community Recorded at Lake Clifton, 2016

Row Labels	AfDdLg	AfHcEp	AfSgTd	AfXpHh	AfXpHg	ArMsTd	EdArTd	EdRbTd	EgMhAp	EgMsTd	EgXpTd	MrGtHg	MrGtTd	MsTd	Xp
<i>Santalum acuminatum</i>									x	x					
<i>Sarcocornia blackiana</i>													x		
<i>Scaevola crassifolia</i>			x												
<i>Scaevola nitida</i>						x									
<i>Senecio diaschides</i>					x	x				x					x
<i>Solanum symonii</i>	x														x
<i>Spyridium globulosum</i>	x	x	x	x	x	x	x	x		x			x		x
<i>Stackhousia</i> sp.					x										
<i>Templetonia retusa</i>				x		x		x		x	x		x		x
<i>Tetralia octandra</i>				x		x									
<i>Threlkeldia diffusa</i>						x									
<i>Thysanotus manglesianus</i>				x	x	x				x			x		x
<i>Trachymene pilosa</i>			x	x	x	x				x			x		x
<i>Trymalium ledifolium</i> var. <i>ledifolium</i>						x									
<i>Typha</i> sp.							x	x							
<i>Veronica distans</i>			x			x									
<i>Xanthorrhoea preissii</i>	x		x	x	x	x	x		x	x	x		x	x	x



Appendix F

Lake Clifton Quadrat Data

Appendix F Lake Clifton Quadrat Data

Site	1	Location	115.657, -32.814
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ls	Soil Colour	Dark brown
Bare Ground	15	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Weeds, evidence of human presence

Photos:

No Photos

Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus marginata</i>	2000	6	T
	<i>Agonis flexuosa</i>	1200	10	T
	<i>Spyridium globulosum</i>	300	0.5	TS
	<i>Xanthorrhoea preissii</i>	200	7	TS
	<i>Hakea lissocarpa</i>	180	3	TS
	<i>Hibbertia cuneiformis</i>	110	0.5	S
	<i>Leucopogon propinquus</i>	100	0.1	S
	<i>Hakea ruscifolia</i>	50	0.1	S
	<i>Macrozamia riedlei</i>	50	1	S
	<i>Desmocladius flexuosus</i>	40	0.1	H
	<i>Hibbertia hypericoides</i>	40	7	S
	<i>Phyllanthus calycinus</i>	40	0.1	S
	<i>Lomandra micrantha</i>	30	0.1	H
	<i>Stackhousia sp.</i>	30	0.1	H
	<i>Thysanotus manglesianus</i>	20	0.1	H
*	<i>Trachyandra divaricata</i>	20	0.1	W
*	<i>Lupinus sp.</i>	10	0.01	W
*	<i>Lysimachia arvensis</i>	4	0.1	W
	<i>Trachymene pilosa</i>	3	0.2	H
*	<i>Lotus subbiflorus</i>	2	0.5	W
*	<i>Hypochaeris glabra</i>	1	2	W
	<i>Drosera erythrorhiza</i>	0.5	0.01	H
	<i>Clematis pubescens</i>	0	0.1	V
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	2	Location	115.652, -32.809
Observers	FdW & LvG		
Date	21/06/2016		

Topography	Ls-ms	Soil Colour	Brown
Bare Ground	2	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	G

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1600	2	T
	<i>Agonis flexuosa</i>	1200	40	T
	<i>Hibbertia cuneiformis</i>	200	3	TS
	<i>Xanthorrhoea preissii</i>	150	2	TS
*	<i>Trachyandra divaricata</i>	40	15	W
*	<i>Euphorbia terracina</i>	20	0.1	W

Site	3	Location	115.654, -32.806
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ls	Soil Colour	Brown
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	G

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	2200	6	T
	<i>Agonis flexuosa</i>	1000	4	T
	<i>Spyridium globulosum</i>	200	1	TS
	<i>Hibbertia cuneiformis</i>	100	3	TS
	<i>Xanthorrhoea preissii</i>	100	2	S
	<i>Phyllanthus calycinus</i>	40	0.4	S
*	<i>Trachyandra divaricata</i>	30	20	W
*	<i>Ursinia anthemoides</i>	10	1	W
*	<i>Euphorbia peplus</i>	5	40	W
*	<i>Lysimachia arvensis</i>	5	1	W
*	<i>Solanum nigrum</i>	5	10	W
*	<i>Sonchus oleraceus</i>	5	2	W
	<i>Clematis linearifolia</i>	0	0.1	V

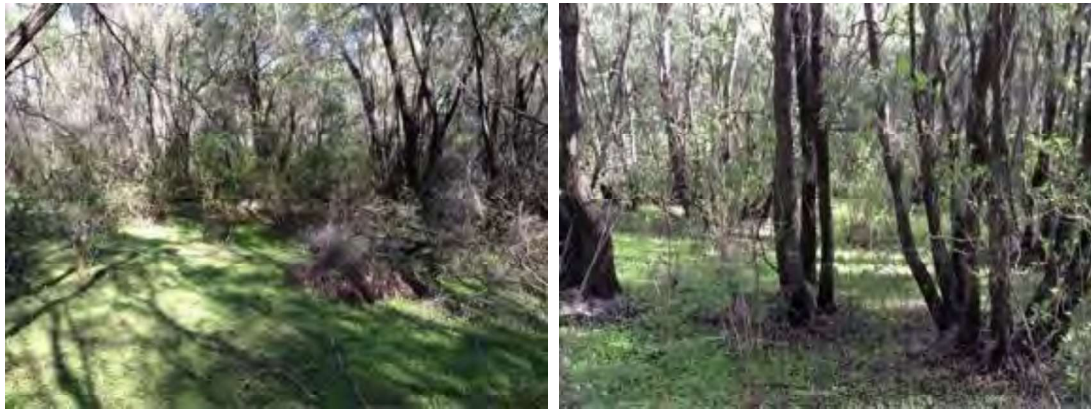
Site	4	Location	115.652, -32.806
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ls	Soil Colour	Brown
Bare Ground	4	Condition	Moist
Cryptogram	Yes	Fire	10+
Soil Type	Sand	Condition	G

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	3000	1	T
	<i>Agonis flexuosa</i>	1200	40	T
	<i>Hibbertia cuneiformis</i>	200	6	TS
	<i>Xanthorrhoea preissii</i>	100	0.5	S
*	<i>Arctotheca calendula</i>	10	0.1	W
*	<i>Lotus subbiflorus</i>	10	2	W
*	<i>Euphorbia peplus</i>	5	20	W
*	<i>Geranium molle</i>	5	60	W
*	<i>Lysimachia arvensis</i>	5	1	W
	<i>Pentapeltis peltigera</i>	5	5	H
*	<i>Sonchus oleraceus</i>	5	2	W
	<i>Clematis linearifolia</i>	0	0.5	V

Site	5	Location	115.657, -32.799
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	400	0.1	TS
	<i>Hakea prostrata</i>	250	3	TS
	<i>Spyridium globulosum</i>	220	0.2	TS
	<i>Hakea trifurcata</i>	200	0.5	TS
* DP	<i>Gomphocarpus fruticosus</i>	170	1.5	W
	<i>Xanthorrhoea preissii</i>	150	1	S
	<i>Templetonia retusa</i>	120	1	S
	<i>Melaleuca systema</i>	60	40	S
	<i>Leucopogon parviflorus</i>	50	1	S
	<i>Hibbertia cuneiformis</i>	40	0.1	S
*	<i>Trachyandra divaricata</i>	30	60	W
*	<i>Geranium molle</i>	2	1	W
*	<i>Hypochaeris glabra</i>	1	0.5	W
	<i>Cassytha racemosa</i>	0	0.1	V
	<i>Clematis linearifolia</i>	0	0.2	V

Site	6	Location	115.657, -32.799
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	10	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus decipiens</i>	800	30	T
	<i>Eucalyptus petrensis</i>	350	10	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	300	0.5	TS
	<i>Spyridium globulosum</i>	230	1	TS
	<i>Agonis flexuosa</i>	200	0.5	TS
	<i>Melaleuca systema</i>	200	1	TS
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	200	0.2	TS
	<i>Templetonia retusa</i>	180	1	TS
	<i>Xanthorrhoea preissii</i>	160	3	S
	<i>Hibbertia cuneiformis</i>	100	0.5	S
	<i>Hibbertia hypericoides</i>	80	0.1	S
	<i>Melaleuca systema</i>	70	0.2	S
	<i>Senecio diaschides</i>	30	0.1	H
*	<i>Trachyandra divaricata</i>	30	5	W
*	<i>Lotus subbiflorus</i>	10	0.5	W
*	<i>Geranium molle</i>	2	2	W
	<i>Clematis linearifolia</i>	0	0.3	V

Site	7	Location	115.657, -32.796
Observers	LvG and FdW		
Date	21/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	.5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	250	10	TS
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	240	3	TS
	<i>Spyridium globulosum</i>	240	8	TS
	<i>Hakea prostrata</i>	220	0.1	TS
* DP	<i>Gomphocarpus fruticosus</i>	120	0.1	W
	<i>Hibbertia cuneiformis</i>	80	1	S
	<i>Melaleuca systema</i>	80	40	S
	<i>Leucopogon propinquus</i>	60	0.1	S
	<i>Templetonia retusa</i>	60	1	S
	<i>Grevillea preissii</i> subsp. <i>preissii</i>	50	0.2	S
	<i>Leucopogon parviflorus</i>	40	1	S
	<i>Drosera macrantha</i>	30	0.1	H
*	<i>Trachyandra divaricata</i>	30	5	W
	<i>Hibbertia racemosa</i>	20	0.1	S
	<i>Banksia dallanneyi</i>	10	0.1	S
*	<i>Solanum nigrum</i>	10	1	W
*	<i>Geranium molle</i>	2	2	W
*	<i>Lysimachia arvensis</i>	2	1	W

Cons	Taxon	Ht/cm	%A	Form
*	<i>Hypochaeris glabra</i>	1	0.4	W
*	<i>Lotus subbiflorus</i>	1	0.5	W
	<i>Clematis linearifolia</i>	0	1	V

Site	8	Location	115.650, -32.768
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ls	Soil Colour	White to brown
Bare Ground	0	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	E

Additional notes:

Low intensity weeds, rabbits

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	900	5	T
	<i>Agonis flexuosa</i>	700	40	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	400	6	TS
dead	<i>Banksia grandis</i>	300	0.5	T
	<i>Xanthorrhoea preissii</i>	250	2	TS
	<i>Spyridium globulosum</i>	230	2	TS
	<i>Melaleuca systema</i>	220	0.5	TS
	<i>Hakea ruscifolia</i>	160	0.1	S
	<i>Hakea lissocarpha</i>	140	0.2	S
	<i>Templetonia retusa</i>	100	3	S
	<i>Hibbertia hypericoides</i>	40	20	S
	<i>Macrozamia riedlei</i>	40	0.2	S
	<i>Acanthocarpus preissii</i>	30	0.1	H
	<i>Leucopogon propinquus</i>	30	0.1	S
	<i>Lomandra micrantha</i>	30	0.2	H
	<i>Opercularia hispidula</i>	30	0.1	H
	<i>Drosera macrantha</i>	20	0.01	H
	<i>Hibbertia racemosa</i>	20	0.1	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Desmodadus flexuosus</i>	15	0.1	H
*	<i>Lysimachia arvensis</i>	5	0.1	W
	<i>Trachymene pilosa</i>	5	0.1	H
	<i>Lagenophora huegelii</i>	1	0.1	H
	<i>Orchid sp.</i>	1	0.01	H
	<i>Drosera erythrorhiza</i>	0.5	0.2	H
	<i>Cassytha racemosa</i>	0	0.1	V
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	9	Location	115.649, -32.768
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ls to ms	Soil Colour	Brown to white
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	E

Additional notes:

Rabbits

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	700	20	T
	<i>Agonis flexuosa</i>	600	50	T
	<i>Eucalyptus petrensis</i>	600	2	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	250	10	TS
	<i>Jacksonia furcellata</i>	250	0.2	S
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	240	4	TS
	<i>Templetonia retusa</i>	240	8	TS
	<i>Melaleuca systema</i>	200	1	TS
	<i>Xanthorrhoea preissii</i>	200	0.5	TS
	<i>Hakea lissocarpha</i>	100	0.1	S
	<i>Acacia pulchella</i>	50	0.1	S
	<i>Hibbertia hypericoides</i>	50	25	S
	<i>Macrozamia riedlei</i>	50	0.2	S
	<i>Grevillea preissii</i> subsp. <i>preissii</i>	40	0.1	S
Juvenile	<i>Hibbertia cuneiformis</i>	40	0.1	S
	<i>Leucopogon propinquus</i>	40	0.2	S
	<i>Pyrorchis nigricans</i>	40	0.01	H
	<i>Acacia cyclops</i>	30	0.1	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Desmocladius flexuosus</i>	20	0.1	H
	<i>Lomandra micrantha</i>	20	0.1	H
dead	<i>Banksia dallanneyi</i>	10	0.1	S
	<i>Orchid sp.</i>	6	0.01	H
	<i>Trachymene pilosa</i>	5	0.1	H
	<i>Lagenophora huegelii</i>	1	0.1	H
	<i>Drosera erythrorhiza</i>	0.5	0.2	H

Site	10	Location	115.650, -32.770
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ls	Soil Colour	Grey
Bare Ground	5	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	E

Additional notes:

Rabbits, low intensity weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1400	10	T
	<i>Agonis flexuosa</i>	900	35	T
	<i>Xanthorrhoea preissii</i>	250	10	TS
	<i>Banksia littoralis</i>	240	2	T
	<i>Templetonia retusa</i>	230	5	TS
	<i>Jacksonia furcellata</i>	220	0.1	TS
	<i>Acacia saligna</i>	200	0.1	TS
	Planted urn	180	0.1	S
	<i>Goodenia pulchella</i>	100	0.1	?W
	<i>Acacia pulchella</i>	80	0.1	S
	<i>Hakea lissocarpha</i>	60	0.1	S
	<i>Hibbertia hypericoides</i>	60	3	S
	<i>Macrozamia riedlei</i>	50	0.2	S
	<i>Drosera macrantha</i>	30	0.2	H
	<i>Lepyrodia drummondiana</i>	30	0.1	Sedge
	<i>Leucopogon propinquus</i>	30	0.1	S
	<i>Lomandra micrantha</i>	30	0.2	H
	<i>Patersonia occidentalis</i>	30	0.1	H

Cons	Taxon	Ht/cm	%A	Form
Juvenile	<i>Spyridium globulosum</i>	30	0.1	S
	<i>Drosera macrantha</i>	20	0.01	H
	<i>Opercularia hispidula</i>	15	0.1	H
*	<i>Lysimachia arvensis</i>	2	0.1	W
	<i>Trachymene pilosa</i>	2	0.2	H
	<i>Lagenophora huegelii</i>	1	0.1	H
	<i>Drosera erythrorhiza</i>	0.5	0.1	H
*	<i>Hypochaeris glabra</i>	0.5	0.1	W
	<i>Cassutha racemosa</i>	0	0.01	V
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	11	Location	115.646, -32.770
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Flat	Soil Colour	Light brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	E

Additional notes:

Barely any weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1500	20	T
	<i>Agonis flexuosa</i>	1400	30	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	300	1	TS
	<i>Xanthorrhoea preissii</i>	300	10	TS
	<i>Melaleuca systema</i>	200	5	TS
	<i>Hemiandra pungens</i>	200	0.1	S
	<i>Templetonia retusa</i>	150	5	TS
	<i>Acacia pulchella</i>	80	0.1	S
	<i>Drosera macrantha</i>	80	0.01	H
	<i>Hibbertia hypericoides</i>	80	10	S
	<i>Macrozamia riedlei</i>	80	0.5	S
	<i>Hakea lissocarpha</i>	60	0.2	S
	<i>Lomandra micrantha</i>	30	0.1	H
	<i>Desmocladius flexuosus</i>	15	0.02	H
	<i>Opercularia hispidula</i>	10	0.1	H
	<i>Orchid</i> sp.	10	0.01	H
	<i>Spyridium globulosum</i>	10	0.1	S
	<i>Lagenophora huegelii</i>	5	0.1	H

Cons	Taxon	Ht/cm	%A	Form
*	<i>Lysimachia arvensis</i>	5	0.02	W
	<i>Trachymene pilosa</i>	5	0.02	H
*	<i>Hypochaeris glabra</i>	1	0.02	W
	<i>Drosera erythrorhiza</i>	0.5	0.1	H
	<i>Cassytha racemosa</i>	0	0.01	V
	<i>Hardenbergia comptoniana</i>	0	0.02	V

Site	12	Location	115.646, -32.779
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Wetland	Soil Colour	Black
Bare Ground	0	Condition	Waterlogged
Cryptogram	N/A	Fire	10+
Soil Type	Clay loam	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1600	5	T
	<i>Eucalyptus petrensis</i>	1500	30	T
	<i>Melaleuca cuticularis</i>	550	80	T
	<i>Banksia littoralis</i>	500	2	T
	<i>Melaleuca raphiophylla</i>	500	10	T
	<i>Melaleuca systema</i>	200	5	TS
	<i>Templetonia retusa</i>	180	5	TS
	<i>Xanthorrhoea preissii</i>	170	8	TS
	<i>Juncus kraussii subsp. australiensis</i>	130	15	Sedge

Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	130	2	S
	<i>Gahnia trifida</i>	120	30	Sedge
	<i>Opercularia hispidula</i>	40	0.1	H
	<i>Lepyrodia drummondiana</i>	30	0.5	Sedge
*	<i>Trachyandra divaricata</i>	30	0.1	W
DP	<i>Zantedeschia aethiopica</i>	20	0.1	W
	<i>Sarcocornia blackiana</i>	20	15	H
	<i>Thysanotus manglesianus</i>	20	0.01	H
	<i>Agonis flexuosa</i>	10	30	T
*	<i>Geranium molle</i>	10	0.1	W
*	<i>Lysimachia arvensis</i>	10	0.02	W
	<i>Orchid</i> sp.	7	0.01	H
	<i>Trachymene pilosa</i>	7	0.02	H
*	<i>Trifolium campestre</i>	5	0.01	W
	<i>Lagenophora huegelii</i>	5	0.1	H
	? <i>Threlkeldia diffusa</i>	5	20	H
	<i>Clematis linearifolia</i>	0	0.1	H
	<i>Clematis pubescens</i>	0	2	V
	<i>Kennedia coccinea</i>	0	0.2	H

Site	13	Location	115.638, -32.769
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Hilltop	Soil Colour	Brown
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	G

Additional notes:

Rabbits, weeds, no understorey

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	800	35	T
	<i>Planted Callistemon</i>	300	0.1	S
* DP	<i>Gomphocarpus fruticosus</i>	190	0.5	W
	<i>Xanthorrhoea preissii</i>	130	0.5	S
	<i>Hibbertia cuneiformis</i>	120	3	S
*	<i>Trachyandra divaricata</i>	40	20	W
*	<i>Solanum nigrum</i>	15	0.1	W
*	<i>Trifolium campestre</i>	5	0	W
*	<i>Geranium molle</i>	5	5	W
*	<i>Arctotheca calendula</i>	2	0.01	W
	<i>Clematis linearifolia</i>	0	0.5	V

Site	14	Location	115.636, -32.773
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	4	Condition	Moist
Cryptogram	Yes	Fire	10+
Soil Type	Sandy loam	Condition	G

Additional notes:

Weeds, maybe missing all trees

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus platypus</i>	500	0.1	T
	<i>Acacia cyclops</i>	400	1	TS
	<i>Agonis flexuosa</i>	400	5	T
	<i>Xanthorrhoea preissii</i>	250	50	TS
* DP	<i>Gomphocarpus fruticosus</i>	100	0.1	W
	<i>Melaleuca systema</i>	70	25	S
	<i>Leucopogon propinquus</i>	60	0.1	S
	<i>Hakea prostrata</i>	50	5	S
*	<i>Trachyandra divaricata</i>	40	5	W
	<i>Phyllanthus calycinus</i>	20	0.2	S
*	<i>Arctotheca calendula</i>	5	0.01	W
*	<i>Trifolium campestre</i>	5	0.2	W
*	<i>Geranium molle</i>	2	1	W
*	<i>Hypochaeris glabra</i>	2	0.2	W
*	<i>Lysimachia arvensis</i>	2	0.02	W
*	<i>Brassica tournefortii</i>	0.1	0.01	W

Site	15	Location	115.639, -32.777
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	N/A
Soil Type	Sandy loamy	Condition	VG

Additional notes:

Vg to excellent, weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	2700	20	T
	<i>Agonis flexuosa</i>	900	20	T
	<i>Xanthorrhoea preissii</i>	250	35	TS
	<i>Hibbertia cuneiformis</i>	150	1	S
	<i>Macrozamia riedlei</i>	100	2	S
*	<i>Trachyandra divaricata</i>	30	0.05	W
*	<i>Solanum nigrum</i>	20	0.05	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Banksia attenuata</i>	8	20	T
*	<i>Trifolium campestre</i>	5	0.02	W
*	<i>Geranium molle</i>	5	0.02	W
*	<i>Lysimachia arvensis</i>	5	0.01	W
*	<i>Hypochaeris glabra</i>	1	0.02	W
	<i>Drosera erythrorhiza</i>	0.5	0.01	H
	<i>Hardenbergia comptoniana</i>	0	1	V

Site	16	Location	115.636, -32.780
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	1	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	G

Additional notes:

Lacking tree stratum

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Xanthorrhoea preissii</i>	200	50	TS
	<i>Lomandra micrantha</i>	50	0.02	H
*	<i>Dittrichia graveolens</i>	45	0	W
	<i>Melaleuca systema</i>	30	0.1	S
*	<i>Trachyandra divaricata</i>	30	1	W
	<i>Hibbertia racemosa</i>	15	0	S
*	<i>Trifolium campestre</i>	5	0.01	W
*	<i>Lysimachia arvensis</i>	5	0.02	W
*	<i>Geranium molle</i>	2	0.02	W
*	<i>Hypochaeris glabra</i>	1	0.5	W
*	<i>Brassica tournefortii</i>	0.1	0.01	W

Site	17	Location	115.639, -32.781
Observers	LvG and FdW		
Date	22/06/2016		

Topography	Ms	Soil Colour	Black brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	G

Additional notes:

Weeds, declared pests

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca huegelii subsp. huegelii</i>	250	2	TS
	<i>Xanthorrhoea preissii</i>	200	7	TS
* DP	<i>Gomphocarpus fruticosus</i>	170	5	W
	<i>Hibbertia cuneiformis</i>	100	3	S
	<i>Melaleuca systema</i>	100	75	S
	<i>Templetonia retusa</i>	80	2	S
	<i>Pimelea sp.</i>	70	0.01	H
*	<i>Trachyandra divaricata</i>	40	5	W
	<i>Leucopogon propinquus</i>	20	0.01	S
*	<i>Arctotheca calendula</i>	2	0.01	W
*	<i>Geranium molle</i>	2	0.02	W
*	<i>Hypochaeris glabra</i>	1	1	W
	<i>Clematis linearifolia</i>	0	1	V

Site	18	Location	115.642, -32.791
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Dune crest	Soil Colour	Brown
Bare Ground	0	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam with lots of organic matter	Condition	G

Additional notes:

Weeds, low diversity and missing understorey stratum

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia rostellifera</i>	600	10	TS
	<i>Agonis flexuosa</i>	600	10	T
	<i>Santalum acuminatum</i>	300	1	T
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	250	20	TS
	<i>Xanthorrhoea preissii</i>	200	0.2	S
	<i>Acanthocarpus preissii</i>	80	20	H
	<i>Hibbertia cuneiformis</i>	80	4	S
	<i>Phyllanthus calycinus</i>	50	0.1	S

Cons	Taxon	Ht/cm	%A	Form
*	<i>Trachyandra divaricata</i>	50	30	W
*	<i>Euphorbia peplus</i>	20	7	W
*	<i>Solanum nigrum</i>	20	2	W
	<i>Eucalyptus gomphocephala</i>	15	5	T
*	<i>Geranium molle</i>	10	1	W
	<i>Clematis linearifolia</i>	0	40	V

Site	19	Location	115.643, -32.790
Observers	LvG and FdW		
Date	23/06/2016		

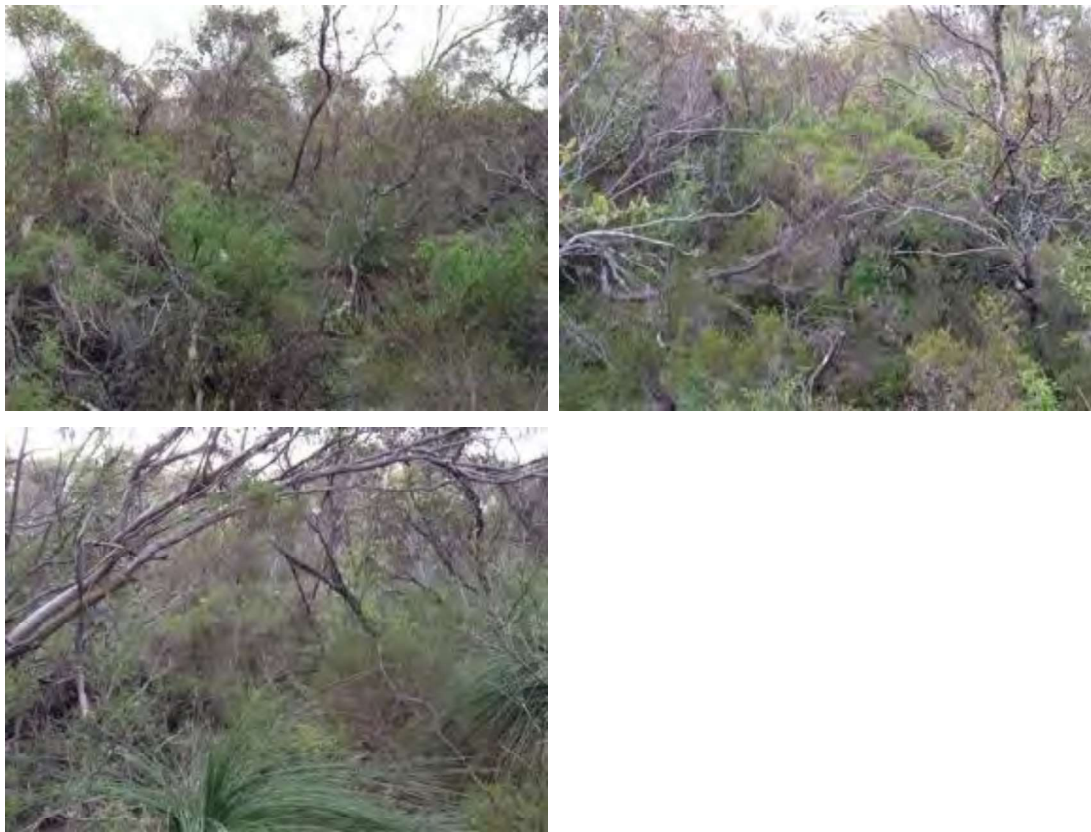
Topography	Ls	Soil Colour	Grey
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Ground stratum all weeds

Can hear cockatoos

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus foecunda</i>	500	50	T
	<i>Spyridium globulosum</i>	400	5	TS
	<i>Hakea prostrata</i>	250	0.1	TS
* DP	<i>Gomphocarpus fruticosus</i>	200	0.1	W
	<i>Xanthorrhoea preissii</i>	200	7	TS
	<i>Planted Callistemon</i>	170	0.01	S
	<i>Melaleuca systema</i>	160	10	TS
	<i>Hibbertia cuneiformis</i>	100	3	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Hibbertia hypericoides</i>	90	5	S
	<i>Leucopogon parviflorus</i>	60	0.1	S
	<i>Templetonia retusa</i>	60	3	S
*	<i>Trachyandra divaricata</i>	50	0.2	W
	<i>Senecio diaschides</i>	15	1	H
	<i>Loxocarya cinerea</i>	10	0.01	H
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Solanum nigrum</i>	7	0.2	W
*	<i>Lysimachia arvensis</i>	5	0.02	W
*	<i>Geranium molle</i>	2	0.2	W
	<i>Trachymene pilosa</i>	2	0.2	H
*	<i>Hypochaeris glabra</i>	1	1	W
	<i>Lagenophora huegelii</i>	1	0.01	H
*	<i>Arctotheca calendula</i>	0.5	0.1	W
	<i>Clematis linearifolia</i>	0	15	V
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	20	Location	115.639, -32.785
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	5	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	G

Additional notes:

Weeds no native understorey

Euc gomph over xanth preissii over weeds

Photos:



Site	21	Location	115.636, -32.788
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Dune swale	Soil Colour	Brown to white
Bare Ground	N/A	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	G

Additional notes:

Weed understorey

21a is wetland with types surrounded by euc decipiens and callitris over xanth

Photos:



Wetland Taxon

Cons	Taxon	Ht/cm	%A	Form
	<i>Allocasuarina fraseriana</i>	800	1	T
	<i>Eucalyptus decipiens</i>	700	25	T
	<i>Callitris preissii</i>	600	15	T
	<i>Acacia rostellifera</i>	350	30	TS
	<i>Xanthorrhoea preissii</i>	300	20	TS
	<i>Agonis flexuosa</i>	200	2	TS
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	200	1	TS
	<i>Hibbertia cuneiformis</i>	130	0.1	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca systema</i>	100	1	S
	<i>Leucopogon parviflorus</i>	50	0.1	S
*	<i>Trachyandra divaricata</i>	50	20	W
	<i>Lomandra maritima</i>	30	5	H
	<i>Spyridium globulosum</i>	20	0.05	S
*	<i>Solanum nigrum</i>	15	0.05	W
*	<i>Trifolium campestre</i>	5	0.05	W
*	<i>Lysimachia arvensis</i>	5	0.02	W
	<i>Clematis linearifolia</i>	0	0.2	V

Adjacent Vegetation

Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia rostellifera</i>	500	10	TS
	<i>Melaleuca lanceolata</i>	500	8	TS
	<i>Eucalyptus sp. (planted)</i>	400	5	T
	<i>Agonis flexuosa</i>	300	1	TS
	<i>Typha sp.</i>	200	80	Sedge
	<i>Baumea juncea</i>	180	10	Sedge
	<i>Leucopogon parviflorus</i>	80	0.02	S

Site	22	Location	115.646, -32.790
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Ms	Soil Colour	Light brown
Bare Ground	0	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	2500	15	T
	<i>Xanthorrhoea preissii</i>	250	75	TS
	<i>Leucopogon parviflorus</i>	150	0	S
	<i>Templetonia retusa</i>	100	0	S
	<i>Melaleuca systema</i>	60	0	S
*	<i>Trachyandra divaricata</i>	40	0.5	W
*	<i>Solanum nigrum</i>	15	0.5	W
*	<i>Geranium molle</i>	10	1	W
*	<i>Trifolium campestre</i>	5	0.02	W
*	<i>Lysimachia arvensis</i>	5	0.05	W
*	<i>Hypochaeris glabra</i>	1	1	W

Site	23	Location	115.656, -32.787
Observers	LvG and FdW		
Date	27/06/2016		

Topography	Ls	Soil Colour	Brown
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	2000	15	T
	<i>Banksia grandis</i>	900	2	T
	<i>Banksia attenuata</i>	700	5	T
	<i>Eucalyptus petrensis</i>	700	5	T
	<i>Nuytsia floribunda</i>	600	0	T
	<i>Agonis flexuosa</i>	500	40	T
* DP	<i>Gomphocarpus fruticosus</i>	300	6	W
	<i>Xanthorrhoea preissii</i>	250	7	TS
	<i>Hibbertia cuneiformis</i>	150	0.1	S
	<i>Macrozamia riedlei</i>	100	2	S
*	<i>Trachyandra divaricata</i>	60	5	W
*	<i>Solanum nigrum</i>	15	0.2	W
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Trifolium campestre</i>	5	0.1	W
*	<i>Geranium molle</i>	5	0.2	W
*	<i>Lysimachia arvensis</i>	5	0.2	W
	<i>Trachymene pilosa</i>	5	0.1	H
*	<i>Hypochaeris glabra</i>	1	0.1	W

Cons	Taxon	Ht/cm	%A	Form
	<i>Cassytha racemosa</i>	0	0.02	V
	<i>Clematis pubescens</i>	0	2	V
	<i>Hardenbergia comptoniana</i>	0	0.05	V

Site	24	Location	115.652, -32.782
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Flat	Soil Colour	Black, dark brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand, loamy	Condition	VG

Additional notes:

Weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1500	20	T
	<i>Agonis flexuosa</i>	900	60	T
	<i>Banksia grandis</i>	400	0.05	T
	<i>Xanthorrhoea preissii</i>	150	4	S
	<i>Templetonia retusa</i>	120	0.2	S
* DP	<i>Gomphocarpus fruticosus</i>	110	1	W
	<i>Macrozamia riedlei</i>	90	2	S
	<i>Hibbertia cuneiformis</i>	60	0.1	S
	<i>Poaceae sp.</i>	15	0.02	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Thysanotus manglesianus</i>	10	0.01	H
*	<i>Trifolium campestre</i>	5	0.1	W
*	<i>Geranium molle</i>	5	0.02	W
*	<i>Lysimachia arvensis</i>	5	0.1	W
	<i>Orchid sp.</i>	5	0.01	H
	<i>Trachymene pilosa</i>	5	0.1	H
*	<i>Hypochaeris glabra</i>	1	0.1	W
	<i>Lagenophora huegelii</i>	1	0.05	H

Cons	Taxon	Ht/cm	%A	Form
	<i>Drosera erythrorhiza</i>	0.5	0.01	H
	<i>Clematis pubescens</i>	0	10	V

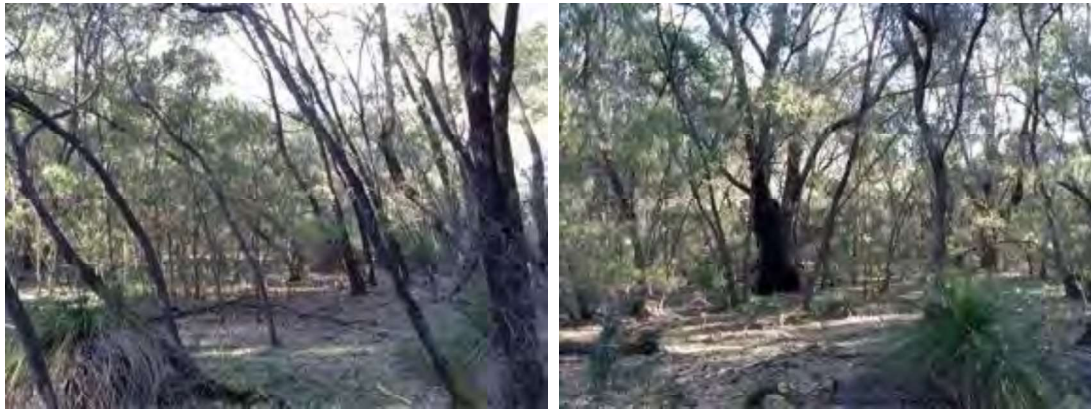
Site	25	Location	115.652, -32.780
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Flat	Soil Colour	Dark brown, grey
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loamy	Condition	VG

Additional notes:

Weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1500	15	T
	<i>Agonis flexuosa</i>	1200	60	T
	<i>Banksia grandis</i>	800	0	T
	<i>Xanthorrhoea preissii</i>	220	10	TS
	<i>Macrozamia riedlei</i>	150	7	S
	<i>Templetonia retusa</i>	120	0.5	S
DP	<i>Zantedeschia aethiopica</i>	30	0.02	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Poaceae sp.</i>	10	0.01	W
*	<i>Solanum nigrum</i>	10	0.05	W
	<i>Thysanotus manglesianus</i>	10	0.02	H
	<i>Trachymene pilosa</i>	10	0.1	H
*	<i>Lysimachia arvensis</i>	5	0.1	W
*	<i>Hypochaeris glabra</i>	1	0.05	W
	<i>Lagenophora huegelii</i>	1	0.01	H
	<i>Clematis pubescens</i>	0	7	V
	<i>Hardenbergia comptoniana</i>	0	0.02	V

Site	26	Location	115.656, -32.808
Observers	LvG and FdW		
Date	23/06/2016		

Topography	Wetlad	Soil Colour	Black
Bare Ground	N/A	Condition	N/A
Cryptogram	N/A	Fire	10+
Soil Type	Loam	Condition	D

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1900	2	T
	<i>Agonis flexuosa</i>	400	2	TS
	<i>Melaleuca teretifolia</i>	300	25	TS
	<i>Melaleuca raphiophylla</i>	300	10	TS
* DP	<i>Gomphocarpus fruticosus</i>	200	2	W
	<i>Gahnia trifida</i>	150	25	Sedge
*	<i>Dittrichia graveolens</i>	30	5	W
	<i>Hibbertia cuneiformis</i>	30	0.1	S
*	<i>Trachyandra divaricata</i>	2	1	W
*	<i>Arctotheca calendula</i>	2	2	W
*	<i>Brassica tournefortii</i>	2	2	W
*	<i>Trifolium campestre</i>	2	2	W
*	<i>Euphorbia peplus</i>	2	2	W
*	<i>Geranium molle</i>	2	2	W
*	<i>Hypochaeris glabra</i>	2	2	W
*	<i>Lysimachia arvensis</i>	2	2	W
*	<i>Solanum nigrum</i>	2	2	W

Site	27	Location	115.653, -32.798
Observers	LvG and FdW		
Date	24/06/2016		

Topography	Ls	Soil Colour	Dark brown
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Loam sand	Condition	G

Additional notes:

Weeds, lacks native understorey

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1600	20	T
	<i>Santalum acuminatum</i>	450	0	T
	<i>Spyridium globulosum</i>	350	0	TS
	<i>Xanthorrhoea preissii</i>	250	25	TS
	<i>Hakea prostrata</i>	200	1	TS
	<i>Melaleuca systema</i>	150	5	S
*	<i>Poaceae sp.</i>	80	0.02	W
*	<i>Trachyandra divaricata</i>	60	60	W
*	<i>Lysimachia arvensis</i>	10	0.05	W
*	<i>Trifolium campestre</i>	5	0.1	W
*	<i>Geranium molle</i>	5	0.1	W
	<i>Trachymene pilosa</i>	5	0.02	H
*	<i>Hypochaeris glabra</i>	1	0.02	W
*	<i>Arctotheca calendula</i>	0.5	0.02	W
*	<i>Brassica tournefortii</i>	0.1	0.01	W
	<i>Cassutha racemosa</i>	0	0.02	V
	<i>Clematis linearifolia</i>	0	7	V

Site	28	Location	115.647, -32.804
Observers	LvG and FdW		
Date	24/06/2016		

Topography	Ls	Soil Colour	Dark brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Weed understorey lacking native trees and shrubs

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1600	20	T
	<i>Acacia rostellifera</i>	400	20	TS
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	350	0.01	TS
	<i>Agonis flexuosa</i>	300	0	T
	<i>Melaleuca systema</i>	250	30	TS
* DP	<i>Gomphocarpus fruticosus</i>	200	0.02	W
	<i>Hibbertia cuneiformis</i>	200	7	TS
	<i>Xanthorrhoea preissii</i>	170	2	TS
DP	<i>Solanum linnaeanum</i>	100	1	W
	<i>Templetonia retusa</i>	100	0.2	S
*	<i>Trachyandra divaricata</i>	70	10	W
*	<i>Arctotheca calendula</i>	10	2	W
*	<i>Brassica tournefortii</i>	10	2	W
*	<i>Trifolium campestre</i>	10	2	W
*	<i>Euphorbia peplus</i>	10	2	W
*	<i>Geranium molle</i>	10	2	W
*	<i>Hypochaeris glabra</i>	10	2	W
*	<i>Lysimachia arvensis</i>	10	2	W

Cons	Taxon	Ht/cm	%A	Form
*	<i>Solanum nigrum</i>	10	2	W
	<i>Clematis linearifolia</i>	0	30	V

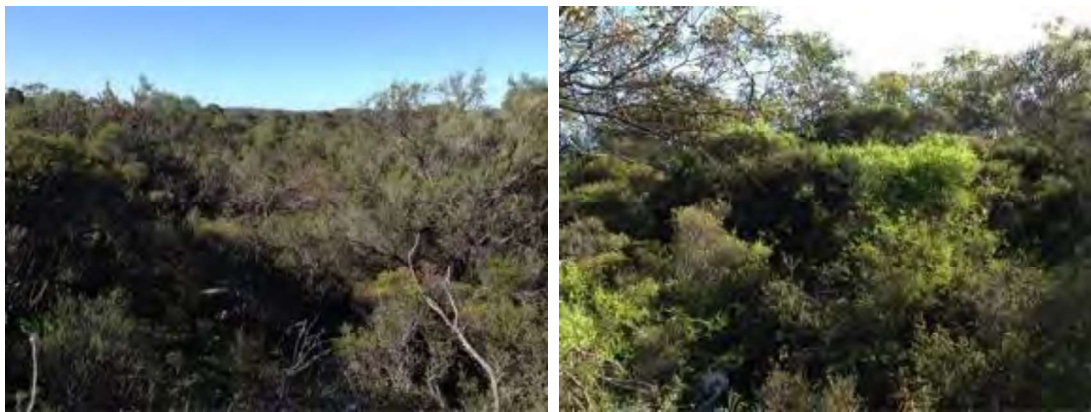
Site	29	Location	115.656, -32.796
Observers	LvG and FdW		
Date	27/06/2016		

Topography	Us sand dunes with limestone	Soil Colour	Brown
Bare Ground	1	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Ground cover weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
T	<i>Eucalyptus argutifolia</i>	500	7	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	300	5	TS
	<i>Eucalyptus foecunda</i>	250	2	T
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	250	20	TS
	<i>Spyridium globulosum</i>	200	1	TS
	<i>Hakea prostrata</i>	150	0.5	S
	<i>Melaleuca systema</i>	150	50	TS
	<i>Templetonia retusa</i>	150	5	TS
	<i>Hibbertia cuneiformis</i>	130	5	S
	<i>Leucopogon parviflorus</i>	70	0	S
*	<i>Trachyandra divaricata</i>	70	1	W
	<i>Grevillea preissii</i> subsp. <i>preissii</i>	60	2	S
	<i>Banksia dallanneyi</i>	20	0.02	S
*	<i>Geranium molle</i>	15	5	W
*	<i>Solanum nigrum</i>	15	10	W
*	<i>Trifolium campestre</i>	10	0.5	W
*	<i>Lysimachia arvensis</i>	10	20	W
	<i>Orchid</i> sp.	10	0.01	H

Cons	Taxon	Ht/cm	%A	Form
*	<i>Arctotheca calendula</i>	5	5	W
	<i>Trachymene pilosa</i>	5	0.02	H
*	<i>Hypochoeris glabra</i>	1	2	W
	<i>Clematis linearifolia</i>	0	7	V
	<i>Hardenbergia comptoniana</i>	0	0.2	V

Site	30	Location	115.654, -32.779
Observers	LvG and FdW		
Date	27/06/2016		

Topography	Ls	Soil Colour	Orange to brown
Bare Ground	2	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand some loam	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	800	10	T
	<i>Agonis flexuosa</i>	700	60	T
	<i>Banksia grandis</i>	400	0	T
	<i>Acacia rostellifera</i>	300	0	TS
	<i>Xanthorrhoea preissii</i>	250	8	TS
	<i>Acacia pulchella</i>	170	0.1	S
* DP	<i>Gomphocarpus fruticosus</i>	170	0	W
	<i>Hakea ruscifolia</i>	160	0	S
	<i>Templetonia retusa</i>	150	6	S
	<i>Macrozamia riedlei</i>	100	1	S
	<i>Hibbertia hypericoides</i>	90	12	S
	<i>Phyllanthus calycinus</i>	50	0	S
	<i>Lomandra micrantha</i>	40	0.01	S
	<i>Tetraria octandra</i>	40	0.01	Sedge
	<i>Hibbertia racemosa</i>	30	0.02	S
	<i>Leucopogon propinquus</i>	30	0.01	S
	<i>Leucopogon nutans</i>	20	0	S
	<i>Pterostylis sanguinea</i>	20	0	H

Cons	Taxon	Ht/cm	%A	Form
*	<i>Lysimachia arvensis</i>	10	0.2	W
	<i>Thysanotus manglesianus</i>	10	0	H
*DP	<i>Zantedeschia aethiopica</i>	10	0	W
	<i>Trachymene pilosa</i>	5	0.2	H
*	<i>Hypochaeris glabra</i>	1	0.2	W
*	<i>Arctotheca calendula</i>	0.5	0	W
	<i>Drosera erythrorhiza</i>	0.5	0.02	V
	<i>Clematis pubescens</i>	0	0	V
	<i>Hardenbergia comptoniana</i>	0	0	V
	<i>Drosera macrantha</i>		0.01	V

Site	31	Location	115.634, -32.766
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Sand dune	Soil Colour	Light brown, yellowy
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Weeds some are patches

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus sp. (planted)</i>	400	1	T
	<i>Eucalyptus platypus</i>	400	1	T
	<i>Acacia rostellifera</i>	300	20	TS
	<i>Melaleuca huegelii subsp. huegelii</i>	240	18	TS
	<i>Banksia sessilis var. cygnorum</i>	200	1	TS
	<i>Hakea prostrata</i>	150	0	TS
	<i>Melaleuca systema</i>	100	15	S
	<i>Hibbertia cuneiformis</i>	70	4	S
	<i>Phyllanthus calycinus</i>	70	0.5	S

Cons	Taxon	Ht/cm	%A	Form
*	<i>Trachyandra divaricata</i>	50	80	W
	<i>Leucopogon parviflorus</i>	40	0.5	S
	<i>Templetonia retusa</i>	40	0.5	S
	<i>Acanthocarpus preissii</i>	30	3	S
*	<i>Geranium molle</i>	20	0.2	W
*	<i>Solanum nigrum</i>	10	5	W
	<i>Clematis linearifolia</i>	0	10	V

Site	32	Location	115.632, -32.768
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Sand dune	Soil Colour	Brown
Bare Ground	2	Condition	Dry
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Ground cover weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia rostellifera</i>	350	35	TS
	<i>Spyridium globulosum</i>	200	2	TS
	<i>Melaleuca systema</i>	150	20	S
*	<i>Trachyandra divaricata</i>	70	5	W
	<i>Hibbertia cuneiformis</i>	60	0.1	S
	<i>Acanthocarpus preissii</i>	50	20	S
	<i>Phyllanthus calycinus</i>	50	2	S
	<i>Leucopogon parviflorus</i>	40	0.5	S
	<i>Lomandra maritima</i>	40	20	H
	<i>Tetaria octandra</i>	20	0.02	Sedge
*	? <i>Daucus glochidiatus</i>	15	5	W
	<i>Senecio diaschides</i>	15	0.01	H
*	<i>Solanum nigrum</i>	10	0.01	W
*	<i>Trifolium campestre</i>	7	0.02	W
	<i>Orchid sp.</i>	7	0.02	H
	<i>Trachymene pilosa</i>	3	0.01	H
	<i>Clematis linearifolia</i>	0	20	V
	<i>Veronica distans</i>	0	0.01	V

Site	33	Location	115.629, -32.771
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Wetland swale	Soil Colour	Yellow white grey
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus decipiens</i>	600	30	T
	<i>Allocasuarina fraseriana</i>	500	0.2	T
	<i>Callitris preissii</i>	400	15	T
	<i>Eucalyptus sp. (planted)</i>	400	5	T
	<i>Melaleuca lanceolata</i>	400	5	T
	<i>Melaleuca rhapsiophylla</i>	400	1	T
	<i>Acacia rostellifera</i>	300	1	TS
	<i>Eucalyptus sp. (planted)</i>	300	1	T
	<i>Acacia rostellifera</i>	250	10	TS

Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca huegelii</i>	250	8	TS
	<i>Templetonia retusa</i>	230	0.5	S
	<i>Spyridium globulosum</i>	200	4	TS
	<i>Typha sp.</i>	200	80	Sedge
	<i>Alyxia buxifolia</i>	100	0.2	S
	<i>Juncus kraussii subsp. australiensis</i>	100	2	Sedge
	<i>Rhagodia baccata subsp. baccata</i>	100	15	V
	<i>Melaleuca systema</i>	80	1	S
	<i>Leucopogon parviflorus</i>	60	0.2	S
	<i>Acanthocarpus preissii</i>	50	3	S
	<i>Phyllanthus calycinus</i>	50	1	S
*	<i>Trachyandra divaricata</i>	30	50	W
*	<i>Solanum nigrum</i>	10	2	W
*	<i>Geranium molle</i>	5	0.5	W

Site	34	Location	115.625, -32.767
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Sand dune	Soil Colour	Cream
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Ground cover weeds

Done from car, torrential rain

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	350	15	TS
	<i>Acacia rostellifera</i>	300	20	TS
	<i>Spyridium globulosum</i>	300	20	TS
	<i>Acacia saligna</i>	200	0	TS
	<i>Olearia axillaris</i>	160	0.5	S
	<i>Anthocercis littorea</i>	150	0	S
	<i>Melaleuca systena</i>	150	0	S
	<i>Phyllanthus calycinus</i>	80	13	S
	<i>Acanthocarpus preissii</i>	40	30	S
*	<i>Trachyandra divaricata</i>	40	5	W
*	<i>Solanum nigrum</i>	5	0.2	W
	<i>Trachymene pilosa</i>	5	0.5	H

Site	35	Location	115.626, -32.772
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Sand dune crest and upper slope	Soil Colour	Cream
Bare Ground	10	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	400	40	T
	<i>Spyridium globulosum</i>	300	10	TS
	<i>Alyxia buxifolia</i>	200	10	S
	<i>Acacia rostellifera</i>	170	15	TS
	<i>Olearia axillaris</i>	150	5	S
	<i>Acanthocarpus preissii</i>	100	10	S
	<i>Diplolaena dampieri</i>	100	7	S
	<i>Hibbertia cuneiformis</i>	80	2	S
*	<i>Trachyandra divaricata</i>	70	7	W
	<i>Scaevola nitida</i>	40	0.5	S
	<i>Phyllanthus calycinus</i>	30	0.5	S
*	<i>Solanum nigrum</i>	15	0.5	W
	<i>Senecio diaschides</i>	10	0.1	H
	<i>Trachymene pilosa</i>	5	0.05	H
	<i>Clematis pubescens</i>	0	0.1	V

Site	36	Location	115.626, -32.773
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Sand dune Swale	Soil Colour	Cream
Bare Ground	10	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Less *Trachyandra divaricata*

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	450	2	T
	<i>Eucalyptus lehmannii</i>	400	2	T
	<i>Melaleuca sp. (huegelii x raphiophylla)</i>	320	1	TS
	<i>Spyridium globulosum</i>	270	15	TS
	<i>Olearia axillaris</i>	250	3	TS
	<i>Alyxia buxifolia</i>	200	5	S
	<i>Acacia rostellifera</i>	100	4	TS
	<i>Diplolaena dampieri</i>	100	4	S
*	<i>Trachyandra divaricata</i>	80	6	W
	<i>Acacia truncata</i>	70	0	S
	<i>Eucalyptus decipiens</i>	70	2	T
	<i>Leucopogon parviflorus</i>	70	1	S
	<i>Acanthocarpus preissii</i>	60	10	S
	<i>Acrotriche cordata</i>	60	0	S
	<i>Phyllanthus calycinus</i>	60	1	S
	<i>Acacia littorea</i>	50	3	S
	<i>Melaleuca huegelii subsp. huegelii</i>	50	1	S
	<i>Carpobrotus virescens</i>	10	2	H
*	<i>Brassica tournefortii</i>	0.1	0.01	W

Site	37	Location	115.629, -32.773
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Sand dune swale	Soil Colour	Cream
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:

No Photos

Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	450	3	T
	<i>Acacia saligna</i>	400	1	TS
	<i>Olearia axillaris</i>	300	0.5	TS
	<i>Spyridium globulosum</i>	250	3	TS
	<i>Alyxia buxifolia</i>	200	30	S
	<i>Hibbertia cuneiformis</i>	190	5	S
	<i>Hemiandra pungens</i>	150	0.5	S
	<i>Acacia littorea</i>	100	3	S
	<i>Acanthocarpus preissii</i>	70	3	S
*	<i>Trachyandra divaricata</i>	70	1	W
	<i>Acrotriche cordata</i>	60	5	S
	<i>Leucopogon parviflorus</i>	60	5	S
	<i>Scaevola crassifolia</i>	40	0.1	S
	<i>Veronica distans</i>	35	0.02	V
	<i>Poaceae sp.</i>	15	0.01	W
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Solanum nigrum</i>	10	0.1	W
*	<i>Trifolium campestre</i>	7	0.02	W
	<i>Trachymene pilosa</i>	5	0.01	H
	<i>Clematis pubescens</i>	0	0	V
	<i>Hardenbergia comptoniana</i>	0	0.01	V

Site	38	Location	115.632, -32.773
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Dune Swale and drainage	Soil Colour	Cream
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1300	3	T
	<i>Agonis flexuosa</i>	1000	20	T
	<i>Spyridium globulosum</i>	320	1	TS
	<i>Solanum symonii</i>	220	1	TS
	<i>Alyxia buxifolia</i>	170	4	S
	<i>Lepidosperma gladiatum</i>	120	50	Sedge
	<i>Diplolaena dampieri</i>	100	10	S
	<i>Hibbertia cuneiformis</i>	100	3	S
	<i>Leucopogon parviflorus</i>	80	0.5	S
*	<i>Trachyandra divaricata</i>	80	20	W
	<i>Acanthocarpus preissii</i>	50	1	S
*DP	<i>Zantedeschia aethiopica</i>	30	0.01	W
*	<i>Geranium molle</i>	20	1	W
*	<i>Euphorbia peplus</i>	15	0.5	W
*	<i>Euphorbia peplus</i>	10	0.2	W
*	<i>Solanum nigrum</i>	10	0.02	W
	<i>Clematis linearifolia</i>	0	7	V

Site	39	Location	115.636, -32.772
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Flat	Soil Colour	Brown
Bare Ground	4	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	G

Additional notes:

Understorey weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus sp. (planted)</i>	600	3	T
	<i>Agonis flexuosa</i>	500	20	T
	<i>Xanthorrhoea preissii</i>	300	4	TS
	<i>Hibbertia cuneiformis</i>	120	4	S
*	<i>Trachyandra divaricata</i>	80	10	W
*	<i>Euphorbia peplus</i>	20	3	W
*	<i>Geranium molle</i>	15	3	W
*	<i>Solanum nigrum</i>	15	0.5	W
*	<i>Hypochaeris glabra</i>	1	0.2	W

Site	40	Location	115.644, -32.774
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Wetland	Soil Colour	Black with grey
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	650	2	T
	<i>Agonis flexuosa</i>	600	85	T
	<i>Melaleuca raphiophylla</i>	250	1	T
	<i>Acacia saligna</i>	220	1	TS
	<i>Gahnia trifida</i>	150	2	Sedge
	<i>Juncus kraussii subsp. australiensis</i>	130	95	Sedge
	<i>Olearia axillaris</i>	120	0.5	H
	<i>Haemodorum sp.</i>	120	0.01	S
	<i>Leucopogon parviflorus</i>	100	1	S
	<i>Spyridium globulosum</i>	100	1	S
*	<i>Trachyandra divaricata</i>	70	0.5	W
*	<i>Geranium molle</i>	15	0.05	W
*	<i>Lysimachia arvensis</i>	10	0.05	W
	<i>Orchid sp.</i>	10	0.02	H
	<i>Trachymene pilosa</i>	5	0.02	H
*	<i>Hypochaeris glabra</i>	1	0.02	W
	<i>Hardenbergia comptoniana</i>	0	0.02	V

Site	41	Location	115.645, -32.780
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	500	3	TS
	<i>Eucalyptus foecunda</i>	350	5	T
	<i>Acacia rostellifera</i>	300	0	TS
	<i>Xanthorrhoea preissii</i>	300	3	TS
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	270	60	S
* DP	<i>Gomphocarpus fruticosus</i>	250	0.8	W
	<i>Melaleuca systema</i>	170	15	S
	<i>Templetonia retusa</i>	170	15	S
	<i>Leucopogon parviflorus</i>	90	0.2	S

Cons	Taxon	Ht/cm	%A	Form
*	<i>Trachyandra divaricata</i>	70	7	W
	<i>Hibbertia cuneiformis</i>	30	0.1	S
	<i>Thysanotus manglesianus</i>	20	0.01	H
	<i>Poaceae sp.</i>	15	0	W
*	<i>Arctotheca calendula</i>	10	0.2	W
*	<i>Euphorbia peplus</i>	10	0.2	W
*	<i>Geranium molle</i>	10	0.5	W
*	<i>Solanum nigrum</i>	10	0.5	W
*	<i>Trifolium campestre</i>	5	0.1	W
*	<i>Lysimachia arvensis</i>	5	0.5	W
	<i>Orchid sp.</i>	5	0	H
*	<i>Hypochaeris glabra</i>	1	0.2	W
	<i>Clematis linearifolia</i>	0	0.2	V
	<i>Clematis pubescens</i>	0	0.2	V
	<i>Hardenbergia comptoniana</i>	0	0.2	V

Site	42a	Location	115.652, -32.793
Observers	LvG and FdW		
Date	28/06/2016		

Topography	Hilltop	Soil Colour	Brown
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Still weeds present

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	400	0.5	T
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	250	7	TS
	<i>Xanthorrhoea preissii</i>	200	0.2	TS
* DP	<i>Gomphocarpus fruticosus</i>	170	1	W
	<i>Hakea prostrata</i>	150	1	S
	<i>Templetonia retusa</i>	150	3	S
	<i>Melaleuca systema</i>	120	7	S
	<i>Melaleuca systema</i>	100	55	S
*	<i>Trachyandra divaricata</i>	80	3	W
	<i>Pimelea</i> sp.	40	0.01	S
	<i>Hibbertia racemosa</i>	30	0.01	S
*	<i>Trifolium campestre</i>	10	0.5	W
*	<i>Geranium molle</i>	10	0.1	W
*	<i>Hypochaeris glabra</i>	1	0.1	W
	<i>Lagenophora huegelii</i>	1	0.1	H
	<i>Clematis linearifolia</i>	0	0.5	V

Site	42b	Location	115.652, -32.794
Observers	LvG and FdW		
Date	28/06/2016		

Topography	N/A	Soil Colour	N/A
Bare Ground	N/A	Condition	N/A
Cryptogram	N/A	Fire	N/A
Soil Type	N/A	Condition	N/A

Additional notes:

Isolated stands of *Euc foecunda*

Photos:



Site	43	Location	115.633, -32.778
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune us	Soil Colour	Brown
Bare Ground	4	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Some weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia rostellifera</i>	350	30	TS
	<i>Melaleuca systema</i>	130	6	S
	<i>Xanthorrhoea preissii</i>	130	2	S
	<i>Hibbertia cuneiformis</i>	120	1	S
	<i>Acanthocarpus preissii</i>	80	0.1	S
	<i>Spyridium globulosum</i>	80	0.01	S
	<i>Leucopogon parviflorus</i>	70	0.5	S
	<i>Phyllanthus calycinus</i>	70	7	S
*	<i>Trachyandra divaricata</i>	70	2	W
	<i>Lomandra maritima</i>	30	6	H
*	<i>Arctotheca calendula</i>	10	0.1	W
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Solanum nigrum</i>	10	0.2	W
	<i>Thysanotus manglesianus</i>	10	0.1	H
*	<i>Lysimachia arvensis</i>	5	0.5	W
	<i>Trachymene pilosa</i>	5	0.1	H
*	<i>Hypochaeris glabra</i>	1	0.1	W
	<i>Clematis linearifolia</i>	0	4	V
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	44	Location	115.629, -32.777
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Wetland	Soil Colour	N/A
Bare Ground	N/A	Condition	N/A
Cryptogram	N/A	Fire	10+
Soil Type	N/A	Condition	VG

Additional notes:

Planted and weeds dominate ground cover. Drainage line, planted Eucalypts, Grevillea and Acacia over *Trachyandra divaricata*. Some natives (*Hibbertia cuneiformis*, *Acanthocarpus preissii*, *Xanthorrhoea preissii*).

Photos:



Site	45	Location	115.628, -32.769
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Dune Swale	Soil Colour	Brown
Bare Ground	10	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Weeds, eucalypts are planted

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	800	30	T
	<i>Eucalyptus platypus</i>	800	1	T
	<i>Acacia rostellifera</i>	210	1	TS
	<i>Spyridium globulosum</i>	150	3	TS
	<i>Hibbertia cuneiformis</i>	120	0.5	S
	<i>Melaleuca systema</i>	100	10	S
	<i>Rhagodia baccata subsp. baccata</i>	100	5	V
*	<i>Trachyandra divaricata</i>	70	20	W
	<i>Leucopogon parviflorus</i>	40	0.5	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Phyllanthus calycinus</i>	40	0.1	S
	<i>Acanthocarpus preissii</i>	20	0.1	S
*	<i>Geranium molle</i>	15	0.1	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Senecio diaschides</i>	10	0.01	H
	<i>Thysanotus manglesianus</i>	10	0.05	H
*	<i>Trifolium campestre</i>	5	0.05	W
	<i>Trachymene pilosa</i>	3	0.05	H
	<i>Cassytha racemosa</i>	0	0.01	V
	<i>Clematis linearifolia</i>	0	1	V

Site	46	Location	115.628, -32.768
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune us	Soil Colour	Cream
Bare Ground	2	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Dark green is dense spyridium. More open is more diverse understorey

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	400	5	T
	<i>Eucalyptus platypus</i>	400	8	T
	<i>Spyridium globulosum</i>	250	60	TS
	<i>Leucopogon parviflorus</i>	150	1	S
	<i>Olearia axillaris</i>	120	1	S
	<i>Acrotriche cordata</i>	100	1	S
	<i>Comesperma ?flavum</i>	90	0.02	S
	<i>Trymalium ledifolium var. ledifolium</i>	90	0.1	S
	<i>Acacia littorea</i>	80	0.5	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Alyxia buxifolia</i>	80	1	S
	<i>Templetonia retusa</i>	80	0.5	S
	<i>Lomandra maritima</i>	70	30	H
	<i>Acanthocarpus preissii</i>	60	3	S
	<i>Melaleuca systema</i>	60	1	S
	<i>Lepidosperma squamatum</i>	50	0.1	Sedge
	<i>Phyllanthus calycinus</i>	50	0.5	S
P3	<i>Stylidium maritimum</i>	30	0.05	H
	<i>Desmocladius flexuosus</i>	20	0.05	H
*	<i>Trifolium campestre</i>	5	0.1	W
	<i>Trachymene pilosa</i>	5	10	H
	<i>Cassytha racemosa</i>	0	0.1	V

Site	47	Location	115.627, -32.768
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune crest	Soil Colour	Cream
Bare Ground	15	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	200	2	TS
	<i>Spyridium globulosum</i>	100	4	TS
	<i>Templetonia retusa</i>	100	5	S
	<i>Jacksonia furcellata</i>	90	0.1	S
	<i>Acrotriche cordata</i>	80	5	S
	<i>Leucopogon parviflorus</i>	70	1	S
	<i>Melaleuca systena</i>	70	5	S
	<i>Acacia cochlearis</i>	60	5	S
	<i>Acanthocarpus preissii</i>	60	10	S
	<i>Trymalium ledifolium</i> var. <i>ledifolium</i>	50	0.1	S
	<i>Hemiandra pungens</i>	30	4	S
	<i>Pimelea ferruginea</i>	30	0.8	S
P3	<i>Stylidium maritimum</i>	30	0.1	H
	<i>Acacia littorea</i>	20	0.5	S
	<i>Veronica distans</i>	20	0.01	V
	<i>Lomandra maritima</i>	20	9	H
	<i>Cryptandra mutila</i>	5	0.01	S
	<i>Cassutha racemosa</i>	0	0.5	V

Site	48	Location	115.627, -32.778
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Dune swale	Soil Colour	Cream
Bare Ground	3	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	400	6	T
	<i>Acacia rostellifera</i>	300	5	TS
	<i>Acacia rostellifera</i>	200	15	TS
	<i>Alyxia buxifolia</i>	200	1	TS
	<i>Spyridium globulosum</i>	200	1	TS
	<i>Diplolaena dampieri</i>	170	50	S
	<i>Leucopogon parviflorus</i>	150	0.5	S
	<i>Acanthocarpus preissii</i>	100	30	S
	<i>Opercularia hispidula</i>	100	0.2	S

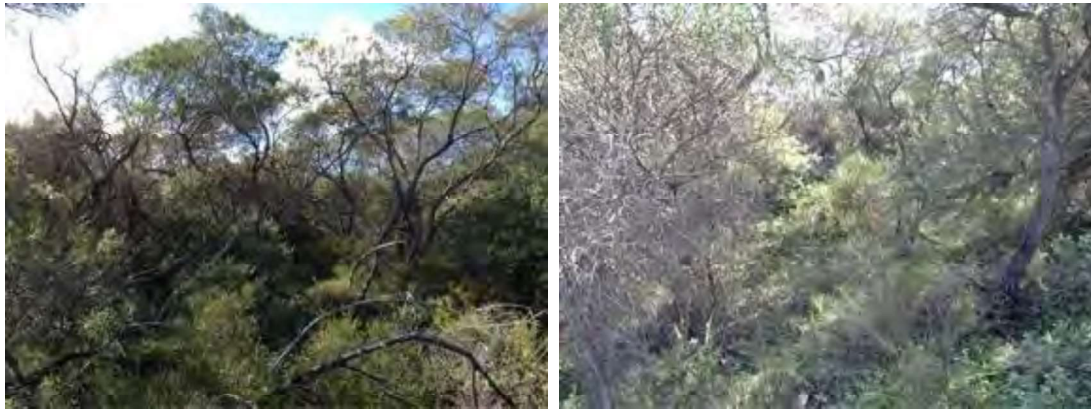
Cons	Taxon	Ht/cm	%A	Form
	<i>Rhagodia baccata subsp. baccata</i>	90	2	S
	<i>Phyllanthus calycinus</i>	80	1	S
*	<i>Trachyandra divaricata</i>	80	10	W
	<i>Lepidosperma squamatum</i>	40	0.01	Sedge
*	<i>Solanum nigrum</i>	15	5	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Senecio diaschides</i>	10	0.1	H
	<i>Trachymene pilosa</i>	5	0.1	H
	<i>Clematis linearifolia</i>	0	2	V
	<i>Clematis pubescens</i>	0	1	V

Site	49	Location	115.629, -32.781
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune ms	Soil Colour	Cream
Bare Ground	2	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	450	2	T
	<i>Acacia rostellifera</i>	400	30	TS
	<i>Spyridium globulosum</i>	300	30	TS
	<i>Acacia rostellifera</i>	200	0.2	TS
	<i>Acanthocarpus preissii</i>	120	25	S
	<i>Melaleuca systema</i>	120	5	S
	<i>Leucopogon parviflorus</i>	100	3	S
	<i>Phyllanthus calycinus</i>	90	8	S
*	<i>Trachyandra divaricata</i>	80	4	W
	<i>Tetralia octandra</i>	40	0.1	Sedge
	<i>Hibbertia cuneiformis</i>	20	0.2	S
	<i>Leucopogon nutans</i>	20	0.1	S
	<i>Lomandra maritima</i>	20	0.1	H
*	<i>Solanum nigrum</i>	15	1	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Poaceae sp.</i>	10	0.02	G
	<i>Senecio diaschides</i>	10	0.02	H
*	<i>Trifolium campestre</i>	5	0.01	W

Cons	Taxon	Ht/cm	%A	Form
	<i>Trachymene pilosa</i>	5	0.02	H
	<i>Hardenbergia comptoniana</i>	0	0.1	V

Site	50	Location	115.628, -32.782
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune us	Soil Colour	Cream
Bare Ground	4	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Spyridium globulosum</i>	300	20	TS
	<i>Acacia rostellifera</i>	250	0	TS
	<i>Olearia axillaris</i>	250	2	TS
	<i>Alyxia buxifolia</i>	230	3	S
	<i>Rhagodia baccata subsp. baccata</i>	210	2	V
	<i>Diplolaena dampieri</i>	190	20	S
	<i>Threlkeldia diffusa</i>	160	0.5	H
	<i>Acanthocarpus preissii</i>	100	1	S
	<i>Melaleuca systema</i>	90	0.5	S
*	<i>Trachyandra divaricata</i>	70	0.1	W
	<i>Phyllanthus calycinus</i>	60	0.2	S
	<i>Leucopogon parviflorus</i>	50	0	S
	<i>Tetragia octandra</i>	40	0.1	Sedge
*	<i>Geranium molle</i>	15	0.02	W
	<i>Senecio diaschides</i>	15	0.02	H
*	<i>Solanum nigrum</i>	15	0.8	W
	<i>Trachymene pilosa</i>	5	0.02	H
	<i>Cassitya racemosa</i>	0	0.5	V
	<i>Hardenbergia comptoniana</i>	0	1.5	V

Site	51	Location	115.629, -32.785
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune crest	Soil Colour	Cream
Bare Ground	40	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Rabbits

Photos:



Site	52	Location	115.629, -32.790
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune ms	Soil Colour	Brown
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia rostellifera</i>	350	25	TS
	<i>Spyridium globulosum</i>	275	10	TS
	<i>Alyxia buxifolia</i>	170	0.5	S
	<i>Olearia axillaris</i>	170	1	S
	<i>Rhagodia baccata subsp. baccata</i>	120	8	V
	<i>Acanthocarpus preissii</i>	80	5	SS
	<i>Hibbertia cuneiformis</i>	80	0.2	S
	<i>Phyllanthus calycinus</i>	80	6	S
*	<i>Trachyandra divaricata</i>	70	8	W
	<i>Melaleuca systema</i>	60	1	S
	<i>Leucopogon parviflorus</i>	50	1	S
	<i>Tetraria octandra</i>	30	0.02	Sedge
	<i>Veronica distans</i>	25	0.01	V
	<i>Threlkeldia diffusa</i>	20	0.1	H
	<i>Opercularia hispidula</i>	20	0.1	H
	<i>Orchid sp.</i>	15	0.01	H
	<i>Senecio diaschides</i>	15	0.02	H
*	<i>Lysimachia arvensis</i>	5	0	W
*	<i>Solanum nigrum</i>	5	0.1	W

Cons	Taxon	Ht/cm	%A	Form
	<i>Trachymene pilosa</i>	5	0.01	H
	<i>Clematis linearifolia</i>	0	2	V

Site	53	Location	115.632, -32.793
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune ms	Soil Colour	Brown
Bare Ground	3	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Some weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	500	15	T
	<i>Spyridium globulosum</i>	240	8	TS
	<i>Acacia rostellifera</i>	220	8	TS
	<i>Acacia saligna</i>	200	0.5	TS
	<i>Rhagodia baccata subsp. baccata</i>	160	1	V
	<i>Hibbertia cuneiformis</i>	130	8	S
	<i>Melaleuca systema</i>	100	10	S
	<i>Acanthocarpus preissii</i>	80	5	S
*	<i>Trachyandra divaricata</i>	70	10	W

Cons	Taxon	Ht/cm	%A	Form
	<i>Leucopogon parviflorus</i>	60	0.1	S
	<i>Phyllanthus calycinus</i>	50	7	S
	<i>Lomandra maritima</i>	30	0.2	H
*	<i>Arctotheca calendula</i>	15	0.1	W
*	<i>Geranium molle</i>	15	0.1	W
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Solanum nigrum</i>	10	1	W
*	<i>Trifolium campestre</i>	5	0.02	W
*	<i>Lysimachia arvensis</i>	5	0.05	W
	<i>Trachymene pilosa</i>	5	0.02	H
	<i>Cassytha racemosa</i>	0	0.1	V
	<i>Clematis linearifolia</i>	0	0.5	V
	<i>Hardenbergia comptoniana</i>	0	1	V

Site	54	Location	115.637, -32.793
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Sand dune ms	Soil Colour	Cream
Bare Ground	7	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	E

Additional notes:

Bare areas of weeds only in sight

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Agonis flexuosa</i>	350	0.5	T
	<i>Acacia rostellifera</i>	300	25	TS
	<i>Acanthocarpus preissii</i>	80	3	S
	<i>Cryptandra mutila</i>	80	0.02	S
	<i>Templetonia retusa</i>	60	2	S
	<i>Leucopogon parviflorus</i>	50	0.1	S
	<i>Melaleuca systema</i>	50	30	S
	<i>Phyllanthus calycinus</i>	50	8	S
	<i>Lepidosperma squamatum</i>	40	0	Sedge
*	<i>Trachyandra divaricata</i>	40	1	W
	<i>Lomandra maritima</i>	30	20	H
	<i>Orchid sp.</i>	10	0.01	H
*	<i>Arctotheca calendula</i>	5	0.2	W
*	<i>Trifolium campestre</i>	5	0.2	W
*	<i>Lysimachia arvensis</i>	5	0.2	W
	<i>Trachymene pilosa</i>	5	0.2	H
	<i>Clematis linearifolia</i>	0	2	V

Site	55	Location	115.657, -32.807
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Wetland	Soil Colour	Black brown
Bare Ground	3	Condition	Waterlogged
Cryptogram	N/A	Fire	10+
Soil Type	Loam	Condition	VG

Additional notes:

Weeds, lacking structure

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca teretifolia</i>	230	10	TS
	<i>Melaleuca raphiophylla</i>	230	30	TS
	<i>Melaleuca lanceolata</i>	200	3	TS
	<i>Gahnia trifida</i>	160	60	Sedge
*	<i>Trachyandra divaricata</i>	50	2	W
*	<i>Dittrichia graveolens</i>	30	2	W
*	<i>Arctotheca calendula</i>	5	2	W
*	<i>Trifolium campestre</i>	5	3	W
*	<i>Geranium molle</i>	5	1	W
*	<i>Hypochaeris glabra</i>	5	5	W
*	<i>Lysimachia arvensis</i>	5	3	W
*	<i>Brassica tournefortii</i>	0.1	1	W
	<i>Clematis linearifolia</i>	0	1	V

Site	56	Location	115.654, -32.811
Observers	LvG and FdW		
Date	29/06/2016		

Topography	Ms	Soil Colour	Light brown
Bare Ground	5	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Rows of cleared veg

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia cyclops</i>	500	5	TS
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	500	8	TS
	<i>Hakea prostrata</i>	300	10	S
	<i>Xanthorrhoea preissii</i>	200	30	TS
	<i>Hakea ruscifolia</i>	180	1	S
	<i>Spyridium globulosum</i>	180	2	TS
	<i>Solanum symonii</i>	160	1	TS
	<i>Hibbertia cuneiformis</i>	100	5	S
	<i>Templetonia retusa</i>	100	15	S
	<i>Acacia pulchella</i>	80	0.05	S
	<i>Melaleuca systema</i>	80	15	S
*	<i>Trachyandra divaricata</i>	70	1	W
	<i>Desmocladius flexuosus</i>	50	0.01	H
	<i>Phyllanthus calycinus</i>	50	0.5	S
	<i>Hibbertia hypericoides</i>	40	4	S
	<i>Astroloma pallidum</i>	30	0.02	S
*	<i>Avena barbata</i>	30	0.1	W
	<i>Hibbertia racemosa</i>	30	0.1	S

Cons	Taxon	Ht/cm	%A	Form
*	<i>Geranium molle</i>	20	1	W
*	<i>Euphorbia peplus</i>	10	1	W
*	<i>Solanum nigrum</i>	10	0.2	W
*	<i>Arctotheca calendula</i>	5	0.5	W
*	<i>Lysimachia arvensis</i>	5	1	W
*	<i>Hypochaeris glabra</i>	1	4	W
*	<i>Brassica tournefortii</i>	0.1	1	W
	<i>Clematis linearifolia</i>	0	2	V

Site	57	Location	115.648, -32.804
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Secondary dune crest	Soil Colour	Orange
Bare Ground	4	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Altered structure from linear row clearing

Photos:



Cons	Taxon	Ht/cm	%A	Form
	Acacia saligna	500	1	TS
	Agonis flexuosa	450	5	T
	Agonis flexuosa	300	3	T
	Banksia sessilis var. cygnorum	270	0.2	TS
	Acacia littorea	200	2	S
	Hakea prostrata	200	0.2	TS
	Spyridium globulosum	200	15	TS
	Templetonia retusa	200	4	TS
	Hibbertia cuneiformis	180	8	S
	Hibbertia cuneiformis	180	8	S
	Olearia axillaris	170	4	S
	Xanthorrhoea preissii	170	0.5	S
	Alyxia buxifolia	130	1	S
* DP	Gomphocarpus fruticosus	120	0.01	W
	Melaleuca systema	120	50	S
	Jacksonia furcellata	110	0.5	S
	Acacia cochlearis	80	8	S
	Melaleuca systema	80	4	S

Cons	Taxon	Ht/cm	%A	Form
	<i>Leucopogon parviflorus</i>	70	2	S
	<i>Phyllanthus calycinus</i>	70	1	S
	<i>Phyllanthus calycinus</i>	70	4	S
*	<i>Trachyandra divaricata</i>	70	0.4	W
*	<i>Trachyandra divaricata</i>	70	7	W
	<i>Acanthocarpus preissii</i>	60	3	S
	<i>Acacia cyclops</i>	40	0	S
	<i>Lomandra maritima</i>	20	0.5	H
P3	<i>Stylidium maritimum</i>	20	0.5	H
	<i>Carpobrotus virescens</i>	15	0.5	H
	<i>Desmocladius flexuosus</i>	15	0.2	H
*	<i>Euphorbia peplus</i>	15	1	W
	Poaceae sp.	15	0.1	G
*	<i>Geranium molle</i>	10	1	W
	<i>Hibbertia racemosa</i>	10	0	S
	<i>Senecio diaschides</i>	10	0.01	H
*	<i>Solanum nigrum</i>	10	0.2	W
*	<i>Arctotheca calendula</i>	5	0.5	W
*	<i>Lysimachia arvensis</i>	5	0.2	W
*	<i>Solanum nigrum</i>	5	0.2	W
*	<i>Hypochaeris glabra</i>	1	1	W
*	<i>Brassica tournefortii</i>	0.1	0.5	W
	<i>Clematis linearifolia</i>	0	2	V
	<i>Hardenbergia comptoniana</i>	0	0.5	V

Site	58	Location	115.648, -32.802
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Ms	Soil Colour	Orange
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand	Condition	VG

Additional notes:

Clearing of rows

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Acacia saligna</i>	500	1	TS
	<i>Nuytsia floribunda</i>	450	4	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	270	0.2	TS
	<i>Hakea prostrata</i>	200	0.2	TS
	<i>Templetonia retusa</i>	200	4	TS
	<i>Hibbertia cuneiformis</i>	180	8	S
	<i>Xanthorrhoea preissii</i>	170	0.5	S
* DP	<i>Gomphocarpus fruticosus</i>	120	0.01	W
	<i>Melaleuca systena</i>	120	50	S
	<i>Phyllanthus calycinus</i>	70	4	S
*	<i>Trachyandra divaricata</i>	70	7	W
	<i>Acacia cyclops</i>	40	0	S
*	<i>Euphorbia peplus</i>	15	1	W
	<i>Poaceae</i> sp.	15	0.1	G
*	<i>Geranium molle</i>	10	1	W
	<i>Hibbertia racemosa</i>	10	0	S
*	<i>Solanum nigrum</i>	10	0.2	W
*	<i>Arctotheca calendula</i>	5	0.5	W

Cons	Taxon	Ht/cm	%A	Form
*	<i>Lysimachia arvensis</i>	5	0.2	W
*	<i>Hypochaeris glabra</i>	1	1	W
*	<i>Brassica tournefortii</i>	0.1	0.5	W
	<i>Clematis linearifolia</i>	0	2	V

Site	59	Location	115.651, -32.813
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Ms	Soil Colour	Brown
Bare Ground	1	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sand loam	Condition	VG

Additional notes:

Row clearing, weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus decipiens</i>	800	0.1	T
	<i>Agonis flexuosa</i>	500	5	T
	<i>Nuytsia floribunda</i>	450	0	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	350	5	TS
	<i>Hakea prostrata</i>	350	4	TS
* DP	<i>Gomphocarpus fruticosus</i>	200	2	W
	<i>Templetonia retusa</i>	200	10	TS
	<i>Xanthorrhoea preissii</i>	200	10	TS
	<i>Hibbertia cuneiformis</i>	170	15	S
	<i>Melaleuca systema</i>	130	30	S
	<i>Leucopogon parviflorus</i>	120	0.2	
*	<i>Trachyandra divaricata</i>	70	30	W
*	<i>Solanum nigrum</i>	60	3	W
	<i>Hibbertia racemosa</i>	40	0.2	S
*	<i>Euphorbia peplus</i>	10	10	W
*	<i>Euphorbia peplus</i>	10	10	W
*	<i>Lupinus</i> sp.	10	0	W
*	<i>Brassica tournefortii</i>	1	0	W

Cons	Taxon	Ht/cm	%A	Form
*	<i>Hypochaeris glabra</i>	1	1	W
	<i>Trachymene pilosa</i>	1	0.01	H
*	<i>Arctotheca calendula</i>	0.5	1	W
	<i>Clematis linearifolia</i>	0	0.5	V

Site	60	Location	
Observers	LvG and FdW		
Date	30/06/2016		

Topography		Soil Colour	
Bare Ground		Condition	
Cryptogram		Fire	
Soil Type		Condition	

Additional notes:

Photos:

Cons	Taxon	Ht/cm	%A	Form
	<i>Hakea prostrata</i>	270	6	TS
	<i>Templetonia retusa</i>	220	10	TS
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	200		TS
	<i>Acacia cochlearis</i>	170	0.5	S
* DP	<i>Gomphocarpus fruticosus</i>	150	0.2	W
	<i>Hibbertia cuneiformis</i>	150	10	S
	<i>Melaleuca systema</i>	120	40	S
*	<i>Trachyandra divaricata</i>	70	7	W
	<i>Phyllanthus calycinus</i>	60	0.2	S
	<i>Hibbertia racemosa</i>	50	0.2	S
*	<i>Dittrichia graveolens</i>	30	0	W
*	<i>Euphorbia peplus</i>	10	1	W
*	<i>Lupinus</i> sp.	10	0.1	W
*	<i>Brassica tournefortii</i>	1	0	W
*	<i>Hypochoeris glabra</i>	1	1	W
	<i>Trachymene pilosa</i>	1	0.01	H
*	<i>Arctotheca calendula</i>	0.5	1	W

Site	61	Location	115.653, -32.817
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Us	Soil Colour	Brown
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Cleared rows, weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus decipiens</i>	600	0	T
	<i>Agonis flexuosa</i>	350	1	T
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	270	4	TS
	<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	220	3	TS
	<i>Spyridium globulosum</i>	200	0	TS
	<i>Templetonia retusa</i>	200	10	TS
* DP	<i>Gomphocarpus fruticosus</i>	150	0.2	W
	<i>Hibbertia cuneiformis</i>	120	8	S
	<i>Melaleuca systema</i>	120	50	S
	<i>Xanthorrhoea preissii</i>	110	0.5	S
* DP	<i>Gomphocarpus fruticosus</i>	100	0.1	W
	<i>Leucopogon parviflorus</i>	100	0.5	
	<i>Phyllanthus calycinus</i>	80	1	S
*	<i>Trachyandra divaricata</i>	60	7	W
	<i>Grevillea preissii</i> subsp. <i>preissii</i>	40	0.1	S
*	<i>Dittrichia graveolens</i>	30	0	W
	<i>Hibbertia racemosa</i>	30	0	S
	<i>Senecio diaschides</i>	15	0.01	H

Cons	Taxon	Ht/cm	%A	Form
	<i>Hakea prostrata</i>	10	0.02	S
	<i>Poaceae sp.</i>	10	0.02	G
*	<i>Geranium molle</i>	5	0.5	W
*	<i>Hypochoeris glabra</i>	5	0.5	W
*	<i>Lysimachia arvensis</i>	5	0.5	W
*	<i>Arctotheca calendula</i>	0.5	0.05	W
*	<i>Brassica tournefortii</i>	0.1	0.1	W

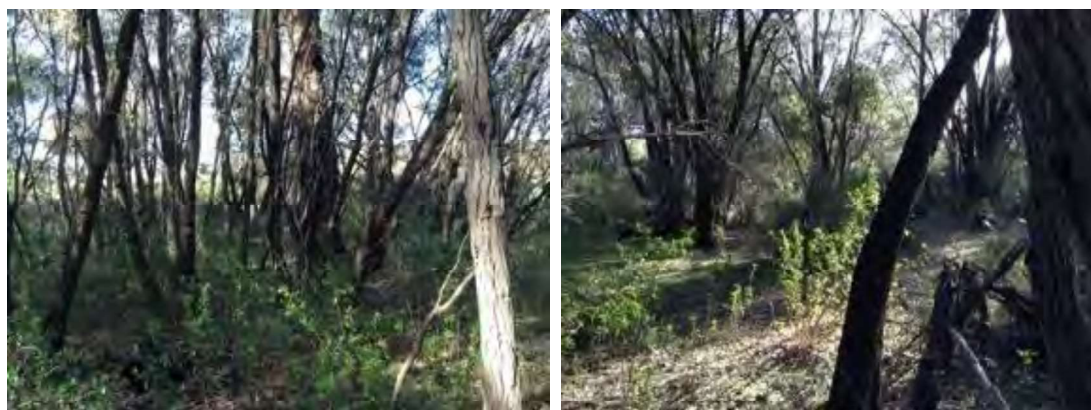
Site	62	Location	115.655, -32.815
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Ls	Soil Colour	Dark brown
Bare Ground	0	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Loam sand	Condition	VG

Additional notes:

Cleared rows, weeds

Photos:



Cons	Taxon	Ht/cm	%A	Form
	<i>Eucalyptus gomphocephala</i>	1800	2	T
	<i>Agonis flexuosa</i>	1100	40	T
	<i>Eucalyptus marginata</i>	700	20	T
	<i>Xanthorrhoea preissii</i>	190	5	S
	<i>Hibbertia cuneiformis</i>	140	8	S
	<i>Macrozamia riedlei</i>	100	1	S
	<i>Melaleuca systema</i>	100	0.2	S
	<i>Hibbertia hypericoides</i>	80	3	
	<i>Hakea lissocarpha</i>	60	1	S
	<i>Senecio diaschides</i>	30	0.01	H
*	<i>Geranium molle</i>	10	0.02	W
	<i>Orchid sp.</i>	10	0.01	H
	<i>Poaceae sp.</i>	10	0.02	G
*	<i>Lysimachia arvensis</i>	5	0.05	W
*	<i>Hypochaeris glabra</i>	1	0.02	W
	<i>Hardenbergia comptoniana</i>	0	2	V

Site	63	Location	115.653, -32.813
Observers	LvG and FdW		
Date	30/06/2016		

Topography	Us to ms	Soil Colour	Brown
Bare Ground	N/A	Condition	Moist
Cryptogram	N/A	Fire	10+
Soil Type	Sandy loam	Condition	VG

Additional notes:

Cleared rows

Mosaic of varying densities of species captured in this site. Trees often clustered or isolated single occurrences. *Mel huegelii* on crests, *xanth pressii* on lower slopes.

Photos:



Cons	Taxon	Ht/cm	%A	Form
*	<i>Trifolium campestre</i>	5		W
*	<i>Brassica tournefortii</i>	0.1		W
	<i>Clematis linearifolia</i>	0		V
	<i>Agonis flexuosa</i>			T
*	<i>Arctotheca calendula</i>			W
	<i>Banksia sessilis</i> var. <i>cygnorum</i>			TS
*	<i>Dittrichia graveolens</i>			W
*	<i>Euphorbia pepus</i>			W
*	<i>Geranium molle</i>			W
* DP	<i>Gomphocarpus fruticosus</i>			W
	<i>Grevillea preissii</i> subsp. <i>preissii</i>			S
	<i>Hakea prostrata</i>			S
	<i>Hibbertia racemosa</i>			S
	<i>Hibbertia cuneiformis</i>			S
*	<i>Hypochoeris glabra</i>			W
	<i>Leucopogon parviflorus</i>			
*	<i>Lysimachia arvensis</i>			W

Cons	Taxon	Ht/cm	%A	Form
	<i>Melaleuca huegelii subsp. huegelii</i>			TS
	<i>Melaleuca systema</i>			S
	<i>Phyllanthus calycinus</i>			S
	<i>Poaceae sp.</i>			G
	<i>Lepidosperma squamatum</i>			Sedge
	<i>Spyridium globulosum</i>			TS
	<i>Templetonia retusa</i>			S
*	<i>Trachyandra divaricata</i>			W
	<i>Xanthorrhoea preissii</i>			TS



Appendix G

Vascular Flora Species
List, 2016

Appendix G Vascular Flora Species List for Lake Clifton including ENV (2009) and the 2016 Survey

Family	Weed	Taxon	AECOM	ENV (2009)
Aizoaceae		* <i>Carpobrotus edulis</i>		X
		<i>Carpobrotus virescens</i>	X	
		<i>Tetragonia decumbens</i>		X
Anthericaceae		<i>Dichopogon</i> sp.		X
Apiaceae		? <i>Daucus glochidiatus</i>	X	
		<i>Daucus glochidiatus</i>		X
		<i>Hydrocotyle tetragonocarpa</i>		X
		<i>Pentapeltis peltigera</i>	X	
Apocynaceae		<i>Alyxia buxifolia</i>	X	X
		* <i>Gomphocarpus fruticosus</i>	X	X
Araceae		* <i>Zantedeschia aethiopica</i>	X	
Araliaceae		<i>Trachymene pilosa</i>	X	X
Asparagaceae		<i>Acanthocarpus preissii</i>	X	X
		<i>Lomandra maritima</i>	X	X
		<i>Lomandra micrantha</i>	X	
		<i>Lomandra suaveolens</i>		X
		<i>Thysanotus manglesianus</i>	X	
Asphodelaceae		* <i>Trachyandra divaricata</i>	X	X
Asteraceae		? <i>Senecio pinnatifolius</i> var. <i>latilobus</i>		X
		* <i>Arctotheca calendula</i>	X	X
		<i>Asteridea pulverulenta</i>		X
		* <i>Cirsium vulgare</i>		X
		* <i>Conyza</i> sp.		X
		* <i>Dittrichia graveolens</i>	X	
		* <i>Hypochaeris glabra</i>	X	X
		<i>Lagenophora huegelii</i>	X	
		<i>Leptorhynchos scaber</i>		X
		<i>Olearia axillaris</i>	X	X
		<i>Podolepis gracilis</i>		X
		<i>Senecio diaschides</i>	X	
		<i>Senecio pinnatifolius</i> var. <i>latilobus</i>		X
		<i>Senecio pinnatifolius</i> var. <i>pinnatifolius</i>		X
		* <i>Sonchus asper</i>		X
		* <i>Sonchus oleraceus</i>	X	X
		* <i>Ursinia anthemoides</i>	X	
Brassicaceae		* <i>Brassica tournefortii</i>	X	
		* <i>Cakile maritima</i>		X
		* <i>Heliophila pusilla</i>		X
Campanulaceae		* <i>Wahlenbergia capensis</i>		X
Caryophyllaceae		* <i>Cerastium glomeratum</i>		X
		* <i>Petrorhagia dubia</i>		X
		* <i>Polycarpon tetraphyllum</i>		X
Casuarinaceae		<i>Allocasuarina fraseriana</i>	X	X
Celastraceae		<i>Stackhousia</i> sp.	X	
Chenopodiaceae		<i>Rhagodia baccata</i> subsp. <i>baccata</i>	X	X
		<i>Sarcocornia blackiana</i>	X	

Appendix G Vascular Flora Species List for Lake Clifton including ENV (2009) and the 2016 Survey

Family	Weed	Taxon	AECOM	ENV (2009)
		<i>Threlkeldia diffusa</i>	x	x
Crassulaceae		<i>Crassula colorata</i>		x
		<i>Crassula colorata</i> var. <i>acuminata</i>		x
		* <i>Crassula glomerata</i>		x
		<i>Crassula</i> sp.		x
Cupressaceae		<i>Callitris preissii</i>	x	
Cyperaceae		<i>Baumea articulata</i>		x
		<i>Baumea juncea</i>	x	
		<i>Baumea vaginalis</i>		x
		<i>Ficinia nodosa</i>		x
		<i>Gahnia trifida</i>	x	x
		* <i>Isolepis marginata</i>		x
		<i>Lepidosperma ?pubisquameum</i>		x
		<i>Lepidosperma gladiatum</i>	x	x
		<i>Lepidosperma squamatum</i>	x	
		<i>Lepyrodia drummondiana</i>	x	
		<i>Tetraria octandra</i>	x	x
Dilleniaceae		<i>Hibbertia cuneiformis</i>	x	x
		<i>Hibbertia huegelii</i>		x
		<i>Hibbertia hypericoides</i>	x	x
		<i>Hibbertia racemosa</i>	x	x
Droseraceae		<i>Drosera erythrorhiza</i>	x	
		<i>Drosera macrantha</i>	x	
Ericaceae		<i>Acrotriche cordata</i>	x	x
		<i>Astroloma pallidum</i>	x	
		<i>Conostephium pendulum</i>		x
		<i>Leucopogon nutans</i>	x	
		<i>Leucopogon parviflorus</i>	x	x
		<i>Leucopogon propinquus</i>	x	x
Euphorbiaceae		* <i>Euphorbia paralias</i>		x
		* <i>Euphorbia peplus</i>	x	
		* <i>Euphorbia terracina</i>	x	
		? <i>Monotaxis</i> sp.		x
Fabaceae		<i>Acacia cochlearis</i>	x	x
		<i>Acacia cyclops</i>	x	x
		<i>Acacia littorea</i>	x	
		<i>Acacia pulchella</i>	x	x
		<i>Acacia rostellifera</i>	x	x
		<i>Acacia saligna</i>	x	x
		<i>Acacia truncata</i>	x	x
		<i>Hardenbergia comptoniana</i>	x	x
		<i>Jacksonia furcellata</i>	x	x
		<i>Kennedia coccinea</i>	x	
		* <i>Lotus angustissimus</i>		x
		* <i>Lotus subbiflorus</i>	x	x
		* <i>Lupinus</i> sp.	x	
		<i>Melilotus albus</i>		x
		<i>Melilotus indicus</i>		x
		<i>Templetonia retusa</i>	x	x
		* <i>Trifolium campestre</i>	x	x
		* <i>Trifolium campestre</i> var. <i>campestre</i>		x
		* <i>Trifolium fragiferum</i> var. <i>fragiferum</i>		x
		* <i>Trifolium</i> sp.		x

Appendix G Vascular Flora Species List for Lake Clifton including ENV (2009) and the 2016 Surv

Family	Weed	Taxon	AECOM	ENV (2009)
Fumariaceae		* <i>Fumaria</i> sp.		x
Geraniaceae		* <i>Geranium molle</i>	x	x
		<i>Geranium retrorsum</i>		x
Goodeniaceae		<i>Goodenia pulchella</i>	x	
		<i>Scaevola crassifolia</i>	x	x
		<i>Scaevola nitida</i>	x	
Haemodoraceae		<i>Conostylis candidans</i> subsp. <i>calpicola</i>		x
		<i>Haemodorum</i> sp.	x	
Iridaceae		<i>Patersonia occidentalis</i>	x	
Juncaceae		<i>Juncus kraussii</i> subsp. <i>australiensis</i>	x	x
		<i>Juncus pallidus</i>		x
Lamiaceae		<i>Hemiandra pungens</i>	x	x
Lauraceae		<i>Cassytha racemosa</i>	x	
		<i>Cassytha</i> sp.		x
Lobeliaceae		<i>Isotoma hypocrateriformis</i>		x
		<i>Isotoma hypocrateriformis</i> var. <i>hypocrateriformis</i>		x
		<i>Lobelia tenuior</i>		x
Loranthaceae		<i>Nuytsia floribunda</i>	x	x
Myrtaceae		<i>Agonis flexuosa</i>	x	x
		<i>Eucalyptus argutifolia</i> (T)	x	x
		<i>Eucalyptus decipiens</i>	x	x
		<i>Eucalyptus foecunda</i>	x	x
		<i>Eucalyptus gomphocephala</i>	x	x
		<i>Eucalyptus lehmannii</i>	x	
		<i>Eucalyptus</i> ? <i>marginata</i>		x
		<i>Eucalyptus marginata</i>	x	
		<i>Eucalyptus marginata</i> subsp. <i>marginata</i>		x
		<i>Eucalyptus</i> ? <i>petrensis</i>		x
		<i>Eucalyptus petrensis</i>	x	x
		<i>Eucalyptus platypus</i>	x	x
		* <i>Eucalyptus</i> sp. (planted)	x	x
		<i>Melaleuca cuticularis</i>	x	x
		<i>Melaleuca huegelii</i>	x	x
		<i>Melaleuca huegelii</i> subsp. <i>huegelii</i>	x	
		<i>Melaleuca lanceolata</i>	x	
		<i>Melaleuca raphiophylla</i>	x	x
		<i>Melaleuca</i> sp. (<i>huegelii</i> x <i>raphiophylla</i>)	x	
		<i>Melaleuca systema</i>	x	x
		<i>Melaleuca teretifolia</i>	x	x
		<i>Melaleuca viminea</i> subsp. <i>viminea</i>		x
Oleaceae		* <i>Olea europaea</i>		x
Orchidaceae		<i>Microtis media</i> subsp. <i>media</i>		x
		Orchid sp.	x	
		<i>Pterostylis sanguinea</i>	x	
		<i>Pyrorchis nigricans</i>	x	
		? <i>Thelymitra</i> sp.		x
Orobanchaceae		* <i>Bartsia trixago</i>		x

Appendix G Vascular Flora Species List for Lake Clifton including ENV (2009) and the 2016 Survey

Family	Weed	Taxon	AECOM	ENV (2009)
		* <i>Orobanche minor</i>		X
Oxalidaceae		* <i>Oxalis pes-caprae</i>		X
		* <i>Oxalis</i> sp.		X
Phyllanthaceae		<i>Phyllanthus calycinus</i>	X	X
		<i>Poranthera microphylla</i>		X
Plantaginaceae		<i>Veronica distans</i>	X	
Planted		<i>Planted Callistemon</i>	X	
Poaceae		* <i>Aira caryophylla</i>		X
		* <i>Aira praecox</i>		X
		* <i>Aira</i> sp.		X
		<i>Austrodanthonia caespitosa</i>		X
		<i>Austrodanthonia</i> sp.		X
		<i>Austrostipa flavescens</i>		X
		* <i>Avena barbata</i>	X	
		* <i>Avena barbata</i>		X
		* <i>Briza minor</i>		X
		<i>Bromus arenarius</i>		X
		* <i>Bromus diandrus</i>		X
		* <i>Bromus hordeaceus</i>		X
		* <i>Cynodon dactylon</i>		X
		* <i>Desmazeria rigida</i>		X
		* <i>Holcus setiger</i>		X
		* <i>Hordeum geniculatum</i>		X
		* <i>Hordeum leporinum</i>		X
		* <i>Lolium rigidum</i>		X
		<i>Poa drummondiana</i>		X
		* <i>Poaceae</i> sp.	X	X
		<i>Spinifex hirsutus</i>		X
		* <i>Vulpia muralis</i>		X
		* <i>Vulpia myuros</i>		X
Polygalaceae		<i>Comesperma ?flavum</i>	X	
Portulacaceae		<i>Calandrinia ?brevipedata</i>		X
Primulaceae		* <i>Lysimachia arvensis</i>	X	X
		<i>Samolus junceus</i>		X
Proteaceae		<i>Banksia attenuata</i>	X	X
		<i>Banksia dallanneyi</i> var. <i>dallanneyi</i>	X	
		<i>Banksia grandis</i>	X	X
		<i>Banksia littoralis</i>	X	X
		<i>Banksia sessilis</i> var. <i>cygnorum</i>	X	X
		<i>Grevillea preissii</i> subsp. <i>preissii</i>	X	X
		<i>Grevillea</i> sp.		X
		<i>Hakea costata</i>		X
		<i>Hakea lissocarpha</i>	X	X
		<i>Hakea prostrata</i>	X	X
		<i>Hakea ruscifolia</i>	X	
		<i>Hakea trifurcata</i>	X	
Ranunculaceae		<i>Clematis linearifolia</i>	X	
		<i>Clematis pubescens</i>	X	X
		<i>Ranunculus</i> sp.		X
Restionaceae		<i>Desmocladius flexuosus</i>	X	

Appendix G Vascular Flora Species List for Lake Clifton including ENV (2009) and the 2016 Survey

Family	Weed	Taxon	AECOM	ENV (2009)
		<i>Loxocarya cinerea</i>	x	
Rhamnaceae		<i>Cryptandra mutila</i>	x	
		<i>Spyridium globulosum</i>	x	x
		<i>Trymalium ledifolium</i> var. <i>ledifolium</i>	x	x
Rubiaceae		* <i>Galium murale</i>		x
		* <i>Sherardia arvensis</i>		x
		<i>Opercularia hispidula</i>	x	x
		<i>Opercularia vaginata</i>		x
Rutaceae		<i>Diplolaena dampieri</i>	x	x
		<i>Diplolaena drummondii</i>		x
Santalaceae		<i>Santalum acuminatum</i>	x	x
Scrophulariaceae		* <i>Dischisma arenarium</i>		x
Solanaceae		<i>Anthocercis littorea</i>	x	
		* <i>Solanum linnaeanum</i>	x	
		* <i>Solanum nigrum</i>	x	x
		<i>Solanum symonii</i>	x	x
Stylidiaceae		<i>Stylidium bulbiferum</i>		x
		<i>Stylidium maritimum</i> (P3)	x	x
Thymelaeaceae		<i>Pimelea ferruginea</i>	x	
		<i>Pimelea</i> sp.	x	
Typhaceae		<i>Typha orientalis</i>		x
		<i>Typha</i> sp.	x	
Utricaceae		<i>Parietaria debilis</i>		x
Xanthorrhoeaceae		<i>Xanthorrhoea preissii</i>	x	x
Zamiaceae		<i>Macrozamia riedlei</i>	x	x
Zygophyllaceae		<i>Zygophyllum ?angustifolium</i>		x
		<i>Zygophyllum fruticosum</i>		x



Appendix H

Weed Species and their
Significance Recorded
at Lake Clifton, 2016

Appendix H Weed Species and their Significance Recorded at Lake Clifton, 2016

Taxon	No. of Occurrences in Sites	EWSWA Rating	Swan Priority Rating
<i>Arctotheca calendula</i>	22	Moderate	H
<i>Asphodelus fistulosus</i>	2	Mild	FAR
<i>Avena barbata</i>	1		VH
<i>Brassica tournefortii</i>	14	High	H
<i>Dittrichia graveolens</i>	6		M
<i>Euphorbia peplus</i>	17	Moderate	H
<i>Euphorbia terracina</i>	1	High	VH
<i>Geranium molle</i>	37	Low	M
<i>Gomphocarpus fruticosus</i>	20	Moderate	M
<i>Hypochaeris glabra</i>	33		H
<i>Lotus subbiflorus</i>	4		U
<i>Lupinus sp.</i>	3	High	U
<i>Lysimachia arvensis</i>	35		FAR
<i>Poaceae sp.</i>	1		
<i>Solanum linnaeanum</i>	1	Moderate	H
<i>Solanum nigrum</i>	33		M
<i>Sonchus oleraceus</i>	3		FAR
<i>Trachyandra divaricata</i>	48	Mild	FAR
<i>Trifolium campestre</i>	24		FAR
<i>Ursinia anthemoides</i>	1		M
<i>Zantedeschia aethiopica</i>	2	High	VH

EWSWA represents the Environmental Weed Strategy for Western Australia CALM 1999)

Swan Rating derived from Swan Environmental Weed Assessment (2008)

Ratings include VH-Very High, H-High, FAR-Further Assessment Required, M-Moderate, U-Unknown



Appendix I

Fauna Species
Recorded during the
Field Survey

Appendix I Fauna Species Recorded During the Field Survey

Name	Common Name	Conservation Status	
		Commonwealth	State
Birds			
<i>Anas superciliosa</i>	Pacific Black Duck	-	-
<i>Anhinga novaehollandiae</i>	Australasian Darter	-	-
<i>Anthochaera carunculata</i>	Red Wattlebird	-	-
<i>Artamus cinereus</i>	Black-faced Woodswallow	-	-
<i>Aquila audax</i>	Wedge-tailed Eagle	-	-
<i>Barnardius zonarius semitorquatus</i>	Twenty-eight Parrot	-	-
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	Marine	-
<i>Calyptorhynchus latirostris</i>	Carnaby's Black Cockatoo	E	EN
<i>Circus approximans</i>	Swamp Harrier	Marine	-
<i>Corvus coronoides</i>	Australian Raven	-	-
<i>Cracticus tibicen</i>	Australian Magpie	-	-
<i>Dacelo novaeguineae</i>	Laughing Kookaburra*	-	-
<i>Dicaeum hirundinaceum</i>	Mistletoebird	-	-
<i>Dromaius novaehollandiae</i>	Emu	-	-
<i>Eolophus roseicapilla</i>	Galah	-	-
<i>Falco cenchroides</i>	Nankeen Kestrel	Marine	-
<i>Fulica atra</i>	Eurasian Coot	-	-
<i>Gerygone fusca</i>	Western Gerygone	-	-
<i>Grallina cyanoleuca</i>	Magpie-lark	Marine	-
<i>Haliastur sphenurus</i>	Whistling Kite	Marine	-
<i>Hieraaetus morphnoides</i>	Little Eagle	-	-
<i>Hirundo neoxena</i>	Welcome Swallow	Marine	-
<i>Microeca fascinans</i>	Jacky Winter	-	-
<i>Ninox novaeseelandiae</i>	Southern Boobook	Marine	-
<i>Pachycephala pectoralis</i>	Golden Whistler	-	-
<i>Petrochelidon nigricans</i>	Tree Martin	Marine	-
<i>Phaps chalcoptera</i>	Common Bronzewing	-	-
<i>Rhipidura albiscapa</i>	Grey Fantail	-	-
<i>Rhipidura leucophrys</i>	Willie Wagtail	-	-
<i>Streptopelia senegalensis</i>	Laughing Turtle-dove*	-	-
<i>Tadorna tadornoides</i>	Australian Shelduck	-	-

Name	Common Name	Conservation Status	
		Commonwealth	State
Mammals			
<i>Canis lupis familiaris</i>	Dog*	-	-
<i>Macropus fuliginosus</i>	Western Grey Kangaroo	-	-
<i>Mus musculus</i>	House Mouse*		
<i>Isoodon obesulus fusciventer</i>	Quenda, Southern Brown Bandicoot	-	P4
<i>Oryctolagus cuniculus</i>	European Wild Rabbit*	-	-
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	V	EN
<i>Trichosurus vulpecula</i>	Common Brushtail Possum	-	-
<i>Vulpes vulpes</i>	Red Fox*	-	-
Reptiles			
<i>Tiliqua rugosa rugosa</i>	Southwestern Bobtail	-	-
Amphibians			
<i>Limnodynastes dorsalis</i>	Banjo Frog	-	-
<i>Litoria adelaidensis</i>	Slender Tree Frog	-	-

Note: Species listed as Marine under the EPBC Act are only considered conservation significant when in a Commonwealth marine reserve.



Appendix J

Black Cockatoo Foraging Assessment

Carnaby's Black Cockatoo Foraging Assessment

Site	Initial Score	Is within the Swan Coastal Plain	Contains trees known to be used for breeding	Primarily comprises Marri	Contains trees with breeding potential	Known to be a large or key roosting site	Within 6km of a known night roost	Is <12km from known breeding location	Is <2km from a watering point	Greater than 6km from known roosting site	No other foraging habitat within 6 km	Is >12km from known breeding location	Minimal marri and less than 20% prots cover	More Than 2km from Watering Point	Disease present	Final Score
1	1	3	0	0	0	0	1	1	0	0	0	0	-3	-1	0	2
2	2	3	0	0	0	0	1	1	0	0	0	0	-3	-1	0	3
3	2	3	0	0	2	0	1	1	1	0	0	0	-3	0	0	7
4	2	3	0	0	0	0	0	1	1	-1	0	0	-3	0	0	3
5	2	3	0	0	2	0	1	1	1	0	0	0	-3	0	0	7
6	2	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	5
7	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
8	1	3	0	0	0	0	1	1	0	0	0	0	-3	-1	0	2
9	1	3	0	0	2	0	1	1	0	0	0	0	-3	-1	0	4
10	1	3	0	0	2	0	1	1	0	0	0	0	-3	-1	0	4
11	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
12	2	3	0	0	2	0	1	1	1	0	0	0	-3	0	0	7
13	2	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	5
14	7	3	0	0	2	0	0	1	1	-1	0	0	-3	0	0	10
15	1	3	0	0	0	0	0	1	1	-1	0	0	-3	0	0	2
16	2	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	5
17	1	3	0	0	0	0	0	1	1	-1	0	0	-3	0	0	2
18	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
19	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
20	2	3	0	0	2	0	0	1	1	-1	0	0	-3	0	0	5
21	2	3	0	0	2	0	0	1	1	-1	0	0	-3	0	0	5
22	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
23	2	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	5
24	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4
25	2	3	0	0	2	0	1	1	1	0	0	0	-3	0	0	7
26	1	3	0	0	2	0	1	1	0	0	0	0	-3	-1	0	4
27	1	3	0	0	2	0	1	1	0	0	0	0	-3	-1	0	4
28	1	3	0	0	2	0	1	1	0	0	0	0	-3	-1	0	4
29	7	3	0	0	2	0	0	1	1	-1	0	0	-3	0	0	10
30	7	3	0	0	2	0	0	1	1	-1	0	0	-3	0	0	10
31	7	3	0	0	2	0	1	1	1	0	0	0	-3	0	0	12
32	2	3	0	0	2	0	0	1	1	0	0	0	-3	-1	0	5
33	2	3	0	0	0	0	1	1	0	0	0	0	-3	-1	0	3
34	2	3	0	0	0	0	1	1	0	0	0	0	-3	-1	0	3
35	1	3	0	0	0	0	1	1	1	0	0	0	-3	0	0	4

Forest Red-tailed Black Cockatoo Foraging Assessment

Site	Initial Score	Jarrah and/or Marri shows good recruitment	Contains trees known to be used for breeding	Primarily contains Marri and/or Jarrah	Contains trees with breeding potential	Known to be a large or key roosting site	Within 6km of a known night roost	Is <12km from known breeding location	Is <2km from watering point	Greater than 6km from known roosting site	No other foraging habitat within 6 km	Is >12km from known breeding location	More Than 2km from Watering Point	Minimal marri	Disease present	Final Score
26	10	3	0	2	2	0	0	0	0	-1	0	-1	-1	-3	0	11
27	10	3	0	2	2	0	0	0	0	-1	0	-1	-1	-3	0	11
28	10	3	0	2	2	0	0	0	0	-1	0	-1	-1	-3	0	11

Baudin's Black Cockatoo Foraging Assessment

Site	Initial Score	Is within known foraging area	Contains trees known to be used for breeding	Primarily comprises Marri	Contains trees with breeding potential	Known to be a large or key roosting site	Within 6km of a known night roost	Is <12km from known breeding location	Is <2km from a watering point	Greater than 6km from known roosting site	No other foraging habitat within 6km	Is >12km from known breeding location	Minimal marri and less than 20% prots cover	More Than 2km from Watering Point	Disease present	Final Score
36	2	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0	-2
9	1	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0	-3
10	2	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	0
11	2	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	0
12	2	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	0
13	7	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	5
14	2	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0	-2
16	2	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	0
18	2	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	0
19	2	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	0
20	7	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	5
3	2	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	0
7	1	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0	-3
24	1	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0	-3
36	1	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0	-3
14	7	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	5
29	7	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	5
25	7	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	5
33	7	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	5
5	2	0	0	0	2	0	0	0	1	-1	0	-1	-3	0	0	0
6	2	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0	-2
8	1	0	0	0	0	0	0	0	0	-1	0	-1	-3	-1	0	-5
22	1	0	0	0	0	0	0	0	1	-1	0	-1	-3	0	0	-3



Appendix K

Black Cockatoo Trees
Quadrat Raw Data

Object ID	Quadrat No.	Veg Unit	No Trees	Fire Scar	Tree Species	DBH (CM)	Tree Height	Occupancy	Evidence of Use	Comments	Easting	Northing
1	1	AXpHh	0	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	No trees	373550.6	6373562
2	2	AfhcEp	2	No	Eucalyptus gomphocephala (Tuart)	57	1800	<Null>	No	No hollows	373968	6369421
3		AfhcEp	No	No	Eucalyptus gomphocephala (Tuart)	53	2200	<Null>	No	No hollows	373985.5	6369438
4	3	AfhcEp	1	No	Eucalyptus gomphocephala (Tuart)	50	1800	<Null>	No	No hollows	373793.9	6369090
5	4	Eg	8	No	Eucalyptus gomphocephala (Tuart)	130	26	<Null>	No	1 hollow total - potentially suitable	373713.4	6369415
6		Eg	No	No	Eucalyptus gomphocephala (Tuart)	102	18	<Null>	No	1 hollow total - unsuitable	373702.2	6369413
7		Eg	No	No	Eucalyptus gomphocephala (Tuart)	120	1700	<Null>	No	No hollows	373672.7	6369417
8		Eg	No	No	Eucalyptus gomphocephala (Tuart)	160	2200	<Null>	No	No hollows	373663.7	6369415
9		Eg	No	No	Eucalyptus gomphocephala (Tuart)	62	2300	<Null>	No	No hollows	373694.7	6369392
10		Eg	No	No	Eucalyptus gomphocephala (Tuart)	91	1800	<Null>	No	No hollows	373698.6	6369426
11		Eg	No	No	Eucalyptus gomphocephala (Tuart)	74	25	No	No	2 hollows - 1 potentially suitable	373687.6	6369412
12		Eg	No	No	Eucalyptus gomphocephala (Tuart)	89	25	<Null>	No	3 hollows - 2 potentially suitable	373689.5	6369408
164	5	EgMsTd	5	No	Stag (old dead tree, unknown species)	50	1800	<Null>	No	No hollows	373848.4	6370282
165		EgMsTd	No	No	Stag (old dead tree, unknown species)	60	1800	<Null>	No	No hollows	373865.7	6370278
166		EgMsTd	No	No	Eucalyptus gomphocephala (Tuart)	78	2000	<Null>	No	Two main stems, second stem DBH 50+	373836.8	6370284
167		EgMsTd	No	No	Eucalyptus gomphocephala (Tuart)	105	1800	<Null>	No	No hollows	373848.4	6370270
168		EgMsTd	No	No	Eucalyptus gomphocephala (Tuart)	60	1400	<Null>	No	No hollows	373822.6	6370269
131	6	Eg	11	No	Eucalyptus gomphocephala (Tuart)	51	1300	<Null>	No	No hollows	372773.7	6371196
133		Eg	No	No	Eucalyptus gomphocephala (Tuart)	81	2200	<Null>	No	4 hollows - 1 potentially suitable	372748.3	6371204
134		Eg	No	No	Eucalyptus gomphocephala (Tuart)	110	2200	<Null>	Honeycomb inside	4 trunk hollows - 1 is potentially suitable but has honeycomb inside.	372745	6371197
136		Eg	No	No	Eucalyptus gomphocephala (Tuart)	72	1700	<Null>	No	No hollows	372791.4	6371216
137		Eg	No	No	Eucalyptus gomphocephala (Tuart)	64	1700	<Null>	No	No hollows	372775.9	6371242
139		Eg	No	No	Eucalyptus gomphocephala (Tuart)	54	1800	<Null>	No	1 spout hollow potentially suitable	372780.4	6371239
141		Eg	No	No	Eucalyptus gomphocephala (Tuart)	98	15	<Null>	No	2 potentially suitable hollows	372775.4	6371225
142		Eg	No	No	Eucalyptus gomphocephala (Tuart)	63	12	<Null>	No	2 potentially suitable hollows	372781.1	6371236
143		Eg	No	No	Eucalyptus gomphocephala (Tuart)	53	20	<Null>	No	No hollows	372767.7	6371213
144		Eg	No	No	Eucalyptus gomphocephala (Tuart)	102	25	<Null>	No	2 hollows - 1 potentially suitable	372769.5	6371229
145		Eg	No	No	Eucalyptus gomphocephala (Tuart)	67	20	<Null>	No	Dead tree - 1 small unsuitable hollow	372776.6	6371205
123	7	AXpHh	6	No	Eucalyptus gomphocephala (Tuart)	95	2200	<Null>	No	No hollows	374106	6371550
146		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	78	2000	<Null>	No	No hollows	374119.7	6371528
147		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	219	2200	<Null>	No	No hollows	374119.9	6371535
148		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	54	2200	<Null>	No	No hollows	374132.6	6371530
149		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	80	2500	<Null>	No	No hollows	374106.5	6371540
150		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	96	1900	<Null>	No	No hollows	374101.8	6371536
17	8	AXpHh	7	Yes	Eucalyptus gomphocephala (Tuart)	95	1800	<Null>	No	No hollows	373786.9	6372118
18		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	84	1900	<Null>	No	No hollows	373788.1	6372129
19		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	81	1800	<Null>	No	No hollows	373794.4	6372136
20		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	65	2200	<Null>	No	No hollows	373791.9	6372141
21		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	80	2200	<Null>	No	No hollows	373815.6	6372111
22		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	57	1800	<Null>	No	Two main trunks, one dead with 3 hollows	373797	6372120
23		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	78	2000	<Null>	No	No hollows	373801.4	6372136
25	9	AXpHh	6	No	Eucalyptus gomphocephala (Tuart)	74	2000	<Null>	No	No hollows	373728.2	6372306
26		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	76	1800	<Null>	No	No hollows	373714.8	6372312
27		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	86	2000	<Null>	No	No hollows	373722.5	6372319
28		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	60	1700	<Null>	No	No hollows	373706.6	6372327
30		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	150	1800	<Null>	No	No hollows	373720.7	6372335
31		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	100	1600	<Null>	No	Main trunk broken and burnt, second stem DBH 50+, no hollows	373743.1	6372323
34	10	AXpHh	6	No	Eucalyptus gomphocephala (Tuart)	53	1300	<Null>	No	No hollows	373185.5	6373366
35		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	50	1100	<Null>	No	No hollows	373186.1	6373378
36		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	73	1300	<Null>	No	No hollows	373182.5	6373395
37		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	60	1200	<Null>	No	No hollows	373184.8	6373396
38		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	63	1500	<Null>	No	2 hollows - none suitable	373176.4	6373377
39		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	63	1600	<Null>	No	2 stems, second stem DBH 50+	373181.4	6373389
42		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	50	1300	<Null>	No	2 hollows, 0 potentially suitable	373210.6	6373391
43	11	AXpHh	5	Yes	Eucalyptus gomphocephala (Tuart)	106	1400	<Null>	No	No hollows - tree half dead	373571.1	6373425
44		AXpHh	No	No	Eucalyptus gomphocephala (Tuart)	57	1500	<Null>	No	1 hollow - unsuitable	373571.1	6373409
45		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	68	800	Bees	No	Dead, 4 hollows - none suitable	373556.4	6373422
46		AXpHh	Yes	No	Eucalyptus gomphocephala (Tuart)	62	1100	<Null>	No	1 hollow unsuitable	373540.6	6373403
47		AXpHh	Yes	No	Stag (old dead tree, unknown species)	53	1100	<Null>	No	No hollows	373540.5	6373400

51	12	AfhcEp	0	<Null>	<Null>	<Null>	<Null>	<Null>	No	No trees	372434.4	6373464
52	13	EgXpTd	9	No	Eucalyptus gomphocephala (Tuart)	73	1500	<Null>	No	No hollows	372505.5	6372519
53		EgXpTd		Yes	Eucalyptus gomphocephala (Tuart)	74	1600	<Null>	No	No hollows	372513.9	6372516
54		EgXpTd		Yes	Eucalyptus gomphocephala (Tuart)	75	2000	<Null>	No	2 hollows - 0 suitable due to small size	372517.8	6372522
55		EgXpTd		No	Eucalyptus gomphocephala (Tuart)	45	2100	<Null>	No	1 hollow - 0 suitable too small	372520.8	6372536
56		EgXpTd		No	Eucalyptus gomphocephala (Tuart)	105	<Null>	<Null>	No	5 hollows - 2 potentially suitable	372529	6372553
57		EgXpTd		No	Eucalyptus gomphocephala (Tuart)	90	1800	<Null>	No	3 hollows - 2 potentially suitable	372533	6372548
58		EgXpTd		No	Eucalyptus gomphocephala (Tuart)	72	1600	<Null>	No	No hollows	372526.3	6372568
59		EgXpTd		Yes	Eucalyptus gomphocephala (Tuart)	110	2200	<Null>	No	1 hollow, none suitable	372500.8	6372561
60		EgXpTd		No	Eucalyptus gomphocephala (Tuart)	89	1800	<Null>	No	No hollows	372511.4	6372575
173	14	Eg	7	No	Eucalyptus gomphocephala (Tuart)	91	2000	<Null>	No	No hollows	373649.4	6368833
175		Eg		No	Eucalyptus gomphocephala (Tuart)	78	2000	<Null>	No	No hollows	373653.6	6368829
176		Eg		No	Eucalyptus gomphocephala (Tuart)	76	2200	<Null>	No	No hollows	373662.4	6368799
177		Eg		Yes	Stag (old dead tree, unknown species)	61	15	<Null>	No	4 hollows - 3 potentially suitable	373607.5	6368830
178		Eg		No	Eucalyptus gomphocephala (Tuart)	89	1800	<Null>	Being used by owl	No hollows	373643.5	6368799
179		Eg		No	Eucalyptus gomphocephala (Tuart)	95	20	<Null>	No	No hollows	373616.7	6368828
180		Eg		Yes	Eucalyptus gomphocephala (Tuart)	50	15	<Null>	No	2 hollows - none potentially suitable	373626.2	6368827
62	15	ADxpHhHg	1	No	Eucalyptus gomphocephala (Tuart)	62	2500	<Null>	No	No hollows	374229.3	6368439
66	16	ADxpHhHg	3	No	Eucalyptus marginata (jarrah)	58	2000	<Null>	No	No hollows	374212.6	6368556
67		ADxpHhHg		No	Eucalyptus gomphocephala (Tuart)	50	2200	<Null>	No	No hollows	374214.8	6368570
69		ADxpHhHg		No	Eucalyptus marginata (jarrah)	53	1200	<Null>	No	No hollows	374264.1	6368550
70	17	ADxpHh	1	Yes	Eucalyptus marginata (jarrah)	59	11	<Null>	No	No hollows	373554.4	6373673
71	18	AfhcEP	0	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	No trees	373697.9	6369159
72	19	AfhcEp	0	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	No trees	372226.7	6373200



Appendix L

Lake Clifton Wetlands Assessment Forms

Appendix L Lake Clifton Wetland Assessment Forms

1.0 UFI 3096

1.1 General Information

Assessor details	
Name	Floora de Wit and Lyn van Gorp
Date of site visit	27-28 June 2016
Company	AECOM Australia Pty Ltd
Weather during visit	Cloudy, light rains
Landowner	Main Roads Western Australia
Property details	
Location (lot/street)	
Latitude and longitude or Easting northing	
Wetland details	
Name	
UFI	3096
Hill et al. (1996) map sheet number and wetland ID number	
Consanguineous suite	Clifton
Area (ha) of wetland	54 ha
Area (ha) subject to this evaluation	54 ha
Is wetland assessed as portion of wetland with varying degrees of value?	No
Mapped management category	Conservation
Wetland type (see table below)	Sumpland

Water permanence	Host landform				
	Basin	Flat	Slope	Highland	Channel
Permanent inundation	Lake	-	-	-	River*
Seasonal inundation	Sumpland	Floodplain*	-	-	Creek*
Intermittent inundation	Playa*	Barkarra*	-	-	Wadi*
Seasonal waterlogging	Dampland	Palusplain	Paluslope	Palusmont*	Trough*

*Wetland types not applicable to this evaluation methodology.

1.2 Wetland desktop evaluation

Land uses	
Current ownership of wetland	Main Roads Western Australia
Current land use	Vegetated
Past land use	Agriculture
Surrounding land use	RAMSAR wetland, native vegetation
Existing management	No known management
Fire history/regime	Unknown, no evidence of recent fire

International, national or regional significance	
Indicate whether the wetland is identified (permanent or interim) on one of the following international, national or state registers or listings.	
Conservation Significance	Y/N
Ramsar Convention on Wetlands (Ramsar 1971)	N
Directory of Important Wetlands in Australia (Environment Australia 2001)	N
Register of National Estate (Commonwealth of Australia 2007)	N
Conservation Reserves for Western Australia Systems 1, 2, 3, 5 (Department of Conservation and Environment, 1976)	n/a
Conservation Reserves for Western Australia, The Darling System – System 6 (Department of Conservation and Environment, 1983)	N
A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region (Pen 1997)	N
The Environmental Significance of Wetlands in the Perth to Bunbury Region (Le Provost et al. 1987)	N
Bush Forever (Government of Western Australia 2000)	N
Swan Bioplan (Environmental Protection Authority 2010)	N
Environmental Protection (Swan Coastal Plain Lakes) Policy 1992	N
Environmental Protection (Western Swamp Tortoise Habitat) Policy Approval Order 2002	N
Conservation Estate (e.g. National Park, Nature Reserve, A Class Reserve)	N
Other (list):	Y ESA
Does the wetland retain the values for which it was originally registered or listed, describe: Yes, contains TEC.	

Fauna			
Note the presence (recorded or observed) or evidence of fauna in or surrounding the wetland which is listed by the Commonwealth (e.g. Environment Protection and Biodiversity Conservation Act 1999, CAMBA, RoKAMBA, JAMBA) or State (e.g. Threatened or Specially Protected Fauna under the Wildlife Conservation Act 1950) or Priority Fauna or Priority or Threatened Ecological Communities related to fauna which are listed by DPaW.			
Species / name of ecological community	Significance (e.g. EPBC Act, CAMBA)	Observations (e.g. population size, age, evidence, activities, habitat requirements)	Source of information (e.g. observatory, literature, DPaW, WA Museum)

Scientific value		
List any scientific values including geoheritage or geoconservation values (e.g. important sediments or geological features, fossils, pollen records, stromatolites, thrombolites, evidence of evolutionary processes, evidence of a change in climate, unique flora or fauna adaptations) that the wetland may contain.		
Scientific, geoheritage or geoconservation values	Significance and observations	Source of information (e.g. observatory, literature, DPaW, WA Museum)

Flora				
Use aerial photography and a site visit to determine and confirm the condition of the vegetation within and 50 metres surrounding the wetland. Using the scale outlined in Appendix B, display the locations of the vegetation conditions in the attached map and calculate their total area:				
Vegetation condition	Total area (%) within the wetland	Area (%) 50 metres surrounding the wetland		
Pristine				
Excellent	100%	100%		
Very Good				
Good				
Degraded				
Completely Degraded				
Using this information, is the wetland dominated by vegetation in a good or better condition:		Yes		
What vegetation complex (Hedde et al. 1980) does the wetland belong to:		Yoongarillup complex		
Using the information sources outlined in Appendix B, what extent of the vegetation complex is remaining on the Swan Coastal Plain		38 %		
List any occurrences of Priority and Threatened Ecological Communities related to flora and wetland systems which are known to occur within and 5 kilometres surrounding the wetland. If they are located within or adjacent to the wetland display their boundary in the attached map:				
Name of ecological community	Significance (e.g. priority, threatened)	Observations (e.g. condition, area, habitat type)	Source of information (e.g. observatory, literature, DPaW)	
FCT25 Southern <i>Eucalyptus gomphocephala</i> and <i>Agonis flexuosa</i> woodland	Priority 3	Adjacent to wetland boundary	DPaW, ENV(2009)	
Stromatolite like freshwater microbialite community of coastal brackish lakes	Cth: Critically Endangered State: Critically Endangered	Wetland within buffer of this TEC	DPaW	
List any occurrences of Declared Rare flora or Priority flora known to occur within and 1 kilometre surrounding the wetland and display their location in the attached map:				
Species	Significance (e.g. Declared Rare, Priority 1)	Population measure (number, single record, abundance comment)	Observations (e.g. habitat type, flowering season)	Source of information (e.g., literature, DPaW, surveyed population, Herbarium record)
<i>Lasiopetalum membranaceum</i>	P3	Single record	None	DPaW database record from 1988 located 250 east of wetland boundary.
<i>Eucalyptus argutifolia</i>	Cth: Threatened State: Threatened	One population (no count data available)	None	DPaW database records, ENV (2009) and Weston (2003)

Representativeness

Using the wetlands data outlined in section 4.3, Appendix D and available on DPaW's website record the corresponding area:

	% area
What is the % area of wetlands with the same classification assigned a Conservation management category on the Swan Coastal Plain	37.0
What is the % area of wetlands in the same consanguineous suite assigned a Conservation management category	78.1
What is the % area of wetlands with the same classification in the same consanguineous suite assigned a conservation management category	24.7
Is the wetland rare? (e.g. only wetland in its consanguineous suite, best wetland example in its consanguineous suite or region, only Conservation management category wetland in the consanguineous suite or region, primary saline wetland within a consanguineous suite predominated by freshwater):	N

No.	Criteria	Y/N
1	The wetland is currently recognised as internationally or nationally significant for its natural values. Lists/registers include: <ul style="list-style-type: none"> - The Ramsar Convention on Wetlands - State government endorsed candidate sites for the Ramsar Convention on Wetlands - Directory of Important Wetlands in Australia - National Heritage List - Or equivalent. 	N N N N N
2	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is identified as significant for its natural values under one or more of the following: <ul style="list-style-type: none"> - <i>Conservation Reserves for Western Australia Systems 1, 2, 3, 5</i> - <i>Conservation Reserves for Western Australia, The Darling System – System 6</i> - <i>A Systematic Overview of Environmental Values of the Wetlands, Rivers and Estuaries of the Busselton – Walpole Region</i> - <i>The Environmental Significance of Wetlands in the Perth to Bunbury Region</i> - <i>Bush Forever, Swan Bioplan or equivalent.</i> 	N N N N N
3	The wetland supports a breeding, roosting, or refuge site or a critical feeding site for populations of fauna listed by the Australian Government (for example, <i>Environment Protection and Biodiversity Conservation Act 1999</i> , migratory bird agreements such as JAMBA, CAMBA and RoKAMBA) or the State (for example, Threatened and Specially Protected Fauna listed under the <i>Wildlife Conservation Act 1950</i>).	Y
4	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and supports one or more of the following: <ul style="list-style-type: none"> - An occurrence of a Threatened Ecological Community - A confirmed occurrence of a Priority 1 or Priority 2 Ecological Community - A confirmed occurrence of a Declared Rare (Threatened) flora species. 	N Y N
5	Equal to or greater than 90% of the wetland supports vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B.	Y
6	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and is known to support internationally, nationally or state-wide scientific values including geoheritage and geoconservation.	N
7	The wetland is spatially dominated by vegetation in a good or better condition using the vegetation condition scale outlined in Appendix B and meets one of the following: <ul style="list-style-type: none"> - ≤10% of wetlands of the same type are assigned Conservation management category within the Swan Coastal Plain (by area) - ≤10% of all wetlands in the same consanguineous suite are assigned Conservation management category (by area) - ≤10% of wetlands of the same type in its consanguineous suite are assigned Conservation management category (by area) - best representative of its type within its consanguineous suite domain. 	N N N N

1.3 Secondary Assessment Form

No.	General criteria	Criteria	Score
Geomorphology			
1	<i>Representativeness</i>	≤20% of wetlands of the same type are assigned Conservation on the Swan Coastal Plain by area.	H
2		≤20% of wetlands in the same consanguineous suite are assigned Conservation by area.	H
3		≤20% of wetlands of the same type in the same consanguineous suite are assigned Conservation by area.	H
4		The wetland is outstanding in some geomorphic aspect, for example size, origin, height relative to sea level, depth, age.	H
5	<i>Naturalness</i>	Alteration to the wetland's geomorphology by % area: < 25% altered 25-75% altered > 75% altered.	H I L
6	<i>Scarcity</i>	The wetland exhibits unusual geomorphology or unusual internal geomorphic features compared to other wetlands of the same type in the consanguineous suite.	H
7		The wetland is the best example of its type in its consanguineous suite.	H
Wetland processes			
8	<i>Representativeness</i>	The wetland is an important component of the natural hydrological cycle providing natural functions (e.g. flood protection and recharge/discharge). The wetland's vegetation, geomorphology, hydrology or sediments are modified; however, the wetland is still a component of the hydrological cycle providing natural and artificial functions (e.g. flood remediation, recharge/discharge and hydrological storage). The wetland's vegetation, geomorphology, hydrology or sediments are modified to the extent that the wetlands hydrological functions are artificial such as storage, or the wetland has been disconnected from the natural hydrological cycle and no longer provides natural attributes and functions.	H
9		The wetland supports a representative process (e.g. wetland process typical of the wetland's hydrological setting, sediment accretionary process typical of the wetland's geomorphic setting or hydrochemical process typical of the wetland's geological setting).	H
10	<i>Naturalness</i>	The wetland is not subject to altered wetland processes or, is subject to altered wetland processes and the wetland's natural attributes and functions are maintained. The wetland is subject to altered wetland processes and the wetland's natural attributes and functions have been changed; however, they have the potential to be rehabilitated. The wetland is subject to altered wetland processes to the extent that the wetland no longer supports natural attributes and functions.	H
11	<i>Scarcity</i>	The wetland exhibits unusual processes (e.g. hydrological, sedimentological, chemical, biological) compared to other wetlands of the same type in the consanguineous suite.	H

No.	General criteria	Criteria	Score
Linkages			
12	<i>Representativeness</i>	The wetland is a hydrological link in a larger or more complex and intact system.	H
13	<i>Naturalness</i>	The wetland is part of a continuous ecological linkage or wildlife corridor, or a regionally significant ecological linkage or wildlife corridor connecting bushland or wetland areas. The wetland is part of a fragmented ecological linkage or wildlife corridor. The wetland is disturbed and isolated, surrounded by either a built or highly disturbed environment with no nearby native vegetation or waterways to support an intact or fragmented ecological linkage or wildlife corridor.	H I L
14	<i>Scarcity</i>	The wetland has unusual hydrological, hydrochemical or ecological linkages with adjacent wetland or bushland.	I
Habitats			
15	<i>Representativeness</i>	The wetland is isolated from other undisturbed wetlands or bushland and as a result, maintains important ecological or genetic fauna or flora diversity within its consanguineous suite domain.	H
16		The wetland contains evidence of surface water that is vital to maintaining regionally significant populations of native aquatic or terrestrial flora or fauna.	H
17		The wetland provides a nursery for native fauna populations, or maintains fauna populations at a vulnerable stage of their life cycle.	H
18	<i>Naturalness</i>	The wetland supports habitats that are unaltered or the wetland has been altered and its natural habitats are maintained. The wetland supports habitats that are altered; however, the habitats are still identifiable and have the potential to be rehabilitated. The wetland is altered and as a result is no longer supporting natural habitats which can be rehabilitated.	H I L
19	<i>Scarcity</i>	The wetland supports habitats that are unusual compared to other wetlands of the same type on the Swan Coastal Plain.	H
Flora			
20	<i>Representativeness</i>	The wetland's current diversity of native flora is similar to what would be expected in an unaltered state. The wetland supports a reduced diversity of native flora due to human induced disturbances. The wetland supports a significantly reduced diversity of native flora species due to human induced disturbances.	H I L
21		The wetland is identified in a vegetation complex (Hedde et al. 1980) which is represented by: ≤30% of the pre-European extent 30-50% of the pre-European extent.	 H I
22	<i>Naturalness</i>	Using the vegetation condition scale outlined in Appendix B, the wetland's vegetation condition by area is: ≥ 75% Good, Very Good, Excellent or Pristine 25-75% Good, Very Good, Excellent or Pristine < 25% Good, Very Good, Excellent or Pristine.	 H I L

No.	General criteria	Criteria	Score
23		The wetland or ≥ 50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	H
		The wetland or 10-50% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	I
		The wetland or < 10% of the wetland boundary is surrounded by land dominated by remnant native vegetation.	L
24	<i>Scarcity</i>	The wetland supports an occurrence of Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora, or an occurrence of 3 or more significant flora taxa.	H
25		The wetland is likely to support Declared Rare, Priority 1, Priority 2, Priority 3 or Priority 4 flora; however, the occurrence cannot be located or its habitat has been altered and is no longer in a natural state.	I
26		The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	H
27		The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community.	I
Fauna			
28	<i>Representativeness</i>	The wetland is an ecological refuge for regionally significant fauna species or fauna assemblages.	H
		The wetland has the potential to be an ecological refuge but is disturbed and its attributes and functions require rehabilitation.	
29		The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regionally significant native fauna.	H
		The wetland supports a permanent or seasonal feeding, breeding, roosting or watering site for regional or local fauna but only in association with other surrounding natural areas.	I
30	<i>Naturalness</i>	The wetland's current diversity of native fauna is similar to what would be expected in an unaltered state, or the wetland supports diverse fauna compared to other wetlands of the same type.	H
		The wetland supports a reduced diversity of fauna compared to other wetlands of the same type.	I
31		The wetland supports limited attributes and functions for fauna populations due to human induced disturbances.	L
32	<i>Scarcity</i>	The wetland is likely to support a breeding, roosting, refuge or feeding site for populations of fauna listed by the Commonwealth (e.g. <i>EPBC Act 1999</i> , JAMBA, CAMBA, RoKAMBA Agreements) or the State (e.g. Threatened or Specially Protected Fauna listed under the <i>Wildlife Conservation Act 1950</i>).	H
33		The wetland supports a breeding, roosting, refuge or feeding site for Priority 1, Priority 2, Priority 3 or Priority 4 fauna.	H
34		The wetland supports an occurrence of a Threatened Ecological Community, Priority 1 or Priority 2 ecological community.	H
35		The wetland supports an occurrence of a Priority 3 or Priority 4 ecological community or a breeding, roosting, refuge or feeding site for significant fauna.	I
Cultural			
36	<i>Representativeness</i>	The wetland or its immediate surrounds is identified for its natural values on a national or State heritage list or the wetland supports other known regional heritage values.	H
37		The wetland or its immediate surrounds is identified for its natural values on a municipal heritage list or the wetland supports other known local heritage values.	I

No.	General criteria	Criteria	Score
38		The wetland or its immediate surrounds is identified on a national, State or local list or register for its Aboriginal cultural value (e.g. Department of Aboriginal Affairs register).	H
39		The wetland is important to the local community either nationally or state wide for its natural values.	H
40		The wetland is or has the potential to be a site for public or private based recreation.	I
41		The wetland is likely to support heritage, cultural or social values; however, the value cannot be confirmed or the value has been disturbed and are no longer as important or significant.	I
		The wetland did support heritage, cultural or social values; however, these have been significantly disturbed and are no longer important or the values have been removed.	L
Scientific and educational			
42	<i>Representativeness</i>	The wetland supports known important teaching or research characteristics and for this reason is an existing or potential education or research site. Note, the wetland must still support the relevant teaching or research characteristics.	H
		The wetland has the potential to be used as a study or research site.	I
43		The wetland supports known scientific, geoheritage or geoconservation values.	H
44		The wetland did support scientific or educational values; however, these have been significantly disturbed and are no longer as important or the values have been removed.	L

1.4 Results

Attributes/functions /values	Scores		
	High	Intermediate	Low
Geomorphology	1		
Wetland processes	3		
Linkages	2	1	
Habitats	2		
Flora	3	2	
Fauna	4	1	
Cultural		1	
Scientific and educational			
Total Score	15	5	
Defining attributes/ functions/values	Fauna		
Applicable management category	Conservation		

Appendix D: AECOM (2020) Lake Clifton Tuart TEC Assessment

Targeted Tuart Woodlands TEC Survey

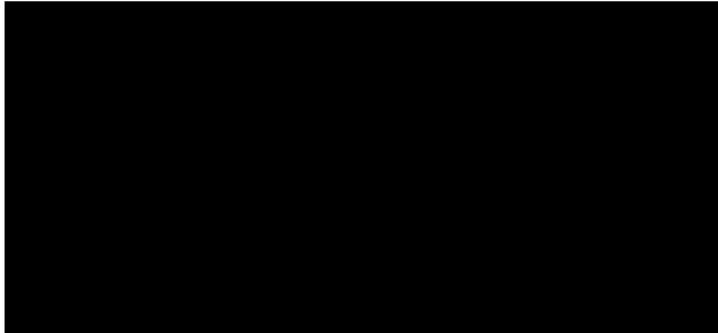
Lake Clifton



Targeted Tuart Woodlands TEC Survey

Lake Clifton

Client: Main Roads Western Australia



08-Sep-2020

Job No.: 60612387

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

© AECOM Australia Pty Ltd (AECOM). All rights reserved.

AECOM has prepared this document for the sole use of the Client and for a specific purpose, each as expressly stated in the document. No other party should rely on this document without the prior written consent of AECOM. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. This document has been prepared based on the Client's description of its requirements and AECOM's experience, having regard to assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified. Subject to the above conditions, this document may be transmitted, reproduced or disseminated only in its entirety.

Quality Information

Document Targeted Tuart Woodlands TEC Survey

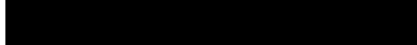
Ref 60612387

Date 08-Sep-2020

Prepared by



Reviewed by



Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
B	21-May-2020	Draft for Internal Review		
C	07-Aug-2020	Draft for Client Review		
D	07-Sep-2020	Draft for Client Review		
0	08-Sep-2020	Final for Issue		

Table of Contents

Executive Summary		i
1.0	Introduction	1
	1.1 Background	1
	1.2 Location	1
	1.3 Objectives	1
2.0	Existing Environment	3
	2.1 Climate	3
	2.2 Landforms	3
	2.3 IBRA Regions	4
	2.4 Vegetation	4
	2.5 Wetlands and Watercourses	4
	2.6 Conservation Areas	5
3.0	Methodology	7
	3.1 Desktop Assessment	7
	3.2 Field Survey	7
	3.3 Mapping	10
4.0	Survey Limitations	11
5.0	Results	12
	5.1 Desktop Assessment	12
	5.2 Tuart Woodlands TEC Classification	15
	5.2.1 Patch 1	15
	5.2.2 Patch 2	18
	5.2.3 Patch 3	20
	5.2.4 Patch 4	22
	5.2.5 Patch 5	24
	5.2.6 Patch 6	26
	5.2.7 Patch 7	28
6.0	Conclusions	32
7.0	References	33
Appendix A	Flora Species by Family and Patch	A
Appendix B	Quadrat and Relevé Data	B
Appendix C	DBCA Tuart TEC Advice	C
Appendix D	Recorded Tuart Tree Canopy Sizes	D
List of Tables		
Table 1	Key Diagnostic Features of Tuart Woodlands TEC	8
Table 2	Condition categories and thresholds for the Tuart Woodland TEC	9
Table 3	Limitations of the Targeted Tuart Woodlands TEC survey	11
Table 4	Potential patches of Tuart Woodlands TEC identified in the desktop assessment	12
Table 5	The densities of Tuart trees (trees/ha) of the patches of Tuart Woodlands TEC within the survey area.	15
Table 6	Detailed assessment and Tuart Woodland TEC Key Diagnostic Features of Patch 1	16
Table 7	Detailed assessment and key diagnostic features of Patch 2.	18
Table 8	Detailed assessment and key diagnostic features of Patch 3.	20
Table 9	Detailed assessment and key diagnostic features of Patch 4.	22
Table 10	Detailed assessment and key diagnostic features of Patch 5.	24
Table 11	Detailed assessment and key diagnostic features of Patch 6.	26
Table 12	Detailed assessment and key diagnostic features of Patch 7.	28
Table 13	The canopy sizes of the Tuart trees recorded during the Tuart Woodlands TEC targeted survey	D-1

List of Figures

Figure 1	Survey Area	2
Figure 2	Bunbury Weather Station (9965) Climate Data (BoM, 2020)	3
Figure 3	Hedde vegetation complexes	6
Figure 4	Desktop results	14
Figure 5	Tuart Woodlands TEC Patches	30
Figure 6	Tuart Woodland TEC vegetation condition	31

Executive Summary

Main Roads Western Australia (Main Roads) commissioned AECOM Australia Pty Ltd (AECOM) to undertake a targeted Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain Threatened Ecological Community (Tuart Woodlands TEC) survey for potential future offsets. The Tuart Woodlands TEC is listed as Critically Endangered under the EPBC Act. The objective of the survey was to identify and map the extent of the TEC within the proposed offset site. The survey included 411^oha of Reserve 53178 adjacent to Lake Clifton to determine the extent of the Tuart Woodlands TEC present and the suitability of the land for future offsets.

A desktop assessment was undertaken incorporating data from previous ecological studies of the survey area (AECOM, 2016) with interrogation of relevant GIS data and aerial imagery to identify potential areas of Tuart Woodlands TEC. The desktop assessment identified five potential areas mapped as the Tuart Woodlands TEC and several other patches containing Tuart trees or likely to contain Tuart trees. The results of the desktop assessment informed the field survey plan.

The field survey was conducted between 29 June to 1 July 2020 by Senior Botanist [REDACTED] assisted by botanists [REDACTED]. Data recorded included patch location, extent, key diagnostic features, condition and floristics of Tuart Woodlands TEC patches.

Seven discreet patches of Tuart Woodlands TEC were defined and mapped, and ranged from 'moderate' to 'very high' condition. In summary:

- Patch 1 – 66.18 ha, high condition
- Patch 2 – 6.08 ha, moderate condition
- Patch 3 – 5.90 ha, moderate condition
- Patch 4 – 1.22 ha very high condition
- Patch 5 – 2.01 ha, moderate condition
- Patch 6 – 1.82 ha, high condition
- Patch 7 – 1.10 ha, high condition.

The patches extend across 84.31^oha of the 411 ha reserve, predominantly in the eastern and central sections with isolated patches in the west also occurring in the coastal dune swales. The Tuart Woodlands TEC patches are suitable to be used as future offsets by Main Roads.

1.0 Introduction

1.1 Background

Main Roads Western Australia (Main Roads) purchased Lots 1000, 2240, 2275, 2657 & 3045 Preston Beach Road, Lake Clifton to offset impacts for various Main Roads projects. These land parcels have been transferred to the Department of Biodiversity, Conservation and Attractions (DBCA) and are now vested as A Class National Park (R53178). Lot 1000 has been completely utilised as an offset. The remaining land within R53178 has been allocated as offset for current projects, with some land banked for future offsets.

Main Roads requested a targeted survey for the Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain Threatened Ecological Community (Tuart Woodlands TEC) within approximately 411 hectares (ha) of Reserve 53178 adjacent to Lake Clifton. The outcome of the survey will inform Main Roads of the potential presence and extent of the Tuart Woodlands TEC and suitability of the land as an offset.

1.2 Location

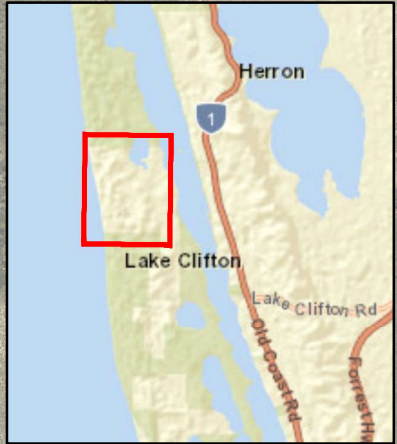
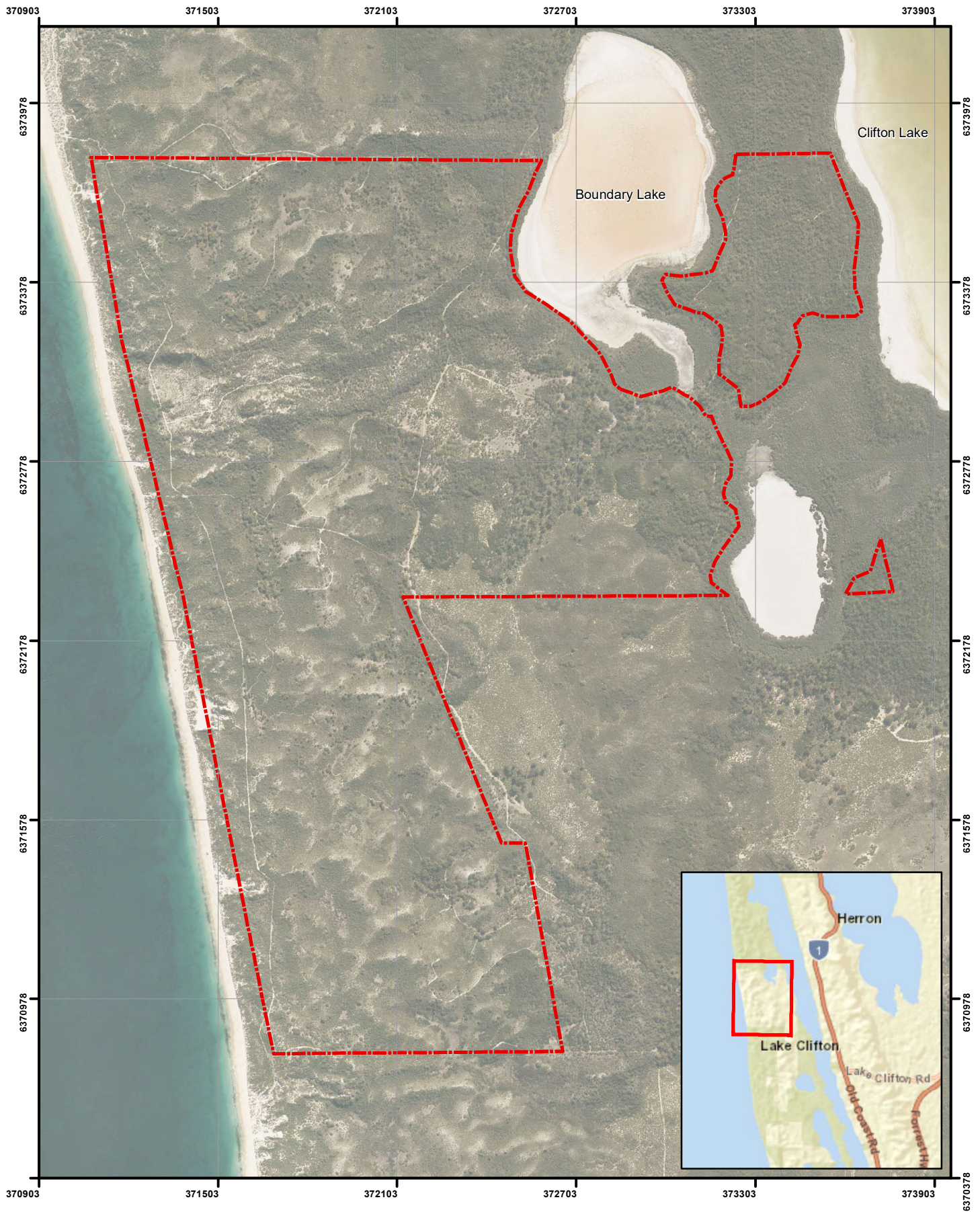
The survey area is located adjacent to Lake Clifton, within the shire of Waroona, approximately 90 (km) kilometres south of Perth. The survey area extends across four lots (Lots 2240, 2275, 2657 and 3045 Preston Beach Road, Lake Clifton) within Reserve 53178 (Figure 1).

1.3 Objectives

The objective of the targeted Tuart Woodlands TEC survey was to define and map the patches of the Tuart Woodlands TEC present within the survey area to determine the suitability of the area as an offset.

The specific objectives of the assessment were to:

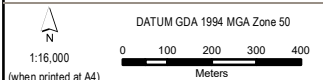
- Undertake a desktop study comprised of a review of reports and spatial data that are relevant for the Lake Clifton site. The results were used to develop a field survey plan.
- Conduct a targeted Tuart Woodlands TEC field survey through the implementation of the field survey plan.
- Assess potential patches of Tuart Woodlands TEC using methods outlined in the Department of Agriculture, Water and the Environment (DAWE) 2019 conservation advice and Main Roads (2020) Tuart Woodlands TEC technical guide factsheet.
- Conduct a vegetation survey equivalent to a combination of reconnaissance and detailed levels of survey described in EPA (2016) flora survey technical guide.



PROJECT ID 60612387
 CREATED BY SR
 APPROVED BY PB
 LAST MODIFIED 07 SEP 2020



LEGEND
 Survey Area



DATUM GDA 1994 MGA Zone 50
Data sources: Service Layer Credits. Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010) Geoscience Australia, Streipro

Survey Area

MAIN ROADS WESTERN AUSTRALIA

TARGETED TUART WOODLAND
 SURVEY
 LAKE CLIFTON

Figure
1

2.0 Existing Environment

2.1 Climate

The survey area is located approximately 90 km south of Perth in the Shire of Waroona, in Western Australia. This region experiences a Mediterranean climate, which is characterised by warm to hot dry summers and mild to cool wet winters.

The Mediterranean climate in Australia is a result of the Indian Ocean High, a high-pressure cell that shifts towards the poles in summer and the equator in winter, playing a major role in the formation of the deserts of Western Australia, and the Mediterranean climate of southwest and south-central Australia. Precipitation occurs during winter months, with the possibility of some summer storms.

The nearest Bureau of Meteorology (BoM) weather station with comprehensive rainfall and temperature data is Bunbury (station 009965) with data from 1951 to 2020. The months immediately preceding the field survey had near average rainfall, with the exception of April and June which both had lower than average rainfall (Figure 2). Rainfall was lower than average across eight out of twelve months between July 2019 and June 2020. It is not anticipated that the lower rainfall would have influenced the survey results.

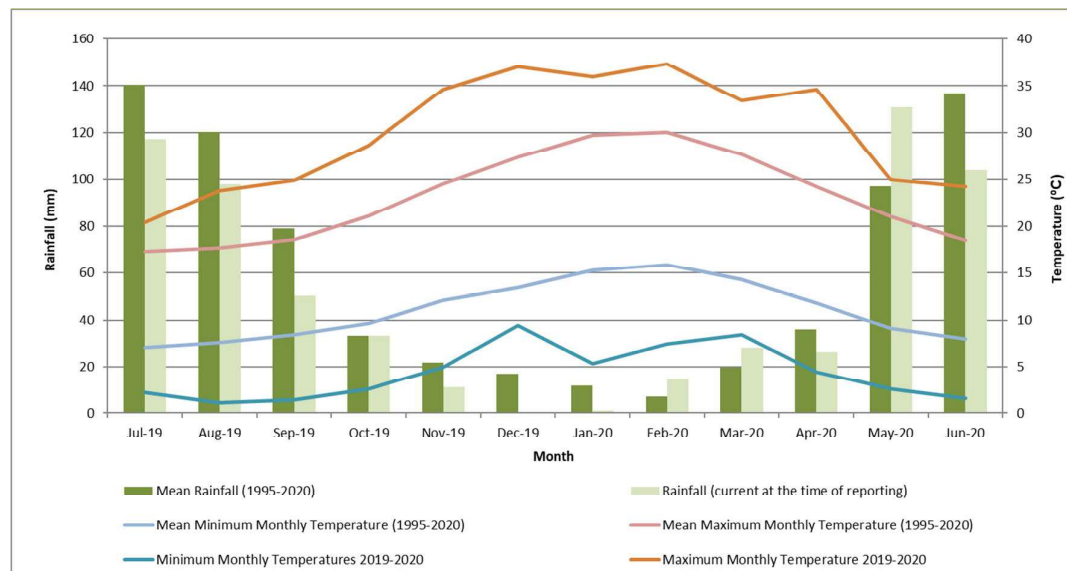


Figure 2 Bunbury Weather Station (9965) Climate Data (BoM, 2020)

2.2 Landforms

The western portion of the survey area is characterised by the Quindalup dune system of low relief dunes with steep slopes and uniform calcareous sands (Wyrwoll, 2003). The topography and soils transition into the Spearwood dune system of dune ridges with shallow to moderately deep siliceous yellow-brown sands with very common limestone outcrops in the central portion of the survey area. The north eastern and south eastern portions of the survey area are characterised by low topography dunes with deep siliceous yellow-brown sands or pale sand with yellow brown subsoils and minor limestone outcrops (Wyrwoll, 2003). The easternmost extent of the survey area and the areas between and surrounding boundary lake and the smaller lake to the south are flat, low lying and characterised by black sandy loams and loams overlying unconsolidated shell beds or clayey marl. The underlying bedrock of the survey area is the Tamala limestone (Wyrwoll, 2003).

2.3 IBRA Regions

The largest regional vegetation classification scheme recognised by the Department of Water and Environmental Regulation (DWER) Environmental Protection Authority Services Unit (EPA Services Unit) is the Interim Biogeographical Region of Australia (IBRA). The IBRA regions provide the planning framework for the systematic development of a comprehensive, adequate and representative (CAR) national reserve system. There are 89 recognised IBRA regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (IBRA 7, 2012).

The survey area is situated on the Swan Coastal Plain 2 (SWA02) subregion, within the Swan Coastal Plain bioregion. This is described by Mitchell *et al.* (2002) as a low lying coastal plain, mainly covered with Woodlands. The region is dominated by species of Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. Land use is a mix of agriculture, urban and rural residential, conservation, roads and infrastructure.

2.4 Vegetation

Beard (1979) mapping is used to determine the current extent of remnant vegetation remaining when compared to pre-European vegetation extent. EPA's objective is to retain at least 30% of all pre-European ecological communities, which is consistent with recognised retention levels (EPA, 2015).

Two pre-European vegetation associations exist within the survey area, including:

- Spearwood woodlands of the southwest (vegetation association 998) occurs over the eastern extent of the survey area and are composed of medium woodlands characterised by Tuarts (*Eucalyptus Gomphocephala*), Jarrah (*Eucalyptus marginata*), Marri (*Corymbia calophylla*) and Wandoo (*Eucalyptus wandoo*). The Spearwood woodlands have 36.25% of its pre-European extent remaining in Western Australia (WA) with 70.26% remaining in the Shire of Waroona (Govt. of WA, 2019).
- The coastal dunes of the western half of the survey area are the Rockingham scrub-heath/thicket vegetation system (vegetation association 1007) which is characterised by mosaic: shrublands; *Acacia lasiocarpa* & *Melaleuca acerosa* heath / Shrublands; *Acacia rostellifera* and *Acacia cyclops* thicket. This vegetation system has 68.05% of its pre-European extent remaining in WA and 86.24% remaining within the Shire of Waroona (Govt. of WA, 2019).

Vegetation complexes in the survey area have been defined by Heddle *et al.* (1980) and are based on vegetation in association with landforms and underlying geology. There are three vegetation complexes within the survey area:

- Quindalup Complex is characterised by coastal dune complexes consisting mainly of two alliances - the strand and fore-dune alliance and the mobile and stable dune alliance, characterised by low closed forest and closed scrub.
- Cottesloe Complex- Central and South is characterised by a mosaic of woodland of *Eucalyptus gomphocephala* (Tuart) and open forest of *Eucalyptus gomphocephala* (Tuart) - *Eucalyptus marginata* (Jarrah) - *Corymbia calophylla* (Marri); closed heath on the Limestone outcrops.
- Yoongarillup Complex is characterised by woodland to tall woodland and open forest. A mixture of *Eucalyptus gomphocephala* woodland with *Agonis flexuosa* understorey or open forest *E. gomphocephala*, *E. marginata* and *Corymbia calophylla*.

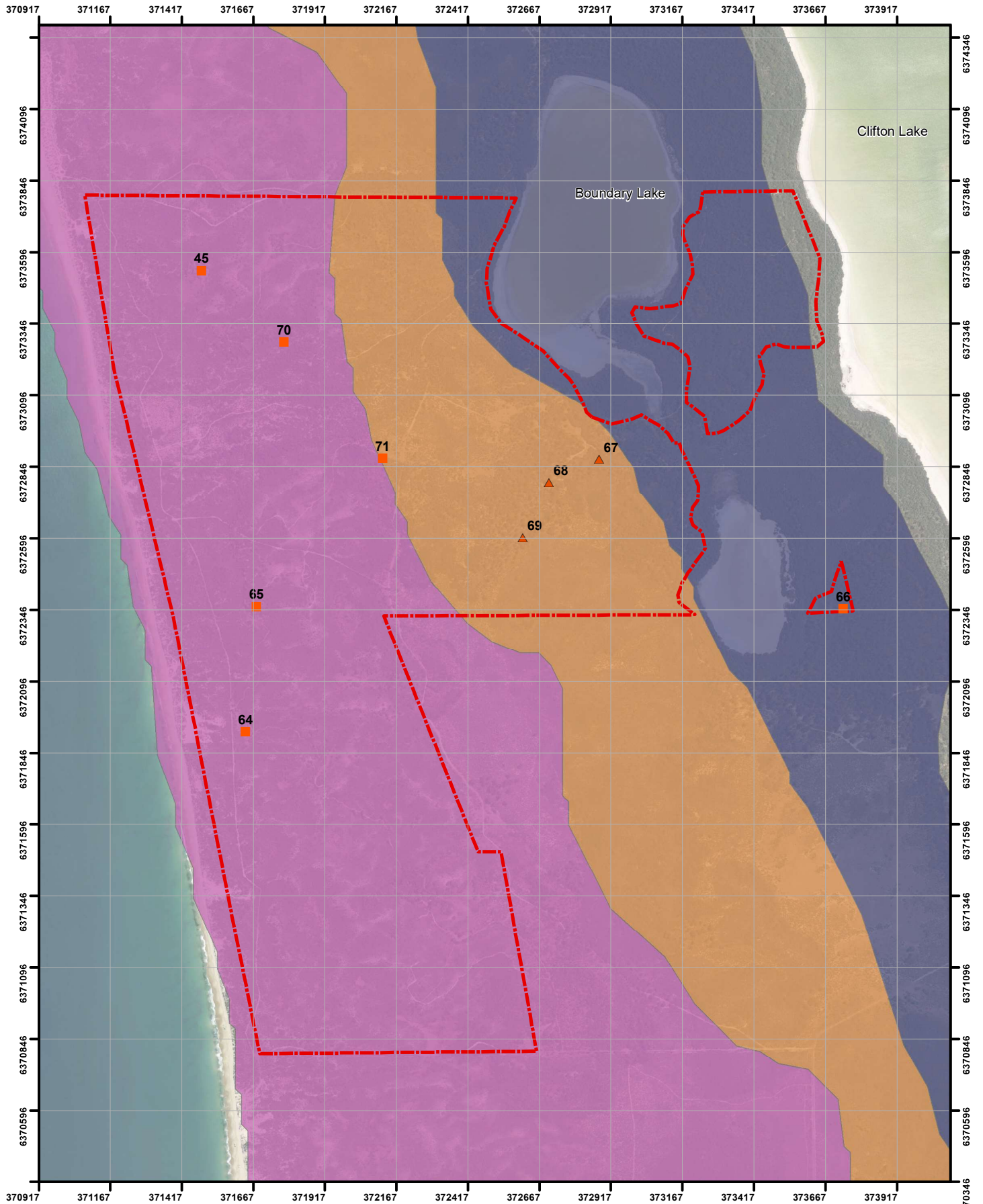
See Figure 3 for the extent of each vegetation complex within the survey area. Note that the vegetation complex public GIS layer does not extend to the north eastern section of the survey area due to this area being classified as a water body.

2.5 Wetlands and Watercourses


The Ramsar listed Yalgorup Lakes System occurs within the eastern extent of the survey area. Boundary Lake and a smaller salt lake to the south intersect the north eastern portion of the survey area. Lake Clifton is also directly adjacent to the survey area in the east (Figure 1). The lake systems were not included in the survey area.

2.6 Conservation Areas

The entire survey area (411^oha) is classified as a nature reserve and an Environmentally Sensitive Area (ESA). The ESA corresponds with the Yalgorup Lakes System.






PROJECT ID 60612387
 CREATED BY SR
 APPROVED BY PB
 LAST MODIFIED 07 SEP 2020


 www.aecom.com




DATUM GDA 1994 MGA Zone 50
 1:16,696
 (when printed at A4)
Data sources: Service Layer Credits.

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority (trading as Landgate (2020) Geoscience Australia, Streipre

LEGEND

-  Relevés
-  Quadrats
-  Survey Area

Vegetation Complexes

-  Cottlesloe Complex-Central and South
-  Quindalup Complex
-  Yoongarillup Complex

Heddle Vegetation Complexes

MAIN ROADS WESTERN AUSTRALIA

TARGETED TUART WOODLAND SURVEY
LAKE CLIFTON

Figure 3

3.0 Methodology

3.1 Desktop Assessment

A desktop review of data collected in previous ecological studies of the survey area (AECOM, 2016) was undertaken in conjunction with interrogation of aerial imagery and the Tuart Woodlands GIS dataset (data.wa.gov dataset: DBCA-048). This was used to identify patches within the survey area likely to represent the Tuart Woodlands TEC as defined in the DAWE (2019) conservation advice. This was achieved through the following steps:

1. The vegetation community types identified in the Lake Clifton ecological report (AECOM, 2016) were examined to identify areas previously classified as Tuart Woodlands communities.
2. The quadrats completed within these Tuart Woodlands communities were compiled.
3. The species lists for other quadrats were then searched to identify other occurrences of Tuart trees within the survey area, to create a second list of quadrats and vegetation communities that may contain Tuart Woodlands.
4. Existing areas of the survey area already classified as Tuart woodland were confirmed through examining the Tuart Woodlands GIS dataset (data.wa.gov dataset: DBCA-048).
5. The canopy size of areas previously classified as Tuart woodland was used in conjunction with previously recorded potential black cockatoo breeding tree locations to identify additional areas that may contain Tuart Woodlands on the aerial imagery of the survey area.

The findings of the desktop assessment were used to develop the field survey plan.

3.2 Field Survey

The field survey included traversing the survey area with vehicle and on foot and visiting all patches of Tuart Woodlands identified from the desktop assessment.

The diagnostic characteristics and conditions required for a patch to be classified as the Tuart Woodlands TEC are summarised in Table 1 and Table 2.

The methods implemented to determine the presence, condition and boundaries of patches of the Tuart Woodlands TEC included:

- The expected location of an edge of each patch was traversed by foot.
- All trees on the edge of the patch were marked with a GPS. Outliers were visited and mapping was undertaken to determine whether they were within 60 metres (m) of the patch.
- Each Tuart tree with a DBH >15 centimetres (cm) encountered around the periphery of a patch was recorded using GPS (accuracy of +/-5 m) and the size of the tree's canopy recorded.
- Meandering transects through the centre of each patch were conducted to confirm the presence of Tuart trees within the patch (particularly for larger patches).
- Confirmed patches of Tuart Woodland had non-permanent 10 x 10 m quadrats conducted in locations representative of the vegetation condition of each patch. Relevés were also conducted in Patch 1 to record changes in the vegetation condition and composition within the patch, and confirm the occurrence of tuart trees throughout the patch in a time efficient manner.

Table 1 Key Diagnostic Features of Tuart Woodlands TEC

Key Diagnostic Features
Occurs on the Swan Coastal Plain bioregion, Western Australia
Primarily occurs on the Spearwood and Quindalup dune systems but can occur on Bassendean dunes and Pinjarra Plain. Can occur on banks of rivers and wetlands.
Presence of at least two living established <i>E. gomphocephala</i> trees in uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent Tuart trees (single-stemmed or mallee growth form).
Occurs as woodland or forest, open forest, woodland, open woodland and various mallee forms.
Other canopy or sub-canopy species may be present including: <i>Agonis flexuosa</i> , <i>Banksia grandis</i> , <i>Banksia attenuata</i> , <i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i> , <i>Banksia menziesii</i> and <i>Banksia prionotes</i> .

Condition thresholds apply for patches between 0.5 and 2 ha, outlined in Table 2. The condition was determined by assessing the floristic diversity of all patches using a combination of relevés, quadrats and observation points. Quadrats and relevés were completed in accordance with the Flora Survey Technical Guide (EPA, 2016).

Where quadrats had been completed in 2016, no additional floristic data was collected.

Data collected from quadrats included the presence of plant species, their cover abundance, structural composition of vegetation, physical environment, and presence/absence of disturbance. Each new monitoring site was given a unique site number, and the following parameters recorded:

- date
- location using hand-held GPS (accuracy of 5 m)
- sample site type (quadrat/relevé)
- photograph (taken from corner of each quadrat)
- soil details (type, colour, moisture)
- landform
- vegetation condition using the EPA (2016) scale adapted from Keighery (1994) and description of disturbance
- fire history
- comprehensive species list
 - estimated height
 - estimated percentage cover (for trees both percentage within quadrat and within community was recorded to enable better description of vegetation community).

Table 2 Condition categories and thresholds for the Tuart Woodland TEC

Patch Size	≥2 ha <5 ha	≥0.5 ha <2 ha
Biotic Thresholds		
<p>Very high condition ≥80 % of all understorey[^] vegetation cover is native# Or At least 12 native understorey[^] species per 0.01 ha (10x10 m)</p>	Medium sized patches with very high condition understorey. Considered TEC	Smaller patches with very high condition understorey. Considered TEC
<p>High condition ≥60 % of all understorey[^] vegetation cover is native# Or At least 8 native understorey[^] species per 0.01 ha (10x10 m)</p>	Medium sized patches with high condition understorey. Considered TEC	Smaller patches with high condition understorey. AND That either: have an important landscape role (≤100 m to native vegetation)* OR have a habitat role (≥2 very large trees per 0.5 ha)* OR show regeneration (≥15 seedlings and/or saplings per 0.5 ha)* Considered TEC
<p>Moderate condition ≥50 % of all understorey[^] vegetation cover is native# Or At least 4 native understorey[^] species per 0.01 ha (10x10 m)</p>	Medium sized patches with moderate condition understorey. AND That either: have an important landscape role (≤100 m to native vegetation)* OR have a habitat role (≥2 very large trees per 0.5 ha)* OR show regeneration (≥15 seedlings and/or saplings per 0.5 ha)* Considered TEC	Not the TEC but may be a focus for local protection or restoration
<p>Poor Has minimal or no native cover and species richness. That is: <50 % of all understorey[^] vegetation cover is native# And Less than 4 native understorey[^] species per 0.01 ha (10x10 m)</p>	Not the TEC but may be a focus for local protection or restoration	Not the TEC but may be a focus for local protection or restoration
<p># 'Native' refers to species naturally occurring in southwest Western Australia. [^] Understorey vegetation cover includes annual and perennial vascular plant species of both the ground layer and the shrub layer up to 3 m in height. * Indicators of important landscape, habitat or regeneration features: Landscape – the patch occurs in close proximity (≤100 m) to another patch of native vegetation of at least 1 ha in size. Other patches of native vegetation can be other patches of the ecological community and/or other vegetation where ≥50 % of the vegetation cover across all layers is comprised of plant species naturally occurring in southwest Western Australia. OR Habitat – the patch contains a mean of ≥2 very large trees (≥50 cm Diameter at Breast Height (DBH)) per half hectare of any species native to southwest Western Australia. OR Regeneration – the patch displays evidence of natural regeneration of eucalypts (Corymbia or Eucalyptus) naturally occurring in southwest Western Australia, represented by seedlings, saplings or other submature stages (<15 cm DBH) with at least a mean of 15 individuals per half hectare.</p>		

3.3 Mapping

The extent of the Tuart Woodlands TEC within the survey area was calculated using the following method:

1. The distance between recorded Tuart tree canopies was calculated using the ArcMap GIS buffering tool. Buffers of differing sizes corresponding to the canopy sizes of the recorded Tuart trees were applied. This allowed the extent of continuous patches of Tuart Woodland TEC to be determined.
2. The 30 m extension past the edge of Tuart canopies surrounding each patch of Tuart Woodlands TEC stipulated in the approved conservation advice was then applied to provide the total extent of the Tuart Woodland TEC within the survey area.
3. The condition assessment as explained in Table 2 was applied.

4.0 Survey Limitations

No significant limitations were identified that may impact on the ability to use the data to inform the environmental impact assessment. Limitations of the ecological surveys are discussed in Table 3.

Table 3 Limitations of the Targeted Tuart Woodlands TEC survey

Limitation	Tuart Woodlands TEC Survey
Availability of contextual information on the region	Nil Sufficient resources for the Swan Coastal Plain were available to provide contextual information including Beard (1979), Heddle <i>et al.</i> (1980) vegetation mapping, and the Keighery <i>et al.</i> (2012) Swan Coastal Plain dataset, the Biological Assessment of Lake Clifton Report and its associated data (AECOM, 2016).
Competency/experience of consultant conducting survey	Nil The targeted Tuart Woodlands Survey were led by Flora de Wit who has more than 14 years' experience conducting surveys of similar scope.
Proportion of flora identified, recorded and/or collected (based on sampling, timing and intensity)	Nil The Tuart Woodlands were represented by five quadrats and four relevés. Site data can be found in Appendix B and site locations are shown in Figure 5 The frequency of a minimum of one quadrat/relevé survey per patch of Tuart TEC woodlands was suitable for characterising the vegetation present within the Tuart Woodlands TEC patches encountered.
Completion (is further work needed)	Nil The objectives of the Targeted Tuart Woodlands TEC Survey Flora and Vegetation Survey were met in that the identification, extent and condition of patches of Tuart Woodlands TEC within the survey were able to be recorded and mapped to inform future environmental offset planning.
Remoteness and/or access problems	Nil The entire survey area was able to be accessed.
Timing, weather, season, cycle	Minor Rainfall was below average across most months between July 2019 and June 2020. Although, the lower than average rainfall was not substantial enough to significantly inhibit the growth of flora. The survey being conducted during the winter months limited the amount of flora species that were able to be detected due to germination and flowering periods of many species primarily occurring during late winter (August) and spring. However, for the purpose of this assessment, it is not considered a significant limitation.
Disturbances (e.g. fire flood, accidental human intervention) which affected results of the survey	Nil The botanical survey was not disrupted or impacted.

5.0 Results

5.1 Desktop Assessment

The DBCA Tuart Woodlands mapping layer shows the Tuart TEC is likely to occur in the northeast corner of the survey area (see Figure 4). Previous survey results were interrogated as part of the desktop assessment. The following key locations were identified by the desktop assessment for further investigation:

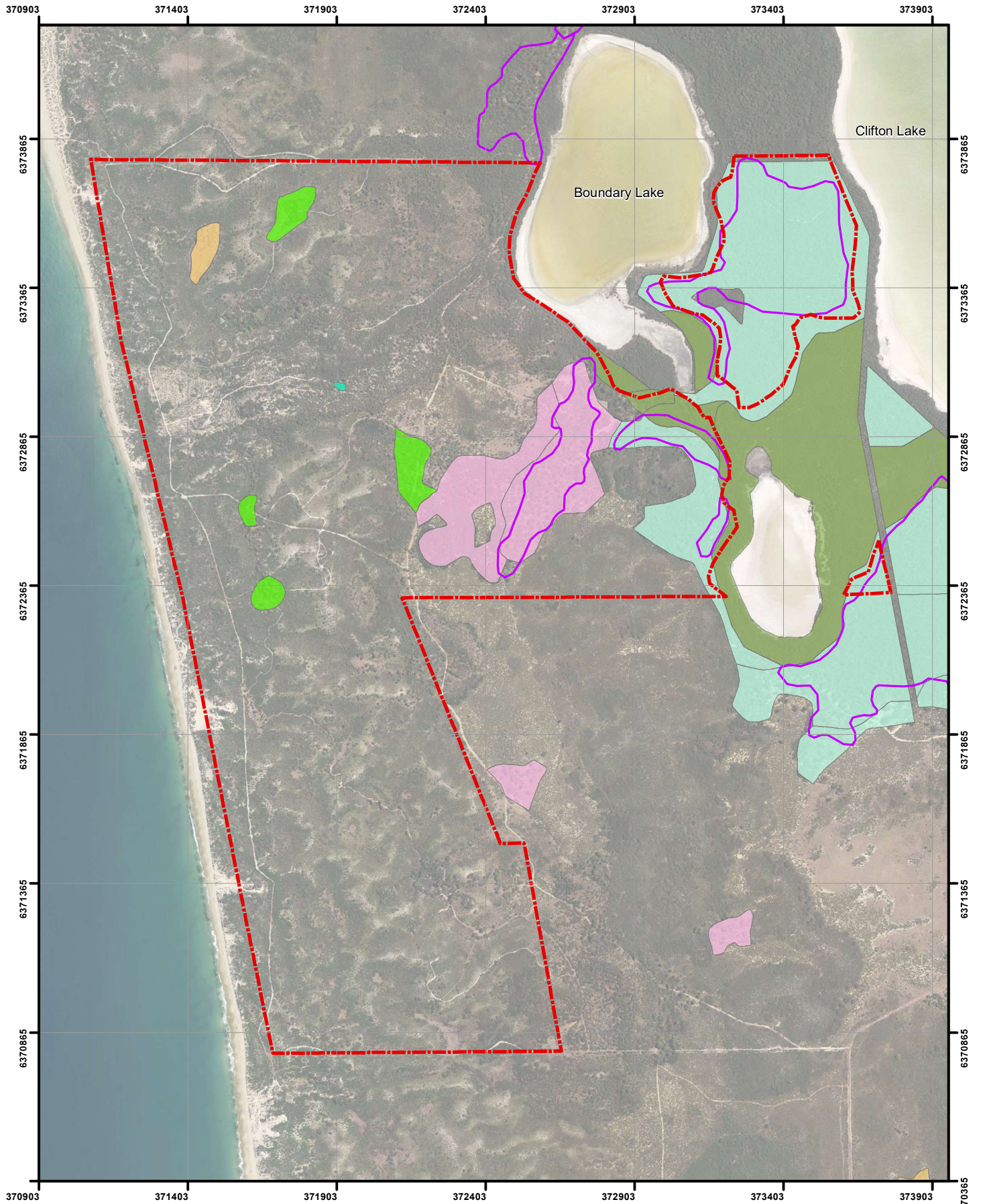
- The north eastern portion of the study area, which is directly east of Boundary Lake (Figure 4), has been classified as Tuart Woodlands TEC within the Tuart Woodlands GIS dataset (data.gov.wa dataset: DBCA-048).
- Six quadrats were identified as being within areas previously mapped as Tuart Woodlands in AECOM's (2016) biological assessment of Lake Clifton.
- Two quadrats were identified that had Tuarts previously recorded within them.
- Additional potential patches of Tuart woodlands were identified through interrogation of the aerial imagery and previously recorded black cockatoo tree data within AECOM's (2016) survey data.

The quadrat, related community type and approximate location within the survey area of each potential patch of Tuart Woodlands TEC are summarised in Table 4.

Table 4 Potential patches of Tuart Woodlands TEC identified in the desktop assessment

Quadrat	Community	Description (AECOM 2016)
2016 Quadrats within Tuart Woodland Communities		
8	AfXpHh	<i>Agonis flexuosa</i> and <i>Eucalyptus marginata</i> mid woodland with emergent <i>Eucalyptus gomphocephala</i> over <i>Xanthorrhoea preissii</i> , <i>Hakea lissocarpha</i> and <i>Hardenbergia comptoniana</i> low to tall open shrubland over * <i>Hypochaeris glabra</i> and * <i>Lysimachia arvensis</i> low sparse forbland.
9		
10		
11		
15	EgXpTd	<i>Eucalyptus gomphocephala</i> , <i>Agonis flexuosa</i> and <i>Banksia attenuata</i> tall open forest over <i>Xanthorrhoea preissii</i> , <i>Macrozamia riedlei</i> and <i>Hibbertia cuneiformis</i> mid to tall shrubland over * <i>Trachyandra divaricata</i> , * <i>Solanum nigrum</i> and * <i>Geranium molle</i> low isolated forbs.
45	EgMsTd	<i>Eucalyptus gomphocephala</i> mid woodland over <i>Melaleuca systema</i> , <i>Hibbertia cuneiformis</i> and <i>Xanthorrhoea preissii</i> mid to tall shrubland over * <i>Trachyandra divaricata</i> , * <i>Geranium molle</i> and * <i>Trifolium campestre</i> low forbland.
2016 Quadrats containing Tuart		
38	AfDdLg	<i>Agonis flexuosa</i> mid woodland with emergent <i>Eucalyptus gomphocephala</i> over <i>Diplolaena dampieri</i> , <i>Alyxia buxifolia</i> and <i>Hibbertia cuneiformis</i> mid to tall open shrubland over <i>Lepidosperma gladiatum</i> , * <i>Trachyandra divaricata</i> and * <i>Geranium molle</i> tall closed sedgeland.
40	MrGtTd	<i>Melaleuca raphiophylla</i> and <i>Melaleuca cuticularis</i> low closed forest over <i>Gahnia trifida</i> , <i>Juncus kraussii</i> subsp. <i>australiensis</i> and <i>Lepyrodia drummondiana</i> mid to tall sedgeland over * <i>Trachyandra divaricata</i> , * <i>Geranium molle</i> and * <i>Lysimachia arvensis</i> low isolated forbs. This community captures three distinct zones of riparian vegetation associated with the wetland in the Survey Area. The third zone furthest from the water contains tuart within <i>Eucalyptus petrensis</i> , <i>Agonis flexuosa</i> and <i>Eucalyptus gomphocephala</i> (Tuart) mid closed forest over <i>Xanthorrhoea preissii</i> , <i>Templetonia retusa</i> and <i>Melaleuca systema</i> mid open shrubland over <i>Lepyrodia drummondiana</i> and <i>Gahnia trifida</i> tall sedgeland.

Quadrat	Community	Description (AECOM 2016)
Potential Tuart Woodland Patches		
Coastal swale Tuart tree groves	ArMsTd and Planted	<p>Patches of trees evident from aerial imagery, generally in dune swales of ArMsTd, mapped as Planted.</p> <p><i>Acacia rostellifera</i>, <i>Spyridium globulosum</i> and <i>Clematis linearifolia</i> tall shrubland over <i>Melaleuca systema</i>, <i>Phyllanthus calycinus</i> and <i>Acanthocarpus preissii</i> mid heathland to open heathland over low sparse to closed forbland of <i>*Trachyandra divaricata</i>, <i>*Solanum nigrum</i> and <i>*Geranium molle</i>.</p> <p>Emergent <i>Agonis flexuosa</i> and <i>Eucalyptus platypus</i> in places as well as areas of planted Eucalypts.</p>



PROJECT ID 60612387
 CREATED BY SR
 APPROVED BY PB
 LAST MODIFIED 07 SEP 2020

AECOM
 www.aecom.com

DATUM GDA 1994 MGA Zone 50

1:16,000
 (when printed at A4)

0 100 200 300 400
 Meters

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority (trading as Landgate) (2010); Geoscience Australia; Streetpro

LEGEND

- Survey Area
- DBCA Tuart TEC Extent
- Tuart Woodlands Community**
 - AfXpHh
 - EgMsTd
 - EgXpTd
- Occasional Tuart Community**
 - AfDdLg
 - MrgTtd
- Tuart in Swales Community**
 - Planted (ArMsTd)

Desktop Study Results

MAIN ROADS WESTERN AUSTRALIA

TARGETED TUART WOODLAND SURVEY
 LAKE CLIFTON

Figure
4

5.2 Tuart Woodlands TEC Classification

A total of seven patches of Tuart Woodlands were assessed, six with quadrats (Patches 2-7) and one with relevés (Patch 1). All seven patches were found to represent the Tuart Woodlands TEC. Two additional patches were also investigated but did not meet the suitable condition criteria to be classified as the Tuart Woodlands TEC due to their small size, isolation and poor condition and were therefore not surveyed.

The Tuart trees recorded within the Tuart Woodland TEC patches varied in height between 10 and 30 m and provided canopy cover of 30-70% across every patch except for Patch 1. Therefore, the Patches of Tuart Woodland TEC identified are predominantly medium open forest, excepting Patch 1 which is mid woodland due to large areas of dispersed Tuart trees amongst shrubland within the patch. The Tuart trees encountered were all mature with a DBH of >40 cm. Juvenile Tuarts were not encountered due to a lack of Tuart germination and regeneration resulting from the prolonged absence (>10 years) of fire in the survey area. The canopy size of the surveyed Tuart trees varied from 1 to 22.5 m with a mean canopy size of 7.5 m (Appendix D).

The density of tuart trees across the Tuart Woodlands TEC patches were accurately captured for the smaller patches (Patches 3-7). The density of Tuart trees in Patches 1 and 2 was not determined due to the large extents (>5°ha) automatically qualifying these patches as Tuart Woodland, causing density considerations to be obsolete for TEC classification. It was also impractical and time inefficient to record every tree across the large extents of Patches 1 and 2. The average density of the patches of coastal planted Tuart Woodlands TEC (Patches 3, 5, 6, 7) was 11 Tuart per ha which was significantly lower than the 60 Tuarts per ha present within the naturally occurring Tuart Woodlands located at Patch 4. The Tuart tree densities within the Tuart Woodland TEC patches are summarised in Table 5.

Table 5 The densities of Tuart trees (trees/ha) of the patches of Tuart Woodlands TEC within the survey area.

Patch	Number of recorded Tuart Trees	Area (ha)	Density (Tuarts per ha)
Patch 1	413*	66.18	Not captured
Patch 2	57*	6.08	Not captured
Patch 3	101	5.90	17.13
Patch 4	73	1.22	59.94
Patch 5	22	2.01	10.95
Patch 6	19	1.82	10.44
Patch 7	6	1.10	5.44

* Only represents Tuart trees on the periphery of the patch.

Sections 5.2.1 to 5.2.7 provide the details, diagnostic features and condition of each identified patch of Tuart Woodlands TEC.

5.2.1 Patch 1

The vegetation in the central northern and north eastern sections of the survey area were classified as a contiguous patch of Tuart Woodlands TEC extending across 66.18°ha within the survey area. The total identified extent of Patch 1 including areas outside of the survey area (particularly the area between the north eastern and central portions of the survey area) is 81.18°ha. Vegetation condition varied from degraded in historically cleared areas for grazing to very good in areas of the patch not impacted by edge effects. The patch exceeds the 5 ha minimum size threshold and meets the key diagnostic characteristics and patch definition. As such it **does** represent the Tuart Woodland TEC. A detailed assessment is presented in Table 6.

Table 6 Detailed assessment and Tuart Woodland TEC Key Diagnostic Features of Patch 1

Location and extent	<p>The patch is located in the north-eastern corner of the survey area adjacent to Lake Clifton and Boundary Lake extending to the northern central section of the survey area (Figure 5).</p> <p>Patch 1 extends 66.18 ha within the survey area and was identified as extending 84.18^oha including areas outside of the survey area (not mapped in the figures).</p> <p>The cumulative extent of the patches of Tuart Woodlands TEC within the survey area is 84.31 ha with Patch 1 contributing 78.49% of the total extent.</p>
Variety	<p>The patch includes firebreaks/tracks and cleared areas formerly used for cattle grazing. The vegetation communities present in the patch vary from <i>Agonis flexuosa</i> dominated low to mid open to closed forest in the north east to tall open tuart forest over <i>Xanthorrhoea preissii</i>, <i>Macrozamia riedlei</i> and <i>Hibbertia cuneiformis</i> in the northern central section of the survey area.</p> <p>Plate 1 and Plate 2 illustrate the variety in the patch.</p>
Condition	<p>The condition of the patch varies across its extent from 'degraded to very good' (AECOM, 2016). The most degraded areas are found adjacent to tracks in areas previously cleared for cattle grazing. These are characterised by little to no native understorey and widespread <i>Trachyandra divaricata</i> which forms a near continuous 'grassland'. The extant native vegetation exhibits prominent edge effects with vegetation condition improving with distance from the edge of the patch. Vegetation in the edge of the patch was generally in poor-good condition with condition improving to very good in the centre of the patch.</p> <p>The patch has not experienced fire for at least 10 years.</p>
Buffer and adjacent land use	<p>The buffer of native vegetation is limited to ~50% of total "edge" of this patch. Much of the buffer area extends beyond the survey area in the eastern central and north eastern sections of the patch.</p> <p>The adjacent land uses to the patch are the Yalgorup National Park and Boundary Lake in the north, Lake Clifton to the east and the surrounding native vegetation conservation offset reserve elsewhere.</p>
Land use history	<p>Previous land use was cattle grazing.</p>
Evidence of recruitment	<p>No evidence of recruitment.</p>
Presence of unique fauna/flora	<p>No Threatened or Priority flora were recorded. See Appendix A for all species recorded within the survey area, sorted by family and patch.</p>
Species richness	<p>Relevés 67, 68 and 69 were assessed in Patch 1. Species richness was 21 native and 11 weed species (total) with an average of 10 native and seven weeds per sample location. Weeds covered an average of 24% of the quadrat. The relatively low weed cover and high native species richness are indicative of high condition Tuart Woodlands TEC (Figure 5). Species data recorded within the patch is presented in Appendix A, with quadrat/relevé data included in Appendix B.</p> <p>The presence of native understorey species varied across the patch with disturbed and edge areas exhibiting higher weed abundance and lower species richness. Interior areas of the patch exhibited higher species richness associated with intact native understorey.</p>

Connectedness	Represents a large area of well-connected Tuart woodlands and surrounding wetlands.
TEC Assessment Result	The patch is larger than 5 ha and is therefore automatically considered part of the TEC. Condition thresholds are therefore not applicable.
Key Diagnostic Features	Y/N and Comments
Occurs on the Swan Coastal Plain Bioregion, Western Australia.	Y
Primarily occurs on the Spearwood and Quindalup dune systems, but can occur on Bassendean dunes and Pinjarra Plain. Can occur on banks of rivers and wetlands.	Y Patch 1 is located on the Spearwood dune system
Presence of at least two living established <i>E. gomphocephala</i> trees in uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent Tuart trees (single-stemmed or mallee growth form).	Y The patch in the survey area incorporates 100+ Tuart trees across 66.18 ha.
Occurs as woodland or forest, open forest, woodland, open woodland and various mallee forms.	Y Mapped as mid woodland
Other canopy or sub-canopy species may be present including: <i>Agonis flexuosa</i> , <i>Banksia grandis</i> , <i>Banksia attenuata</i> , <i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i> , <i>Banksia menziesii</i> and <i>Banksia prionotes</i> .	Y <i>Agonis flexuosa</i> , <i>Banksia</i> trees and <i>Eucalyptus marginata</i> were present.



Plate 1 The mid to low Tuart and *Agonis flexuosa* forest present in the north east of the survey area.



Plate 2 The tall open Tuart forest with *Xanthorrhoea preissii* and *Macrozamia riedlei* dominated understory located in the central northern portion of the survey area.

5.2.2 Patch 2

Patch 2 is a heterogenous patch of Tuart Woodlands which occurs in the north west of the survey area. The south western extent of the patch is a planted wetland infested with weed species, surrounded by planted Tuarts with a coastal heath regrowth understorey. The north eastern portion of the survey area is comprised of sparsely distributed Tuarts over coastal shrublands and heathlands in very good to excellent condition.

The condition of the patch was largely degraded; however, the patch exceeds the 5 ha minimum size threshold and meets the key diagnostic characteristics. As such, Patch 2 **does** represent the Tuart Woodlands TEC.

Advice from DBCA was sought to determine whether this planted Tuart woodland represents the Tuart Woodland TEC. This advice is presented in Appendix C. The advice states that based on the location and landform, this patch may be a representation of the TEC. Further advice regarding this matter is currently being sought from the Department of Agriculture, Water and Environment (DAWE), as it is a Commonwealth listed TEC.

A detailed assessment is presented in Table 7, with identified flora species by family and patch included in Appendix A.

Table 7 Detailed assessment and key diagnostic features of Patch 2.

Location and extent	Patch 2 extends 6.08 ha in the north-west of the survey area in a dune swale. Patch 2 constitutes 7.10% of the Tuart Woodlands TEC within the survey area.
Variety	The patch is composed of large naturally occurring Tuarts and smaller planted Tuarts over coastal native heath and a constructed wetland. Plate 3 and Plate 4 illustrate the vegetation that occurs within the patch.
Condition	The condition of the patch was variable. The north east portion of the patch is characterised by sparsely distributed naturally occurring Tuarts over native heath in very good to excellent condition. The eastern section is in a degraded condition resulting from historical disturbance and is characterised by planted Tuarts over native heathlands and a constructed wetland containing aquatic weeds. The patch has not experienced fire for at least 10 years.
Buffer and adjacent land use	The buffer of native vegetation is uninterrupted around Patch 2. The adjacent land use is the Yalgorup National Park.
Land use history	Previous land use was cattle grazing.
Evidence of recruitment	No evidence of recruitment.
Presence of unique fauna/flora	No Threatened or Priority flora were recorded. See Appendix A for all species recorded within the survey area, sorted by family and patch.
Species richness	Quadrat 70 was assessed in Patch 2. Species richness was 12 native and 5 weed species. Weeds covered 43% of the quadrat area. The relatively high weed cover and high native species richness are indicative of moderate condition Tuart Woodlands TEC (Figure 5). It should be noted that species richness was significantly poorer in the disturbed area of the patch compared to the undisturbed area in the north eastern of the patch. Species data recorded within the patch is presented in Appendix A with quadrat/relevé data included in Appendix B.
Connectedness	This patch is surrounded by intact native vegetation on dune systems that connect to other patches of Tuart Woodland TEC.

TEC Assessment Result	The patch is larger than 5 ha and is therefore automatically considered part of the TEC. Condition thresholds are therefore not applicable.
Key Diagnostic Features	Y/N and Comments
Occurs on the Swan Coastal Plain Bioregion, Western Australia	Y
Primarily occurs on the Spearwood and Quindalup dune systems, but can occur on Bassendean dunes and Pinjarra Plain. Can occur on banks of rivers and wetlands.	Y Patch 2 is located on the Quindalup dune system
Presence of at least two living established <i>E. gomphocephala</i> trees in uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent Tuart trees (single-stemmed or mallee growth form).	Y The patch in the survey area incorporates 40+ Tuart trees across 6.08 ha.
Occurs as woodland or forest, open forest, woodland, open woodland and various mallee forms.	Y Mapped as medium open forest and open woodland over heathland to open heathland.
Other canopy or sub-canopy species may be present including: <i>Agonis flexuosa</i> , <i>Banksia grandis</i> , <i>Banksia attenuata</i> , <i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i> , <i>Banksia menziesii</i> and <i>Banksia prionotes</i> .	No sub-canopy species present.



Plate 3 Quadrat location at Patch 2 on dune slope above the constructed wetland drainage channel



Plate 4 The very good to excellent condition tall shrublands with scattered Tuarts located in the north eastern section of Patch 2

5.2.3 Patch 3

Patch 3 is located in the west of the survey area in a dune swale and dune slope. The area is primarily planted Tuarts over previously cleared areas dominated by *Trachyandra divaricata*. Tuarts also extend up a dune slope and overlay native coastal shrubland. A small constructed pond was also present within the patch. The patch exceeds the 5 ha minimum size threshold and meets the key diagnostic characteristics, as such Patch 3 **does** represent the Tuart Woodlands TEC. A detailed assessment is presented in Table 8 below.

Advice from DBCA was sought to determine whether this planted Tuart woodland represents the Tuart Woodland TEC. This advice is presented in Appendix C. The advice states that based on the location and landform, this patch may be a representation of the TEC. Further advice regarding this matter is currently being sought from DAWE, as it is a Commonwealth listed TEC.

Table 8 Detailed assessment and key diagnostic features of Patch 3.

Location and extent	<p>Patch 3 is 5.90 ha across the western section of the survey area in a coastal dune swale.</p> <p>Patch 3 constitutes 6.89% of the total extent of the Tuart Woodlands TEC within the survey area.</p>
Variety	<p>The patch is composed of planted Tuarts over predominantly cleared land dominated by <i>*Trachyandra divaricata</i>. It extends onto adjacent dune slopes comprising native vegetation in excellent condition. It includes a small constructed wetland vegetated by weed species. Vehicle tracks are present.</p> <p>Plate 6 illustrates the variety in the patch.</p>
Condition	<p>The condition of the patch is 'degraded to good' (AECOM, 2016). The most degraded areas are adjacent to the tracks in areas previously cleared for cattle grazing which are characterised by little to no native understorey and widespread <i>*Trachyandra divaricata</i> which forms a near continuous 'grassland'. The native shrublands found on adjacent dune slopes are in excellent condition (AECOM, 2016).</p> <p>The patch has not experienced fire for at least 10 years.</p>
Buffer and adjacent land use	<p>The buffer of native vegetation is uninterrupted around Patch 3, except for small sections where vehicle tracks occur.</p>
Land use history	<p>Previous land use was cattle grazing.</p>
Evidence of recruitment	<p>No evidence of recruitment resulting from a lack of recent fires required for Tuart germination to occur.</p>
Presence of unique fauna/flora	<p>No Threatened or Priority flora were recorded. See Appendix A for all species recorded within the survey area, sorted by family and patch.</p>
Species richness	<p>Quadrat 65 was assessed in Patch 3. Species richness was 8 native and 3 weed species. Weeds covered 74% of the quadrat area. The relatively high weed cover and high native species richness are indicative of moderate condition Tuart Woodlands TEC (Figure 5)</p> <p>Species data recorded within the patch is presented in Appendix A with quadrat/relevé data included in Appendix B</p> <p>The presence of native understorey species varied across the patch with disturbed and edge areas exhibiting higher weed abundance and lower species richness. The shrublands containing scattered planted Tuarts located on the dune slopes surrounding the swale exhibited higher species richness associated with intact native understorey.</p>

Connectedness	This patch is surrounded by intact native vegetation on dune systems that connect to other patches of Tuart Woodland TEC.
TEC Assessment Result	The patch is larger than 5 hectares and is therefore automatically considered part of the TEC. Condition thresholds are not applicable.
Key Diagnostic Features	Y/N and Comments
Occurs on the Swan Coastal Plain Bioregion, Western Australia	Y
Primarily occurs on the Spearwood and Quindalup dune systems, but can occur on Bassendean dunes and Pinjarra Plain. Can occur on banks of rivers and wetlands.	Y Patch 3 is located on the Quindalup dune system
Presence of at least two living established <i>E. gomphocephala</i> trees in uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent Tuart trees (single-stemmed or mallee growth form).	Y The patch in the survey area incorporates 50+ Tuart trees across 5.90 ha.
Occurs as woodland or forest, open forest, woodland, open woodland and various mallee forms.	Y Patch 3 occurs as mid open forest and coastal scrubland with isolated Tuart trees.
Other canopy or sub-canopy species may be present including: <i>Agonis flexuosa</i> , <i>Banksia grandis</i> , <i>Banksia attenuata</i> , <i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i> , <i>Banksia menziesii</i> and <i>Banksia prionotes</i> .	No canopy or sub-canopy species present.



Plate 5 Quadrant location at Patch 3 in a dune swale. Note Tuarts over a 'grassland' of *Trachyandra divaricata*.



Plate 6 Planted reticulated Tuart located along vehicle track to the north of Patch 3 quadrat location.

5.2.4 Patch 4

Patch 4 occurs in the south eastern of the survey area between an unnamed salt lake and Lake Clifton as low to mid open to closed forest dominated by *Agonis flexuosa* and *Eucalyptus gomphocephala* over *Xanthorrhoea preissii* and *Templetonia retusa* (AECOM, 2016). Only a small portion of Patch 4 falls within the survey area (1.22 ha). The patch in its entirety exceeds the 5 ha minimum size threshold and meets the key diagnostic characteristics. Patch 4 therefore **does** represent the Tuart Woodlands TEC.

A detailed assessment is presented in Table 9 below.

Table 9 Detailed assessment and key diagnostic features of Patch 4.

Location and extent	Patch 4 occurs in the south eastern portion of the survey area between an unnamed lake and Lake Clifton. The extent of Patch 4 within the survey area is 1.22 ha, which is 1.42% of the total extent of the Tuart Woodlands TEC within the survey area. This patch extends outside of the survey area over an area and was noted to be greater than 5 ha.
Variety	The patch is composed of low to mid open to closed forest of <i>Agonis flexuosa</i> , <i>Eucalyptus gomphocephala</i> and occasional <i>Banksia grandis</i> over <i>Xanthorrhoea preissii</i> , <i>Templetonia retusa</i> (AECOM, 2016). Plate 7 illustrates the variety in the patch.
Condition	The condition of the patch is 'very good' reflecting the flora diversity and weed invasion (AECOM, 2016). Understorey is low under a dense canopy of <i>Agonis flexuosa</i> and Tuarts. The patch has not experienced fire for at least 10 years.
Buffer and adjacent land use	The buffer of native vegetation is uninterrupted around Patch 4.
Land use history	Previous land use was cattle grazing.
Evidence of recruitment	No evidence of recruitment.
Presence of unique fauna/flora	One Priority flora species was recorded, <i>Styphelia filifolia</i> (P3). See Appendix A for all species recorded within the survey area, sorted by family and patch.
Species richness	Quadrat 66 was assessed in Patch 4. Species richness was 20 native and four weed species. Weeds covered 1% of the quadrat with native species covering the remaining 99%. The extremely low weed cover and high native species richness are indicative of very high condition Tuart Woodlands TEC (Figure 6) Species data recorded within the patch is presented in Appendix A with quadrat/relevé data included in Appendix B
Connectedness	This patch is surrounded by intact native vegetation on dune systems that connect to other patches of Tuart Woodland TEC.
TEC Assessment Result	The larger patch of Tuart Woodlands TEC that Patch 4 exists within, is larger than 5 hectares and is therefore automatically considered part of the TEC. Condition thresholds are therefore not applicable.

Key Diagnostic Features	Y/N and Comments
Occurs on the Swan Coastal Plain Bioregion, Western Australia	Y
Primarily occurs on the Spearwood and Quindalup dune systems, but can occur on Bassendean dunes and Pinjarra Plain. Can occur on banks of rivers and wetlands.	Y Patch 4 occurs on the Spearwood dune system.
Presence of at least two living established <i>E. gomphocephala</i> trees in uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent Tuart trees (single-stemmed or mallee growth form).	Y The patch in the survey area incorporates 100+ Tuart trees across 1.22 ha.
Occurs as woodland or forest, open forest, woodland, open woodland and various mallee forms.	Y Patch 4 occurs as medium open forest
Other canopy or sub-canopy species may be present including: <i>Agonis flexuosa</i> , <i>Banksia grandis</i> , <i>Banksia attenuata</i> , <i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i> , <i>Banksia menziesii</i> and <i>Banksia prionotes</i> .	Y <i>Agonis flexuosa</i> present.



Plate 7 Sample location 66 (quadrat) of Patch 4 showing low to mid open to closed forest of *Agonis flexuosa*, *Eucalyptus gomphocephala* and occasional *Banksia grandis* over *Xanthorrhoea preissii*, *Templetonia retusa*.

5.2.5 Patch 5

Patch 5 is located in the southwest of the survey area in a dune swale. The area is primarily planted mallee form Tuarts over coastal heath. The patch is 2.01 ha, meets the key diagnostic characteristics and is in moderate condition, as such Patch 5 does represent the Tuart Woodlands TEC. A detailed assessment is presented in Table 10 and Appendix A

Advice from DBCA was sought to determine whether this planted Tuart woodland represents the Tuart Woodland TEC. This advice is presented in Appendix C. The advice states that based on the location and landform, this patch may be a representation of the TEC. Further advice regarding this matter is currently being sought from DAWE, as it is a Commonwealth listed TEC.

Table 10 Detailed assessment and key diagnostic features of Patch 5.

Location and extent	Patch 5 occurs in the south west of the survey area in a dune swale and extends for 2.01 ha which is 2.4% of the cumulative extent of the patches of Tuart Woodlands TEC within the survey area.
Variety	The patch is composed of planted Tuart trees over <i>Trachyandra divaricata</i> with patches of native coastal shrubland remnant vegetation. The area may have been historically cleared or grazed resulting in a low species richness. Plate 8 illustrates the variety in the patch.
Condition	The condition of Patch 5 is 'degraded to good' reflecting the historic disturbance and degradation of large areas of the patch associated with cattle grazing (AECOM, 2016). The patch has not experienced fire for at least 10 years.
Buffer and adjacent land use	The buffer of native vegetation is uninterrupted around Patch 5 except for vehicle tracks.
Land use history	Previous land use was cattle grazing.
Evidence of recruitment	No evidence of recruitment.
Presence of unique fauna/flora	No Threatened or Priority flora were recorded. See Appendix A for all species recorded within the survey area, sorted by family and patch.
Species richness	16 species, including two weed species were recorded in quadrat 64 within Patch 5. Weeds covered 41% of the quadrat area. Native species richness was variable across the patch with most areas having significantly lower species richness and higher weed cover than the quadrat. Overall, the patch can be considered moderate condition Tuart Woodlands TEC. Species data recorded within the patch is presented in Appendix A, with quadrat/relevé data included in Appendix B.
Connectedness	This patch is surrounded by intact native vegetation on dune systems that connect to other patches of Tuart Woodland TEC.
TEC Assessment Result	Patch 5 is between two to five hectares and is classified as moderate condition due to its size, the high weed coverage across the patch and average presence of more than 4 native understorey species across the patch. Therefore, Patch 5 is classified as Tuart Woodlands TEC.

Key Diagnostic Features	Y/N and Comments
Occurs on the Swan Coastal Plain Bioregion, Western Australia	Y
Primarily occurs on the Spearwood and Quindalup dune systems, but can occur on Bassendean dunes and Pinjarra Plain. Can occur on banks of rivers and wetlands.	Y Located on Quindalup dune system
Presence of at least two living established <i>E. gomphocephala</i> trees in uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent Tuart trees (single-stemmed or mallee growth form).	Y The patch in the survey area incorporates 20+ Tuart trees across 2.01 ha.
Occurs as woodland or forest, open forest, woodland, open woodland and various mallee forms.	Y Patch 5 occurs as mallee woodlands over coastal heaths.
Other canopy or sub-canopy species may be present including: <i>Agonis flexuosa</i> , <i>Banksia grandis</i> , <i>Banksia attenuata</i> , <i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i> , <i>Banksia menziesii</i> and <i>Banksia prionotes</i> .	N No canopy or sub-canopy species present.



Plate 8 The mallee Tuart woodlands over coastal heath and **Trachyandra divaricata* found at Patch 5.

5.2.6 Patch 6

Patch 6 is a planted Tuart Woodlands overlying coastal heath, extending 1.82 ha across the northwest corner of the survey area in a dune swale. Twenty-two plant species, including four weed species, were recorded in sample location 45 (quadrat), which was completed within Patch 6. The 1.82 ha extent, presence of more than 12 native understorey species in sample location 45 and the presence of an average of at least 8 native understorey species across the patch (high vegetation condition) classifies Patch 6 as Tuart Woodlands TEC. A detailed assessment of the patch is presented in Table 11 and Appendix A

Advice from DBCA was sought to determine whether this planted Tuart woodland represents the Tuart Woodland TEC. This advice is presented in Appendix C. The advice states that based on the location and landform, this patch may be a representation of the TEC. Further advice regarding this matter is currently being sought from DAWE, as it is a Commonwealth listed TEC.

Table 11 Detailed assessment and key diagnostic features of Patch 6.

Location and extent	Patch 6 occurs across of the north western corner of the survey area in a dune swale and extends 1.82 ha which is 2.16% of the cumulative extent of the patches of Tuart Woodlands TEC within the survey area.
Variety	Patch 6 is <i>Eucalyptus gomphocephala</i> mid woodland over <i>Melaleuca systena</i> , <i>Hibbertia cuneiformis</i> and <i>Xanthorrhoea preissii</i> mid to tall shrubland over <i>*Trachyandra divaricata</i> , <i>*Geranium molle</i> and <i>*Trifolium campestre</i> low forbland. Plate 9 illustrates the variety in the patch.
Condition	The condition of Patch 6 is 'degraded to good' reflecting the historic disturbance and degradation of large areas of the patch associated with cattle grazing. The patch has not experienced fire for at least 10 years.
Buffer and adjacent land use	The buffer of native vegetation is uninterrupted around Patch 6.
Land use history	Previous land use was cattle grazing.
Evidence of recruitment	No evidence of recruitment resulting from a lack of recent fires required for Tuart germination to occur.
Presence of unique fauna/flora	No Threatened or Priority flora were recorded. See Appendix A for all species recorded within the survey area, sorted by family and patch.
Species richness	22 species, including four weed species, were recorded in sample location 45 (quadrat) completed within Patch 6. Weeds covered 20% of the quadrat. Species richness was highly variable across the patch with some areas heavily degraded and dominated by weed species. The Tuart trees of Patch 6 are less than 100 m from native vegetation and provide an important landscape role. Patch 6 is high condition Tuart Woodlands TEC due to the landscape role of the Tuart trees present, as well as the average species richness and weed coverage across the patch. Species data recorded within the patch is presented in Appendix A, with quadrat/relevé data included in Appendix B.
Connectedness	This patch is surrounded by intact native vegetation on dune systems that connect to other patches of Tuart Woodland TEC.

TEC Assessment Result	Patch 6 is classified as high condition Tuart Woodland TEC due to the combination of extending less than two hectares, containing Tuart trees which provide an important landscape function, and exhibiting an average presence of at least 8 native understorey species across the patch.	
Key Diagnostic Features	Y/N and Comments	
Occurs on the Swan Coastal Plain Bioregion, Western Australia	Y	
Primarily occurs on the Spearwood and Quindalup dune systems, but can occur on Bassendean dunes and Pinjarra Plain. Can occur on banks of rivers and wetlands.	Y Located on Quindalup dune system.	
Presence of at least two living established <i>E. gomphocephala</i> trees in uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent Tuart trees (single-stemmed or mallee growth form).	Y The patch in the survey area incorporates 20+ Tuart trees across 1.82 ha.	
Occurs as woodland or forest, open forest, woodland, open woodland and various mallee forms.	Y Patch 6 occurs as Tuart mid woodlands over coastal shrubs and heaths.	
Other canopy or sub-canopy species may be present including: <i>Agonis flexuosa</i> , <i>Banksia grandis</i> , <i>Banksia attenuata</i> , <i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i> , <i>Banksia menziesii</i> and <i>Banksia prionotes</i> .	No canopy or sub-canopy species present.	



Plate 9 Patch 6 – Tuart mid woodland.

5.2.7 Patch 7

Patch 7 extends 1.10 ha in the central western area of the survey area adjacent to a vehicle track. The patch is characterised by planted *Eucalyptus gomphocephala* and *Eucalyptus decipiens* mid woodland over *Hibbertia cuneiformis* and **Trachyandra divaricata* shrublands (AECOM, 2016). A total of 20 plant species, including seven weed species, were recorded in sample location 71 (quadrat) which was completed within Patch 7. The 1.10 ha extent in conjunction with high condition due to the presence of more than 8 native understorey species across the patch, a low 18% coverage of weeds and the important landscape role of the Tuart trees present, classifies Patch 7 as Tuart Woodlands TEC. A detailed assessment of the patch is presented in Table 12 and Appendix A.

Advice from DBCA was sought to determine whether this planted Tuart woodland represents the Tuart Woodland TEC. This advice is presented in Appendix C. The advice states that based on the location and landform, this patch may be a representation of the TEC. Further advice regarding this matter is currently being sought from DAWE, as it is a Commonwealth listed TEC.

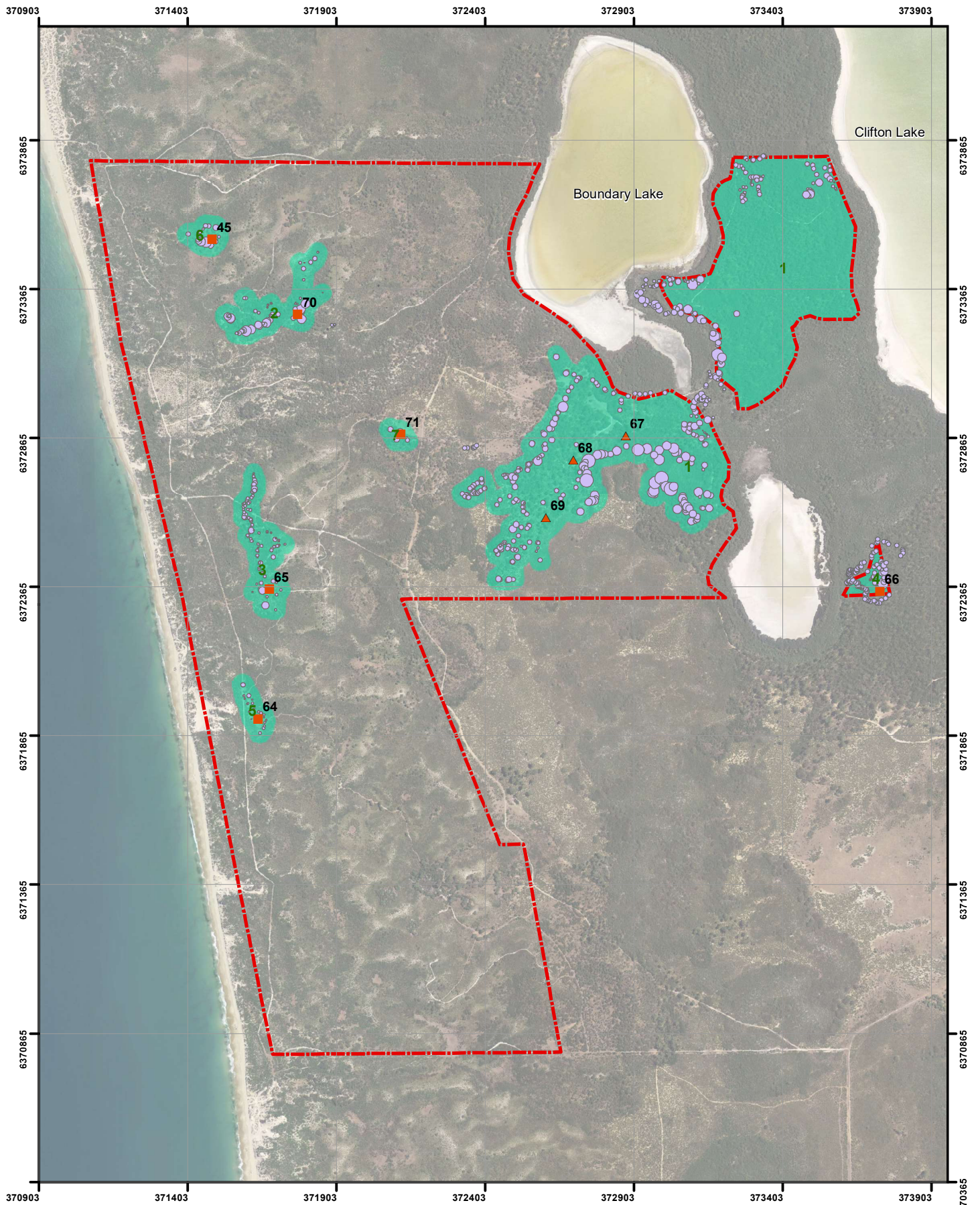
Table 12 Detailed assessment and key diagnostic features of Patch 7.

Location and extent	Patch 7 is 1.10 ha and occurs in the western central portion of the survey area. It includes planted trees along a track. Patch 7 accounts for 1.30% of the cumulative extent of the patches of Tuart Woodlands TEC within the survey area.
Variety	Patch 7 is characterised by <i>Eucalyptus gomphocephala</i> and <i>Eucalyptus decipiens</i> mid woodland over <i>Hibbertia cuneiformis</i> and * <i>Trachyandra divaricata</i> shrublands (AECOM, 2016). Plate 10 illustrates the variety in the patch.
Condition	The condition of Patch 6 is 'degraded to very good' reflecting the historic disturbance and degradation of the edge areas of the patch associated with cattle grazing and invasive weeds (AECOM, 2016). The patch has not experienced fire for at least 10 years.
Buffer and adjacent land use	The buffer of native vegetation around Patch 7 is interrupted in the north by an east to west orientated track.
Land use history	Previous land use was cattle grazing.
Evidence of recruitment	No evidence of recruitment.
Presence of unique fauna/flora	No Threatened or Priority flora were recorded. See Appendix A for all species recorded within the survey area, sorted by family and patch.
Species richness	Quadrat 71 was assessed in Patch 7. Species richness was 13 native and seven weed species. Weeds covered 18% of the quadrat area. Areas of the patch outside of the quadrat area have lower native understorey species richness and high weed abundance. Consequently, the average native understorey species richness occur across Patch 7 was greater than eight. The Tuart trees of Patch 6 are less than 100 m from native vegetation and provide an important landscape role. Patch 7 is high condition Tuart Woodlands TEC due to the landscape role of the Tuart trees present, as well as the high average species richness and low weed coverage across the patch (Figure 6). Species data recorded within the patch is presented in Appendix A, with quadrat/relevé data included in Appendix B.


Connectedness	Patch 7 is surrounded by intact native vegetation on dune systems that connect to other patches of Tuart Woodland TEC.
TEC Assessment Result	Patch 7 is less than two hectares and is classified as high condition due to the presence of an average of more than 8 native understorey species across the patch, low weed abundance (18%) and the important landscape role provided by the Tuart trees present. Therefore, Patch 7 is classified as Tuart Woodlands TEC.
Key Diagnostic Features	Y/N and Comments
Occurs on the Swan Coastal Plain Bioregion, Western Australia	Y
Primarily occurs on the Spearwood and Quindalup dune systems, but can occur on Bassendean dunes and Pinjarra Plain. Can occur on banks of rivers and wetlands.	Y Located on the boundary of the Quindalup Dune system and the Spearwood dune system
Presence of at least two living established <i>E. gomphocephala</i> trees in uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent Tuart trees (single-stemmed or mallee growth form).	Y The patch in the survey area incorporates 6 Tuart trees across 1.10 ha.
Occurs as woodland or forest, open forest, woodland, open woodland and various mallee forms.	Y Patch 7 occurs as Tuart mid woodland
Other canopy or sub-canopy species may be present including: <i>Agonis flexuosa</i> , <i>Banksia grandis</i> , <i>Banksia attenuata</i> , <i>Eucalyptus marginata</i> , <i>Corymbia calophylla</i> , <i>Banksia menziesii</i> and <i>Banksia prionotes</i> .	Y No canopy or sub-canopy species present.



Plate 10 Patch 7 *E. gomphocephala* and *E. decipiens* mid woodland.








PROJECT ID 60612387
 CREATED BY SR
 APPROVED BY PB
 LAST MODIFIED 07 SEP 2020


 www.aecom.com

DATUM GDA 1994 MGA Zone 50
 1:16,000
 (when printed at A4)
 0 100 200 300 400 Meters

LEGEND

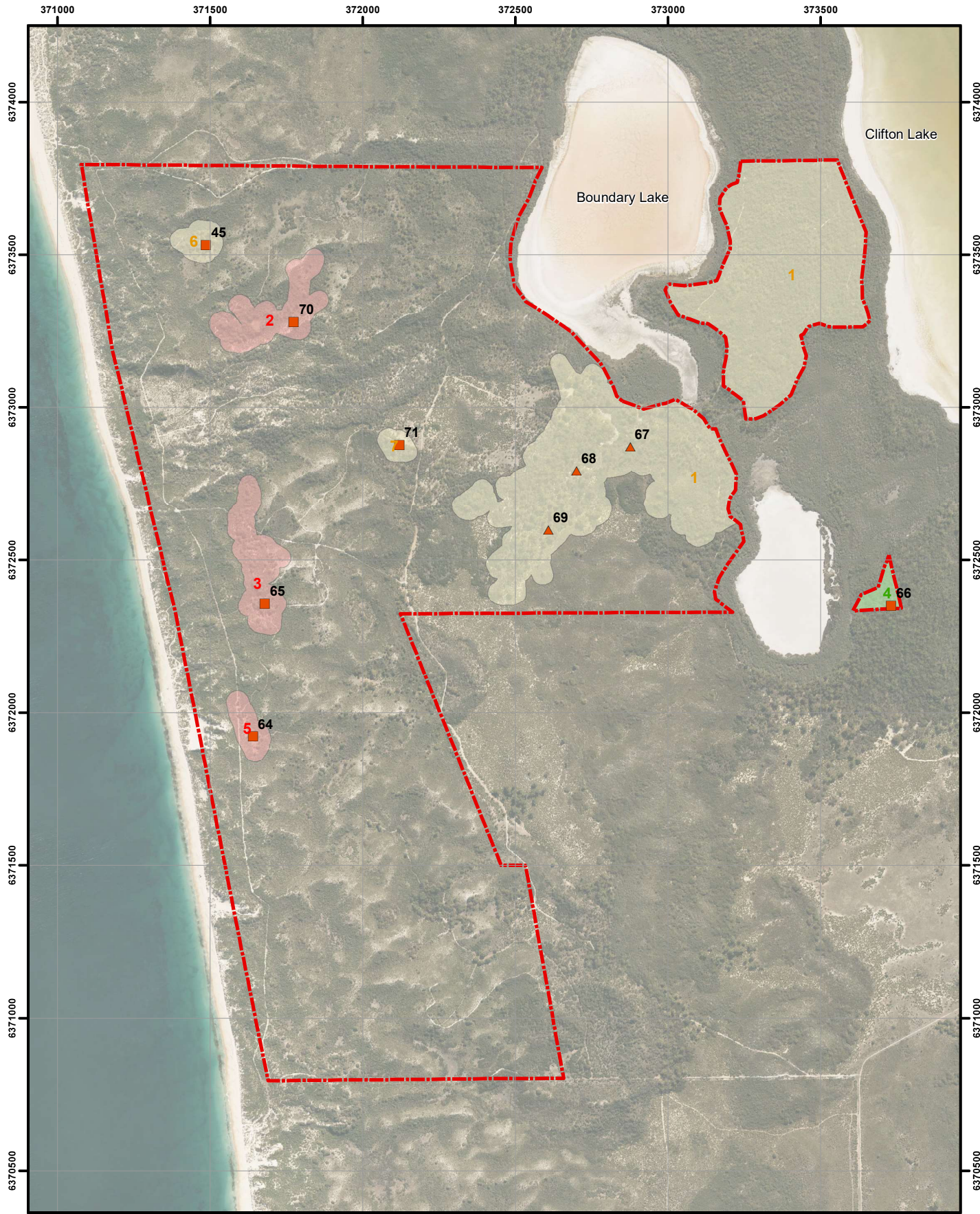
-  Survey Area
-  Quadrats
-  Relevés
-  Tuart Tree Canopy
-  Tuart Woodlands TEC of the Swan Coastal Plain (EPBC TEC Critically Endangered) - Patch name labelled ()

Tuart Woodlands TEC Vegetation Patches

MAIN ROADS WESTERN AUSTRALIA

TARGETED TUART WOODLAND SURVEY
LAKE CLIFTON

Figure 5



PROJECT ID 60612387
 CREATED BY SR
 APPROVED BY PB
 LAST MODIFIED 07 SEP 2020

AECOM
 www.aecom.com

DATUM GDA 1994 MGA Zone 50
 1:16,000
 (when printed at A4)

Scale bar: 0 100 200 300 400 Metres

Data sources: Service Layer Credits:
 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority (trading as Landgate) (2010), Geoscience Australia, Streipiro

LEGEND

- Quadrats
- ▲ Relevés
- - - Survey Area

Tuart Woodlands TEC Vegetation Condition - Patch name labelled ()

- Moderate
- High
- Very High

Vegetation Condition

MAIN ROADS WESTERN AUSTRALIA

TARGETED TUART WOODLAND SURVEY
 LAKE CLIFTON

Figure 6

6.0 Conclusions

A targeted Tuart Woodlands TEC survey was completed for Main Roads at Lake Clifton Lots 2240, 2275, 2657 & 3045. The field survey was conducted by qualified personnel to confirm the presence, location, and extent of Tuart Woodlands TEC.

Seven patches of Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain TEC (EPBC Act Critically Endangered) were recorded within the survey area. These patches were characterised by:

- The identified patches are mid open forest, excluding Patch 1 which is mid open woodland
- The recorded Tuart tree canopy sizes varied from 1 to 22 m with the average canopy measuring 7.5 m.
- The densities of Tuart trees across the patches were variable with the planted patches exhibiting much lower density (11 Tuarts per hectare) than the naturally occurring Patch 4 which had a Tuart density of 60 Tuarts per hectare.
- The identified patches were in moderate to very high condition and met the diagnostic features of Tuart Woodlands TEC.
- Total Tuart Woodlands TEC extent within the survey area is 84.31 ha with patch sizes varying from 1.10 ha to 66.18 ha.
- Flora species richness averaged 14 native and four weed species across the quadrat and relevé sample locations conducted during the field survey.
- Tuarts in the patches located on the western coastal Quindalup dune system are mostly planted (Figure 5).
- No patches have experienced burning for at least 10 years.
- The Tuart Woodlands TEC patches are surrounded by intact native vegetation on dune systems that connect to other patches of Tuart Woodland TEC.

Although five of the seven patches identified consist of planted tuarts, the diagnostic features of these patches meet the condition criteria to be classified as representing the Tuart Woodland TEC. Further advice regarding this matter is currently being sought from DAWE.

The weed *Trachyandra divaricata* was often a dominant understorey species, displacing native understorey herbs. Native species richness varied across the patches from eight to 21 native species with 30% to 99% total foliage cover. Weed foliage cover varied from 1% to 74%.

No limitations that may impact on the ability to assess environmental values of the survey area were identified.

7.0 References

- AECOM, 2016. Biological Assessment of Lake Clifton Report. prepared for Main Roads WA.
- Beard JS, 1979. Vegetation of the Perth area Western Australia; map and explanatory memoir, 1: 250 000 series. Vegmap Publications.
- BOM, 2020. Climate Statistics for Australian Locations. <http://www.bom.gov.au/climate>
- Department of Agriculture, Water and Environment (DAWE) 2019b. Approved Conservation Advice (incorporating listing advice) for the Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain ecological community. Canberra: Department of Agriculture, Water and Environment
- EPA, 2016a. Technical Guidance – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment. EPA, Western Australia.
- Government of Western Australia, 2019. 2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report). Current as of June 2018. DPaW, Kensington, Western Australia
- Hedde EM, Loneragan OW, Havell JJ, 1980. Vegetation of the Darling System in Atlas of Natural Resources, Darling System, Western Australia. Department of Environment and Conservation: Perth, Western Australia.
- IBRA7, 2012. Interim Biogeographic Regionalisation for Australia, Version 7. Available at <http://www.environment.gov.au/system/files/pages/5b3d2d31-2355-4b60-820c-e370572b2520/files/bioregions-new.pdf>.
- Keighery BJ, 1994. Bushland Plant Survey - A Guide to Plant Community Survey for the Community Wildflower Society of WA (inc) Nedlands WA.
- Mitchell D, Williams K, Desmond A, 2002. Swan Coastal Plain 2 (SWA2 – Swan Coastal Plain subregion). In: A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002.
- Wyrwoll, KH, 2003). The geomorphology of the Perth region, Western Australia. Australian Geomechanics, 38(30), 17-32.

Appendix A

Flora Species by Family
and Patch

Appendix A Flora Species by Family and Communities Matrix

Appendix A - Flora Species by Family and Patch

Family	Taxon	Patch 1	Patch 2	Patch 3	Patch 4	Patch 5	Patch 6	Patch 7
Apiaceae	<i>Apium prostratum</i>			X		X		
	<i>Daucus glochidiatus</i>	X		X	X	X		X
Apocynaceae	* <i>Gomphocarpus fruticosus</i>	X						
Araliaceae	<i>Trachymene pilosa</i>						X	
Asparagaceae	<i>Acanthocarpus preissii</i>		X				X	X
	<i>Lomandra caespitosa</i>				X			
	<i>Lomandra nigricans</i>				X			
	<i>Thysanotus manglesianus</i>				X		X	
Asphodelaceae	<i>Asphodelus fistulosus</i>							X
	* <i>Trachyandra divaricata</i>	X	X	X		X	X	X
Asteraceae	* <i>Arctotheca calendula</i>							X
	<i>Asteridea pulverulenta</i>	X						
	* <i>Hypochaeris glabra</i>	X			X			
	<i>Lagenophora huegelii</i>				X			
	<i>Senecio diaschides</i>		X			X	X	
Chenopodiaceae	<i>Rhagodia baccata</i>		X	X		X	X	
	<i>Rhagodia baccata subsp. baccata</i>						X	
Cupressaceae	<i>Callitris sp. (planted)</i>		X					
Cyperaceae	<i>Schoenus sp.</i>	X						X
Dilleniaceae	<i>Hibbertia cuneiformis</i>	X		X		X	X	X
	<i>Hibbertia hypericoides</i>	X						
Ericaceae	<i>Leucopogon parviflorus</i>		X				X	X
	<i>Styphelia filifolia (P3)</i>					X		
	<i>Styphelia propinqua</i>	X			X	X		
Euphorbiaceae	* <i>Euphorbia pepus</i>	X	X	X	X	X		
Fabaceae	<i>Acacia rostellifera</i>	X	X			X	X	X
	<i>Hardenbergia comptoniana</i>				X			
	<i>Templetonia retusa</i>	X			X			
	* <i>Trifolium campestre</i>						X	
	<i>Trifolium sp.</i>							X
Geraniaceae	* <i>Geranium molle</i>	X					X	X
Iridaceae	* <i>Romulea rosea</i>	X	X					X
Lauraceae	<i>Cassytha racemosa</i>						X	
Myrtaceae	<i>Agonis flexuosa</i>	X			X			
	<i>Eucalyptus decipiens</i>							X
	<i>Eucalyptus gomphocephala</i>	X	X	X	X	X	X	X
	<i>Eucalyptus platypus</i>					X	X	
	<i>Eucalyptus sp. white trunk</i>							X
	<i>Melaleuca systema</i>	X	X		X	X	X	
Orchidaceae	<i>Caladenia flava</i>				X			
	<i>Eriochilus sp.</i>				X			
	<i>Orchid sp.</i>						X	
Oxalidaceae	* <i>Oxalis pes-caprae</i>	X						

Appendix A - Flora Species by Family and Patch

Family	Taxon	Patch 1	Patch 2	Patch 3	Patch 4	Patch 5	Patch 6	Patch 7
Papaveraceae	<i>* Fumaria capreolata</i>	X						
Phyllanthaceae	<i>Phyllanthus calycinus</i>	X				X	X	
Poaceae	<i>* Avena barbata</i>	X		X				
	<i>* Briza maxima</i>				X			X
	<i>Poa drummondiana</i>				X	X		
Proteaceae	<i>Banksia attenuata</i>	X						
Primulaceae	<i>Lysimachia arvensis</i>	X			X			X
Ranunculaceae	<i>Clematis linearifolia</i>		X	X			X	X
	<i>Clematis pubescens</i>	X			X			
Rhamnaceae	<i>Spyridium globulosum</i>		X	X			X	
Restionaceae	<i>Desmocladus flexuosus</i>				X	X		
Rutaceae	<i>Rhadinothamnus anceps</i>		X		X			
Solanaceae	<i>Solanum nigrum</i>		X					
Urticaceae	<i>Parietaria debilis</i>	X		X	X	X		
Xanthorrhoeaceae	<i>Chamaescilla corymbosa</i>	X			X			
	<i>Xanthorrhoea preissii</i>	X			X			X
Zamiaceae	<i>Macrozamia fraseri</i>	X						
	<i>Macrozamia riedlei</i>	X			X			
Zygophyllaceae	<i>Zygophyllum</i> sp.		X					

Appendix B

Quadrat and Relevé
Data

Appendix B Quadrat and Relevé Data

Quadrat Data

Site No: 64	Associated Patch No.: 5	Type: Quadrat	Longitude: 115.62933	Latitude: -32.783147
Date: 29/06/2020			Soil Types: Sand	
Topography: Dune swale			Soil Colour: Pale cream brown	
Surface: 3% twigs, 10% leaves			Soil Condition: Moist	
Community (2016): ArMsTd			Fire History: 10+	
Vegetation Condition: Good				



Weed	Taxon	Height (cm)	% Alive
	<i>Eucalyptus gomphocephala</i>	1200	5
	<i>Eucalyptus platypus</i>	300	2
	<i>Acacia rostellifera</i>	100	6
	<i>Hibbertia cuneiformis</i>	40	0.5
	<i>Melaleuca systema</i>	40	0.1
*	<i>Trachyandra divaricata</i>	30	40

Weed	Taxon	Height (cm)	% Alive
	<i>Phyllanthus calycinus</i>	20	0.5
	<i>Styphelia propinqua</i>	20	0.1
	<i>Desmocladius flexuosus</i>	10	0.01
	<i>Rhagodia baccata</i>	10	0.01
	<i>Senecio diaschides</i>	10	0.01
	<i>Apium prostratum</i>	5	0.1
	<i>Poa drummondiana</i>	5	0.01
*	<i>Euphorbia peplus</i>	3	1
	<i>Daucus glochidiatus</i>	0.1	0.1
	<i>Parietaria debilis</i>		

Site No: 65	Associated Patch No.: 3	Type: Quadrat	Longitude: 115.62980	Latitude: -32.779218
Date: 29/06/2020			Soil Types: Sand	
Topography: Dune swale			Soil Colour: Dark brown	
Surface: 5% twigs, 15% leaves			Soil Condition: Moist	
Community (2016): PI			Fire History: 10+	
Vegetation Condition: Good				



Weed	Taxon	Height (cm)	% Alive
	<i>Eucalyptus gomphocephala</i>	2200	40
	<i>Spyridium globulosum</i>	200	10
	<i>Hibbertia cuneiformis</i>	40	0.1
*	<i>Avena barbata</i>	30	0.5
*	<i>Trachyandra divaricata</i>	30	70
	<i>Rhagodia baccata</i>	10	0.1
	<i>Apium prostratum</i>	5	0.1
*	<i>Euphorbia peplus</i>	4	3
	<i>Daucus glochidiatus</i>	2	0.5

Weed	Taxon	Height (cm)	% Alive
	<i>Clematis linearifolia</i>		0.1
	<i>Parietaria debilis</i>		

Site No: 66	Associated Patch No.: 4	Type: Quadrat	Longitude: 115.65170	Latitude: -32.779517
Date: 30/06/2020		Soil Types: Sand		
Topography: Lower slope		Soil Colour: Brown		
Surface: 2% twigs, 80% leaves		Soil Condition: Moist		
Community (2016): AfXpHh		Fire History: 10+		
Vegetation Condition: Very Good				



Weed	Taxon	Height (cm)	% Alive
	<i>Eucalyptus gomphocephala</i>	2000	6
	<i>Agonis flexuosa</i>	1000	30
	<i>Xanthorrhoea preissii</i>	200	6
	<i>Templetonia retusa</i>	130	5
	<i>Melaleuca systema</i>	120	2
	<i>Macrozamia riedlei</i>	60	0.5
	<i>Styphelia propinqua</i>	40	0.1
	<i>Styphelia</i>	20	0.5
	<i>Desmocladius flexuosus</i>	10	0.1

Weed	Taxon	Height (cm)	% Alive
	<i>Lomandra caespitosa</i>	10	0.1
	<i>Lomandra nigricans</i>	10	0.1
*	<i>Briza maxima</i>	5	0.2
	<i>Chamaescilla corymbosa</i>	5	0.1
	<i>Caladenia flava</i>	3	0.1
*	<i>Euphorbia peplus</i>	3	0.5
	<i>Poa drummondiana</i>	3	0.01
	<i>Daucus glochidiatus</i>	2	0.1
*	<i>Hypochaeris glabra</i>	2	0.1
*	<i>Lysimachia arvensis</i>	2	0.5
	<i>Lagenophora huegelii</i>	1	0.1
	<i>Eriochilus</i> sp.	1	0.1
	<i>Clematis pubescens</i>		1
	<i>Hardenbergia comptoniana</i>		0.2
	<i>Parietaria debilis</i>		
	<i>Rhadinothamnus anceps</i>		
	<i>Thysanotus manglesianus</i>		

Site No: 67	Associated Patch No.: 1	Type: Revele	Longitude: 115.6426	Latitude: -32.774719
Date: 30/06/2020		Soil Types: Loamy sand		
Topography: Lower slope		Soil Colour: Dark brown		
Surface: 5% twigs, 30% leaves		Soil Condition: Moist		
Community (2016): AfXpHh		Fire History: 10+		
Vegetation Condition: Good to Very Good				



Weed	Taxon	Height (cm)	% Alive
	<i>Eucalyptus gomphocephala</i>	2200	15
	<i>Agonis flexuosa</i>	800	60
*	<i>Gomphocarpus fruticosus</i>	150	2
*	<i>Fumaria capreolata</i>	60	1
	<i>Macrozamia riedlei</i>	50	1
*	<i>Trachyandra divaricata</i>	30	35
	<i>Acacia rostellifera</i>	20	0.1
*	<i>Avena barbata</i>	10	1
*	<i>Romulea rosea</i>	10	0.1

Weed	Taxon	Height (cm)	% Alive
*	<i>Euphorbia peplus</i>	5	2
	<i>Hibbertia cuneiformis</i>	5	0.1
*	<i>Geranium molle</i>	4	5
*	<i>Lysimachia arvensis</i>	3	1
	<i>Daucus glochidiatus</i>	2	5
*	<i>Oxalis pes-caprae</i>	2	5
	<i>Clematis pubescens</i>		0.2

Site No: 68	Associated Patch No.: 1	Type: Revele	Longitude: 115.6407729	Latitude: -32.77542345
Date: 30/06/2020		Soil Types: Loamy sand		
Topography: Mid slope		Soil Colour: brown		
Surface: 5% twigs, 30% leaves		Soil Condition: Moist		
Community (2016): EgXpTd		Fire History: 10+		
Vegetation Condition: Good				



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus gomphocephala</i>		3000	15
<i>Agonis flexuosa</i>		500	4
<i>Acacia rostellifera</i>		200	10
<i>Xanthorrhoea preissii</i>		180	10
<i>Hibbertia cuneiformis</i>		150	3
<i>Macrozamia fraseri</i>		100	1
<i>Hibbertia hypericoides</i>		30	1
<i>Phyllanthus calycinus</i>		20	0.2

Taxon	Cons. Code	Height (cm)	% Alive
<i>Trachyandra divaricata</i>	*	20	3
<i>Romulea rosea</i>	*	10	0.1
Weed stars		10	0.1
<i>Oxalis pes-caprae</i>	*	5	1
<i>Schoenus</i> sp.		3	0.5
<i>Daucus glochidiatus</i>		2	3
<i>Euphorbia peplus</i>	*	2	4
<i>Lysimachia arvensis</i>	*	2	1
<i>Hypochaeris glabra</i>	*	1	5
<i>Asteridea pulverulenta</i>			
<i>Clematis pubescens</i>			0.5
<i>Parietaria debilis</i>			

Site No: 69	Associated Patch No.: 1	Type: Revele	Longitude: 115.6397663	Latitude: -32.77715202
Date: 30/06/2020		Soil Types: Sand		
Topography: Mid slope		Soil Colour: Light brown		
Surface: 5% logs, 5% twigs, 15% leaf		Soil Condition: Moist		
Community: EgXpTd		Fire History: 10+		
Vegetation Condition: Good, partial clearing				



Taxon	Cons. Code	Height (cm)	% Alive
<i>Eucalyptus gomphocephala</i>		3500	8
<i>Banksia attenuata</i>		500	2
<i>Xanthorrhoea preissii</i>		300	60
<i>Melaleuca systena</i>		120	1
<i>Macrozamia riedlei</i>		50	2
<i>Templetonia retusa</i>		30	0.3
<i>Phyllanthus calycinus</i>		20	0.2
<i>Trachyandra divaricata</i>	*	20	1

Taxon	Cons. Code	Height (cm)	% Alive
<i>Romulea rosea</i>	*	5	0.5
<i>Weed stars</i>		5	0.1
<i>Apium prostratum</i>		3	0.1
<i>Chamaescilla corymbosa</i>		1	0.5
<i>Hypochaeris glabra</i>	*	1	2
<i>Lysimachia arvensis</i>	*	1	2
<i>Parietaria debilis</i>			
<i>Styphelia propinqua</i>			

Site No: 70	Associated Patch No.: 2	Type: Quadrat	Longitude: 115.63094	Latitude: -32.770898
Date: 30/06/2020		Soil Types: Sand		
Topography: Sand dune slope		Soil Colour: Pale white/cream		
Surface: 5% logs, 10% litter		Soil Condition: Moist		
Community (2016): AfSgTd		Fire History: 10+		
Vegetation Condition: Good; weeds, disturbance				



Weed	Taxon	Height (cm)	% Alive
	<i>Eucalyptus gomphocephala</i>	2200	15
	<i>Acacia rostellifera</i>	200	4
	<i>Rhagodia baccata</i>	150	5
	<i>Spyridium globulosum</i>	150	0.5
	<i>Acanthocarpus preissii</i>	60	40
*	<i>Trachyandra divaricata</i>	20	40
*	<i>Euphorbia peplus</i>	5	1
*	<i>Romulea rosea</i>	5	1
*	<i>Solanum nigrum</i>	5	0.1

Weed	Taxon	Height (cm)	% Alive
	<i>Portulaca oleracea</i>	4	0.2
*	<i>Cerastium glomeratum</i>		
	Callitris sp. (planted)		
	<i>Clematis linearifolia</i>		0.2
	<i>Styphelia propinqua</i>		
	<i>Melaleuca systema</i>		
	<i>Rhadinothamnus anceps</i>		
	<i>Senecio diaschides</i>		

Site No: 71	Associated Patch No.: 7	Type: Quadrat	Longitude: 115.6345845	Latitude: -32.77458353
Date: 1/07/2020		Soil Types: Loamy sand		
Topography: Lower slope		Soil Colour: Dark brown		
Surface: 2% twigs, 15% leaves		Soil Condition: Moist		
Community (2016): PI		Fire History: 10+		
Vegetation Condition: Very Good				



Weed	Taxon	Height (cm)	% Alive
	<i>Eucalyptus decipiens</i>	1500	60
	<i>Eucalyptus gomphocephala</i>	1500	20
	<i>Eucalyptus</i> sp. (planted)	1500	8
	<i>Acacia rostellifera</i>	200	3
	<i>Xanthorrhoea preissii</i>	200	
	<i>Hibbertia cuneiformis</i>	130	16
	<i>Asphodelus fistulosus</i>	30	
*	<i>Trachyandra divaricata</i>	30	12
	<i>Eriachne</i> sp.	15	0.1

Weed	Taxon	Height (cm)	% Alive
	<i>Acanthocarpus preissii</i>	10	0.1
*	<i>Briza maxima</i>	10	0.1
	<i>Leucopogon parviflorus</i>	10	0.2
	<i>Schoenus</i> sp.	10	0.1
*	<i>Arctotheca calendula</i>	5	0.5
	<i>Daucus glochidiatus</i>	5	0.1
	<i>Romulea rosea</i>	5	0.1
*	<i>Geranium molle</i>	3	5
*	<i>Lysimachia arvensis</i>	2	1
*	<i>Trifolium</i> sp.	2	3
	<i>Clematis linearifolia</i>		1

Appendix D

Recorded Tuart Tree
Canopy Sizes

Appendix D Recorded Tuart Tree Canopy Sizes

Table 13 The canopy sizes of the Tuart trees recorded during the Tuart Woodlands TEC targeted survey

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
2	5	115.64693	-32.76658	1
3	6	115.646993	-32.766665	1
4	7.5	115.647082	-32.766784	1
5	4	115.64725	-32.766912	1
6	2.5	115.647284	-32.76704	1
7	3	115.647262	-32.76711	1
8	5	115.647309	-32.767157	1
9	5	115.647089	-32.767236	1
10	5	115.646995	-32.767225	1
11	2.5	115.646978	-32.767264	1
12	4	115.646868	-32.767311	1
13	5	115.647033	-32.767397	1
14	7.5	115.646991	-32.767473	1
15	7.5	115.646977	-32.767473	1
16	7.5	115.646962	-32.767484	1
17	7.5	115.646941	-32.767538	1
18	7.5	115.647041	-32.767603	1
19	7.5	115.646968	-32.767661	1
20	7.5	115.646735	-32.766551	1
21	7.5	115.647341	-32.766419	1
22	7.5	115.647351	-32.766411	1
23	7.5	115.647361	-32.766408	1
24	7.5	115.647636	-32.766339	1
25	7.5	115.647749	-32.766297	1
26	7.5	115.64772	-32.766295	1
27	7.5	115.647589	-32.766378	1
28	7.5	115.649926	-32.766674	1
29	5	115.650092	-32.766622	1
30	7.5	115.650117	-32.766754	1
31	10	115.64999	-32.766913	1
32	10	115.650108	-32.767009	1
33	5	115.650143	-32.767067	1
34	2.5	115.650259	-32.767116	1
35	5	115.650209	-32.767235	1

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
36	4	115.650301	-32.767304	1
37	2.5	115.650323	-32.767345	1
38	2	115.650455	-32.76732	1
65	7.5	115.644973	-32.774554	1
66	15	115.644816	-32.774488	1
67	7.5	115.644975	-32.774377	1
68	7.5	115.64496	-32.774396	1
69	5	115.645207	-32.774159	1
77	12.5	115.646003	-32.772949	1
78	12.5	115.646116	-32.772572	1
79	7.5	115.646135	-32.772454	1
80	12.5	115.645993	-32.771729	1
81	10	115.644692	-32.771024	1
90	17.5	115.645124	-32.77016	1
91	12.5	115.645411	-32.770004	1
174	10	115.645372	-32.774821	1
175	7.5	115.645183	-32.774733	1
176	7.5	115.645093	-32.774702	1
177	10	115.644921	-32.774612	1
178	5	115.644971	-32.774564	1
179	12.5	115.645133	-32.77445	1
180	12.5	115.645605	-32.774257	1
184	20	115.645988	-32.772292	1
185	17.5	115.645883	-32.771735	1
186	15	115.645406	-32.771219	1
194	7.5	115.644402	-32.769996	1
195	7.5	115.644402	-32.769978	1
196	5	115.645132	-32.770014	1
242	4	115.647562	-32.766912	1
243	7.5	115.6476	-32.766973	1
244	2.5	115.64761	-32.766969	1
245	4	115.647704	-32.766904	1
246	7	115.647623	-32.766993	1
247	7.5	115.649295	-32.76655	1
248	7.5	115.649491	-32.766586	1
249	7.5	115.649523	-32.766692	1
250	7.5	115.649628	-32.766872	1

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
336	7.5	115.64246	-32.773934	1
337	7.5	115.642516	-32.773702	1
338	7.5	115.642515	-32.773629	1
339	7.5	115.642762	-32.773514	1
344	7.5	115.644085	-32.773422	1
345	7.5	115.64227	-32.773393	1
346	7.5	115.642235	-32.773425	1
347	7.5	115.641952	-32.773331	1
348	7.5	115.641926	-32.77329	1
349	7.5	115.641676	-32.773171	1
350	7.5	115.641618	-32.773099	1
351	7.5	115.6415	-32.773015	1
352	7.5	115.641046	-32.772944	1
353	7.5	115.641015	-32.772957	1
354	7.5	115.640975	-32.772945	1
355	7.5	115.640831	-32.772838	1
356	7.5	115.640571	-32.772751	1
357	7.5	115.640262	-32.773955	1
358	7.5	115.640188	-32.774151	1
359	7.5	115.640075	-32.774275	1
360	7.5	115.640024	-32.774482	1
361	7.5	115.63969	-32.774578	1
362	7.5	115.639321	-32.774897	1
363	7.5	115.639717	-32.774994	1
364	7.5	115.639763	-32.775023	1
365	7.5	115.639647	-32.775272	1
366	7.5	115.63956	-32.775326	1
367	7.5	115.639367	-32.775438	1
368	7.5	115.639211	-32.775515	1
369	7.5	115.639107	-32.775683	1
370	7.5	115.638847	-32.77569	1
371	7.5	115.638802	-32.775667	1
372	7.5	115.63871	-32.775898	1
373	7.5	115.638614	-32.775939	1
374	7.5	115.63838	-32.775872	1
375	7.5	115.638313	-32.775865	1
376	7.5	115.638335	-32.775923	1

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
377	7.5	115.637572	-32.776232	1
378	7.5	115.637584	-32.776253	1
379	7.5	115.63748	-32.776068	1
380	7.5	115.637464	-32.775996	1
381	7.5	115.63734	-32.776075	1
382	7.5	115.637227	-32.776144	1
383	7.5	115.63717	-32.776192	1
384	7.5	115.637062	-32.776237	1
385	7.5	115.636935	-32.776433	1
386	7.5	115.636961	-32.776482	1
387	7.5	115.636926	-32.776487	1
388	7.5	115.636987	-32.776496	1
389	7.5	115.637133	-32.776399	1
390	7.5	115.637196	-32.776356	1
391	7.5	115.637248	-32.776398	1
392	7.5	115.637298	-32.776402	1
393	7.5	115.637328	-32.776389	1
394	7.5	115.637383	-32.776351	1
395	7.5	115.63743	-32.776319	1
396	7.5	115.637549	-32.776262	1
397	7.5	115.637562	-32.776254	1
398	7.5	115.637473	-32.776086	1
399	7.5	115.637469	-32.775989	1
406	7.5	115.637462	-32.775958	1
407	7.5	115.637304	-32.776091	1
408	7.5	115.637183	-32.776143	1
409	7.5	115.637124	-32.776198	1
410	7.5	115.637041	-32.776249	1
411	7.5	115.636902	-32.77644	1
412	7.5	115.636772	-32.776406	1
413	7.5	115.63686	-32.776489	1
414	7.5	115.63696	-32.77652	1
415	7.5	115.636994	-32.776517	1
416	7.5	115.638117	-32.776604	1
417	7.5	115.638002	-32.77675	1
418	7.5	115.638607	-32.776679	1
419	7.5	115.638754	-32.776636	1

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
420	7.5	115.638952	-32.776712	1
421	7.5	115.638945	-32.776826	1
422	7.5	115.638979	-32.776974	1
423	7.5	115.639077	-32.777048	1
424	7.5	115.639135	-32.777384	1
425	7.5	115.639157	-32.777406	1
426	7.5	115.639078	-32.777474	1
427	7.5	115.63887	-32.777452	1
428	7.5	115.638697	-32.777368	1
429	7.5	115.638563	-32.777478	1
430	7.5	115.638762	-32.777696	1
431	7.5	115.638587	-32.777857	1
432	7.5	115.638406	-32.778005	1
433	7.5	115.638253	-32.777905	1
434	7.5	115.63814	-32.777989	1
435	7.5	115.638096	-32.778033	1
436	7.5	115.638081	-32.778113	1
437	7.5	115.637946	-32.77814	1
438	7.5	115.638	-32.778243	1
439	7.5	115.638019	-32.778249	1
440	7.5	115.63813	-32.778123	1
441	7.5	115.638364	-32.778083	1
442	7.5	115.638558	-32.77812	1
443	7.5	115.638681	-32.778332	1
444	7.5	115.638516	-32.778485	1
445	7.5	115.638065	-32.779003	1
446	7.5	115.638058	-32.779028	1
447	7.5	115.638347	-32.779054	1
448	7.5	115.638552	-32.779021	1
449	7.5	115.638547	-32.7785	1
450	7.5	115.638712	-32.778376	1
451	7.5	115.638675	-32.778136	1
452	7.5	115.638977	-32.77806	1
453	7.5	115.63916	-32.777897	1
454	7.5	115.639454	-32.777913	1
455	7.5	115.6403	-32.776585	1
456	7.5	115.640386	-32.776483	1

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
457	7.5	115.640847	-32.776258	1
458	7.5	115.640931	-32.776029	1
459	7.5	115.640994	-32.775804	1
460	7.5	115.641083	-32.775544	1
461	7.5	115.64114	-32.775539	1
462	7.5	115.6412	-32.775483	1
494	10	115.6455038	-32.77500145	1
495	2.5	115.6454533	-32.77494203	1
496	3	115.6455254	-32.77480962	1
497	5	115.64562	-32.77476492	1
498	3	115.6455646	-32.77469835	1
499	3	115.6454928	-32.77465003	1
500	1	115.6454298	-32.77458988	1
501	2.5	115.6452952	-32.77450675	1
502	2.5	115.6453761	-32.77437953	1
503	10	115.6453137	-32.77435412	1
504	7.5	115.6449369	-32.77451017	1
505	2.5	115.6448086	-32.77446053	1
506	10	115.644766	-32.77438593	1
507	5	115.6450184	-32.77413122	1
508	10	115.6451687	-32.77401825	1
509	7.5	115.6451093	-32.77393453	1
510	10	115.645099	-32.77386297	1
530	10	115.6458947	-32.77293132	1
531	10	115.6459239	-32.77297868	1
533	10	115.6460516	-32.77287362	1
534	10	115.6460307	-32.77284407	1
535	5	115.6461093	-32.77253032	1
536	15	115.6461484	-32.77237993	1
537	7.5	115.6459928	-32.77199942	1
538	10	115.6460224	-32.77193017	1
540	10	115.6459323	-32.77142268	1
541	10	115.6466945	-32.77105868	1
542	10	115.645501	-32.77126453	1
543	5	115.6451195	-32.77105423	1
544	7.5	115.6451993	-32.77103332	1
545	5	115.6450723	-32.77098467	1

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
546	15	115.6449464	-32.77090692	1
547	10	115.6446583	-32.77082308	1
548	7.5	115.6444932	-32.77084455	1
549	7.5	115.6445722	-32.77089372	1
563	7.5	115.6441063	-32.77011737	1
564	7.5	115.6443404	-32.77013577	1
565	5	115.6442294	-32.7699298	1
566	7.5	115.6440979	-32.77015802	1
567	7.5	115.6443074	-32.77000242	1
568	5	115.6445919	-32.77004318	1
569	8	115.6445881	-32.77007887	1
570	10	115.6446138	-32.77006545	1
571	5	115.6448466	-32.77003457	1
572	3.5	115.6448745	-32.77005323	1
573	5	115.6449556	-32.77007732	1
574	5	115.6453458	-32.77013293	1
576	5	115.6471286	-32.7664046	1
577	7.5	115.6472626	-32.76693027	1
578	7.5	115.6473479	-32.7669263	1
579	10	115.6474639	-32.76694678	1
580	5	115.6474481	-32.76700468	1
581	7.5	115.6474802	-32.76702048	1
582	7.5	115.6475331	-32.76722798	1
583	5	115.6475189	-32.76731448	1
584	6	115.6475614	-32.76736652	1
585	7.5	115.6475723	-32.76745162	1
586	12.5	115.6497151	-32.76711673	1
587	5	115.6495007	-32.7671389	1
588	6	115.6493148	-32.76732088	1
589	10	115.6493444	-32.76741403	1
590	10	115.6493967	-32.76737863	1
591	12.5	115.6494156	-32.7674371	1
592	15	115.6493736	-32.76746915	1
593	7.5	115.6493367	-32.76752285	1
594	12.5	115.649245	-32.76748377	1
606	7.5	115.6408816	-32.77496168	1
607	7.5	115.6401509	-32.77634408	1

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
608	7.5	115.6396617	-32.77670152	1
609	6	115.63947	-32.77792927	1
610	4	115.6394568	-32.7780753	1
611	4	115.6394002	-32.77817415	1
612	7.5	115.639532	-32.77844617	1
613	7.5	115.6389661	-32.77805465	1
614	3.5	115.6388552	-32.77801722	1
615	5	115.6386323	-32.77810852	1
616	10	115.6387267	-32.77834325	1
617	7.5	115.6385418	-32.77848197	1
618	10	115.6384016	-32.77902057	1
619	7.5	115.6380817	-32.7790173	1
620	10	115.6380258	-32.77900058	1
621	8	115.6381485	-32.77811018	1
622	7.5	115.6379601	-32.77814485	1
623	1.5	115.6379765	-32.77822603	1
624	10	115.6381022	-32.7780451	1
625	3	115.6381049	-32.77801327	1
626	4	115.6381086	-32.77798538	1
627	3.5	115.6382563	-32.77791138	1
628	12.5	115.6385612	-32.77749398	1
629	10	115.6386877	-32.77735443	1
630	8	115.6388683	-32.7774456	1
631	7.5	115.6389521	-32.77696163	1
632	6	115.6389209	-32.77683018	1
633	3	115.6389874	-32.77672078	1
634	7.5	115.6386928	-32.77659657	1
635	7.5	115.6384683	-32.77650032	1
636	10	115.6386626	-32.776216	1
637	9	115.6385913	-32.77605518	1
639	5	115.6382787	-32.77585042	1
640	4	115.638236	-32.77585427	1
641	4	115.6386762	-32.77576795	1
642	12.5	115.6385669	-32.77590617	1
643	10	115.6386659	-32.77593912	1
644	7.5	115.6387775	-32.77573772	1
645	2.5	115.6388412	-32.77566435	1

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
646	8	115.6391206	-32.77571062	1
647	10	115.6391529	-32.77554578	1
648	7.5	115.6391625	-32.77553812	1
649	15	115.6394853	-32.77544307	1
650	5	115.6395106	-32.77536333	1
651	10	115.6392885	-32.77491547	1
652	10	115.6397629	-32.77507462	1
653	7.5	115.6397561	-32.77493145	1
654	10	115.6400029	-32.77480947	1
655	10	115.6397349	-32.77463382	1
656	10	115.6399198	-32.77446963	1
657	12.5	115.6400694	-32.77430617	1
658	10	115.6401414	-32.77416457	1
659	7.5	115.6402383	-32.77398843	1
660	17.5	115.6404228	-32.77381398	1
661	10	115.640512	-32.77355933	1
662	7.5	115.6406187	-32.77333793	1
663	7.5	115.6407319	-32.77322303	1
664	7.5	115.6409196	-32.77302452	1
665	10	115.6405462	-32.77279752	1
666	10	115.6401998	-32.77229627	1
678	12.5	115.6449721	-32.77733065	1
679	7.5	115.6451239	-32.77732331	1
680	10	115.6451861	-32.77727166	1
681	10	115.6451879	-32.77719062	1
682	5	115.6445231	-32.77700176	1
683	12.5	115.6447905	-32.77702415	1
684	10	115.6447763	-32.77697774	1
685	7.5	115.6447762	-32.77694623	1
686	5	115.6447201	-32.77687928	1
687	7.5	115.6446317	-32.77680675	1
688	15	115.6444754	-32.77695484	1
689	7.5	115.6436993	-32.77647125	1
690	10	115.643678	-32.77651917	1
691	17.5	115.6435907	-32.77643564	1
692	17.5	115.6436411	-32.7763946	1
693	20	115.6436863	-32.77614496	1

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
694	22.5	115.6439253	-32.77600909	1
695	5	115.6439129	-32.77619278	1
696	17.5	115.6440804	-32.77626826	1
697	22.5	115.6442541	-32.77634371	1
698	15	115.6443543	-32.77626981	1
699	12.5	115.6446762	-32.77657094	1
700	15	115.6446703	-32.77664301	1
701	7.5	115.6447135	-32.77667671	1
702	12.5	115.6447352	-32.77677554	1
703	15	115.6448364	-32.77689125	1
704	12.5	115.6449112	-32.77693946	1
705	12.5	115.6450329	-32.77710565	1
706	7.5	115.645356	-32.77692921	1
707	7.5	115.6453934	-32.77693673	1
708	12.5	115.6456169	-32.77693672	1
709	10	115.6456777	-32.77655664	1
710	12.5	115.6455538	-32.7765161	1
711	15	115.6452387	-32.77644405	1
712	5	115.6452871	-32.77659275	1
713	5	115.6454212	-32.77576753	1
714	10	115.6454731	-32.77563363	1
715	10	115.6449944	-32.77555347	1
716	10	115.6450319	-32.77543233	1
717	15	115.6448001	-32.77536739	1
718	10	115.6445782	-32.77547266	1
719	12.5	115.6445248	-32.77522321	1
720	12.5	115.6444172	-32.77524813	1
721	17.5	115.6443709	-32.77511016	1
722	15	115.6441238	-32.77502947	1
723	15	115.6438529	-32.77515937	1
724	17.5	115.6438458	-32.77544974	1
725	12.5	115.6436635	-32.7753066	1
726	17.5	115.6434143	-32.77511801	1
727	10	115.643218	-32.77514397	1
728	20	115.6430918	-32.77514375	1
729	10	115.6426732	-32.77503004	1
730	15	115.6423295	-32.77516656	1

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
731	10	115.6421064	-32.77526213	1
732	12.5	115.641884	-32.77526088	1
733	15	115.6417604	-32.77526257	1
734	15	115.6416284	-32.77527885	1
735	12.5	115.6414266	-32.77544398	1
736	22.5	115.6413132	-32.77545977	1
737	10	115.6411948	-32.77549667	1
738	15	115.6411319	-32.77561802	1
739	10	115.6411593	-32.77568077	1
740	7.5	115.641225	-32.77568549	1
741	15	115.6412563	-32.77585139	1
742	22.5	115.641232	-32.77604882	1
743	15	115.6415152	-32.77650967	1
744	10	115.6415596	-32.77660482	1
745	12.5	115.6415126	-32.77667044	1
746	15	115.6413994	-32.77667123	1
747	12.5	115.6412969	-32.77670795	1
748	12.5	115.6409944	-32.7769933	1
0	7.5	115.647097	-32.76635	1
1	7.5	115.646838	-32.766593	1
466	7.5	115.630783	-32.771018	2
467	10	115.63091	-32.770918	2
468	5	115.630996	-32.770841	2
469	15	115.631038	-32.770822	2
470	7.5	115.631078	-32.770838	2
471	15	115.631057	-32.770755	2
472	3	115.631165	-32.770597	2
473	1.5	115.631849	-32.770263	2
474	3.5	115.631168	-32.770561	2
475	3	115.630935	-32.770591	2
476	3	115.630868	-32.770586	2
477	1	115.630879	-32.770535	2
478	4	115.631048	-32.770421	2
479	4.5	115.631174	-32.769862	2
480	7.5	115.631175	-32.769525	2
481	1.5	115.631205	-32.769345	2
482	7	115.631433	-32.769332	2

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
483	7.5	115.631585	-32.769224	2
484	7.5	115.631583	-32.769222	2
485	3.5	115.631699	-32.769034	2
553	5	115.6310573	-32.7693447	2
668	15	115.6312263	-32.77058667	2
669	7.5	115.630857	-32.77074468	2
670	3.5	115.6300008	-32.77056758	2
671	2.5	115.6299922	-32.77055015	2
672	3	115.6298828	-32.77061218	2
673	2.5	115.6298575	-32.77068638	2
674	5	115.6295471	-32.77084507	2
675	6	115.6294309	-32.77079003	2
676	6	115.6290912	-32.77039602	2
677	5	115.6290341	-32.77039427	2
751	15	115.6310835	-32.77104887	2
752	7.5	115.630244	-32.77089488	2
753	7.5	115.6300406	-32.77089561	2
754	5	115.6299696	-32.77093742	2
755	7.5	115.6300099	-32.77097341	2
756	5	115.6299944	-32.77099843	2
757	10	115.6299504	-32.7710742	2
758	10	115.6298599	-32.77108958	2
759	15	115.6298139	-32.77115668	2
760	7.5	115.6297661	-32.77120022	2
761	5	115.6297001	-32.77117167	2
762	10	115.6295682	-32.77125887	2
763	12.5	115.6295244	-32.77121268	2
764	15	115.6292655	-32.77134827	2
765	17.5	115.6290854	-32.7713888	2
766	10	115.6289991	-32.77137137	2
767	7.5	115.6289572	-32.771389	2
768	7.5	115.6289213	-32.77139447	2
769	7.5	115.6288364	-32.77145451	2
770	5	115.6287805	-32.77144774	2
771	5	115.6287387	-32.7714569	2
772	15	115.6285382	-32.77101402	2
773	15	115.6285306	-32.77099382	2

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
774	12.5	115.6284324	-32.77093904	2
775	7.5	115.6284632	-32.77092091	2
776	5	115.6284849	-32.77092985	2
92	5	115.629442	-32.778586	3
93	7.5	115.629489	-32.778421	3
94	2.5	115.62939	-32.778257	3
95	5	115.629384	-32.778193	3
96	4	115.629402	-32.77807	3
97	5	115.629379	-32.77804	3
98	2.5	115.629419	-32.777954	3
99	4	115.629416	-32.77785	3
100	2	115.629234	-32.777763	3
101	5	115.629183	-32.777754	3
102	4	115.629156	-32.777688	3
103	3.5	115.629063	-32.777634	3
104	5	115.629046	-32.777582	3
105	2.5	115.629097	-32.777521	3
106	2.5	115.629139	-32.777513	3
107	7.5	115.629157	-32.777456	3
108	10	115.629178	-32.777434	3
109	2	115.62916	-32.777314	3
110	2.5	115.629192	-32.77721	3
111	5	115.629174	-32.777143	3
112	5	115.629169	-32.77711	3
113	2.5	115.6291	-32.777088	3
114	5	115.629092	-32.77705	3
115	4	115.629003	-32.777062	3
116	5	115.628946	-32.777069	3
117	7.5	115.628926	-32.777026	3
118	5	115.628936	-32.776943	3
119	5	115.629005	-32.776946	3
120	5	115.628932	-32.776883	3
121	4	115.628908	-32.776799	3
122	5	115.628907	-32.776718	3
123	5	115.628974	-32.776692	3
124	3	115.62889	-32.776628	3
125	4	115.628941	-32.776607	3

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
126	5	115.629029	-32.776546	3
127	5	115.629039	-32.7765	3
128	5	115.629068	-32.77646	3
129	4	115.629215	-32.776404	3
130	2.5	115.629195	-32.776263	3
131	5	115.629236	-32.77627	3
132	10	115.629304	-32.776201	3
133	2	115.629249	-32.776135	3
134	2.5	115.629248	-32.776107	3
135	5	115.629257	-32.776065	3
136	7.5	115.629333	-32.775972	3
137	5	115.629302	-32.775856	3
138	5	115.629286	-32.775793	3
139	2	115.629276	-32.775736	3
140	2.5	115.629294	-32.775707	3
141	7.5	115.62932	-32.775917	3
142	7.5	115.629343	-32.775995	3
143	7.5	115.629296	-32.77604	3
144	10	115.62931	-32.776173	3
145	7.5	115.629311	-32.776225	3
146	2.5	115.62928	-32.776297	3
147	5	115.62925	-32.776388	3
148	5	115.6292	-32.776443	3
149	5	115.629124	-32.776576	3
150	5	115.629091	-32.776611	3
151	5	115.629153	-32.776817	3
152	4	115.629063	-32.776797	3
153	2.5	115.629187	-32.777073	3
154	5	115.629166	-32.777107	3
155	5	115.629216	-32.777266	3
156	2	115.629275	-32.777427	3
157	4	115.629456	-32.777514	3
158	2.5	115.629744	-32.777482	3
159	2.5	115.629754	-32.777505	3
160	2.5	115.629887	-32.777513	3
161	7.5	115.630029	-32.777713	3
162	2.5	115.630165	-32.777733	3

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
163	2.5	115.630155	-32.777777	3
164	3.5	115.630171	-32.777888	3
165	5	115.630127	-32.777911	3
166	5	115.629998	-32.777931	3
167	5	115.629916	-32.777996	3
168	5	115.629536	-32.777908	3
219	2.5	115.629196	-32.779295	3
220	6	115.629476	-32.779192	3
221	3.5	115.629352	-32.779058	3
222	6.5	115.629513	-32.779029	3
223	7	115.629941	-32.778981	3
224	3.5	115.630052	-32.779023	3
225	4	115.630214	-32.779247	3
226	5	115.630057	-32.779387	3
227	4	115.630017	-32.779851	3
228	12.5	115.629647	-32.779711	3
229	4	115.629713	-32.779451	3
230	12.5	115.629551	-32.77926	3
231	5	115.629643	-32.778831	3
232	5	115.629603	-32.778729	3
233	3.5	115.629548	-32.778714	3
234	3.5	115.629441	-32.778622	3
235	4	115.629462	-32.778414	3
236	5.5	115.629894	-32.778043	3
237	4.5	115.629994	-32.777939	3
238	5	115.6301	-32.777916	3
239	3.5	115.630383	-32.777863	3
240	2.5	115.63006	-32.777683	3
241	3	115.62975	-32.777475	3
575	7.5	115.6299555	-32.7782513	3
39	7.5	115.651751	-32.779443	4
40	5	115.651821	-32.77943	4
41	3	115.651784	-32.77936	4
42	4	115.651567	-32.779326	4
43	4	115.651568	-32.779296	4
44	7.5	115.651524	-32.779266	4
45	2.5	115.651507	-32.779149	4

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
46	5	115.651416	-32.779145	4
47	3	115.651376	-32.779153	4
48	2.5	115.651354	-32.779178	4
49	7.5	115.651477	-32.779096	4
50	7.5	115.651475	-32.779093	4
51	7.5	115.651477	-32.77909	4
52	7.5	115.651486	-32.779086	4
53	7.5	115.651579	-32.779058	4
54	2.5	115.651535	-32.778975	4
55	7.5	115.651527	-32.778963	4
56	7.5	115.651279	-32.778913	4
57	7.5	115.651273	-32.778916	4
58	2	115.651479	-32.77881	4
59	7.5	115.651507	-32.778779	4
60	2.5	115.651527	-32.778743	4
61	7.5	115.651612	-32.778718	4
62	7.5	115.651761	-32.778613	4
63	5	115.651799	-32.778654	4
64	7.5	115.6519	-32.778678	4
251	7.5	115.65204	-32.779637	4
265	7.5	115.651196	-32.77962	4
266	7.5	115.651182	-32.779583	4
267	7.5	115.65118	-32.779582	4
268	7.5	115.65118	-32.779583	4
269	7.5	115.65125	-32.779525	4
270	7.5	115.651233	-32.779513	4
271	7.5	115.651227	-32.779458	4
272	7.5	115.651199	-32.779451	4
273	7.5	115.651133	-32.779427	4
274	7.5	115.651059	-32.779411	4
275	7.5	115.651043	-32.77939	4
276	7.5	115.650995	-32.779378	4
277	7.5	115.650957	-32.779375	4
278	7.5	115.65093	-32.779368	4
279	7.5	115.650909	-32.779358	4
280	7.5	115.650931	-32.779331	4
281	7.5	115.650931	-32.779264	4

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
282	7.5	115.650906	-32.779243	4
283	7.5	115.650863	-32.779263	4
284	7.5	115.65079	-32.779225	4
285	7.5	115.650663	-32.779255	4
286	7.5	115.650589	-32.779282	4
287	7.5	115.650572	-32.779282	4
288	7.5	115.650537	-32.779266	4
290	7.5	115.650578	-32.779207	4
291	7.5	115.650587	-32.779197	4
292	7.5	115.650618	-32.779189	4
293	7.5	115.650705	-32.77922	4
294	7.5	115.650732	-32.779171	4
319	7.5	115.651426	-32.778504	4
320	7.5	115.651429	-32.778436	4
321	7.5	115.651477	-32.77835	4
322	7.5	115.65152	-32.778344	4
323	7.5	115.651587	-32.778302	4
325	7.5	115.651608	-32.778052	4
326	7.5	115.651655	-32.778015	4
595	17.5	115.6518171	-32.77929487	4
596	10	115.6518541	-32.77923252	4
597	12.5	115.6519286	-32.77914318	4
598	7.5	115.6518527	-32.77910805	4
599	10	115.6517856	-32.77896923	4
600	12.5	115.6518735	-32.77892988	4
601	7.5	115.6519281	-32.77885573	4
602	5	115.6517847	-32.77886643	4
603	7.5	115.6516861	-32.77881455	4
604	10	115.6518583	-32.77873185	4
197	2	115.629023	-32.782929	5
198	1.5	115.629098	-32.783149	5
199	1.5	115.629423	-32.783227	5
200	5	115.629527	-32.783425	5
201	5	115.629395	-32.783577	5
202	3.5	115.629556	-32.783362	5
203	3.5	115.629571	-32.783254	5
204	3	115.629629	-32.783188	5

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
205	2.5	115.629548	-32.783096	5
206	3.5	115.629549	-32.783021	5
207	5	115.629442	-32.782971	5
208	4	115.629359	-32.782936	5
209	3	115.629192	-32.782842	5
210	4.5	115.629144	-32.782672	5
211	2.5	115.629131	-32.782558	5
212	7	115.629015	-32.78244	5
213	7.5	115.628809	-32.782107	5
214	3.5	115.628841	-32.782438	5
215	2.5	115.628863	-32.782525	5
216	2.5	115.628959	-32.782688	5
217	3	115.628979	-32.782673	5
218	2	115.629019	-32.782913	5
486	1.5	115.628103	-32.768623	6
487	5	115.628154	-32.768529	6
488	10	115.628049	-32.768246	6
489	7.5	115.627794	-32.768196	6
490	7.5	115.627679	-32.768186	6
491	4	115.627592	-32.768287	6
492	7.5	115.62745	-32.768385	6
493	4	115.627453	-32.768449	6
777	7.5	115.6280369	-32.76867333	6
778	7.5	115.6279565	-32.76865225	6
779	5	115.6279533	-32.76868463	6
780	5	115.6279471	-32.76869801	6
781	7.5	115.6278925	-32.76870095	6
782	10	115.6278568	-32.76878091	6
783	17.5	115.6276899	-32.76868329	6
784	15	115.6275068	-32.76866674	6
785	10	115.6274257	-32.76865334	6
786	7.5	115.627052	-32.76843349	6
787	7.5	115.6274109	-32.76860645	6
169	10	115.634441	-32.774726	7
170	9	115.63422	-32.774423	7
171	9	115.634573	-32.774486	7
172	2.5	115.634808	-32.774675	7

ID	Canopy size (m)	Longitude	Latitude	Tuart TEC Patch
173	7	115.634826	-32.77476	7
788	7.5	115.6344693	-32.77451135	7