



Hazer Hydrogen and Graphite CDP – NVCP Supporting Document

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Acronyms / Abbreviations

Acronym / Abbreviation	Definition
BC Act	<i>Biodiversity Conservation Act 2016</i>
BFS	Bush Forever Site
CDP	Commercial Demonstration Plant
DBCA	Department of Biodiversity, Conservation and Attractions
DPaW	Department of Parks and Wildlife (now DBCA – Department of Biodiversity, Conservation and Attractions – Parks and Wildlife Service)
EP Act	<i>Environmental Protection Act 1986</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
FCT	Floristic Community Type
IBRA	Interim Biogeographic Regionalisation for Australia
SCP	Swan Coastal Plain
TEC	Threatened Ecological Community
WA	Western Australia
WWTP	Waste Water Treatment Plant

1. Introduction

Hazer Group Limited ('Hazer') is currently commercialising a novel and patented process to produce low emission hydrogen and graphite from any source of methane, using iron ore as a process catalyst.

Hazer have signed an agreement with the WA Water Corporation to construct and operate a Hydrogen & Graphite Commercial Demonstration Plant (CDP) on the existing Woodman Point Waste Water Treatment Plant (WWTP), owned and operated by Water Corporation, located at 837 Cockburn Road, Munster, WA. The Hydrogen CDP site is located within the Cockburn Shire local government boundary, approximately 8.5 km south of Fremantle between Jervoise Bay and Lake Coogee.

The Hydrogen CDP will utilize biogas from the WWTP as the methane feedstock for the production of fuel cell grade hydrogen whilst capturing the carbon as a graphite by-product. The proposed location of the Hydrogen CDP was chosen to minimise the distance that the raw biogas feedstock must be transported.

The Hazer Commercial Demonstration Plant will be used as a reference site to promote the uptake of the technology to customers in Australia and internationally.

2. Proposed Location and Area

Water Corporation are the owner and operator of the Woodman Point WWTP located at Cockburn Road, Munster, WA. Munster is an industrial suburb south of Perth, located close to the Australian Marine Complex at Henderson, and the Kwinana Industrial Zone. Water Corporation are a Western Australian Government owned corporation principally responsible for the production and supply of potable water, the treatment and disposal of wastewater and the supply of drainage services in WA. It is proposed that Water Corporation will act as both the biogas supplier and project host to the Hazer CDP which is proposed for co-location on the Woodman Point WWTP.

To develop the CDP, it is proposed to clear / disturb up to 0.86 ha of native vegetation. The CDP itself will require approximately ~4500-5000 m² (0.45-0.5 ha) of space, and given the CDP is located within a Bushfire Prone Area, the remaining disturbance footprint around the plant, or the asset protection zone, is required in accordance with the State Planning Policy 3.7.

Although the clearing permit covers an area of 0.86 ha, approximately 0.725 ha will be required to be cleared to the ground, and the remaining vegetation (within the Asset Protection Zone) is required to be managed meaning that understorey species will be cleared, and some limbs of mature trees may need to be trimmed, but no mature trees in this area are required to be cleared. The proposed location is adjacent to the existing Water Corporation Woodman Point Waste Water Treatment Plant to minimise the distance that raw biogas feedstock must be transported. The indicative site location is indicated in the Figure 1 below.

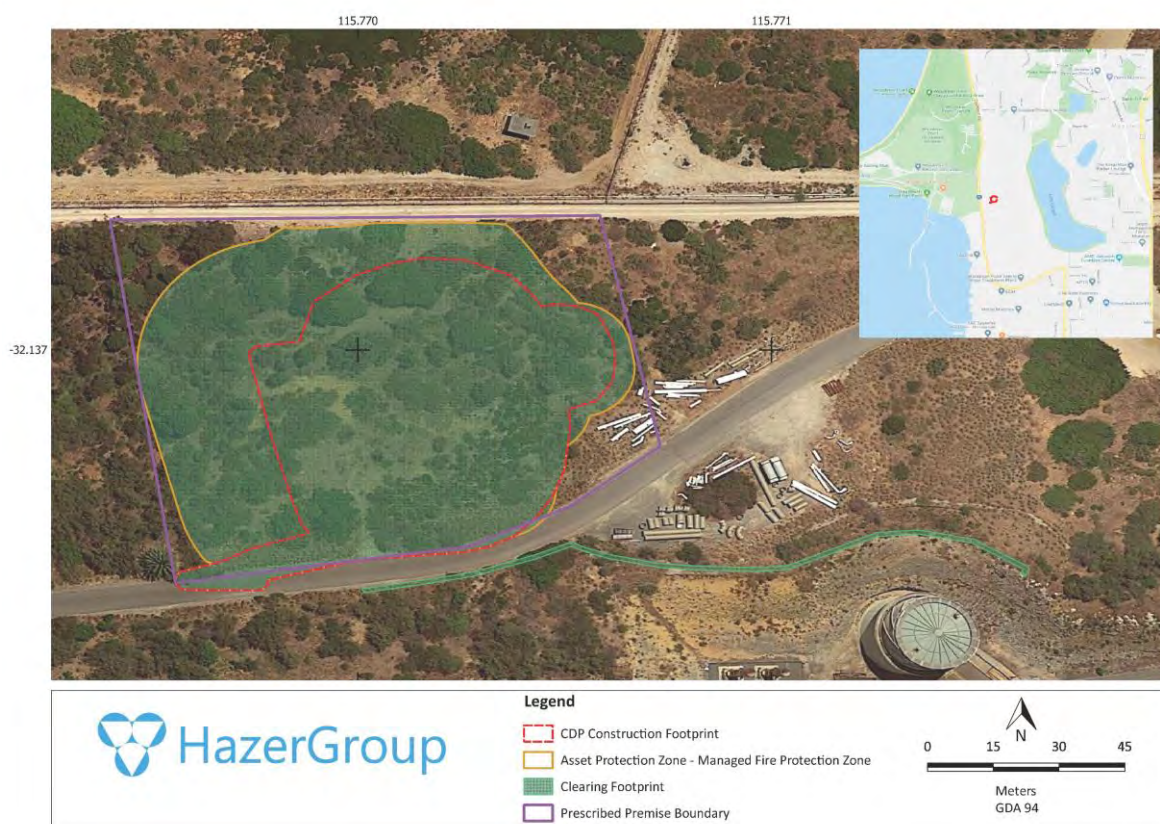


Figure 1 - Proposed Hazer CDP location and clearing application area

3. Biological Survey Methodology and Summary

3.1 Methodology

3.1.1 Desktop

A detailed desktop assessment was undertaken to define the existing environment and identify potential matters of conservation significance to target during the field survey. The desktop assessment was informed by publicly available information including Beard (2013) pre-European vegetation mapping, Hedde *et al.* (1980) vegetation complex mapping, soils and geology. Government databases were requested, and online sources consulted including:

- DBCA Threatened flora and fauna database records (with 12 km buffer)
- Western Australian Herbarium (WAH) records
- NatureMap
- Birdlife black cockatoo roosting database (Birdlife, 2018)
- Atlas of Living Australia (AoLA)
- EPBC Act Protected Matters Search Tool (PMST) database (corners of survey area with 10 km buffer).

All species of conservation significance were reviewed and their likelihood of occurrence determined.

3.1.2 Detailed Flora and Vegetation Survey

A detailed flora and vegetation assessment was undertaken utilising methods outlined in the EPA (2016a) Flora Survey Technical Guide. The field survey was undertaken on 20 November 2019. Data was collected from three quadrats and two relevés. Non-permanent 10 x 10 m quadrats were positioned using a measuring tape. Data collected from quadrats included the presence of plant species, their cover-abundance, structural composition of vegetation, physical environment, and presence/absence of disturbance.

3.1.3 FCT Analysis

Floristic data from the two quadrats were used to infer the Floristic Community Type (FCT) vegetation. Quadrats within the survey area were subject to one scoring event. This deviates from the two events recommended in the DPaw FCT draft analysis methods (2015) and it may cause a low similarity and reduce compatibility of the datasets.

The Keighery *et al.* (2012) SCP dataset was used for the FCT analysis. The survey area data was reconciled with this dataset and all species coded using the three first letters of the genus and species, reducing infraspecific names.

3.1.4 Fauna Survey

A reconnaissance fauna survey was undertaken simultaneously with the flora and vegetation survey. The survey primarily focused on mapping of fauna habitat and assessing the potential presence of conservation significant fauna. The fauna habitats were mapped by assessing changes in the various habitat features.

3.1.5 Targeted Black Cockatoo Survey

A targeted black cockatoo survey was conducted to identify potential breeding, roosting and foraging habitat for the two threatened Black Cockatoo species that are likely to occur in the survey area. These are Carnaby's Cockatoo *Calyptorhynchus latirostris* (Endangered under the EPBC Act and the BC Act), and the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii* subsp. *naso* (Vulnerable under the EPBC Act and the BC Act).

3.2 Summary

Ecological surveys were undertaken for the Hazer Project which included 1.95 ha located within the boundary of the Woodman Point WWTP. To assess the environmental values, a detailed flora and vegetation assessment, reconnaissance fauna survey, and targeted Black Cockatoo survey were conducted by AECOM on 20 November 2019.

A summary of the ecological surveys is presented below:

- The WA TEC SCP30a *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands was confirmed to occur in the survey area. This community is known to occur on Woodman Point. Its occurrence in the survey area was verified by FCT analysis and the floristic data collected from two quadrats. The TEC occupies 0.35 ha and is in Good condition.
- Vegetation condition was mostly mapped as Degraded (0.41 ha) or Completely Degraded (0.58 ha). Vegetation degradation is a result of historical clearing activities, weed invasion and presence of noxious garden escapees.
- No conservation significant flora species were recorded. Their absence is a reflection of vegetation degradation and unsuitable habitat. Most of the desktop flora species identified were associated with wetlands that occur nearby.
- Three fauna habitats were mapped. This habitat may be utilised by several (locally common) conservation significant fauna species including Carnaby's Cockatoo, Quenda, Perth Slider and Rainbow Bee-eater.
- Black Cockatoo foraging habitat was limited to 1.32 ha of Quality foraging habitat for Carnaby's Cockatoo. No Forest Red-tailed Black Cockatoo foraging species were present. One potential breeding tree was recorded, but this tree had no suitable hollows.

4. Environmental Impact Assessment

4.1 Threatened and Priority Flora

The desktop assessment identified 24 species of conservation significance (Threatened or Priority) that may occur within the survey area. These included:

- ten Threatened species listed under the EPBC Act and BC Act
- 14 Priority species under the BC Act.

Of the 24 species identified, only three are considered likely to occur, three may occur and the remaining 18 are considered unlikely to occur. The low likelihood of occurrence is primarily driven by lack of suitable habitat in the survey area which comprises coastal dunes with some limestone. Most of the DBCA database records in this area are associated with freshwater wetlands that occur 5 km east of the survey area.

No species listed as Threatened (T or X) under the BC Act or under the EPBC Act were recorded from within the survey area. No Priority flora species were recorded from the survey area.

4.2 Habitat and Biodiversity

The application area intersects the Department of Biodiversity and Conservation and Attractions (DBCA) buffer around a mapped area of the following Threatened Ecological Community (TEC):

- SCP30a *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain. This TEC is restricted to the Quindalup coastal dunes on white calcareous sands on the Swan Coastal Plain. The community's dominant indicator plant species include the Rottnest Island Pine (*Callitris preissii*), Rottnest Teatree (*Melaleuca lanceolata*), Basket Bush (*Spyridium globulosum*), *Acanthocarpus preissii*, Berry Saltbush (*Rhagodia baccata*), and occasionally Tuart (*Eucalyptus gomphocephala*). This TEC is currently listed as Vulnerable in WA (DBCA, 2018).

This buffer was created around large areas of the TEC that occur in the Woodman Point, Coogee Munster Bush Forever Site (BFS) 341 (WA Planning Commission, 2000) noting that the application area lies outside of this BFS boundary. The presence of *Callitris preissii* may be remnant or due to regeneration since the area was largely cleared in the 1960s (see (left; image sourced from Landgate Map Viewer Plus) (right; current image sourced from Bing)

Figure 2).



(left; image sourced from Landgate Map Viewer Plus) (right; current image sourced from Bing)

Figure 2 - View of the application area in 1965 (cleared) and 2019

4.3 Dieback and Weeds

When undertaking any clearing or other activity authorised under such Permit, Hazer and their contractors will ensure the following steps are implemented to minimise the risk of the introduction and spread of weeds and dieback:

- Clean earth-moving machinery of soil and vegetation prior to entering and leaving the area to be cleared;
- Ensure that no dieback or weed-affected soil, mulch, fill or other material is brought into the area to be cleared; and
- Restrict the movement of machines and other vehicles to the limits of the areas to be cleared.

5. Assessment Against the 10 Clearing Principles

Principle	Assessment	Variance Statement
Principle (a) Native vegetation should not be cleared if it comprises a high level of biological diversity.	The application area is small (0.86 ha) and based upon the vegetation survey undertaken by AECOM (2019), to account for the asset protection zone is comprised of; 3952 m² is in good condition with the remaining vegetation either degraded (2919 m²), completely degraded (1252 m²) or cleared (262 m²). The linear clearing area depicted in Figure 1 is associated with a feed gas pipeline that was not surveyed by AECOM in 2019. However, this area accounts for 180 m² and based upon site investigation is in a degraded condition mainly comprised of introduced species. Desktop investigation indicated three conservation significant flora species were likely to be present, however no species listed as Threatened (T or X) under the BC Act or under the EPBC Act were recorded during the detailed field survey. A total of 57 species from 52 genera and 30 families were recorded during the field survey. However, 25 of these were weed species representing 45 % of the flora diversity. FCT analysis indicates that one of the vegetation communities is likely to be a Threatened Ecological Community (TEC). However, weeds represent 50% of the total foliage cover, and 100% understorey strata foliage cover. As described in Principle (b) three fauna habitats were identified however due the presence of weed species and the quality of the habitat was reduced. Further to this, no significant fauna habitat, such as roosting trees for the Carnaby's Cockatoo were present within the area.	The proposed clearing is not likely to be at variance to this principle

Principle	Assessment	Variance Statement
	Based upon the high percentage of weed species present, low vegetation condition, lack of sensitive fauna habitat and limited clearing of the identified TEC (~1850 m ²), the application area is not considered to contain a high level of biodiversity.	
Principle (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.	Carnaby's cockatoo and Baudin's cockatoo are listed as endangered, with the forest red-tailed cockatoo listed as vulnerable under the EPBC Act (herein collectively referred to as black cockatoos). Black cockatoos breed in large hollow-bearing trees, generally within woodlands or forests or in isolated trees (Commonwealth of Australia, 2012). These species nest in hollows in live or dead trees of karri, marri, wandoo, tuart, salmon gum, jarrah, flooded gum, York gum, powder bark, bullich and blackbutt (Commonwealth of Australia, 2012). During the AECOM (2019) survey, black Cockatoo foraging species including <i>Banksia sessilis</i> and Pine trees were observed within the survey area. Although the vegetation is likely to be Black Cockatoo foraging habitat, no evidence of foraging was observed during the field survey. The survey area contains one <i>Eucalyptus rudis</i> potential breeding tree which had a DBH >500 mm however as it had no suitable hollows, no suitable roosting habitat was identified in the survey area. This tree is outside of the application area thus is not proposed to be cleared. Based upon the AECOM 2019 survey, it was calculated that the area of habitat suitable as foraging habitat required to be disturbed was expected to be in the order of ~6 874 m². In addition to Black cockatoos, the detailed field survey indicates that shrubland within the survey area would be utilised by many common mobile fauna species and conservation significant fauna species including Quenda <i>Isodon fusciventer</i>, Perth Slider <i>Lerista lineata</i> and Rainbow Bee-eater <i>Merops ornatus</i>.	The proposed clearing is not likely to be at variance to this principle

Principle	Assessment	Variance Statement
	It may also provide habitat for the and the Black-striped Snake <i>Neelaps calonotos</i>. Given these species are mobile, the application area is not expected to provide any specific sensitive habitat for sedentary species. The exclusion fence around the WWTP excludes larger mammals such as Tammar Wallaby <i>Notamacropus eugenii</i> from utilising the survey area. Given the above, the application area is not likely to contain significant habitat for fauna indigenous to Western Australia.	
Principle (c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	Desktop investigation indicated three conservation significant species were likely to be present, however no species listed as Threatened under the BC Act or under the EPBC Act were recorded during the detailed field survey. As such, the application is not known to support any rare flora.	The proposed clearing is not likely to be at variance to this principle
Principle (d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.	FCT analysis indicates that one of the vegetation communities is likely to be a Threatened Ecological Community (TEC). However, weeds represent 50% of the total foliage cover, and 100% understorey strata foliage cover. Refer to Section 4.2 for description of the buffer around TEC 'SCP30a <i>Callitris preissii</i> (or <i>Melaleuca lanceolata</i>) forests and woodlands, Swan Coastal Plain'. The presence of the application area within the TEC buffer is not considered an 'important occurrence' as per Department of Parks and Wildlife (2014) due to its small size: "Occurrences within Bush Forever sites, and occurrences with comparatively large intact areas of the community that are in relatively good condition outside of Bush Forever, are considered important occurrences. Occurrences that provide for representation of the community across its	The proposed clearing is at variance to this principle – but not significantly at variance to the principle



Principle	Assessment	Variance Statement								
	<i>geographic range and that can be managed for conservation and/or with conservation included in their purpose are also considered important.”</i> The extent to which the application area will impact on the TEC is limited to approximately ~1850 m² (or 22% of the application area) Weed and dieback management practices will ensure that the adjacent TEC located within the Bush Forever Site is not likely to be significantly impacted by the proposed clearing. Given the above, the proposed clearing is not likely to have a significant impact on the TEC, given that the noted occurrence is considered unimportant, and any disturbance is not expected to directly nor indirectly impact remaining occurrences given the small-scale activity within the defined buffer zone and through implementation of the associated management measures.									
Principle (e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	Three vegetation communities were described and mapped within the survey area including one heath, one woodland and one shrubland. The national objectives and targets for biodiversity conservation in Australia has a target to prevent clearance of ecological communities with an extent below 30 per cent of that present pre-1750, below which species loss appears to accelerate exponentially at an ecosystem level (Commonwealth of Australia, 2001). Based upon Heddle <i>et al.</i> (1980), one mapping vegetation complex was present within the area. Information regarding this community is provided below. <table><tr><th>Association</th><th>Description</th><th>Percent remaining on SCP</th><th>Percent remaining in the state</th></tr><tr><td></td><td></td><td></td><td></td></tr></table>	Association	Description	Percent remaining on SCP	Percent remaining in the state					The proposed clearing is not likely to be at variance to this principle
Association	Description	Percent remaining on SCP	Percent remaining in the state							



Principle	Assessment				Variance Statement
	998	Medium, woodland; Tuart	36.35	36.25	
	More broadly speaking, the application area is located within the Swan Coastal Plain IBRA bioregion, which retains >38% of its pre-European vegetation extent (Government of Western Australia, 2019). The application area represents <0.00002% of the pre-European extent and clearing will still not cause any significant change to the pre-European vegetation extent percent. As the application area is small (0.86 ha) of which only approximately 50% is in Good condition (AECOM, 2019) and as the entire area has been previously cleared, the vegetation within the application area is not considered to be significant as a remnant of native vegetation. Locally speaking, three vegetation communities were identified by AECOM as being present within the application area. These comprised: • Heath - XpLoLa Xanthorrhoea preissii, Banksia sessilis var. cygnorum and Leucopogon propinquus mid shrubland over *Lagurus ovatus, *Avena barbata and *Cenchrus setaceus low to tall open grassland over *Lotus angustissimus, Lomandra micrantha and Tricoryne elatior low open forbland. • Woodland - MIXpBm Melaleuca lanceolata, Callitris preissii, Eucalyptus lehmannii (PL) low woodland over Xanthorrhoea preissii, Calothamnus sanguineus and Rhagodia baccata mid sparse shrubland over *Briza maxima, *Lagurus ovatus and *Ehrharta longiflora low open grassland. Represents the				

Principle	Assessment	Variance Statement								
	WA TEC SCP30a Callitris preissii (or Melaleuca lanceolata) forest or woodlands. • Shrubland - LIAbLa • *Leptospermum laevigatum, Agonis flexuosa and Banksia sessilis var. cygnorum mid to tall shrubland over *Avena barbata, *Lagurus ovatus and *Briza maxima mid grassland over *Lotus angustissimus, *Wahlenbergia capensis and Tricoryne elatior low open forbland. Mid storey density varies from sparse to closed shrubland. With the exception of the Woodland – MIXpBm which was identified as being WA TEC SCP30a discussed earlier, other vegetation communities are well represented in the region. The area of these vegetation communities proposed to be impacted by this application is presented in the table below. <table><tr><th>Association</th><th>Area planned to be disturbed by this application</th></tr><tr><td>Heath - XpLoLa</td><td>848 m²</td></tr><tr><td>Woodland - MIXpBm</td><td>1850 m²</td></tr><tr><td>Shrubland - LIAbLa</td><td>4175 m²</td></tr></table>	Association	Area planned to be disturbed by this application	Heath - XpLoLa	848 m ²	Woodland - MIXpBm	1850 m ²	Shrubland - LIAbLa	4175 m ²	
Association	Area planned to be disturbed by this application									
Heath - XpLoLa	848 m ²									
Woodland - MIXpBm	1850 m ²									
Shrubland - LIAbLa	4175 m ²									
Principle (f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	No watercourses or wetlands have been recorded within the application area. Lake Coogee is located approximately 350 meters from the application area.	The proposed clearing is not likely to be at variance to this principle								

Principle	Assessment	Variance Statement
	Given the distance to this wetland, the application area is not likely to be growing in association with a wetland or watercourse.	
Principle (g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	The area proposed for clearing is small (0.86 ha) and a significant portion of this area will have hardstand (concrete) established as part of the civil works campaign, therefore providing a stable landform structure highly unlikely to result in appreciable land degradation.	The proposed clearing is not likely to be at variance to this principle
Principle (h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	According to available databases, the closest conservation area (Unnamed WA49220 Conservation Park) is located approximately 400 m from the application area. Given the distance to this conservation area, the proposed clearing is not likely to impact upon the environmental values of this area or those further afield.	The proposed clearing is not likely to be at variance to this principle
Principle (i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water	No watercourses or wetlands have been recorded within the application area. Lake Coogee is located approximately 350 meters from the application area. Given the distance to this wetland and small application area, the proposed clearing is not likely to cause deterioration in the quality of surface water. Similarly, the proposed clearing is not likely to have a significant impact on the quality of groundwater and/or lead to a perceptible rise in the water table.	The proposed clearing is not likely to be at variance to this principle
Principle (j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.	The sandy soils (with occasional limestone outcropping) identified over the application area are highly permeable and not prone to flooding. The proposed clearing is not likely to cause or exacerbate the incidence or intensity of flooding. Site drainage has been incorporated into the plant design to ensure localised flooding following rain fall is not exacerbated.	The proposed clearing is not likely to be at variance to this principle

6. Conclusions

This proposal outlines Hazer's application for a NVCP (Area Permit) in accordance with the EP Act to clear up to 0.86 ha of native vegetation to allow construction and operation of their hydrogen and graphite CDP. The following conclusions associated with the permit application are listed below:

- The use of biogas, which is normally flared, provides a significant net environmental benefit by capturing carbon (graphite) and producing a renewable energy source in hydrogen;
- Flora taxa within the application area are known to occur at other locations and are well represented outside of the proposed area;
- The presence of the TEC is not considered an 'important occurrence' as per the recovery plan - Department of Parks and Wildlife (2014) due to its small size;
- Impacts to fauna from the proposed clearing are expected to be minimal as the clearing permit area is comprised of a small area which is well represented locally and regionally and not considered to be a significant occurrence;
- The proposed clearing is not likely to be at significant variance to any of the clearing principles;
- Mature trees which with the potential to support black cockatoo nesting in the future will not be cleared;
- Weed and dieback hygiene protocols will be implemented during vegetation clearing and subsequent earthworks to minimise the risk of introduction or spread; and
- Disturbance to surrounding soil and other vegetation shall be kept to the minimum amount required.

7. References

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Appendix A - Woodman Point Commercial Demonstration Plant - Hazer Ecological Surveys

Hazer Ecological Surveys - Woodman Point WWTP

Hazer Ecological Surveys - Woodman Point WWTP

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Executive Summary

Hazer Group Limited propose to construct Commercial Demonstration Project to commercialise the 'Hazer Process'. The Project will require clearing of approximately 0.5 ha of native vegetation at the Woodman Point Waste Water Treatment Plant (WWTP) to build the facility.

Ecological surveys were completed for a 1.95 ha area to assess the environmental values of the native vegetation within and surrounding the area to be impacted. A desktop assessment, field survey and mapping exercise was undertaken to meet the Project objective. The results of the assessment will inform the design of the project footprint and be used for impact assessment applications.

The desktop assessment identified two Threatened Ecological Communities (TECs) that are known from Woodman Point including one Western Australian TEC SCP30a *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, and one Federal TEC Tuart (*Eucalyptus gomphocephala*) woodlands and forests listed under the Environment Protection Biodiversity Conservation Act (EPBC Act). The field survey confirmed the presence of the State TEC SCP30a which was supported by Floristic Community Type analysis of quadrat data, presence of indicator species, and proximity of survey area to a known TEC. The SCP30a TEC in the survey area represents a woodland, extending for 0.35 ha within the survey area. The vegetation was considered as Good condition. The Federal Tuart Woodlands TEC was not recorded within the survey area.

The remainder of the survey area was considered in Good or Degraded condition. Ground cover comprised entirely of perennial weedy grasses and herbs which have displaced all native species. Introduced shrubs including *Leptospermum laevigatum*, *Pinus radiata* and *Schinus terebinthifolius*.

Three of the 24 conservation significant flora species identified in the desktop assessment were considered likely to occur. This reflects the coastal habitat present in the survey area which is unsuitable for many of these species which prefer wetland habitat. No conservation significant flora species were recorded during the field survey.

Five conservation significant fauna species were considered likely to occur including Carnaby's Cockatoo, Forest Red-tailed Black Cockatoo, Quenda, Perth Slider and Rainbow Bee-eater. The three fauna habitats within the survey area are likely to provide suitable habitat for four of these species, excluding the Forest Red-tailed Black Cockatoo for which no foraging plants were present. The exclusion fence around the WWTP would prevent access for the Tamar Wallaby which is likely to occur in the local area.

The survey area contains one potentially suitable breeding tree (*Eucalyptus rudis*). No suitable hollows were recorded in the tree. No suitable roosting trees were recorded. Carnaby's Cockatoo Quality foraging habitat was assessed based on the presence of preferred foraging species. No foraging evidence was recorded in the field. Quality foraging habitat comprises 1.32 ha within the surveyed area. No Forest Red-tailed Black Cockatoo foraging habitat was recorded.

The ecological surveys for the Hazer Project were successfully completed in Spring, 2019. No limitations were identified that would have a significant impact on the interpretation of the survey results.

1.0 Introduction

1.1 Background

Hazer Group Limited (Hazer) is undertaking the commercialisation of the Hazer Process, a low-emission hydrogen and graphite production process to convert natural gas and methane into hydrogen and high quality graphite, using iron ore as a process catalyst.

The Commercial Demonstration Project (CDP) will be developed at the Woodman Point Waste Water Treatment Plant (WWTP). Clearing of approximately 0.5 ha of vegetation is required to construct the CDP. In order to provide flexibility for deciding on the precise location, surveys were extended to incorporate a 1.95ha area.

1.2 Location

The survey area is located within the suburb of Coogee in the City of Cockburn, approximately 22 km from Perth City, Western Australia (Figure 1).

1.3 Objectives

The objective of the ecological surveys was to define and map significant environmental values of the survey area. The results of the surveys will enable Hazer to adjust their clearing footprint to avoid significant values and inform the environmental impact assessment.



PROJECT ID 60617511 CREATED BY KW APPROVED BY FDW LAST MODIFIED 20 DEC 2019 N 1:3,000 (when printed at A4) DATUM GDA 1994 MGA Zone 50 0 25 50 75 Meters Data sources: 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, Streetpro	LEGEND Survey Area	Survey Area HAZER GROUP HAZER ECOLOGICAL SURVEY Figure 1
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2.0 Legislation

2.1 Overview

Table 1 summarises the key legislation and guidance governing the protection and management of Western Australia's conservation significant flora, fauna and communities.

Table 1 Relevant Legislation, Regulations and Guidance

Legislation	Purpose
Commonwealth of Australia	
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act)	Provides for the protection of the environment and the conservation of biodiversity.
EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species, (DSEWPAC, 2012)	These guidelines are intended to assist proponents in determining whether an action needs to be referred to the Australian Government. Definitions of habitat are provided as are criteria used to judge significant impact for these black Cockatoo species.
Western Australia	
<i>Biodiversity Conservation Act 2016</i> (BC Act)	This Act has replaced both the WC Act and the <i>Sandalwood Act 1929</i> . On 3 December 2016, several parts of the new Act were proclaimed by the State Governor in the Government Gazette. Provisions that replace those existing under the BC Act and <i>Sandalwood Act 1929</i> (including threatened species listings and controls over the taking and keeping of native species) and their associated Regulations will come into effect on 1 January 2019.
<i>Environmental Protection Act 1986</i> (EP Act)	Preventing, controlling and abating environmental harm and conserving, preserving, protecting, enhancing and managing the environment.
<i>Biosecurity and Agriculture Management Act 2007</i> (BAM Act)	Provides for the management, control and prevention of certain plants and animals, and for the protection of agriculture and related resources generally.
EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016a)	Provides guidance to ensure adequate flora and vegetation data of an appropriate standard are obtained and used in EIA.
EPA Technical Guidance – Terrestrial Fauna Surveys (EPA, 2016b)	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.
EPA Technical Guidance – Sampling Methods for Terrestrial Vertebrate Fauna, (EPA, 2016c)	Provides advice on fauna sampling techniques and methodologies for different regions of the State and the analysis, interpretation and reporting requirements for EIA.

2.2 Federal Legislation – EPBC Act

2.2.1 Matters of National Significance

The EPBC Act is the main piece of Federal legislation protecting biodiversity in Australia. All Matters of National Environmental Significance (MNES) are listed under the EPBC Act. These 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.

2.2.2 Flora and Fauna

Species at risk of extinction are recognised at a Commonwealth level and are categorised in one of six categories as outlined in Table 2.

Table 2 Categories of Species Listed under Schedule 179 of the EPBC Act

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.

Conservation	Code Category
CD	Conservation Dependent Taxa which at a particular time if, at that time: 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 the following subparagraphs are satisfied: - the species is a species of fish - 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 the plan of management is in force under a law of the Commonwealth or of a State or Territory cessation of the plan of management would adversely affect the conservation status of the species.

2.2.3 Vegetation Communities

Vegetation 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 federally listed TECs are described in Table 3.

Table 3 Categories of TECs that are listed under the EPBC Act

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.

2.3 Western Australian Legislation

2.3.1 Flora and Fauna

Threatened flora are plants which have been assessed as being at risk of extinction (DEC 2012). Under the BC Act, the Minister for the Environment may declare species of flora to be protected if they are considered to be in danger of extinction, rare or otherwise in need of special protection (WAH 1998). These categories are defined in Table 4.

Species that have not yet been adequately surveyed to warrant being listed under the BC Act, or are otherwise data deficient, are added to a Priority Lists under Priorities 1, 2 or 3 by the State Minister for Environment. 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 species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. Categories and definitions of Priority Flora and Fauna species are provided in Table 5.

Table 4 Conservation Codes for WA Flora and Fauna Listed under the *Biodiversity Conservation Act 2016*

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 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	Migratory birds protected under an international agreement 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.
CD	Special conservation
OS	Special protection for reasons other than those already mentioned

2.3.2 Vegetation Communities

Threatened Ecological Communities (TECs) are naturally occurring biological assemblages that occur in a particular type of habitat and that may be subject to processes that threaten to destroy or significantly modify the assemblage across its range. TECs are listed by both state and commonwealth legislation.

Vegetation communities in Western Australia are described as TECs if they have been endorsed by the Western Australian Minister for Environment following recommendations made by the Threatened Species Scientific Committee. Categories of TECs are defined in Table 6.

Department of Biodiversity, Conservation and Attractions (DBCA) maintains a database of state listed TECs which is available for online searches via their website. Possible TECs that do not meet survey criteria or are not adequately defined are listed as Priority Ecological Communities (PECs) under Priorities 1, 2 and 3. Ecological communities that are adequately known and are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. Conservation dependent communities are classified as Priority 5. PECs are endorsed by the Minister for Environment and are described in Table 7.

DBCA requires that all Priority and Threatened ecological communities are considered during environmental impact assessments and clearing permit applications.

There is currently no formal protection afforded to TECs or PECs listed at the state level.

Table 5 Conservation Codes for WA Flora and Fauna as listed by DBCA

Code	Category
P1	Priority One – Poorly Known Species Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2	Priority Two – Poorly Known Species Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	Priority Three – Poorly Known Species Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations 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 locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
P4	Priority Four – Rare, Near Threatened and other species in need of monitoring - 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. - Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. - Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Table 6 Conservation Codes for State Listed Ecological Communities

Code	Category
PD	Presumed Totally Destroyed
CR	Critically Endangered
EN	Endangered
VU	Vulnerable

Table 7 Categories for Priority Ecological Communities

Code	Category
P1	Priority One: poorly-known ecological communities
P2	Priority Two: poorly-known ecological communities
P3	Priority Three: poorly known ecological communities
P4	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.

2.3.3 Biosecurity and Agriculture Management Act 2007

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 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. Each organism listed under the BAM Act comes with certain legal / import requirements:

- 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.
- Permitted - s11. Permitted organisms may be subject to an import permit if they are potential carriers of high-risk organisms.
- Declared Pest - s22(2). Declared pests may be subject to an import permit if they are potential carriers of high-risk organisms, and may also be subject to control and keeping requirements once within Western Australia.
- Permitted, Requires Permit - r73. Regulation 73 permitted organisms may only be imported subject to an import permit.

Declared pests can be assigned to a C1, C2 or C3 control category under the Biosecurity and Agriculture Management Regulations 2013:

- 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 - 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 BAM Act.

2.3.4 Communities of Local, Regional and National Significance

Significant flora and vegetation units need to take into account a number of other features other than statutory listings in accordance with the Flora and Vegetation Environmental Factor Guideline (EPA, 2016a). These include the following:

- Restricted distribution
- Degree of historical impact from threatening processes
- A role as a refuge
- Providing an important function required to maintain ecological integrity of a significant ecosystem.

3.0 Existing Environment

3.1 Climate

The survey area is located in Perth which experiences a Mediterranean climate. A Mediterranean climate 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.

Rainfall data was obtained from the Jandakot Aero weather station (no. 9172; Figure 2). The climate data in the 12 months preceding the survey shows a fluctuating rainfall pattern, with the majority of the 12 months preceding the survey receiving below average rainfall. Temperature was generally on average in the 12 months preceding the survey.

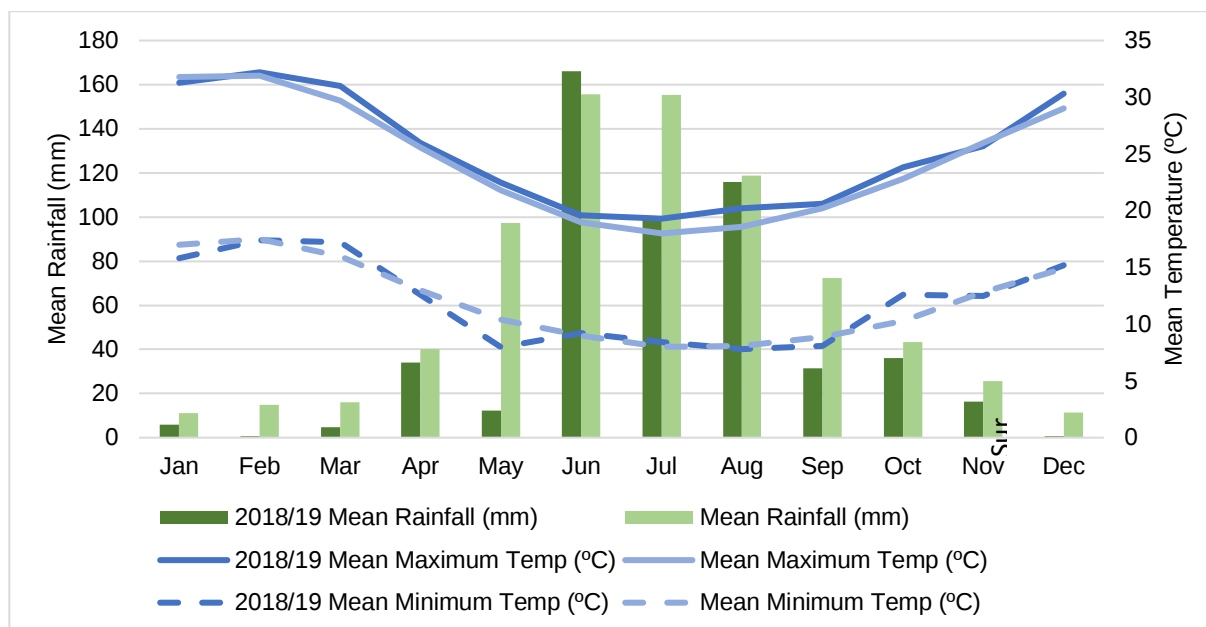


Figure 2 Rainfall data from weather station Jandakot Aero Station (station number 9172) showing mean monthly rainfall and rainfall received in the 12 months preceding the field survey (source: BOM, 2019)

3.2 IBRA Regions

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 (CALM 2002). The survey area lies within the Swan Coastal Plain IBRA region and, on a finer scale, within the Perth subregion (Mitchell *et al.* 2002).

The Perth subregion consists of alluvial river flats, colluvial and aeolian sands, and coastal limestone (Mitchell *et al.* 2002). Vegetation of the subregion comprises heath and/or Tuart (*Eucalyptus gomphocephala*) woodlands on limestone, Jarrah (*Eucalyptus marginata*) and *Banksia* woodlands on Quaternary marine dunes and Marri (*Corymbia calophylla*) on colluvial and alluvial sands. The subregion includes a complex chain of seasonal wetlands.

3.3 Vegetation

Beard (1981) undertook mapping of the Swan region and defined one broad vegetation type within the survey area (Table 8). This vegetation association is above the 30% critical threshold for clearing on the Swan Coastal Plain (Govt. of WA, 2018).

Heddle *et al.* (1980) completed more detailed mapping of the Perth region, mapping one vegetation complex within the survey area (Table 9).

Table 8 Beard (1981) pre-European vegetation within the survey area

Association	Description	Percent remaining on SCP	Percent remaining in the State
998	Medium woodland; Tuart	36.35	36.25

Table 9 Heddle *et al.* (1980) pre-European vegetation within the survey area

Association	Description
Cottesloe complex – central and south	Mosaic of woodland of <i>Eucalyptus gomphocephala</i> and open forest of <i>E. gomphocephala</i> – <i>E. marginata</i> – <i>E. calophylla</i> ; closed heath on the Limestone outcrops.

4.0 Methodology

4.1 Desktop Study

A detailed desktop assessment was undertaken to define the existing environment and identify potential matters of conservation significance to target during the field survey. The desktop assessment was informed by publicly available information including Beard pre-European vegetation mapping, Heddle *et al.* (1980) vegetation complex mapping, soils and geology. Government databases were requested and online sources consulted including:

- DBCA Threatened flora and fauna database records (with 12 km buffer)
- Western Australian Herbarium (WAH) records
- NatureMap
- Birdlife black cockatoo roosting database (Birdlife, 2018)
- Atlas of Living Australia (AoLA)
- EPBC Act Protected Matters Search Tool (PMST) database (corners of survey area with 10 km buffer).

All species of conservation significance were reviewed and their likelihood of occurrence determined using the three categories defined in Table 10.

Table 10 Categories of Likelihood of Occurrence for Species and Communities

Likelihood	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 survey 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 survey area however geographic location does not occur in survey area

4.2 Detailed Flora and Vegetation Survey

A detailed flora and vegetation assessment was undertaken utilising methods outlined in the EPA (2016a) Flora Survey Technical Guide. The assessment was completed by Floora de Wit (collection permit FB62000137). Floora de Wit has 13 years' experience undertaking flora and vegetation assessments. Floora completed a Bachelor of Science in Environmental Biology (Environmental Restoration) and completed a Postgraduate Diploma in Environmental Management and Impact Assessment.

The field survey was undertaken on 20 November 2019. Data was collected from three quadrats and two relevés. Non-permanent 10 x 10 m quadrats were using a measuring tape. 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 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 and size)
- photograph (northwest corner)
- soil details (type, colour, moisture)
- landform
- vegetation condition using the Keighery (1994) scale 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).

Vegetation communities were described and mapped as informed by field survey data. The National Vegetation Information System (NVIS) format for descriptions was applied to the Association level as prescribed in the Flora Survey Technical Guide.

Vegetation condition was mapped in accordance with the Keighery (1994) vegetation condition scale.

4.2.1 Floristic Community Type Analysis

Floristic data from the two quadrats were used to infer the Floristic Community Type (FCT) of the vegetation. Quadrats within the survey area were subject to one scoring event. This deviates from the two events recommended in the DPaW FCT draft analysis methods (2015) and it may cause a low similarity and reduce compatibility of the datasets.

The Keighery *et al.* (2012) SCP dataset was used for the FCT analysis. The survey area data was reconciled with this dataset and all species coded using the three first letters of the genus and species, reducing infra-specific names. All nomenclature of species followed the WA Plant Census.

The program PC Ord was used to undertake the Bray Curtis distance measure. The Bray Curtis dissimilarity measure was used to quantify the compositional dissimilarity between the quadrats based on presence absence data. Subtracting the results from 1 gives the similarity index, also known as the Bray Curtis index. This method is easily interpretable and provides meaningful results. A sense check was completed incorporating appropriate geology, soils, landscape and the description provided in the Gibson *et al.* (1994) reference material and Bush Forever (Government of WA, 2000).

4.3 Fauna Survey

A reconnaissance fauna survey was undertaken simultaneously with the flora and vegetation survey. The survey primarily focused on mapping of fauna habitat and assessing the potential presence of conservation significant fauna. The fauna habitats were mapped by assessing changes in the various habitat features.

Fauna habitats were assessed for specific habitat components, including consideration of structural diversity and refuge opportunities for fauna, in order to determine the potential for these habitats to support conservation significant species. Comparative fauna habitat assessments were completed across the survey area to confirm similarity of habitats already assessed elsewhere in detail.

4.4 Targeted Black Cockatoo Survey

A targeted black cockatoo survey was conducted to identify potential breeding, roosting and foraging habitat for the two threatened Black Cockatoo species that are likely to occur in the survey area. These are Carnaby's Cockatoo *Calyptrorhynchus latirostris* (Endangered under the EPBC Act and the BC Act), and the Forest Red-tailed Black Cockatoo *Calyptrorhynchus banksii* subsp. *naso* (Vulnerable under the EPBC Act and the BC Act). Surveys were conducted in accordance with DSEWPaC (2012) Referral Guidelines. The field survey was conducted by Floora de Wit on 20 November 2019.

4.4.1 Breeding Habitat

The black cockatoo breeding habitat assessment focussed on quantifying native breeding and potential breeding trees within the survey area. Potential breeding trees" are generally considered to be hollow-forming eucalypts with a Diameter at Breast Height (DBH) >500 mm (*Eucalyptus wandoo* >300 mm), with "breeding trees" containing potentially suitable hollows. Details collected for each tree included:

- location
- tree species
- DBH
- height
- number of potentially suitable hollows
- hollow details – including dimensions, height from ground, direction, type of hollow, evidence of use etc.

4.4.2 Roosting Habitat

Carnaby's Cockatoos roost in or near riparian environments or near other permanent water sources, generally within any tall trees, but particularly Flat-topped Yate, Salmon Gum, Wandoo, Marri, Karri, Blackbutt, Tuart, introduced eucalypts and introduced pines. The Forest Red-tailed Black Cockatoo prefers the edges of forests for roosting, within any tall trees, but particularly tall Jarrah, Marri, Blackbutt, Tuart and introduced eucalypt trees (DotEE, 2017). Potential roosting trees were searched for and assessed during the field survey.

4.4.3 Foraging Habitat

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 breeding and potential breeding trees, and proximity to confirmed roost and breeding sites (amongst others). These parameters were utilised by the DotEE (2017) to produce a draft quality of foraging habitat scoring system (Table 11). This scoring system was utilised to assess potential foraging habitat for black cockatoos throughout the survey area. Eight assessments were completed within the survey area.

The scoring tool is used by initially defining the quality of the overall habitat present (i.e. Very High Quality, High Quality, Quality and Low Quality) 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 unit.

Table 11 defines the levels of foraging habitat quality used during the assessment.

Table 11 Black Cockatoo Foraging Assessment Scoring

Score	Foraging Quality
1 – 3	Low Quality
4 – 6	Quality
7 – 8	High Quality
>8	Very High Quality

Table 12 Quality of Foraging Habitat Assessment Tool for Carnaby's Cockatoo and the Forest Red-tailed Black Cockatoo

Starting Score	Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo
10 – Very High Quality	Quality foraging habitat that is being managed for Black Cockatoos, including successful rehabilitation, and/or has some level of protection from clearing	Quality foraging habitat that is being managed for Black Cockatoos, including successful rehabilitation, and/or has some level of protection from clearing
7 – High 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 (not mallee) woodland and forest that is dominated by foraging species. Does not include orchards, canola, 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 – Quality	Pine plantation, mallee eucalypts, introduced eucalypts and /or native vegetation with foraging species that are not dominant	Introduced eucalypts, mallee eucalypts and /or native vegetation with foraging species that are not dominant, as well as the introduced Cape lilac (<i>Melia acedarach</i>)
1 – Low Quality	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	Jarrah and/or Marri shows good recruitment (i.e. evidence of young trees)
+3	Contains trees known to be used for breeding and / or with suitable nest hollows	Contains trees known to be used for breeding and / or with suitable nest hollows
+2	Primarily comprises 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)	
+1	Known to be a large or key roosting site	
Subtractions: Context adjustor – attributes reducing habitat quality		
-2	Does not contain evidence of foraging by species	
-2	No other foraging habitat within 6 km	
-1	Is >12km from known roosting site	
-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: DotEE (2017).

5.0 Survey Limitations

Limitations that may influence the ecological assessments have been addressed in Table 13.

Table 13 Limitations considered for the Project

Limitation	Flora and Vegetation Survey	Level 1 Fauna Survey
Availability of contextual information on the region	Nil Sufficient resources for the Swan Coastal Plain were available to provide contextual information including Beard (1981), Heddle <i>et al.</i> (1980) vegetation mapping, Perth @ 3.5 million (Government of WA, 2015) and the Gibson <i>et al.</i> (1994) and Keighery <i>et al.</i> (2012) swan coastal plain datasets.	Nil Sufficient contextual information is available on the Swan Coastal Plain and the survey area. Resources utilised to inform the level 1 fauna survey include the DBCA database, AoLA (2019), Naturemap, EPBC Act PMST and various field guides and publications.
Competency/experience of consultant conducting survey	Nil The flora and vegetation assessment was led by Floora de Wit who has more than 13 years' experience conducting surveys of similar scope.	Minor The fauna survey was undertaken by Floora de Wit whose primary focus is flora and vegetation. The fauna survey therefore focussed on defining fauna habitats and the likelihood that conservation significant fauna would utilise the survey area.
Proportion of flora/fauna identified, recorded and/or collected (based on sampling, timing and intensity)	Nil The flora and vegetation was represented by three quadrats and two relevés. The flora inventory would be more complete if additional scoring events were completed however it is unlikely that this would change the outcome of the survey.	Minor The fauna survey did not include creating a species inventory based on direct or indirect observations in the field. The fauna survey focusses primarily on mapping fauna habitats to assess the potential use of habitat by conservation significant species and assessing Black Cockatoo breeding and foraging habitat.
Completion (is further work needed)	Nil The objectives of the flora and vegetation survey were met in that significant environmental values were able to be recorded and mapped.	Nil The objectives of the fauna survey were met and no further work is required.
Remoteness and/or access problems	Nil The entire survey area was accessible on foot.	Nil The entire survey area was accessible on foot.
Timing, weather, season, cycle	Minor Rainfall was below average for several months preceding the field survey. This is not considered to have affected the outcome of the survey significantly.	Minor The survey was conducted during a period of reasonable weather in Spring.
Disturbances (e.g. fire flood, accidental human intervention) which affected results of the survey	Nil The flora and vegetation survey was not disrupted or impacted.	Nil The fauna survey was not disrupted or impacted.

6.0 Desktop Assessment Results

6.1 Threatened Ecological Community

The desktop assessment identified four Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) were identified in the desktop assessment as potentially occurring within the survey area (Table 14; Figure 3).

The buffer of two TECs overlap with the survey area including the WA listed SCP30a *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, and the federally listed Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain. Both TECs are considered likely to occur.

TECs and PECs identified by the DBCA database searches are mapped with a buffer of 200-500 m depending on their sensitivity to impacts and their conservation significance status. The presence of TEC and PEC buffers overlapping with the survey area can therefore be misleading.

Table 14 Threatened and Priority Ecological Communities Identified in the Desktop Assessment

Description	Cons. Status		Likelihood
	EPBC Act	WC Act	
Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region	-	P3	Unlikely, survey area represents coastal dune system.
<i>Callitris preissii</i> (or <i>Melaleuca lanceolata</i>) forests and woodlands, Swan Coastal Plain (SCP30a as originally described in Gibson et al. (1994))	-	VU	Likely, known occurrence on Woodman Point.
Northern Spearwood shrublands and woodlands	-	P3	May, several known locations nearby.
Tuart (<i>Eucalyptus gomphocephala</i>) woodlands and forests of the Swan Coastal Plain	CE	P3	Likely, known occurrence on Woodman Point.

6.2 Conservation Significant Flora

The desktop assessment identified 24 species of conservation significance (Threatened or Priority) that may occur within the survey area. These included:

- ten Threatened species listed under the EPBC Act and BC Act
- 14 Priority species under the BC Act.

Of the 24 species identified only three are considered likely to occur, three may occur and the remaining 18 are considered unlikely to occur. The low likelihood of occurrence is primarily driven by lack of suitable habitat in the survey area which comprises coastal dunes with some limestone. Most of the DBCA database records in this area are associated with freshwater wetlands that occur 5 km east of the survey area.

The desktop flora results are mapped on Figure 3. Species considered likely to occur, or may occur, are presented in Table 15. A comprehensive species list of the desktop flora results, including habitat, flowering period, latest count date and likelihood of occurrence is presented in Appendix A.

Table 15 Conservation Significant Flora Species that are Likely to or May Occur

Species	Conservation Status		Preferred Habitat	Likelihood
	EPBC Act	WC Act		
<i>Caladenia huegelii</i>	EN	CR	Grey or brown sand, clay loam.	Likely
<i>Dodonaea hackettiana</i>		P4	Outcropping limestone.	Likely
<i>Grevillea olivacea</i>		P4	White or grey sand. Coastal dunes, limestone rocks.	Likely
<i>Hibbertia spicata</i> subsp. <i>leptotheca</i>		P3	Sand. Near-coastal limestone ridges, outcrops & cliffs.	May
<i>Jacksonia sericea</i>		P4	Calcareous & sandy soils.	May
<i>Pimelea calcicola</i>		P3	Sand. Coastal limestone ridges.	May

6.3 Conservation Significant Fauna

The desktop fauna assessment identified 27 conservation significant fauna species that potentially occur within the survey area, including:

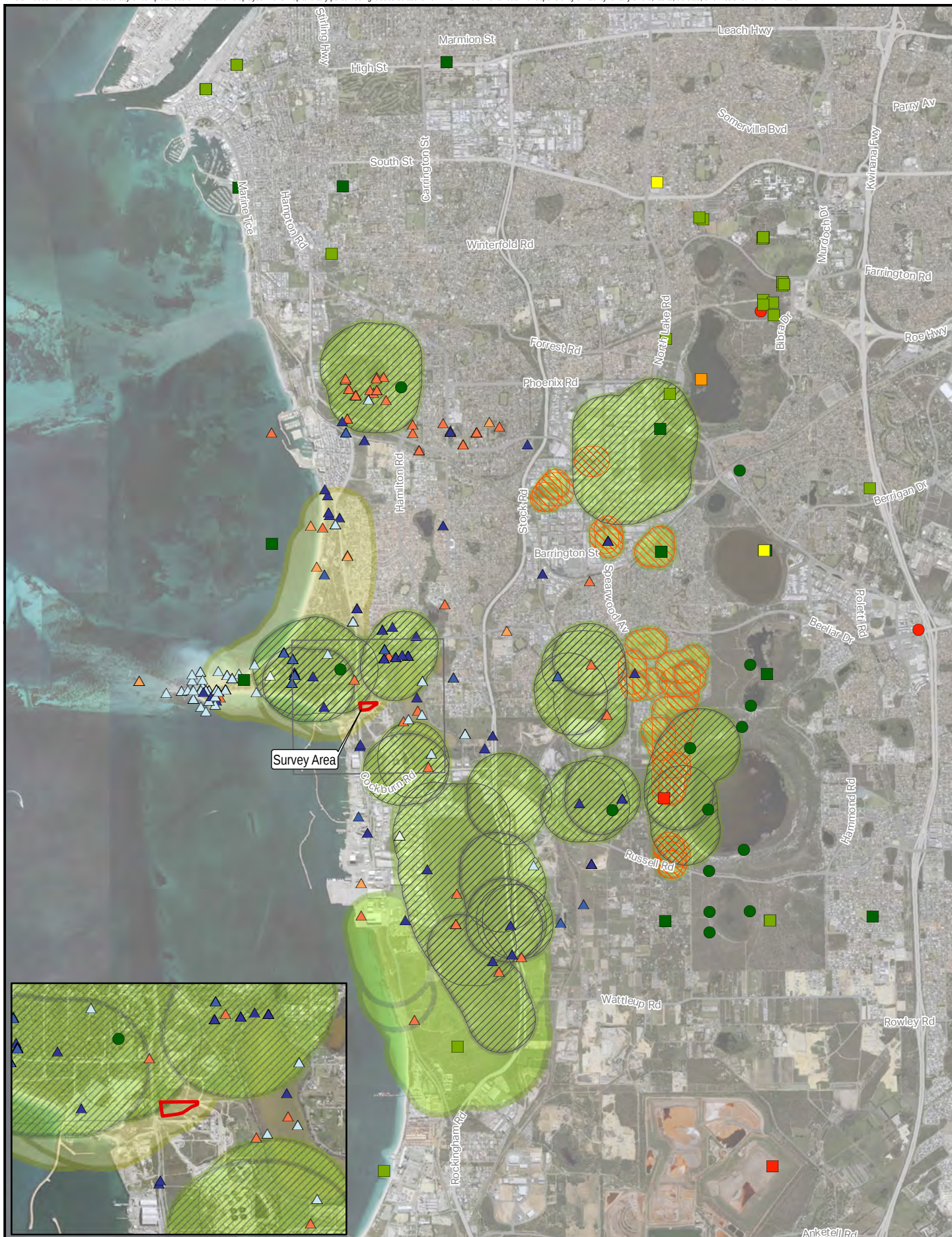
- five species that are likely to occur
- three species that may occur
- 19 species that are unlikely to occur.

The likelihood of occurrence of fauna species was determined by assessing the likely presence of suitable habitat in the survey area and reviewing the recent records and distribution of the species. The five species likely to occur in the survey area include three bird species, one mammal and one reptile and are described in Table 16.

Note: 64 bird species, 27 fish, 15 mammals, six reptiles, 4 sharks, 2 rays and 1 mussel were removed from the desktop assessment as they are marine or water-based animals that will not utilise the vegetation within the survey area.

Table 16 Conservation Significant Fauna Species Likely to Occur within the survey area

Species	Common Name	Cons. Codes		Ecology
		EPBC Act	BC Act	
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	VU	VU	The Forest Red-tailed Black Cockatoo is 55-60 cm in length and are mostly glossy black with a pair of black central tail feathers, a crest, robust bill and bright red, orange or yellow barring in the tail (Higgins, 1999). Males are distinguished by broad red tail panels that are only visible when taking off or alighting (Higgins, 1999). Requires tree hollows to nest and breed, occurs in forests of Karri (<i>Eucalyptus diversicolor</i>), Jarrah (<i>E. marginata</i>) and Marri (<i>Corymbia calophylla</i>), with flocks moving out onto the Swan Coastal Plain in search of food from exotic trees such as White Cedar (Johnstone <i>et al.</i> , 2010). Foraging habitat for the species consists of Jarrah and Marri woodlands and forest throughout its range. Has become more common in the Metropolitan area in the past few years.
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN	Carnaby's Cockatoo is a white-tailed black cockatoo endemic to the south-west of Western Australia. It is a postnuptial nomad and typically moves west soon after breeding. Breeding occurs mainly from early July to mid-December. There has been an apparent shift in its breeding range further west and south since the middle of last century (Johnstone <i>et al.</i> , 2010). The species nests in hollows in eucalypts, particularly Salmon Gum (<i>Eucalyptus salmonophloia</i>) and Wandoo (<i>E. Wandoo</i>), but nests have been found in other eucalypts including York Gum (<i>E. loxophleba</i>), Flooded Gum (<i>E. rudis</i>), Tuart (<i>E. gomphocephala</i>) and Marri (<i>Corymbia calophylla</i>) (Johnstone <i>et al.</i> , 2010). Breeding success is largely dependent on suitable feeding habitat adjacent to the nest site to provide the necessary food for the survival of the chick (Johnstone <i>et al.</i> , 2010). Diet consists of an array of Proteaceous and <i>Eucalyptus</i> species. Foraging habitat, including <i>Banksia</i> woodlands, is considered to be habitat critical to the survival of the species (Johnstone <i>et al.</i> , 2010).
<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. It is possible that this species will occupy open woodland areas within the survey area. The Rainbow Bee-eater avoids heavy forest that would hinder the pursuit of its insect prey (Morcombe, 2003).
<i>Isodon fusciventer</i>	Quenda	P4		The Quenda or Southern Brown Bandicoot exists only in a fragmented distribution to its former range in southern south western and eastern Australia. It is found in forest, woodland, heath and shrub communities in these regions. Preferred habitat usually consists of a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan, 2008).
<i>Lerista lineata</i>	Perth slider	P3		The Perth Lined Lerista is an underground dwelling skink, sheltering in leaf litter and upper layers of loose soil. It is typically found at the bases of shrubs, spoil heaps and stick ant nests (Bush <i>et al.</i> , 2010). The species inhabits sandy soils supporting Eucalypt/ <i>Banksia</i> woodland, coastal heath and low shrubland (Bush <i>et al.</i> , 2010; Wilson and Swan, 2010). There are no records of this species north of the Swan River on the Swan Coastal Plain (South Metro Connect, 2011).



PROJECT ID 60617511 CREATED BY KW APPROVED BY FDW LAST MODIFIED 20 DEC 2019 AECOM www.aecom.com N 1:75,000 (when printed at A4) DATUM GDA 1994 MGA Zone 50 0 0.5 1 1.5 2 Kilometres Data sources: 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, Streetpro	Project Area WA Herb Threatened Priority 1 Priority 2 Priority 3 Priority 4 Threatened and Priority Flora Database Threatened Priority 4 EPBC TEC Critically Endangered Endangered WA TEC / PEC Vulnerable Priority 3 Desktop Threatened Fauna Critically Endangered Endangered Vulnerable Specially Protected International Agreement Priority 3 Priority 4	Desktop Flora and Fauna Results HAZER GROUP HAZER ECOLOGICAL SURVEY Figure 3
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7.0 Field Survey Results

7.1 Vegetation

7.1.1 Threatened and Priority Ecological Communities

The TEC SCP30a *Callitris preissii* and *Melaleuca lanceolata* forest and woodland SCP30a (WA: Vulnerable) was identified in the desktop assessment as likely to occur with the buffer of this community overlapping with the survey area. The presence of this TEC was confirmed during the field survey.

SCP30a is restricted to the Quindalup coastal dunes on white calcareous sands and sometimes brown sands near Perth. The community's dominant plant species include the Rottnest Island pine (*Callitris preissii*), the Rottnest Island Teatree (*Melaleuca lanceolata*) and occasionally Tuart (*Eucalyptus gomphocephala*).

FCT analysis was undertaken for quadrats H01 and H02 which were potential representations of the SCP30a TEC with results presented in Table 17. Quadrat H01 was floristically similar (32%) to a SCP quadrat located at Woodman Point which is classified as the SCP30a TEC. Quadrat H02 results were unable to be accurately inferred using statistical analysis. Landform and location, presence of indicator species, and proximity to H01 was considered suitable evidence to suggest this quadrat also represents SCP30a.

The TEC is very prone to weed invasion and is easily degraded, with all known occurrences affected by weed invasion to some extent. In the survey area the TEC is represented by vegetation community MIXpBm (see Section 7.1.3) and extends for 0.35 ha. Weeds represent 50% of the total foliage cover, and 100% understorey strata foliage cover.

The Project dataset was not readily comparable to the SCP dataset, as demonstrated by the low similarity of the survey quadrats to any SCP quadrats. This reflects the degraded vegetation of the survey area, affected by partial clearing and weed invasion (see Section 7.1.5), and the survey effort (one scoring event in late November).

Table 17 Inferred FCT for Hazer Ecological Surveys – Woodman Point

Quadrat	Quadrat (FCT; % similarity)	Inferred FCT
H01	WOODP-1, FCT30a, 32% M4601, FCT S11, 32% Bold06, FCT 30a, 27% PRES-1, 29a, 25%	FCT30a <i>Callitris preissii</i> and <i>Melaleuca lanceolata</i> forest and woodland. Species diversity is similar to Project quadrat, <i>C. preissii</i> and <i>M. lanceolata</i> present, and occurs on the correct land system.
H02	Bold07, FCT24, 22% Possum5, FCT17, 21% Rowe01, FCT11, 21% Buck01, FCT24 20%	FCT30a <i>Callitris preissii</i> and <i>Melaleuca lanceolata</i> forest and woodland. <i>C. preissii</i> and <i>M. lanceolata</i> present. Does not align with FCT24, 17 or 11. Lower similarity due to displacement of natives from weeds and garden escape plants.

7.1.2 Vegetation Communities

Three vegetation communities were described and mapped within the survey area including one heath, one woodland and one shrubland. These communities were easily distinguishable from their floristic composition.

The communities, survey effort, extent, and photographs are presented in Table 18 and mapped in Figure 4.

Table 18 Vegetation communities recorded in the survey area

Description	Additional Detail	Photograph
Heath - XpLoLa <i>Xanthorrhoea preissii</i>, <i>Banksia sessilis</i> var. <i>cygnorum</i> and <i>Leucopogon propinquus</i> mid shrubland over <i>*Lagurus ovatus</i>, <i>*Avena barbata</i> and <i>*Cenchrus setaceus</i> low to tall open grassland over <i>*Lotus angustissimus</i>, <i>Lomandra micrantha</i> and <i>Tricoryne elatior</i> low open forbland.	Survey effort: quadrat H04 Extent: 0.09 ha Species richness: 17 native and ten weed species Condition: Good	
Woodland - MIXpBm <i>Melaleuca lanceolata</i>, <i>Callitris preissii</i>, <i>Eucalyptus lehmannii</i> (PL) low woodland over <i>Xanthorrhoea preissii</i>, <i>Calothamnus sanguineus</i> and <i>Rhagodia baccata</i> mid sparse shrubland over <i>*Briza maxima</i>, <i>*Lagurus ovatus</i> and <i>*Ehrharta longiflora</i> low open grassland. Represents the WA TEC SCP30a <i>Callitris preissii</i> (or <i>Melaleuca lanceolata</i>) forest or woodlands.	Survey effort: quadrat H01 and H02 Extent: 0.35 ha Species richness: 16 native and 13 weed species Condition: Good	

Description	Additional Detail	Photograph
Shrubland - LIAbLa <i>*Leptospermum laevigatum</i>, <i>Agonis flexuosa</i> and <i>Banksia sessilis</i> var. <i>cygnorum</i> mid to tall shrubland over <i>*Avena barbata</i>, <i>*Lagurus ovatus</i> and <i>*Briza maxima</i> mid grassland over <i>*Lotus angustissimus</i>, <i>*Wahlenbergia capensis</i> and <i>Tricoryne elatior</i> low open forbland. Mid storey density varies from sparse to closed shrubland.	Survey effort: quadrat H03 and relevé H05 Extent: 0.93 ha Species richness: 19 native and 16 weed species Condition: Good to Degraded	

7.1.3 Vegetation Condition

Vegetation condition in the survey area is degraded. Some patches that were further from the edge of the remnant vegetation block were considered in Good condition. The rest of the area was considered Degraded or Completely Degraded. Vegetation condition is mapped in Figure 4.

The survey area is isolated from adjacent native vegetation by roads, exclusion fences for the waste water treatment plant, and cleared areas. Parts if not most of the patch has been cleared previously, perhaps more than 20 years ago.

Degradation was caused by partial historical clearing, weed invasion including thickets of roadside escapee **Leptospermum laevigatum*, and rubbish dumping (one location).

Table 19 Vegetation condition and extent

Condition Rating	Area (ha)
Good	0.67
Degraded	0.41
Completely Degraded	0.58
Cleared (hardstand)	0.30



Plate 1 Invasive high impact weeds are common throughout the survey area



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LEGEND

Survey Area

Vegetation Communities

LIAbLa

MIXpBm

Weeds

XpLoLa

Cleared

SCP30a: WA TEC *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain

Vegetation Condition

Good

Degraded

Completely Degraded

Cleared

Vegetation Community & Vegetation Condition

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HAZER ECOLOGICAL SURVEY

Figure

4

Map Document: \\AUPER1FP001\AU.AECOMNET.COM\Projects\606X\60617511\900_CAD_GIS\920_GIS\02_MXD\01_Report\Figures\G60617511_Fig6_VegComm_Cond_A4P_v1.mxd (WyattK2)

A4 size

7.2 Flora

No species listed as Threatened (T or X) under the BC Act or under the EPBC Act were recorded from within the survey area. No Priority flora species were recorded from the survey area

A total of 57 species from 52 genera and 30 families were recorded during the field survey.

Twenty-five weed species were recorded representing 45 % of the flora diversity. None of the weed species are listed under the BAM Act as Declared Pests. **Lagarus ovatus* and **Avena barbata* were the dominant ground stratum species, occurring in all the quadrats and relevés. Hardy perennial shrubs were also present including **Leptospermum laevigatum*, **Pinus radiata*, **Schinus terebinthifolius*, and **Ricinus communis*.

The species list and the communities they occur in is presented in Appendix B. Qualitative data recorded from quadrats and relevé is presented in Appendix C.

7.3 Fauna Habitats

Three fauna habitats have been defined and mapped within the survey area (Table 20; Figure 5). The most common fauna habitat is Shrubland at 0.98 ha. This habitat contains mid to tall introduced shrubs mixed with native species. This habitat would be utilised by many common mobile fauna species and conservation significant fauna species such as the Carnaby's Cockatoo *Calyptorhynchus latirostris*, Quenda *Isoodon fusciventer*, Perth Slider *Lerista lineata* and Rainbow Bee-eater *Merops ornatus*. It may also provide habitat for the and the Black-striped Snake *Neelaps calonotos*.

The exclusion fence around the WWTP excludes larger mammals such as Tammar Wallaby *Notamacropus eugenii* from utilising the survey area.

Table 20 Fauna Habitats of the survey area

Habitat	Description	Conservation Significant Species Potentially Utilising Habitat	Area (ha)	Photos
Woodland	This habitat contains low woodland of <i>Melaleuca lanceolata</i>, <i>Callitris preissii</i> and <i>Eucalyptus lehmannii</i> over a sparse understorey shrubs and weedy grasses on sandy soils. Minimum litter cover. The habitat is considered moderate quality due to its complexity and variability, but reduced due to the presence of weeds and little understorey or litter cover.	- Foraging habitat for Forest Red-tailed Black Cockatoo and Carnaby's Cockatoo - Habitat for the Quenda - Habitat for the Rainbow Bee-eater - Habitat for the Perth Slider	0.35	
Shrubland	This habitat contains a varied density tall shrubland from thicket to open shrubland. Groundcover comprises weedy grasses and herbs. This habitat is considered of moderate quality due to its variability and complexity, but reduced due to presence of weeds.	- Low quality foraging habitat for Carnaby's Cockatoo - Habitat for Quenda - Habitat for the Rainbow Bee-eater - Habitat for the Perth Slider	0.98	

Habitat	Description	Conservation Significant Species Potentially Utilising Habitat	Area (ha)	Photos
Grassland	Habitat generally comprises of bare soil and / or weeds (may contain the occasional shrub / tree). Habitat is considered very low quality.	Habitat for the Rainbow Bee-eater	0.33	



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Meters

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LEGEND

Survey Area

Potential Black Cockatoo Breeding Tree

Fauna Habitat

Woodland

Grassland

Shrubland

Hardstand

Carnaby Foraging Quality

Quality

Black Cockatoo Foraging and Breeding Habitat

HAZER GROUP

HAZER ECOLOGICAL SURVEY

Figure

6

Map Document: \\AUPER1\FP001\AU.AECOM\NET\COM\Projects\606X\60617511\900_CAD_GIS\920_GIS\02_MXD\01_Report\Figures\G60617511_Fig7_Fauna_BCTrees_A4P_v1.mxd (WyattK2)

A4 size

7.4 Black Cockatoos

The survey area contains one *Eucalyptus rudis* potential breeding tree which had a DBH >500 mm. No potentially suitable hollows were identified (Table 21; Figure 6).

No suitable roosting habitat was identified in the survey area. Roosting habitat for the Carnaby's Cockatoo includes the tallest trees in the landscape in or near riparian environments or near other permanent water sources. 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 number of broken branches on the ground.

The survey area contains 1.32 ha of Quality foraging habitat for Carnaby's Cockatoo. This comprised of woodland and shrublands that include Myrtaceae and Proteaceae species. Carnaby's foraging habitat is mapped in Figure 6. No Carnaby's Cockatoo foraging evidence was recorded.

No suitable Forest Red-tailed Black Cockatoo foraging habitat was recorded in the survey area.

Table 21 Black cockatoo potential breeding trees in the survey area

ID	Species	Height (m)	DBH (cm)	No. of Potentially Suitable Hollows	Photographs
1	<i>Eucalyptus rudis</i> (Flooded Gum)	17	600	0	



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Data sources:

DATUM GDA 1994 MGA Zone 50

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LEGEND

Survey Area

Vegetation Communities

LIAbLa

MIXpBm

Weeds

XpLoLa

Cleared

SCP30a: WA TEC *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain

Vegetation Condition

Good

Degraded

Completely Degraded

Cleared

Vegetation Community & Vegetation Condition

HAZER GROUP

HAZER ECOLOGICAL SURVEY

Figure

7

Map Document: \\AUPER1FP001\AU.AECOMNET.COM\Projects\606X\60617511\900_CAD_GIS\920_GIS\02_MXD\01_Report\Figures\G60617511_Fig6_VegComm_Cond_A4P_v1.mxd (WyattK2)

A4 size

8.0 Conclusions

Ecological surveys were undertaken for the Hazer Project which included 1.95 ha located within the boundary of the Woodman Point WWTP. To assess the environmental values, a detailed flora and vegetation assessment, reconnaissance fauna survey, and targeted Black Cockatoo survey were conducted by Floora de Wit on 20 November 2019.

A summary of the ecological surveys is presented below:

- The WA TEC SCP30a *Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands was confirmed to occur in the survey area. This community is known to occur on Woodman Point. Its occurrence in the survey area was verified by FCT analysis and the floristic data collected from two quadrats. The TEC occupies 0.35 ha and is in Good condition.
- Vegetation condition was mostly mapped as Degraded (0.41 ha) or Completely Degraded (0.58 ha). Vegetation degradation is a result of historical clearing activities, weed invasion and presence of noxious garden escapees.
- No conservation significant flora species were recorded. Their absence is a reflection of vegetation degradation and unsuitable habitat. Most of the desktop flora species identified were associated with wetlands that occur nearby.
- Three fauna habitats were mapped. This habitat may be utilised by several (locally common) conservation significant fauna species including Carnaby's Cockatoo, Quenda, Perth Slider and Rainbow Bee-eater.
- Black Cockatoo foraging habitat was limited to 1.32 ha of Quality foraging habitat for Carnaby's Cockatoo. No Forest Red-tailed Black Cockatoo foraging species were present. One potential breeding tree was recorded, but this tree had no suitable hollows.

The ecological surveys were completed without significant limitations. No additional surveys are recommended at this time.

9.0 References

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Appendix A

Desktop Assessment Results

[Appendix A1: Flora](#)

[Appendix A2: Fauna](#)

Appendix A1 - Flora Desktop Assessment Results

Taxon	Cons. Stat		Count	Record Date	Habitat	Flowering Period	Likelihood
	WA	EPBC					
<i>Acacia lasiocarpa</i> var. <i>bracteolata</i> long peduncle variant (G.J. Keighery 5026)	P1			1957	Grey or black sand over clay. Swampy areas, winter wet lowlands.	May-Aug	Unlikely to occur
<i>Andersonia gracilis</i>	VU	EN			White/grey sand, sandy clay, gravelly loam. Winter-wet areas, near swamps.	Oct-Nov	Unlikely to occur
<i>Austrostipa mundula</i>	P3			1967	No information available.	Sep-Oct	Unlikely to occur
<i>Caladenia huegelii</i>	CR	EN	61	2014	Grey or brown sand, clay loam.	Aug-Oct	Likely to occur
<i>Dampiera triloba</i>	P3			2015	Wetlands, peaty soils.	Aug-Dec	Unlikely to occur
<i>Diuris drummondii</i>	VU	VU		1959	Low-lying depressions, swamps.	Nov-Dec	Unlikely to occur
<i>Diuris micrantha</i>	VU	VU		1985	Winter-wet swamps, in shallow water.	Aug-Oct	Unlikely to occur
<i>Diuris purdiei</i>	EN	EN			Grey-black sand, moist. Winter-wet swamps.	Sep-Oct	Unlikely to occur
<i>Dodonaea hackettiana</i>	P4		95	2005	Outcropping limestone.	Jul-Oct	Likely to occur
<i>Drakaea elastica</i>	CR	EN			White or grey sand. Low-lying situations adjoining winter-wet swamps.	Oct-Nov	Unlikely to occur
<i>Drakaea micrantha</i>	EN	VU			White-grey sand.	Sep-Oct	Unlikely to occur
<i>Eleocharis keigheryi</i>	VU	VU			Clay, sandy loam. Emergent in freshwater: creeks, claypans.	Aug-Nov	Unlikely to occur
<i>Grevillea olivacea</i>	P4			1993	White or grey sand. Coastal dunes, limestone rocks.	Jun-Aug	Likely to occur
<i>Hibbertia spicata</i> subsp. <i>leptotheca</i>	P3			1897	Sand. Near-coastal limestone ridges, outcrops & cliffs.	Jul-Oct	May occur
<i>Jacksonia gracillima</i>	P3			1994	Winter wet flats.	Oct-Nov	Unlikely to occur
<i>Jacksonia sericea</i>	P4			1902	Calcareous & sandy soils.	Oct-Jan	May occur
<i>Lepidosperma rostratum</i>	EN	EN			Peaty sand, clay.	Aug	Unlikely to occur
<i>Microtis quadrata</i>	P4			1960	Seasonally wet depressions and in swampy mounds in near-coastal areas	Dec-Jan	Unlikely to occur
<i>Phlebocarya pilosissima</i> subsp. <i>pilosissima</i>	P3			1978	White or grey sand, lateritic gravel.	Aug-Sep	Unlikely to occur
<i>Pimelea calcicola</i>	P3			1999	Sand. Coastal limestone ridges.	Sep-Nov	May occur
<i>Stylidium longitubum</i>	P4			1973	Sandy clay, clay. Seasonal wetlands.	Oct-Dec	Unlikely to occur
<i>Stylidium paludicola</i>	P3			1974	Peaty sand over clay. Winter wet habitats. Marri and Melaleuca woodland, Melaleuca shrubland.	Oct-Dec	Unlikely to occur
<i>Thelymitra dedmaniarum</i>	CR	EN			Granite.	Nov-Jan	Unlikely to occur
<i>Thelymitra variegata</i>	P2			1959	Sandy clay, sand, laterite.	Jun-Sep	Unlikely to occur

Appendix A2 - Fauna Desktop Assessment Results

Scientific Name	Common Name	Cons. Status		Record Date	DBCA Count	Habitat	Likelihood
		WA	EPBC				
Birds							
<i>Apus pacificus</i>	Fork-tailed Swift	MI	MI			The Fork-tailed Swift is almost exclusively aerial, and a non-breeding visitor to Australia (DotE, 2015). They are rarely seen roosting on land.	Unlikely to occur
<i>Ardea ibis</i>	Cattle Egret		Marine			The Cattle Egret is a small egret weighing only 390g and standing 70cm tall. The heaviest distribution of this species in WA is in the north east, and into the Northern Territory. In the non-breeding season, it can be found throughout most of Australia (DotE, 2015).	Unlikely to occur
<i>Calyptorhynchus banksii naso</i>	Forest Red-tailed Black Cockatoo	VU	VU	2017	36	The Forest Red-tailed Black Cockatoo is 55-60 cm in length, and are mostly glossy black with a pair of black central tail feathers, a crest, robust bill and bright red, orange or yellow barring in the tail (Higgins, 1999). Males are distinguished by broad red tail panels that are only visible when taking off or alighting (Higgins, 1999). Requires tree hollows to nest and breed, occurs in forests of Karri (<i>Eucalyptus diversicolor</i>), Jarrah (<i>E. marginata</i>) and Marri (<i>Corymbia calophylla</i>), with flocks moving out onto the Swan Coastal Plain in search of food from exotic trees such as White Cedar (Johnstone <i>et al.</i> , 2010). Foraging habitat for the species consists of Jarrah and Marri woodlands and forest throughout its range. Has become more common in the Metropolitan area in the past few years.	Likely to occur
<i>Calyptorhynchus baudinii</i>	Baudinii's Cockatoo	EN	EN			Baudin's Cockatoo is a large cockatoo that measures 50–57 cm in length, with a wingspan of approximately 110 cm. Mostly dull black in colour, with pale whitish margins on the feathers (Higgins, 1999). Habitat critical to the survival of this species includes forests of Karri (<i>E. diversicolor</i>), Jarrah (<i>E. marginata</i>) and Marri (<i>C. calophylla</i>), in areas of 600 mm average rainfall per year. Individuals typically move north through the Perth region from March to May and south through the Perth region from August to October. This species ranges north to Gidgegannup and Hoddy Well and west to the Eastern Strip of the Swan Coastal Plain including West Midland in the north, heading south through Armadale, Byford and south and towards the coast until Lake Clifton where it continues to hug the coastline to east of Albany (Johnstone <i>et al.</i> , 2010). Breeding has been recorded to the south-west of the area bounded by Leschenault, Collie and Albany (DSEWPac, 2012), with the most northerly record at Lowden, near Donnybrook (Johnstone & Storr, 1998). Breeding has also been recorded at Serpentine (hills area), and east to Kojonup and near Albany (Johnstone & Kirkby, 2008).	May occur
<i>Calyptorhynchus latirostris</i>	Carnaby's Cockatoo	EN	EN	2016	4311	Carnaby's Cockatoo is a white-tailed black cockatoo endemic to the south-west of Western Australia. It is a postnuptial nomad and typically moves west soon after breeding. Breeding occurs mainly from early July to mid-December. There has been an apparent shift in its breeding range further west and south since the middle of last century (Johnstone <i>et al.</i> , 2010). The species nests in hollows in eucalypts, particularly Salmon Gum (<i>Eucalyptus salmonophloia</i>) and Wandoo (<i>E. Wandoo</i>), but nests have been found in other eucalypts including York Gum (<i>E. loxophleba</i>), Flooded Gum (<i>E. rudis</i>), Tuart (<i>E. gomphocephala</i>) and Marri (<i>Corymbia calophylla</i>) (Johnstone <i>et al.</i> , 2010). Breeding success is largely dependent on suitable feeding habitat adjacent to the nest site to provide the necessary food for the survival of the chick (Johnstone <i>et al.</i> , 2010). Diet consists of an array of Proteaceous and <i>Eucalyptus</i> species. Foraging habitat, including <i>Banksia</i> woodlands, is considered to be habitat critical to the survival of the species (Johnstone <i>et al.</i> , 2010).	Likely to occur

Appendix A2 - Fauna Desktop Assessment Results

Scientific Name	Common Name	Cons. Status		Record Date	DBCA Count	Habitat	Likelihood
		WA	EPBC				
<i>Chlidonias leucopterus</i>	White-winged Black Tern	MI	MI			In Western Australia, the species is widespread on the southern west coast, mainly from Ballingup and the estuary of Vasse River north to Mongers Lake, and also on coasts of the Pilbara region and Kimberley Division, with occasional records farther inland, mainly along major river systems, such as the Ord. The species only rarely occurs in the Gascoyne Region of the central-western coast, and is occasionally recorded along the southern coast, for example a single bird was recorded at Eyre Bird Observatory in October 1980 (Johnstone & Storr 1998).	Unlikely to occur
<i>Falco peregrinus</i>	Peregrine Falcon	OS		2005	3	The Peregrine Falcon is a medium-sized raptor (length 35-55cm; wingspan 80-105cm) with slate-grey back, a striking charcoal black head and face which contrast with a pale cream bib on the neck and breast (Birdlife Australia, 2018). A well-known falcon, the Peregrine inhabits a vast array of environs in Australia. Usually uncommon and migratory (Pizzey & Knight, 2007). This species lays its eggs in recesses of cliff faces, tree hollows or large abandoned nests (Bamford, 2009)	Unlikely to occur
<i>Larus novaehollandiae</i>	Silver Gull		Marine			The Silver Gull occurs across much of the Western Australian Coast and islands and is a casual visitor inland (Johnstone & Storr, 1998).	Unlikely to occur
<i>Larus pacificus</i>	Pacific Gull		Marine			The Pacific Gull typically occurs across most of the west coast of Western Australia from Point Quobba, south to Wedge Island (Johnstone & Storr, 1998).	Unlikely to occur
<i>Leipoa ocellata</i>	Malleefowl	VU	VU			The Malleefowl is a large, ground-dwelling bird with strong feet and a short bill. It is found principally in the semi-arid to arid zone in shrublands and low woodlands dominated by mallee and associated habitats such as such as Broombush (<i>Melaleuca uncinata</i>) and Scrub Pine (<i>Callitris verrucosa</i>). In WA Malleefowl distribution was associated with landscapes that had lower rainfall, greater amounts of mallee and shrubland that occur as large remnants, and lighter soil surface textures (Benshemesh, 2007). At a finer scale, malleefowl occurrence was associated with mallee/shrubland and thicket vegetation with woodland representing poor habitat for the species (Parsons, 2008).	Unlikely to occur
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	MI	MI			Broad-billed Sandpiper occur around the coast and are widespread inland. In Western Australia they are common from Cape arid to the south-west Kimberley region.	Unlikely to occur
<i>Limosa lapponica baueri</i>	Bar-tailed Godwit (baueri)	VU	VU			The bar-tailed godwit (western Alaskan) is a large migratory shorebird. It has a length around 37-39 cm, a wingspan of 62-75 cm and body mass between 250 - 450 g. It has a long neck with a very long upturned bill which is characterized by a dark tip and pinkish base. The bar-tailed godwit has been recorded in the coastal areas of all Australian states. In Western Australia it is widespread around the coast, from Eyre to Derby. Populations have also been recorded in the northern Australia, from Darwin east to the Gulf of Carpentaria. The migratory bar-tailed godwit (western Alaskan) does not breed in Australia (DotE, undated).	Unlikely to occur
<i>Limosa limosa</i>	Black-tailed Godwit	MI	MI			The Black-tailed Godwit is found in all states and territories of Australia however it typically inhabits coastal regions and is concentrated in the north of the country. It can be found elsewhere although is usually present in lower numbers (DotE, 2015).	Unlikely to occur
<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. It is possible that this species will occupy open woodland areas within the survey area. The Rainbow Bee-eater avoids heavy forest that would hinder the pursuit of its insect prey (Morcombe, 2003).	Likely to occur

Appendix A2 - Fauna Desktop Assessment Results

Scientific Name	Common Name	Cons. Status		Record Date	DBCA Count	Habitat	Likelihood
		WA	EPBC				
<i>Numenius phaeopus</i>	Whimbrel	MI	MI			The Whimbrel occurs all along the Australian coast and inhabits estuaries, mangroves, tidal flats, flooded paddocks, and bare grasslands (Pizzey & Knight 2007)	Unlikely to occur
<i>Pachyptila turtur subantarctica</i>	Fairy Prion (southern)		Marine			The burrows of fairy prions (southern) are usually in crevices, in hollows beneath cushions of <i>Colobanthus muscoides</i> (a perennial herb that can form dense mats or cushions up to 250 mm thick and sometimes up to several metres across) or in burrows in peaty soil held together by a thick cover of <i>Cotula plumosa</i> (a short, feathery perennial herb) (Brothers 1984). Fairy prions (southern) build their nests in a dry nest-chamber (about 30 cm across) at the end of a burrow, or, if there is no suitable chamber at the end, about three-quarters of the way along a rock crevice. Crevices are usually large enough for only one adult, but some larger nest chambers support a number of pairs. The nest is usually lined with fallen leaves and sometimes twigs.	Unlikely to occur
<i>Sterna dougallii</i>	Roseate Tern	MI	MI			The Roseate Tern is relatively small, the smallest of all "commic" terns (meaning similar to the Common Tern), with long white tail streamers and a long black bill, occasionally with red on the base (Pizzey & Knight, 2007; Morcombe, 2003). The flight is distinctive, with a direct and fast movement rather than buoyant flight observed in other comic terns. The Roseate Tern is common in seas around Northern Australia and breeds on islands off both the north-east and western coasts, possibly expanding southwards in Western Australia where it is now a casual visitor to the area (Morcombe, 2003).	Unlikely to occur
<i>Tyto novaehollandiae novaehollandiae</i>	Masked Owl (southwest)	P3		2005	3	The Masked Owl occupies a variety of habitats including forests, open woodlands, farmlands with large trees, paperbark woodlands and caves. This species generally occurs in coastal mainland Australia and though widespread it is typically locally uncommon (Pizzey & Knight, 2007).	Unlikely to occur
Mammal							
<i>Dasyurus geoffroii</i>	Chuditch	VU	VU			At maturity the Chuditch is the size of a small domestic cat with white spotted brown pelage,, large rounded ears, pointed muzzle, large dark eyes and non-hopping gait. Following European settlement the range of this species contracted dramatically, from much of the continent to a small area in the south west. It currently only occurs in areas dominated by sclerophyll forest or drier woodland, heath and mallee shrubland (Van Dyck & Strahan, 2008). The Chuditch requires adequate numbers of suitable den and refuge sites (horizontal hollow logs or earth burrows) and sufficient prey biomass (large invertebrates, reptiles and small mammals) to survive.	Unlikely to occur
<i>Falsistrellus mackenziei</i>	Western False Pipistrelle	P4				The ecoregion and forest type is jarrah-karri[7] named for the tall trees karri <i>Eucalyptus diversicolor</i> and jarrah <i>Eucalyptus marginata</i> . The usual roosting sites are in eucalypt tree species old enough to provide hollows, although they have also been recorded in branches or tree stumps.	Unlikely to occur
<i>Isoodon fusciventer</i>	Quenda	P4		2019	262	The Quenda or Southern Brown Bandicoot exists only in a fragmented distribution to its former range in southern south western and eastern Australia. It is found in forest, woodland, heath and shrub communities in these regions. Preferred habitat usually consists of a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan, 2008).	Likely to occur
<i>Myrmecobius fasciatus</i>	Numbat	EN	EN			Originally widespread, the Numbat now only persists in two remnant populations at Dryandra and Perup in Western Australia with several reintroduced populations in the Western Australian wheatbelt (DotE, 2015).	Unlikely to occur

Appendix A2 - Fauna Desktop Assessment Results

Scientific Name	Common Name	Cons. Status		Record Date	DBCA Count	Habitat	Likelihood
		WA	EPBC				
<i>Notamacropus eugenii</i>	Tammar Wallaby	P4				Notamacropus eugenii derbianus is a small nocturnal Tammar Wallaby subspecies that is native to south-western Western Australia and five offshore islands. The mainland population has substantially declined since the 1890s due to habitat clearing, hunting, fire, predation by foxes and cats, and competition with rabbits. Tammar Wallabies shelter in dense low vegetation during daylight and move to open grassy areas to feed after dark. They inhabit coastal scrub, heath, dry sclerophyll forest, and thickets in mallee and woodland.	Unlikely to occur
<i>Pseudocheirus occidentalis</i>	Western Ringtail Possum	CR	CR			This species is restricted to the south-west corner of Western Australia. Closer to the coast it is closely associated with Peppermint (<i>Agonis flexuosa</i>) forest and woodland and Tuart (<i>Eucalyptus gomphocephala</i>) with a peppermint mid-story. Further from the coast the species is found in Jarrah (<i>Eucalyptus marginata</i>), Wandoo (<i>Eucalyptus wandoo</i>) and Marri (<i>Corymbia calophylla</i>) forest (Van Dyck & Strahan, 2008).	Unlikely to occur
Reptile							
<i>Lerista lineata</i>	Perth slider, lined skink	P3		2005	104	The Perth Lined Lerista is an underground dwelling skink, sheltering in leaf litter and upper layers of loose soil. It is typically found at the bases of shrubs, spoil heaps and stick ant nests (Bush <i>et al.</i> , 2010). The species inhabits sandy soils supporting Eucalypt/Banksia woodland, coastal heath and low shrubland (Bush <i>et al.</i> , 2010; Wilson and Swan, 2010). There are no records of this species north of the Swan River on the Swan Coastal Plain (South Metro Connect, 2011).	Likely to occur
<i>Neelaps calonotos</i>	Black-striped Snake	P3		1965	2	The Black-striped Snake is mostly confined to the Swan Coastal Plain between Mandurah and Lancelin. It takes shelter in upper layers of loose soil beneath leaf litter in Eucalyptus/Banksia woodlands, typically at the base of trees and shrubs (Bush <i>et al.</i> , 2010).	May occur
Invertebrate							
<i>Idiosoma sigillatum</i>	Swan Coastal Plain shield-backed trapdoor spider	P3		2019	1	This species can be found in burrows of heavy clay soils in areas of open York Gum (<i>Eucalyptus loxophleba</i>), Salmon Gum (<i>E. salmonophloia</i>) and Wandoo <i>E. wandoo</i> woodland, where <i>Acacia acuminata</i> forms a sparse understorey (Avon Catchment Council, 2007).	Unlikely to occur

Appendix B

Species by Community Matrix

Appendix B - Flora Species by Family and Community

Family	Taxon	MIXpBm		XpLoLa	LIAbLa		Opportunistic
		H01	H02	H04	H03	H05	
Aizoaceae							
	* <i>Carpobrotus edulis</i>	X		X			
Anacardiaceae							
	* <i>Schinus terebinthifolius</i>			X	X		
Asparagaceae							
	<i>Acanthocarpus preissii</i>				X		
	* <i>Asparagus asparagoides</i>	X	X		X		
	<i>Lomandra micrantha</i>			X	X		
Asphodelaceae							
	* <i>Trachyandra divaricata</i>			X			
Asteraceae							
	* <i>Hypochaeris radicata</i>	X					
	* <i>Sonchus oleraceus</i>	X				X	
Campanulaceae							
	<i>Wahlenbergia capensis</i>	X					
Caryophyllaceae							
	<i>Petrorhagia dubia</i>			X			
Chenopodiaceae							
	<i>Rhagodia baccata</i>	X					
Cupressaceae							
	<i>Callitris preissii</i>	X					
Cyperaceae							
	<i>Lepidosperma pubisquameum</i>			X			
	<i>Lepidosperma striatum</i>			X	X		
Dilleniaceae							
	<i>Hibbertia hypericoides</i>			X			
Ericaceae							
	<i>Leucopogon propinquus</i>	X		X	X		
Euphorbiaceae							
	<i>Euphorbia paralias</i>	X		X	X		
	* <i>Euphorbia terracina</i>				X	X	
	* <i>Ricinus communis</i>						X
Fabaceae							
	<i>Acacia rostellifera</i>			X			
	* <i>Lotus angustissimus</i>					X	
	* <i>Lupinus cosentinii</i>				X		

Appendix B - Flora Species by Family and Community

Family	Taxon	MIXpBm		XpLoLa	LIAbLa		Opportunistic
		H01	H02	H04	H03	H05	
Geraniaceae	<i>Tempeltonia retusa</i>					X	
	<i>Viminaria juncea</i>	X		X	X	X	
Hemerocallidaceae	* <i>Pelargonium capitatum</i>			X			
Malvaceae	<i>Tricoryne elatior</i>			X	X		
Myrtaceae	* <i>Brachychiton acerifolius</i>					X	
	<i>Agonis flexuosa</i>	X	X		X	X	
	<i>Calothamnus sanguineus</i>		X				
	* <i>Chamelaucium uncinatum</i>				X		
	* <i>Eucalyptus lehmannii</i>	X					
	<i>Eucalyptus rudis</i>		X				
	* <i>Leptospermum laevigatum</i>			X	X	X	
	<i>Melaleuca huegelii</i>		X			X	
	<i>Melaleuca lanceolata</i>	X	X				
	<i>Melaleuca systema</i>			X			
Orchidaceae	<i>Microtis</i> sp. (sterile)				X		
Papaveraceae	* <i>Fumaria capreolata</i>	X			X		
Pinaceae	* <i>Pinus radiata</i>	X	X				
Poaceae	* <i>Avena barbata</i>	X	X	X	X		
	* <i>Briza maxima</i>	X			X		
	* <i>Cynodon dactylon</i>			X			
	* <i>Cenchrus setaceus</i>			X			
	* <i>Ehrharta longiflora</i>	X				X	
	* <i>Lagurus ovatus</i>		X	X	X	X	
	* <i>Lolium perenne</i>	X					
Proteaceae	<i>Banksia dallanneyi</i>			X			
	<i>Banksia sessilis</i> var. <i>cygnorum</i>			X	X		
	<i>Grevillea preissii</i> subsp. <i>preissii</i>			X	X		

Appendix B - Flora Species by Family and Community

Family	Taxon	MIXpBm		XpLoLa	LIAbLa		Opportunistic
		H01	H02	H04	H03	H05	
Ranunculaceae	<i>Hakea prostrata</i>				X		
	<i>Clematis linearifolia</i>	X				X	
Restionaceae	<i>Desmocladus flexuosus</i>				X		
Rhamnaceae	<i>Spyridium globulosum</i>	X		X			
Stylidiaceae	<i>Levenhookia pusilla</i>	X					
Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>	X	X		X	X	
Zamiaceae	<i>Macrozamia fraseri</i>			X			

Appendix C

Flora Quadrat Data

Appendix C Quadrat Data

Site: 1	Location: 115.768748, -32.136859	Date: 20-11-2019
Type: Quadrat	Size: 10X10	Community: MIXpBm
Topography: Mid slope, sand dune	Soils: Sand	Colour:
Bare Ground: 5% bare, 1% rock, 3% leaves 2% twigs		Fire: 10+
Vegetation significance: WA TEC SCP30a <i>Callitris preissii</i> (or <i>Melaleuca lanceolata</i>) forest or woodlands.		
Condition: Good, weeds, invaded planted, partial clearing, all annuals dead, partial clearing.		



*	Taxon	Height cm	Foliage %
	<i>Agonis flexuosa</i>	300	1
*	<i>Asparagus asparagoides</i>		1
*	<i>Avena barbata</i>	30	0.2
*	<i>Briza maxima</i>	20	2

*	Taxon	Height cm	Foliage %
	<i>Callitris preissii</i>	350	2
*	<i>Carpobrotus edulis</i>	5	0.1
	<i>Clematis linearifolia</i>		0.1
*	<i>Ehrharta longiflora</i>	30	3
* pl	<i>Eucalyptus lehmannii</i>	700	5
	<i>Euphorbia paralias</i>	5	0.2
*	<i>Fumaria capreolata</i>	20	0.5
*	<i>Hypochaeris radicata</i>	5	0.1
*	<i>Lagurus ovatus</i>	20	15
	<i>Leucopogon propinquus</i>	20	0.5
	<i>Levenhookia pusilla</i>	3	0.1
*	<i>Lolium perenne</i>	30	0.1
*	<i>Lotus angustissimus</i>	5	10
	<i>Melaleuca lanceolata</i>	500	20
*	<i>Pinus radiata</i>	700	2
	<i>Rhagodia baccata</i>	30	0.5
*	<i>Sonchus oleraceus</i>	5	0.1
	<i>Spyridium globulosum</i>	100	0.2
	<i>Viminaria juncea</i>	100	0.5
	<i>Wahlenbergia capensis</i>	15	0.1
	<i>Xanthorrhoea preissii</i>	100	6

Note: * depicts an introduced (weed) species

Site: 2	Location: 115.769057, -32.136871	Date: 20-11-2019
Type: Releve	Size: 10X10	Community: MIXpBm
Topography: Mid slope	Soils: Sand	Colour:
Bare Ground:	Fire:	
Vegetation significance: WA TEC SCP30a <i>Callitris preissii</i> (or <i>Melaleuca lanceolata</i>) forest or woodlands.		
Condition: Good, weeds, clearing, limestone outcrop.		



*	Taxon	Height cm	Foliage %
	<i>Agonis flexuosa</i>	400	2
*	<i>Asparagus asparagoides</i>		0.5
*	<i>Avena barbata</i>	80	5
*	<i>Briza maxima</i>	20	10
	<i>Calothamnus sanguineus</i>	50	1
* pl	<i>Eucalyptus lehmannii</i>	500	15

*	Taxon	Height cm	Foliage %
	<i>Eucalyptus rudis</i>	800	opp
*	<i>Lagurus ovatus</i>	30	10
	<i>Lotus angustissimus</i>	5	15
	<i>Melaleuca huegelii</i>		opp
	<i>Melaleuca lanceolata</i>	700	15
*	<i>Pinus radiata</i>	600	opp
	<i>Xanthorrhoea preissii</i>	140	0.5

Note: * depicts an introduced (weed) species

Site: 3	Location: 115.769020, -32.137230	Date: 20-11-2019
Type: Quadrat	Size: 10X10	Community: LIAbLa
Topography: Mid Slope	Soils: Sand	Colour: Grey
Bare Ground: 4% bare, 8% litter, 2% twigs		Fire: 10+
Vegetation significance:		
Condition: Good, weeds, limestone outcrops		



*	Taxon	Height cm	Foliage %
	<i>Acanthocarpus preissii</i>		
	<i>Agonis flexuosa</i>		
*	<i>Asparagus asparagoides</i>	*	*
*	<i>Avena barbata</i>	*	*
	<i>Banksia sessilis</i> var. <i>cygnorum</i>		
*	<i>Briza maxima</i>	*	*
*	<i>Chamelaucium uncinatum</i>	*	*
	<i>Desmocladius flexuosus</i>		
*	<i>Ehrharta longiflora</i>	*	*

*	Taxon	Height cm	Foliage %
	<i>Euphorbia paralias</i>		
*	<i>Euphorbia terracina</i>	*	*
*	<i>Fumaria capreolata</i>	*	*
	<i>Grevillea preissii</i> subsp. <i>preissii</i>		
	<i>Hakea prostrata</i>		
*	<i>Lagurus ovatus</i>	*	*
	<i>Lepidosperma striatum</i>		
*	<i>Leptospermum laevigatum</i>	*	*
	<i>Leucopogon propinquus</i>		
	<i>Lomandra micrantha</i>		
	<i>Lotus angustissimus</i>		
*	<i>Lupinus cosentinii</i>	*	*
	<i>Microtis</i> sp. (sterile)		
*	<i>Pinus radiata</i>	*	*
*	<i>Schinus terebinthifolius</i>	*	*
	<i>Tricoryne elatior</i>		
	<i>Viminaria juncea</i>		
	<i>Wahlenbergia capensis</i>		
	<i>Xanthorrhoea preissii</i>		

Note: * depicts an introduced (weed) species

Site: 4	Location: 115.769738, -32.137398	Date: 20-11-2019
Type: Quadrat	Size: 10X10	Community: XpLoLa
Topography: Upper Slope, dune	Soils: Sand	Colour:
Bare Ground: 1% bare, 8% litter, 2% litter		Fire: 10+
Vegetation significance: NA		
Condition: Good, partial clearing, weeds, limestone outcrop		



*	Taxon	Height cm	Foliage %
	<i>Acacia rostellifera</i>	150	0.2
*	<i>Avena barbata</i>	80	2
	<i>Banksia dallanneyi</i>		opp
	<i>Banksia sessilis</i> var. <i>cygnorum</i>	150	4
*	<i>Carpobrotus edulis</i>	10	0.5
*	<i>Cenchrus setaceus</i>	40	2
*	<i>Cynodon dactylon</i>	20	1

*	Taxon	Height cm	Foliage %
	<i>Euphorbia paralias</i>	20	0.1
	<i>Grevillea preissii</i> subsp. <i>preissii</i>	30	1
	<i>Hibbertia hypericoides</i>	40	1
*	<i>Lagurus ovatus</i>	30	15
	<i>lepidosperma pubisquameum</i>	20	1
	<i>Lepidosperma striatum</i>	20	1
*	<i>Leptospermum laevigatum</i>	200	10
	<i>Leucopogon propinquus</i>	40	2
	<i>Lomandra micrantha</i>	20	2
	<i>Lotus angustissimus</i>	5	20
	<i>Macrozamia fraseri</i>		opp
	<i>Melaleuca systema</i>	30	0.2
*	<i>Pelargonium capitatum</i>	30	1
*	<i>Petrorhagia dubia</i>	10	0.1
*	<i>Schinus terebinthifolius</i>	10	0.1
	<i>Spyridium globulosum</i>	15	0.1
*	<i>Trachyandra divaricata</i>		opp
	<i>Tricoryne elatior</i>	30	2
	<i>Viminaria juncea</i>	30	0.2
	<i>Xanthorrhoea preissii</i>	140	25

Note: * depicts an introduced (weed) species

Site: 5	Location: 115.769967, -32.136872	Date: 20-11-2019
Type: Releve	Size: 10X10	Community: LIAbLa
Topography: Upper Slope, dune	Soils: Sand	Colour:
Bare Ground: none bare		Fire: 10+
Vegetation significance: NA		
Condition: Degraded, no understorey.		



*	Taxon	Height cm	Foliage %
	<i>Agonis flexuosa</i>	200	1
*	<i>Avena barbata</i>	80	10
*	<i>Brachychiton acerifolius</i>		
	<i>Clematis linearifolia</i>		2
*	<i>Ehrharta longiflora</i>	30	1
*	<i>Euphorbia terracina</i>	30	0.5
*	<i>Lagurus ovatus</i>	40	80
*	<i>Leptospermum laevigatum</i>	350	18

*	Taxon	Height cm	Foliage %
*	<i>Lotus angustissimus</i>	5	4
	<i>Melaleuca huegelii</i>	200	4
*	<i>Sonchus oleraceus</i>	10	0.1
	<i>Templetonia retusa</i>	150	1
	<i>Viminaria juncea</i>	150	1
	<i>Xanthorrhoea preissii</i>	150	2

Note: * depicts an introduced (weed) species