



# **Kimberley Technology Solutions Pty Ltd**

## Cockatoo Island Multi-User Supply Base Technical Study - Terrestrial Flora and Fauna

June 2017

# Executive summary

## Introduction

Kimberley Technology Solutions Pty Ltd is proposing to construct and operate the Cockatoo Island Multi-User Supply Base (the project) from Cockatoo Island, Western Australia. The project will involve the upgrade and development of infrastructure on Cockatoo Island, including an airfield, a wharf and an aftermarket subsea workshop as well as other related support infrastructure. GHD Pty Ltd was commissioned by Kimberley Technology Solutions to undertake a terrestrial flora and fauna assessment of the project footprint. Information from this assessment will be used to inform the environmental assessment and approvals process.

## Key findings

- The survey area comprised three vegetation associations, *Eucalyptus* open woodland (EmW), Mixed *Acacia* shrubland (AS) and several small patches of *Dioscorea* Vineland (DtV) and EmW mosaic, as well as highly disturbed/cleared areas. A recent fire (May 2016) throughout the western parts of the survey area has altered the vegetation structure, however, this is likely a temporal change
- The vegetation types are not considered representative of any Commonwealth or State listed TECs or PECs, however, the small patches of DtV and EmW mosaic are likely to represent other significant vegetation as they have a restricted distribution, represent local endemism in restricted habitats and act as a refuge
- No EPBC Act or WC Act-listed flora taxa were recorded within the survey area, or have been previously recorded on Cockatoo Island. One DPaW Priority-listed flora species has been previously recorded within the survey area: *Triodia* sp. Hidden Island (T. Handasyde TH 6109) (Priority 1). An additional Priority-listed species, *Solanum vansittartense* (Priority 2) has been previously recorded on the island, but outside of the survey area. The targeted *Triodia* sp. Hidden Island survey confirmed multiple populations outside the survey area
- Two broad fauna habitat types were identified within the survey area and included woodlands (with rocky ridgelines and exposed rocky areas) and regrowth shrublands. These habitat types are represented outside of the survey area in other parts of the Island
- Five conservation significant fauna species have been recorded in the survey area:
  - Ghost Bat (*Macroderma gigas*) – listed as Vulnerable under the EPBC Act and WC Act
  - Masked Owl (northern sub-species) (*Tyto novaehollandiae* subsp. *kimberli*) – listed as Vulnerable under the EPBC Act and Priority 1 by the DPaW
  - Little North-western Mastiff Bat (*Mormopterus loriae* subsp. *cobourgiana*) – listed as Priority 1 by the DPaW
  - Northern Leaf-nosed Bat (*Hipposideros stenotus*) – listed as Priority 2 by the DPaW
  - Water Rat (*Hydromys chrysogaster*) – listed as Priority 4 by the DPaW
- There is no/limited breeding habitat present within the survey area for the Northern Leaf-nosed Bat, Ghost Bat and Little North-western Mastiff Bat. Furthermore, in its current form (i.e. recently burnt), the woodland habitat within the survey area provides limited breeding habitat for the Masked Owl (northern sub-species). Nevertheless, all of the above species are likely to utilise the survey area opportunistically for foraging
- Although not observed, the Water Rat is likely to be present around the coastal margins of the survey area

- Three species listed as Migratory under the EPBC Act and/or under Schedule 5 of the WC Act were recorded from the survey area during the surveys. These included:
  - Eastern Osprey (*Pandion cristatus*)
  - Lesser Frigatebird (*Fregata ariel*)
  - Common Sandpiper (*Tinga hypoleucos*)

These species were observed flying over the survey area, are considered highly mobile and would opportunistically utilise the survey area for foraging

- Twenty-two SRE invertebrate species from twelve families and five classes have been recorded in the survey area based on the field survey and previous survey data. Although no confirmed SRE species have been recorded this should not be interpreted that none are present within the survey area. The survey results found three species considered *likely* to be SRE species and 15 *potential* SRE species.

# Table of contents

1.	Introduction.....	1
1.1	Background.....	1
1.2	Purpose of the report.....	1
1.3	Location.....	1
1.4	Scope of works.....	1
1.5	Relevant legislation, background information and conservation codes.....	2
1.6	Limitations and assumptions.....	2
2.	Methodology.....	3
2.1	Desktop Assessment.....	3
2.2	Field survey.....	4
2.3	Limitations.....	8
3.	Desktop assessment.....	11
3.1	Climate.....	11
3.2	Regional biogeography.....	11
3.3	Land Systems.....	12
3.4	Vegetation and flora.....	12
3.5	Fauna.....	16
3.6	SRE invertebrate fauna.....	18
4.	Results.....	20
4.1	Vegetation and flora.....	20
4.2	Fauna.....	26
4.3	Short range endemic invertebrate fauna.....	29
5.	Conclusions.....	31
5.1	Vegetation and flora.....	31
5.2	Fauna.....	31
5.3	SRE.....	32
6.	References.....	33

# Table index

Table 1	Data collected during the survey.....	4
Table 2	Survey limitations.....	8
Table 3	Details of Precipice land system found in the survey area (Payne & Schokencht 2011).....	12
Table 4	Vegetation association 8001 extent (Beard 1977, GoWA 2015).....	15
Table 5	Conservation significant flora taxa previously recorded on Cockatoo Island.....	15
Table 6	Other significant flora taxa previously recorded on Cockatoo Island.....	16

Table 7	Vegetation associations within the survey area.....	21
Table 8	Extent of vegetation condition ratings within the survey area .....	23
Table 9	Species recorded as range extensions and their current known range .....	25
Table 10	Fauna Habitat types within the survey area.....	26
Table 11	Invertebrate species recorded within the survey area .....	30

## Appendices

Appendix A – Figures

Appendix B – Relevant legislation, background information and conservation codes

Appendix C – Desktop searches

Appendix D – Flora data

Appendix E – Fauna data

Appendix F – SRE Sample Locations

# 1. Introduction

## 1.1 Background

Kimberley Technology Solutions Pty Ltd is proposing to construct and operate the Cockatoo Island Multi-User Supply Base (the project) from Cockatoo Island, Western Australia. The project will involve the upgrade and development of infrastructure on Cockatoo Island, including an airfield, a wharf and an aftermarket subsea workshop as well as other related support infrastructure.

## 1.2 Purpose of the report

GHD Pty Ltd (GHD) was commissioned by Kimberley Technology Solutions to undertake a terrestrial flora and fauna assessment of the proposed project footprint to inform the environmental assessment and approvals process.

The assessment built upon a previous Level 2 flora and vegetation, terrestrial fauna and Short Range Endemic (SRE) invertebrate assessment completed by GHD on the Island. The current assessment was limited to the terrestrial environment.

## 1.3 Location

Cockatoo Island is located approximately 140 km north-west of Derby in the Buccaneer Archipelago, in Yampi Sound, between Irvine and Koolan Islands. The Island is approximately 6 km long and covers 520 ha.

### 1.3.1 Study area

A study area was defined for the desktop-based searches and desktop component of the terrestrial assessment. The study area includes the entirety of Cockatoo Island (limited to the terrestrial environment).

### 1.3.2 Survey area

A proposed footprint was developed for the terrestrial flora and fauna assessment (herein referred to as the survey area), and is located in the central part of the Island. The survey area was limited to terrestrial areas only and is approximately 2.7 km long, up to 1 km wide and covers approximately 201 ha (Figure 1, Appendix A).

The targeted survey for *Triodia* sp. Hidden Island (T. Handasyde TH 6109) (Priority 1) [referred to as *Triodia* sp. Hidden Island herein] extended beyond the survey area. The locality of the targeted search on Cockatoo Island is illustrated in Figure 1, Appendix A.

## 1.4 Scope of works

The scope of works was to:

- Complete a desktop assessment
- Complete a Level 1 vegetation and flora, terrestrial fauna and SRE invertebrate survey of the survey area including:
  - Verification of previous vegetation mapping and targeted searches for conservation significant flora and significant weed species
  - Verification of previous fauna habitat mapping and targeted searches for conservation significant terrestrial fauna species

- Targeted searches for invertebrate assessment
- Prepare a vegetation and flora, fauna and SRE assessment report including the results of the desktop assessment and field surveys.

## **1.5 Relevant legislation, background information and conservation codes**

In WA some ecological communities, flora and fauna are protected under both Australian Government and State Government legislation. In addition, regulatory authorities also provide a range of guidance and information on expected standards and protocols for environmental surveys.

An overview of key legislation and guidelines, conservation codes and background information relevant to this biological survey is provided in Appendix B.

## **1.6 Limitations and assumptions**

This report has been prepared by GHD for Kimberley Technology Solutions Pty Ltd and may only be used and relied on by Kimberley Technology Solutions Pty Ltd for the purpose agreed between GHD and the Kimberley Technology Solutions Pty Ltd as set out in section 1.2 of this report. GHD otherwise disclaims responsibility to any person other than Kimberley Technology Solutions Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Kimberley Technology Solutions Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and surveys undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

## 2. Methodology

### 2.1 Desktop Assessment

A desktop assessment was carried out prior to the commencement of the field survey to identify relevant environmental information pertaining to the survey area and surrounds. The desktop assessment included a review of the following:

- Existing survey data and relevant reports applicable to the survey area provided by Kimberley Technology Solutions including:
  - Warham, J 1957, *Cockatoo Island Birds*, The Emu, vol 54(4), pp 225-231
  - ENV Australia 2008, Cockatoo Island Declared Rare and Priority Flora Species Search, Unpublished report prepared for Henry Walker Eltin and Portman Mining, February 2008
  - Aprasia Wildlife 2009, Fauna Assessment of Cockatoo Island (Desktop Review), Unpublished report prepared for Cockatoo Mining, July 2009
  - Outback Ecology Services 2009, Cockatoo Island Rehabilitation Planning, Unpublished report prepared for Cockatoo Mining, September 2009
  - Astron Environmental Services 2012, Cockatoo Island Weed Survey, Unpublished report prepared for HWE/Cockatoo Mining, June 2012
  - GHD 2014, Cockatoo Island, Flora, Fauna and SRE Surveys, Unpublished survey data collected for Pluton Resources, 2014.
- Department of the Environment and Energy (DotEE) Protected Matters Search Tool (PMST) to identify communities and species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) potentially occurring within the study area (DotEE 2016) (Appendix C)
- Department of Parks and Wildlife (DPaW) Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) database to determine the potential presence for TECs or PECs to be present within the study area
- DPaW *NatureMap* database for flora and vertebrate fauna species previously recorded within the survey area (DPaW 2007–) (Appendix C)
- DPaW Threatened (Declared Rare) and Priority Flora database (TPFL), Western Australian Herbarium database (WAHERB) and DPaW Threatened and Priority Fauna database for Threatened and Priority flora and fauna species listed under the *Wildlife Conservation Act 1950* (WC Act) and listed by the DPaW as previously recorded within the study area
- WA Museum database (WAM) for invertebrate fauna (Arachnids and/or Myriapods, Crustaceans and Molluscs) previously recorded within the study area (WAM 2014)
- Existing datasets including previous vegetation mapping of the survey area (Beard 1977), aerial photography, geology/soils and hydrology information to provide background information on the variability of the environment.

## 2.2 Field survey

### 2.2.1 Vegetation and flora

A GHD ecologist completed a reconnaissance vegetation and flora survey of the survey area from 14-16<sup>th</sup> December 2016. The survey was undertaken to verify existing vegetation units and condition mapping, and to identify and record vascular flora taxa present at the time of survey. Additionally, opportunistic searching for conservation significant flora taxa was undertaken.

The survey was undertaken with reference to the EPA Environmental Factor Guideline - Flora and Vegetation (EPA 2016a) and EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016b).

#### Data collection

Field survey methods included revisiting previous quadrat and relevé locations and additional sampling using relevés to verify existing vegetation unit and condition definition and mapping. The survey area was traversed by foot and vehicle.

Previously described quadrats were 50 x 50 m in size (area of 2,500 m<sup>2</sup>), with relevés of various size. Quadrat and relevé locations generally avoided obvious ecotonal zones between vegetation units and recently disturbed vegetation (e.g. through human/mechanical means). Field data at each site were recorded on a pro-forma data sheet and included a combination of the parameters detailed in Table 1. Ten non-permanent quadrats and six relevés have been described within the survey area. Sampling locations are mapped in Figure 2, Appendix A.

**Table 1 Data collected during the survey**

Aspect	Measurement	Quadrat	Relevé
Collection attributes	Personnel/recorder, date, site ID, dimensions, photograph.	X	X
Location	Coordinates recorded in GDA94 datum using a hand-held Global Positioning System (GPS) tool to accuracy approximately ± 10 m.	X	X
Physical features	Aspect, soil attributes, ground surface cover, leaf and wood litter.	X	
Vegetation condition	Vegetation condition was assessed using the condition rating scale adopted by EPA (2016b).	X	X
Disturbance	Level and nature of disturbances (e.g. weed presence, fire and time since last fire, impacts from grazing, exploration activities).	X	
Flora	List of dominant flora from each structural layer. List of all species within the quadrat including average height and cover (using a modified Braun-Blanquet scale).	X	X

A flora inventory was compiled from taxa listed in described quadrats, relevés and opportunistic floristic records throughout the survey area.

#### Vegetation units

Vegetation units were identified and boundaries delineated using a combination of aerial photography, topographical features, previous mapping (Beard 1977, GHD 2014) and field data.

Vegetation units were described based on structure, dominant taxa and cover characteristics as defined by quadrat and relevé data and field observations. Vegetation descriptions follow the National Vegetation Information System (NVIS) and are consistent with NVIS Level V (Association). At Level V three (or occasionally more) taxa per stratum are used to describe the association (Executive Steering Committee for Australian Vegetation Information (ESCAVI) 2003)).

### **Vegetation condition**

The vegetation condition of the survey area was assessed and mapped in accordance with the vegetation condition rating scale for the Eremaean and Northern Botanical Provinces (EPA 2016b). The scale recognises the intactness of vegetation and consists of six rating levels as outlined in Appendix B.

### **Flora identification and nomenclature**

Flora taxa that were well known to the survey botanists were identified in the field; all other species were collected and assigned a unique collection number to facilitate tracking. All plant specimens collected during the field assessment were dried and processed in accordance with the requirements of the WA Herbarium. Plant species were identified by the use of taxonomic literature, local and regional paper and electronic flora keys and by comparison with the named species held at the WA Herbarium.

The conservation status of all recorded flora was compared against the current lists available on *FloraBase* (WA Herbarium 1998–) and the EPBC Act List of Threatened Flora (DotEE 2017a).

Nomenclature used in this report follows that used by the WA Herbarium as reported on *FloraBase* (WA Herbarium 1998–).

### **Surveys for conservation significant flora**

Prior to the field survey, information from the desktop assessments (e.g. previous survey data, EPBC Act PMST, TPFL, WAHERB and *NatureMap*) was reviewed to determine conservation significant flora potentially present within the survey area.

A key flora taxon of concern that occurs within the survey area is *Triodia* sp. Hidden Island (T. Handasyde TH 6109), listed as Priority 1 by the DPaW. This taxon was not flowering, or otherwise recognisable during the field survey.

#### **2.2.2 Targeted flora**

A follow up survey targeting *Triodia* sp. Hidden Island was undertaken from 8-10<sup>th</sup> May 2017 by two ecologists.

#### **Targeted flora survey area and methods**

Field survey methods involved revisiting the previously known location of *Triodia* sp. Hidden Island within the survey area and then broadening the search outside the survey area (targeted survey area). Rocky drop off areas on Cockatoo Island were given priority because they are the only known habitat for *Triodia* sp. Hidden Island on Hidden Island (WA Herbarium 1998- ). Not all cliff faces on Cockatoo Island could be surveyed due to safety and remoteness. The targeted survey area was traversed by vehicle and foot (Figure 1, Appendix A).

#### **Identification and data management**

*Triodia* sp Hidden Island was towards the end of its flowering period at the time of the field survey. However, some individuals had flowering material and were able to be tentatively identified in the field. Sightings were then marked with a GPS and populations were recorded. Due to the dense nature of some populations, individual counts were difficult; therefore populations  $\geq 50$  were rounded to the nearest 10. Select specimens were collected for verification and lodgement with the WA Herbarium. Locations and count information has also been submitted.

### **2.2.3 Fauna**

A GHD ecologist completed a single season Level 1 fauna survey (reconnaissance survey) of the survey area concurrently with the flora and vegetation survey. The field survey was undertaken to verify existing fauna habitat type mapping, identify and record fauna taxa present at the time of survey, and identify fauna habitats for conservation significant species.

The survey was undertaken with reference to EPA Environmental Factor Guidance – Terrestrial Fauna (EPA 2016f), EPA Technical Guidance – Sampling methods for terrestrial vertebrate fauna (EPA 2016c) and EPA Technical Guidance – Terrestrial fauna surveys (EPA 2016e).

#### ***Habitat assessment***

A fauna habitat assessment was undertaken to document the type, condition and extent of habitats within the survey area, this included:

- Habitat structure (e.g. vegetation type, presence/absence of overstorey, midstorey, understorey and ground cover)
- Presence/absence of refuge including: fallen timber (coarse woody debris), hollow bearing trees and stags and rocks/boulder piles, and the type and extent of each refuge
- Presence/absence of waterways including type, extent and habitat quality within waterways
- A photograph of the habitat type.

#### ***Opportunistic fauna searches***

The fauna survey was an opportunistic survey and did not involve any fauna trapping (multiple season trapping has been previously undertaken on the Island). The survey involved visual and aural surveys for any fauna species utilising the survey area. The survey area was also searched for any fauna signs, such as tracks, scats, bones, diggings and feeding signs.

Surveys also included systematic searching across all habitat types, which is an effective method of surveying for many wildlife species. This involved searching through microhabitats where wildlife is known to frequent, including turning over logs or rocks, turning over leaf litter and examining hollow logs. Reptiles were also sighted as they basked during the day.

#### ***Bat sampling***

Assessment of bats was undertaken using an SM2BAT+ SongMeter recorder (Wildlife Acoustics Inc., USA). Bat calls were recorded between sunset and sunrise at two locations, for one night each across the survey area. Recorded call data were saved as Wildlife Acoustics' patented WAC compressed audio format.

GHD (Craig Grabham) completed the analysis of all data collected during the survey using ultrasonic bat detectors. Data from SM2 units was downloaded and viewed using Kaleidoscope Viewer (version 4, Wildlife Acoustics Inc. 2016) as full-spectrum audio files. A summary of the analysis is provided in Appendix E.

#### ***Fauna nomenclature***

Nomenclature used in this report follows that used by the WA Museum and the DPaW *NatureMap* database with the exception of birds where Christidis and Boles (2008) was used.

## **2.2.4 Short range endemic invertebrates**

Short range endemic (SRE) invertebrates are species with restricted distributions. The isolation of invertebrates in specific habitats or bioregions leads to endemism at various spatial scales. The vast majority of invertebrates are capable of dispersing substantial distances at some phase of their life cycle. Some groups, however, are susceptible to short-range endemism, which describes endemic species with restricted ranges, which has been arbitrarily defined in Western Australia as less than 10,000 km<sup>2</sup> (100 km x 100 km) (Harvey 2002).

### ***Target invertebrate groups***

Short range endemic invertebrate fauna taxa are generally found in sheltered, relatively mesic environments such as isolated habitats (e.g. boulder piles, isolated hills, dense patches of vegetation, gullies) and can include microhabitats within these environments such as deep leaf litter accumulation, large logs, under bark, cave areas and springs and permanent water bodies. Taxonomic invertebrate groups in the Kimberly Region that are most likely to contain SRE taxa comprise:

- Araneae (Mygalomorph Trap Door Spiders)
- Opiliones (Harvestmen)
- Isopoda (Slaters)
- Pseudoscorpionida (Pseudoscorpions)
- Scorpionida (Scorpions)
- Schizomida (Micro-whip scorpions)
- Diplopoda (Millipedes)
- Chilopoda (Centipedes)
- Pulmonata (Land Snails).

These groups of invertebrates were the focus of the SRE survey.

### ***Survey details and effort***

A GHD ecologist completed a single season SRE survey of the survey area concurrently with the flora, vegetation and vertebrate fauna surveys. The survey was undertaken to search for and record SRE invertebrate fauna present at the time of survey. The survey was undertaken with reference to the EPA Technical Guidance – Sampling of short range endemic invertebrate fauna (EPA 2016d).

Field survey methods included active hand foraging including sifting of soil and/or leaf litter (millipede, land snails and isopoda), raking of leaf litter (millipedes, land snails, centipedes, mygalomorph burrows), examination of vegetative material below logs and bark (pseudoscorpions, centipedes, millipedes, isopoda), and an examination of areas of rock outcrops and associated rock piles. Seven sites were examined during the field survey, with a minimum of 30 minutes of foraging completed at each site.

Previous SRE surveys of Cockatoo Island have included a combination of dry pitfall traps and active foraging. Three non-permanent dry pitfall traps sites and seven foraging sites have previously been established/examined within the current survey area.

## Identification, taxonomy, and nomenclature

The level of specimen identification achievable is dependent on the level of taxonomic knowledge and expertise available. The majority of the taxonomic expertise relating to SRE taxa resides with the staff of the WA Museum, while some groups are also worked on by researchers within other government departments and academic institutions. Taxonomic treatments are available for some invertebrate groups, but not all. The EPA expects that invertebrates collected for identification will be identified to the lowest taxonomic level possible. Ideally, this is to species level, but there will be limits due to the nature of specimens (i.e. juveniles) and the availability of taxonomic keys.

Sorting and identification of collected invertebrate material was undertaken by an in-house GHD invertebrate ecologist (Gaynor Owen). Collected material was compared with material collected from previous surveys.

## 2.3 Limitations

### 2.3.1 Desktop limitations

The EPBC Act PMST is based on bioclimatic modelling for the potential presence of species. As such, this does not represent actual records of the species within the area. The records from the DPaW searches of threatened flora and fauna provide more accurate information for the general area. However, some records of collections, sightings or trappings can be dated and often misrepresent the current range of threatened species.

Updated Wildlife Conservation (Rare Flora) and Wildlife Conservation (Specially Protected Fauna) Notices were gazetted on 6 January 2017. The format of these Notices has been changed to align with the EPBC Act threatened species lists. To date information contained in publically available databases such as *NatureMap* does not reflect these newly gazetted Notices. This report has been updated to reflect the conservation status of flora and fauna listed in these Notices. However, the outputs of database searches contained in this report such as *NatureMap*, does not reflect the conservation status of flora and fauna listed in these Notices.

### 2.3.2 Field survey limitations

Technical Guidance state that flora and fauna survey reports for environmental impact assessment should contain a section describing the limitations of the survey methods used (EPA 2016b, EPA 2016c, EPA 2016e). The limitations and constraints associated with this field survey are discussed in Table 2.

**Table 2 Survey limitations**

Aspect	Constraint	Comment
Sources of information and availability of contextual information	Minor	Adequate information is available for the survey area, this includes: <ul style="list-style-type: none"><li>Broad scale (1:1,000,000) mapping by Beard (1977) and Shepherd <i>et al.</i> (2002)</li><li>Regional biogeography (Graham 2001)</li><li>Land systems (Payne and Schoknecht 2011)</li><li>Previous reports as listed in Section 2.1.</li></ul>
Scope (what life forms were sampled etc.)	Nil	Vascular flora and terrestrial vertebrate fauna were sampled during the survey. Non-vascular flora, invertebrate and aquatic fauna were not assessed as part of survey, although opportunistic records were taken of invertebrate fauna during the survey.

Aspect	Constraint	Comment
Proportion of flora collected and identified (based on sampling, timing and intensity) Proportion of fauna identified, recorded and/or collected	Minor	<p>The flora, fauna and SRE survey was a single season survey only and was undertaken in mid-December 2016. However, survey data from multiple season surveys of Cockatoo Island in 2013 and 2014 relevant to the survey area was utilised to supplement the results. The targeted survey was undertaken in May 2017. Flowering material of <i>Triodia</i> sp. Hidden Island was available at the time of the survey.</p> <p>The flora recorded from the field survey is detailed in Section 4.1.5 and a full flora species list is provided in Appendix D. The portion of flora collected and identified was considered high.</p> <p>The fauna assessment sampled those species that can be easily seen, heard or has distinctive signs, such as tracks, scats, diggings, etc. Many cryptic and nocturnal species would not have been identified during a reconnaissance survey and seasonal variation within species often requires targeted surveys at a particular time of the year.</p> <p>The SRE invertebrate assessment was limited to hand foraging in randomly selected habitats. Only species seen or collected were sampled.</p>
Flora determination	Minor	<p>Flora determination was undertaken by the GHD ecologists in the field and at the WA Herbarium.</p> <p>The taxonomy and conservation status of the WA flora is dynamic. This report was prepared with reliance on taxonomy and conservation status current at the time report development but it should be noted this may change in response to ongoing research and review of International Union for Conservation of Nature criteria.</p>
Fauna determination	Nil	<p>Fauna determination was undertaken by the GHD ecologist in the field. Of the fauna species recorded during the survey, all species were identified to a species level.</p>
SRE determination	Moderate	<p>Species were identified to the lowest practical taxonomic level, taking into consideration that the taxonomic framework of many invertebrate groups are incomplete and often in need of substantial revision to enable accurate identification. Short Range Endemic status was assigned using the available information from the WAM database and discussion with appropriate taxonomic authorities for various invertebrate groups.</p> <p>Arachnids, Myriapods and Molluscs were identified and assigned SRE status by the WA Museum. Isopods and Scorpions were identified and assigned SRE status by Phoenix Environmental Sciences.</p>
Completeness and further work which might be needed (e.g. was the relevant area fully surveyed)	Minor	<p>The majority of the survey area was accessed on foot. Information gained from the survey was extrapolated across those small sections of the survey area not accessed on foot during the field survey. The survey area was assessed to a level deemed appropriate for a reconnaissance flora and vegetation survey and a Level 1 fauna survey.</p> <p>Survey data from multiple season surveys (Level 2) of Cockatoo Island in 2013 and 2014 relevant to the survey area was utilised to supplement the results.</p>
Mapping reliability	Minor	<p>The vegetation was mapped at a scale of 1:15,000 using high resolution ESRI aerial imagery obtained from LandGate, topographical features, previous broad scale mapping and field data.</p> <p>Data was recorded in the field using hand-held GPS tools (e.g. Nomad Juno and Garmin GPS). Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers. The Garmin GPS units used for this survey are accurate to within <math>\pm 10</math> m on average. Therefore the data points consisting of coordinates recorded from the GPS may contain inaccuracies.</p>

Aspect	Constraint	Comment
Timing/weather/season/cycle	Minor	<p>The field survey was conducted in mid-December 2016. In the four months prior to the survey (August-November), the Cygnet Bay weather station (No. 003057, BoM 2017) recorded a total of 6.8 mm of rainfall. This rainfall total is less than the long-term average (LTA) for the same period (August-November; 9.6 mm) (BoM 2017).</p> <p>The weather conditions recorded during the survey are within the observed climatic conditions previously recorded for the month of December Cygnet Bay weather station (BoM 2017). The weather conditions recorded during the survey were considered unlikely to have affected the vegetation and flora survey.</p> <p><i>Triodia</i> sp. Hidden Island flowering material was available during the targeted survey (May 2017), therefore survey timing was appropriate.</p>
Disturbances (e.g. fire, flood, accidental human intervention)	Minor	<p>Large portions of the survey area had been recently burnt (May 2016). This fire likely affected the diversity of flora and fauna observed during the survey.</p> <p><i>Triodia</i> spp. could not be distinguished from each other in the burnt area during the May 2017 targeted survey. The area was still recovering and specimens were too immature.</p>
Intensity (in retrospect, was the intensity adequate)	Minor	<p>The vascular flora of the survey area was sampled in accordance with EPA (2016b) and terrestrial fauna sampled in accordance with EPA (2016c) and EPA (2016d).</p> <p>The survey area was sufficiently covered during the survey. Furthermore, survey data from multiple season surveys (Level 2) of Cockatoo Island in 2013 and 2014 relevant to the survey area was utilised to supplement the results.</p> <p>Not all cliff faces – only know habitat of <i>Triodia</i> sp. Hidden Island - on Cockatoo Island could be surveyed due to safety and remoteness. Additional populations are likely to be present elsewhere on Cockatoo Island however, these areas are outside the disturbance footprint.</p>
Resources	Nil	<p>Adequate resources were employed during the field survey. Six person days were spent undertaking the survey using one botanist and one zoologist.</p> <p>Targeted survey efforts involved four people days using two ecologists. Previous survey effort from multiple season surveys (Level 2) of Cockatoo Island in 2013 and 2014 include 50 days using one botanist, one SRE specialist and 2 zoologists.</p>
Access restrictions	Nil	<p>No access problems were encountered during the survey. The majority of the survey area was accessed on foot.</p> <p>Some cliff faces could not be surveyed due to safety and remoteness.</p>
Experience levels	Nil	<p>The ecologists who executed the survey were practitioners suitably qualified in their respective fields.</p> <p>Glen Gaikhorst is a Senior Ecologist (zoologist) with over 18 years' experience in undertaking ecological surveys in WA. Anna Napier is a Principal Ecologist (botanist) with over 30 years' experience in undertaking ecological surveys in WA. Jordan Tindiglia is a Senior Ecologist (botanist) with over 10 years' experience in undertaking ecological surveys in WA. Angela Benkovic is a botanist with 10 years' experience in undertaking ecological surveys in WA.</p>

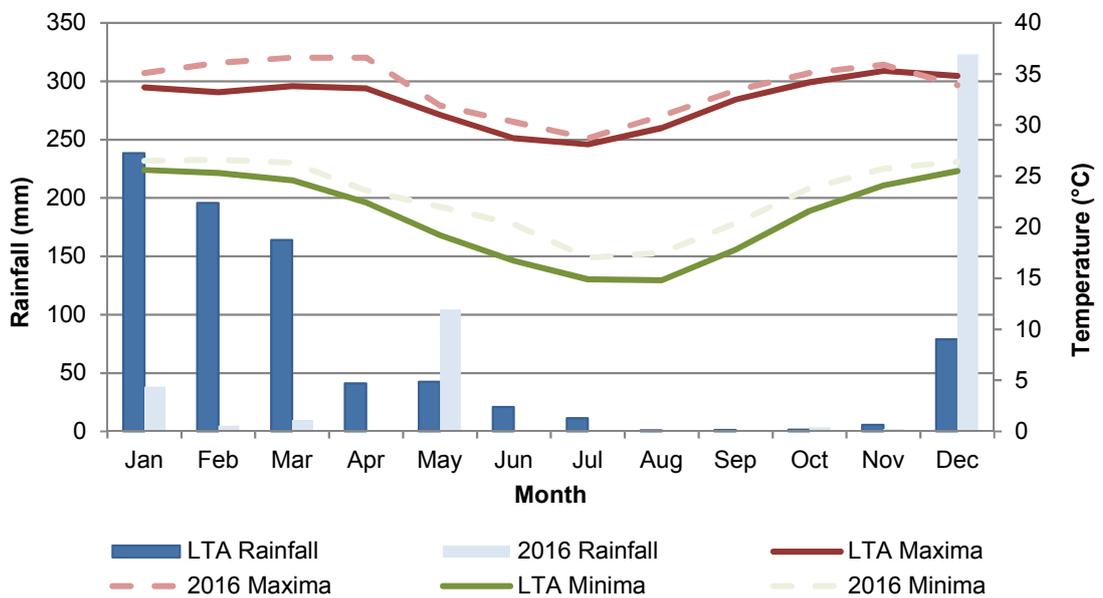
# 3. Desktop assessment

## 3.1 Climate

The survey area is located in the Kimberley region of WA and experiences a tropical monsoon climate with two dominant seasons, wet and dry, separated by short transitional periods. The wet season typically occurs from November to April and is characterised by hot and humid conditions. The region receives about 90 % of its rainfall during the wet season, and is influenced by low pressure systems. The dry season typically occurs from May to October and is characterised by warm conditions, the result of high pressure systems and a predominantly south easterly airflow from the continent's interior. Rainfall during these months is markedly absent.

Climatic data was recorded on Cockatoo Island between 1948 and 2014. Recent climatic data is available from the Bureau of Meteorology (BoM) Cygnet Bay station (site number: 003057), approximately 75 km south-west of Cockatoo Island. Climatic data from Cygnet Bay indicates the mean maximum temperature of the area ranges from 28.1 °C in July to 35.3 °C in November, and the mean minimum temperature of the area ranges from 14.8 °C in August to 25.6 °C in January. The mean annual rainfall is 778.1 mm, with an average of 36.5 rain days per year (BoM 2017).

Rainfall and temperature data for Cygnet Bay in the 12 months preceding the survey are summarised in Plate 1 (BoM 2017). The weather conditions recorded during the field survey included maximum temperatures of 33.1-35.5 °C, minimum temperatures of 25.9-32.5 °C and no rainfall (BoM 2017).



**Plate 1 Rainfall and temperature data for Cygnet Bay (BoM 2017)**

## 3.2 Regional biogeography

The survey area is situated in the Northern Botanical Province of Western Australia (Beard 1990), within the Northern Kimberley bioregion and the Mitchell subregion as described by the Interim Biogeographic Region of Western Australia (IBRA).

The Mitchell subregion is characterised by Savannah woodland over high *Sorghum* grasses and hummock grasses on shallow sandy soils on outcropping Proterozoic siliceous sandstone strata, riparian closed forests of *Melaleuca* and *Pandanus* occur along drainage lines and extensive Mangal occurring in estuaries and deep, sheltered embayments (Graham 2001). Numerous small patches of monsoon rainforest are also scattered through the district (Graham 2001).

The Mitchell IBRA subregion has a number of centres of endemism including a number of endemic vertebrates, endemic plants and patches of rainforest, which may be important to invertebrates such as Camaenid land snails and annelids. 'Dry' rainforest patches, as well as swamp rainforests provide dry season refuges and mangroves and riparian zones also provide refugia (Graham 2001). Sandstone communities and laterite rainforests may provide areas of high species and ecosystem diversity and are resource centres for a variety of fauna (Graham 2001).

### 3.3 Land Systems

The Kimberley region has been surveyed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Western Australian Department of Agriculture and Food (DAFWA), DPaW and Landgate for the purposes of land classification, mapping and resource evaluation. One hundred and eleven land systems have been described for the region, which are distinguished on the basis of topography, geology, soils and vegetation (Payne and Schoknecht 2011). The survey area is located within the Precipice land system (Table 3).

**Table 3 Details of Precipice land system found in the survey area (Payne & Schoknecht 2011)**

Land System	Description	Geology	Geomorphology
Precipice	Occupies 7,530 km <sup>2</sup> and comprises rocky mountainous sandstone country with narrow or restricted basalt valleys, low open woodlands with curly spinifex.	Upper Proterozoic, gently dipping and folded quartzite, sandstone, and shale, with basalt and dolerite flows and intrusions of Upper Proterozoic or Lower Cambrian age.	Formed by dissection of the Kimberley surface - plateaux and mountain ranges: extensive, high plateaux, cuestas, and upstanding mountain summits in strike belts up to 40 km wide, with steep escarpments and upper slopes and restricted lower slopes; basalt and dolerite hills in valley floors; moderately dense, rectangular pattern of narrow, incised valleys; relief up to 530 m.

### 3.4 Vegetation and flora

#### 3.4.1 Existing literature

A literature review of previous vegetation and flora work undertaken within the study area was undertaken prior to the field survey to assess the existing knowledge base. Three reports and existing survey data were reviewed and are summarised below.

#### ***Cockatoo Island Declared Rare and Priority Flora Species Search (ENV Australia 2008)***

This report documents a targeted search for DRF [Threatened] and Priority flora taxa in the stage 4 drilling area, between the operational mining area and tailing storage facility in 2007. The report describes three vegetation associations in the area including two different woodland types dominated by *Eucalyptus miniata* and *Triodia bitextura* hummock grassland.

Two Priority flora taxa were recorded during the survey: *Minuria macrorhiza* (P2) and *Phyllanthus aridus* (P3). Additional flora taxa were also reported as species of interest; these included *Corymbia cadophora*, *Hibbertia oblongata sensu. lato*, an additional *Phyllanthus* specimen and two sterile *Triodia* collections.

### **Cockatoo Island Rehabilitation Planning (Outback Ecology Services 2009)**

In 2009, Outback Ecology undertook an assessment of rehabilitation areas on Cockatoo Island, in conjunction with a limited flora, vegetation and invasive weed survey, and a review of current seed collection methods and storage on the island. Outback Ecology also developed a rehabilitation plan for Stage 4 drill sites on the island and conceptual completion criteria.

Outback Ecology identified seven broad units to map the vegetation of Cockatoo Island, including those areas disturbed or without vegetation. Not all units were visited, and they were therefore described using a process of extrapolation from aerial photography, topographic information and geological studies. The seven vegetation units included Heath/Ridges, Woodland, Woodland (Burnt), Heath Shrub/Grassland on ridges and slopes, Mangroves, Undescribed and Cleared/Disturbed.

Vegetation condition was assessed using the Keighery (1994) Vegetation Condition Scale. The majority of the surveyed area was in Very Good to Excellent condition followed by Completely Degraded to Degraded (operational areas such as the administration area, roads, tailings storage facility, pits and the accommodation village and its surrounds).

No DRF [Threatened Flora] or TECs were recorded during their survey, however, they did record *Phyllanthus aridus*, a Priority species (P3).

In total 104 plant taxa (47 families, 100 genera) were recorded. The dominant family was Fabaceae (Peas) with 27 species, followed by Poaceae (Grasses) with 18 species. Many families, particularly those representing the tropical element, were represented by only one or two species.

Five rehabilitation/revegetation areas were visited and quadrats were established in rehabilitation areas of sufficient size. The floristic diversity of rehabilitated areas was found to be poor and was found to rely upon a small suite of species. Seven introduced species were recorded in disturbed and rehabilitated areas, alongside roads and in native bush. Introduced species comprised up to 20% of the species present in rehabilitated areas.

### **Cockatoo Island Weed Survey (Astron Environmental Services 2012)**

Astron completed a weed survey on Cockatoo Island between 29 March and 2 April 2012. The weed survey included weed mapping of closure features (disturbed areas) and a weed sampling survey to determine baseline weed condition across the island.

Astron recorded ten weed species: *\*Cenchrus ciliaris* (Buffel Grass), *\*C. setiger* (Birdwood Grass), *\*Chloris barbata* (Purpletop Chloris), *\*C. virgata* (Feathertop Rhodes Grass), *\*Clitoria ternatea* (Butterfly Pea), *\*Euphorbia hirta* (Asthma Plant), *\*Leucaena leucocephala* (Leucaena), *\*Melinis repens* (Natal Grass), *\*Merremia dissecta* (White Convolvulus Creeper) and *\*Passiflora foetida* (Stinking Passion Flower).

Natal Grass, Stinking Passion Flower and Purpletop Chloris were the most frequently recorded weed species within the closure features (disturbed areas). Stinking Passion Flower and Natal Grass were the most frequently recorded weed species in sampling sites within the surrounding island. According to Astron the diversity and cover of weed species within the closure features is similar to the surrounding island, however, seven more species were identified during weed mapping of closure areas than in sampling of surrounding areas.

No Declared Pests listed under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) or Weeds of National Significance (WoNS) were recorded.

#### **Cockatoo Island, Flora, Fauna and SRE Survey data (GHD 2014)**

GHD completed a two season Level 2 vegetation and flora assessment of Cockatoo Island from 8-14 August 2013 and 7-13 February 2014. The surveys were undertaken to identify and describe the dominant vegetation units, assess vegetation condition and identify and record vascular flora taxa present at the time of survey. Additionally, targeted searching for conservation significant communities and flora taxa were undertaken during the second survey.

GHD identified five broad floristic formations containing six vegetation associations as well as disturbed areas based on statistical analysis and field observations. The associations included *Eucalyptus* woodlands, *Triodia* hummock grasslands, *Spinifex* tussock grasslands and two shrubland associations. Very small areas of vineland occur in limited locations and generally intergrade into *Eucalyptus* woodlands. The associations were not considered representative of any Federal or State listed TECs or PECs, however, two may represent other significant vegetation as defined by the EPA.

Vegetation condition using the Keighery (1994) Vegetation Condition Scale was assessed. The majority of the Island was in Excellent condition. Areas rated as Degraded or Degraded – Completely Degraded included the accommodation village, and operational areas such as administration, roads and pits as well as historically disturbed areas.

GHD recorded 203 flora taxa (including subspecies and varieties) representing 62 families and 141 genera on the Island during the field surveys. This total comprises 170 (83 %) native taxa and 33 (17 %) introduced taxa. The dry season survey recorded 132 taxa and 165 taxa were recorded during the wet season survey (this included 94 species that were recorded in both surveys). No Declared Pests or WoNS were recorded within the natural vegetation, however, \**Lantana montevidensis* (WoNS) was recorded in the accommodation village.

No EPBC Act or WC Act listed flora were recorded during the surveys, however, two DPaW Priority listed flora taxa were recorded, *Triodia* sp. Hidden Island (T. Handasyde TH 6109) (P1) and *Phyllanthus aridus* (P3) [now delisted and has no conservation status]. A further five species recorded represented range extensions, namely *Flemingia parviflora*, *Chlorophytum laxum*, *Drosera dilatatopetiolaris*, *Alloteropsis semialata* and *Tribulopsis pentandra*.

#### **3.4.2 Broad vegetation mapping and extent**

Broad scale (1:1,000,000) pre-European vegetation mapping of the Kimberley region was completed by Beard (1977) at an association level. The mapping indicates that one vegetation association is present within the survey area: Grasslands, curly spinifex, low tree savanna; bloodwood (*Eucalyptus dichromophloia* [*Corymbia dichromophloia*]) & woollybutt [*Eucalyptus miniata*] over curly spinifex on islands (association 8001).

The pre-European mapping has been adapted and digitised by Shepherd *et al.* (2002). The extent of the vegetation association has been determined by the state-wide vegetation remaining extent calculations maintained by the DPaW (current as of June 2015 – Government of Western Australia (GoWA) 2015). As shown in Table 4, the extent of vegetation association 8001 is greater than 85 % of the pre-European extent remaining at all scales (e.g. State, IBRA bioregion, IBRA subregion and local government authority (LGA)).

#### **3.4.3 Conservation significant ecological communities**

A search of the EPBC Act Protected Matters database (DotEE 2016) and the DPaW TEC and PEC database identified no TECs or PECs within the survey area. In addition, no previous surveys have identified any TECs or PECs.

**Table 4 Vegetation association 8001 extent (Beard 1977, GoWA 2015)**

Scale	Pre-European Extent (ha)	Current Extent (ha)	Remaining (%)	% Current Extent in All DPaW managed lands
State: WA	237,440.25	203,756.79	85.81	-
Bioregion: Northern Kimberley	219,927.66	200,503.71	91.17	-
Sub-region: Mitchell	219,927.66	200,503.71	91.17	-
LGA: Shire of Derby-West Kimberley	233,722.26	201,062.33	86.03	-

#### 3.4.4 Other significant vegetation

Two vegetation associations identified and mapped by GHD represent other significant vegetation as described by the EPA (2016b). These associations, *Aegiceras* open shrubland (AcS) (Mangals) and *Dioscorea* vineland (vineland) occur in small, restricted patches across the Island.

#### 3.4.5 Flora diversity

The flora of the Northern Kimberley bioregion is diverse, with 2,172 vascular species recorded (WA Herbarium 1998–). It is difficult to determine the level of endemism present within this bioregion as collectively Kimberley flora is considered poorly known and collected (Waples 2007).

A search of the *NatureMap* database identified 76 flora taxa recorded within the study area. This included 46 native flora taxa and 30 naturalised (non-native) flora taxa. Dominant families within this search included Fabaceae (13 taxa), Poaceae (eight taxa) and Malvaceae (seven taxa).

#### 3.4.6 Conservation significant flora

Desktop searches of the EPBC PMST, the DPaW *NatureMap* database, the DPaW TPFL and the WAHERB databases, and review of existing literature identified the presence / potential presence of two conservation significant flora taxa within the survey area (Table 5). Previous surveys also recorded *Minuria macrorhiza*, which is subsequently not recognised as occurring on Cockatoo Island (based on a review of collected material) and *Phyllanthus aridus*, which was delisted in 2014 and now has no conservation status.

**Table 5 Conservation significant flora taxa previously recorded on Cockatoo Island**

Family	Taxon	Status	Source
Poaceae	<i>Triodia</i> sp. Hidden Island	P1	GHD (2014)
Solanaceae	<i>Solanum vansittartense</i>	P2	<i>NatureMap</i>

#### 3.4.7 Other significant flora

Previous reports relevant to the survey area have reported and discussed a number of 'species of interest'. A summary of these taxa are provided in Table 6.

#### 3.4.8 Introduced flora (weeds)

Seventeen introduced plant taxa have been previously recorded within the study area. One taxon, *\*Cryptostegia madagascariensis* var. *glaberrima*, is listed as a Declared Pest under the BAM Act.

**Table 6 Other significant flora taxa previously recorded on Cockatoo Island**

Taxon	Description
<i>Corchorus puberulus</i>	Noted by Outback Ecology Services (2009) as being relatively recently described, known from only seven specimens lodged with the WAHERB with little information of its extent or population size, and may be given a Priority listing at some point in the future.
<i>Corymbia cadophora</i>	Noted by ENV Australia (2008) as being of interest to the DPaW as a possible future Priority species. Followed up by Outback Ecology Services (2009) who noted 'the subspecies present on Cockatoo Island (subsp. <i>cadophora</i> ) is not of conservation significance'.
<i>Hibbertia oblongata sensu. lato.</i>	Noted by ENV Australia (2008) as part of a complex that will be shortly revised. Some segregates of which may be given conservation priority.
<i>Phyllanthus</i> collection (CK 1.36)	Noted by ENV Australia (2008) that it cannot be assigned to any current names (the genus is undergoing taxonomic review), so its conservation status is unknown.
<i>Triodia</i> collection (CK 5.5)	Noted by ENV Australia (2008) as a 'hard' <i>Triodia</i> species, several of which are of restricted distribution and none have previously been vouchered from Cockatoo Island. This is potentially a new species of restricted distribution. However, fertile material is required to determine its status.
<i>Triodia</i> collection (CK 1.14)	Noted by ENV Australia (2008) as most likely <i>T. bitextura</i> , but may be <i>T. acutispicula</i> (P3).
<i>Flemingia parviflora</i>	Noted by GHD as a range extension with the nearest record approximately 200 km north-east of the Island.
<i>Chlorophytum laxum</i>	Noted by GHD as a range extension with the nearest record approximately 200 km east of the Island.
<i>Drosera dilatatopetiolaris</i>	Noted by GHD as a range extension with the nearest record approximately 180 km east of the Island.
<i>Alloteropsis semialata</i>	Noted by GHD as a range extension with the nearest record approximately 200 km east of the Island.
<i>Tribulopsis pentandra.</i>	Noted by GHD as a range extension with the nearest record approximately 200 km east of the Island.

## 3.5 Fauna

### 3.5.1 Existing literature

A literature review of previous fauna work within the study area was undertaken prior to the field survey to assess the existing knowledge base. One report, one journal article and existing survey data were reviewed and are summarised below.

#### *Cockatoo Island Birds (Warham 1957)*

In July and August 1957, Warham recorded 40 species of birds on or around Cockatoo Island, five of which were breeding at the time. According to Warham, owing to its rocky 'continental' character, Cockatoo Island has little or no appeal to sea birds for nesting. The rather arid nature of the few beaches probably accounts for the lack of waders. Warham states that the list of birds would be greatly extended if observations were taken over all seasons. According to Warham, obvious absentees were many of the mainland honeyeaters and woodswallows, the Grey-crowned Babbler and Diamond Dove. Small ground and scrub feeding insectivorous birds like wrens, warblers and thornbills were also missing.

Warham recorded the dominant trees of the island as *Eucalyptus miniata* (Woolly butts; growing to about 40 feet high in some places), *Corymbia confertiflora* (Cabbage Gum) and *Eucalyptus tectiflora*, with other dominant species including acacias, grevilleas, figs and spinifex.

Cockatoo Island does not support any large mammals. A number of bats were observed but fruit bats did not appear in any numbers. A rabbit rat was also recorded on the island. Reptiles were common and ground goannas and several species of snakes were observed.

#### ***Fauna Assessment of Cockatoo Island (Desktop Review (Aprasia Wildlife Pty Ltd 2009))***

In June/July 2009 Aprasia Wildlife undertook a fauna desktop review and site reconnaissance.

The desktop review identified 402 vertebrate species as potentially occurring on Cockatoo Island, including: 17 frogs, 91 reptiles, 263 birds and 31 mammal species. Of these, 29 are of high conservation significance being listed under legislation and 12 are of moderate conservation significance, being listed as priority species by the (then) DEC. It should be noted that five migratory marine turtles were included in their list of conservation significant species.

The site inspection was undertaken from 30<sup>th</sup> June-4<sup>th</sup> July 2009. During this survey, Aprasia traversed the island on foot to identify habitat types present, searched for evidence of fauna, especially evidence of significant species such as diggings and burrows, caves, tracks and scats, undertook spotlighting and listening for nocturnal species, opportunistic observations, including bird-watching and targeted trapping for the Northern Quoll (*Dasyurus hallucatus*).

From the site inspection and opportunistic observations, Aprasia recorded 60 vertebrate fauna species including 10 reptiles, 45 birds, 3 mammals and 2 frogs. Of these, five are conservation significant and include three birds (*Haliaeetus leucogaster*, White-bellied Sea Eagle – now delisted; *Fregata ariel*, Lesser Frigatebird; *Merops ornatus*, Rainbow Bee-eater – now delisted), one reptile (*Crocodylus porosus*, Saltwater Crocodile) and one mammal (*Hydromys chrysogaster*, Water Rat).

#### ***Cockatoo Island, Flora, Fauna and SRE Survey data (GHD 2014)***

GHD completed a dual season Level 2 fauna assessment of Cockatoo Island from 8-19 August 2013 and 7-17 February 2014. The surveys were undertaken to collect baseline data on the species present, gain a greater understanding of the faunal assemblages and identify any conservation significant species or potential habitat present on the Island.

GHD identified six broad fauna habitat types including woodlands (with rocky ridgelines and exposed rocky areas), mangroves, rocky hummock grassland (with rocky ridgelines), coastal dunes, rocky coastline, and regrowth shrublands. The variety of habitats across the island provide resources for fauna, including a number of conservation significant species. The Island also contained large areas that have been cleared/highly disturbed or developed; these areas provide little to no habitat value.

GHD recorded a total of 106 vertebrate fauna species, including 70 birds, 24 reptiles, one amphibian and eleven native mammals (including bats). Ninety species were recorded during the dry season survey and 86 during the wet season survey.

Six conservation significant fauna species were recorded on the Island during the GHD surveys including Saltwater Crocodile (*Crocodylus porosus*), Masked Owl (northern sub-species) (*Tyto novaehollandiae kimberli*), Ghost Bat (*Macroderma gigas*), Little North-western Mastiff Bat (*Mormopterus loriae cobourgiana*), Northern Leaf-nosed Bat (*Hipposideros stenotus*), and Water Rat (*Hydromys chrysogaster*). An additional nine species listed as Migratory under the EPBC Act were recorded during the surveys. These species were observed either as fly over, utilising the island or on beaches and coastal areas. All species are considered common, highly mobile and would opportunistically utilise the Island.

### 3.5.2 Fauna diversity

A search of the *NatureMap* database identified 88 terrestrial fauna taxa recorded within the study area. This comprised 60 birds, 21 reptiles, six mammals and one invertebrate. The search also identified species that are considered exclusively marine (e.g. fishes, turtles, sea snakes, sharks), these species have been excluded as they are outside of the scope of this assessment.

### 3.5.3 Conservation significant fauna

Desktop searches of the EPBC Act PMST, DPaW *NatureMap* database and review of existing literature identified the presence/potential presence of 35 conservation significant terrestrial fauna species within the study area, including:

- Thirty-one species, which are listed as Migratory marine birds under the EPBC Act, five of which are also listed under Schedule 1 (Threatened) of the WC Act
- The Saltwater Crocodile (*Crocodylus porosus*), which is listed as Migratory marine reptile under the EPBC Act, and under Schedule 6 of the WC Act
- The Red Goshawk (*Erythrotriorchis radiatus*) which is listed as Vulnerable under the EPBC Act under Schedule 3 (Vulnerable) of the WC Act
- The Water Rat (*Hydromys chrysogaster*), which is Priority 4 listed by the DPaW.

### 3.5.4 Introduced fauna

Database searches identified the Goat (*Capra hircus*) as being introduced to the island by early settlers as a food source for the establishing town. Communications with long-term employees of the island recollect the species being exterminated as they were no longer utilised.

## 3.6 SRE invertebrate fauna

### 3.6.1 Existing literature

A literature review of previous SRE work within the study area was undertaken prior to the field survey to assess the existing knowledge base. No reports are available, but existing survey data was reviewed and is summarised below.

#### *Cockatoo Island, Flora, Fauna and SRE Survey data (GHD 2014)*

GHD completed a dual season SRE invertebrate assessment of Cockatoo Island from 8-19 August 2013 and 7-17 February 2014. The surveys were undertaken to collect baseline data on the species present, and identify any potential or likely SRE species.

GHD recorded 36 invertebrate species from 18 families and five classes. Taxonomic assessment indicated that no confirmed SRE species were recorded, however, three likely and 25 potential SRE species were collected. The remaining eight species recorded during the surveys have a widespread distribution (have no SRE status). GHD noted that although no confirmed SRE species were recorded during the surveys this should not be interpreted that none are present on Cockatoo Island. The majority of the uncertainty surrounding these species is related to deficient data concerning geographic distribution and/or a lack of adequate taxonomic frameworks. Several specimens belong to taxonomic groups that contain numerous SRE taxa but were either juvenile or the incorrect sex to enable full identification.

### 3.6.2 SRE diversity

A search of the *NatureMap* database did not identify SRE invertebrate fauna within the study area. A search of the WAM database identified 32 terrestrial invertebrate fauna taxa recorded within 10 km of the study area (26 Crustacea, three Molluscs and three Arachnida). One confirmed SRE snail and two potential SRE snail species have previously been recorded from Cockatoo Island and been lodged with the WAM collections including:

- Camaenidae: *Kimboraga yampiensis* (confirmed SRE species)
- Camaenidae: *Torresitrachia bathurstensis* (Potential SRE species)
- Camaenidae: *Rhagada* sp. (Potential SRE species).

## 4. Results

### 4.1 Vegetation and flora

#### 4.1.1 Vegetation associations

Three vegetation associations as well as highly disturbed/cleared areas were identified and described from the survey area (Table 7 and Figure 3, Appendix A). The survey area was dominated by *Eucalyptus* open woodland (EmW), which covered approximately 75% of the survey area. This association occurred on hillslopes, cliffs, valleys and gullies across the survey area. The *Eucalyptus* open woodland association was dominated by upper stratum taxa including *Eucalyptus miniata*, *Corymbia cadophora* subsp. *cadophora* and *Brachychiton diversifolius* over a mid- stratum characterised by mixed shrubs and a lower stratum dominated by *Triodia* hummock grasslands. A recent fire (May 2016) throughout the western parts of the survey area (Figure 1) has altered the vegetation structure, with all stratum layers burnt. However, this is likely a temporal change with extensive natural regeneration observed.

In long unburnt areas of the survey area (i.e. the eastern parts) *E. miniata* reached >10 m tall and ground cover comprised a deep detritus layer (over 20-40 cm deep). In the recently burnt areas of the survey area, *E. miniata* was less than 10 m tall or burnt and re-sprouting, and detritus layers much shallower or absent. The differences in depth of detritus layers also impacted the presence (or absence) of *Triodia bynoei* in some areas within the *Eucalyptus* open woodland association. At a number of locations no or very little (<2 %) *T. bynoei* was recorded where thick detritus layers were present.

A true vineland (*Dioscorea* Vineland) has been mapped from one location on the Island, outside of the survey area (covering approximately 20 x 30 m). It has distinctive vegetation that is allied to rainforest, and contains species that generally occur to the north and east of Cockatoo Island, in the northern Kimberley. Several small patches of *Dioscorea* Vineland (DtV) and *Eucalyptus* open woodland (EmW) mosaic were recorded within the survey area. These areas contained a number of the species that occurred within the vineland, including *Canarium australianum* var. *australianum* and *Dioscorea transversa*, but structurally were an intergrade between a rainforest patch and *Eucalyptus* open woodland.

Mixed *Acacia* shrubland (AS) was recorded on and adjacent to the tailings dam within the survey area. This area had previously been cleared and the vegetation that comprised this association was native regrowth at various ages dominated by *Acacia* species.

#### 4.1.2 Conservation significant ecological communities

No Federal or State listed TECs or PECs were identified within the survey area during the survey.

**Table 7 Vegetation associations within the survey area**

Vegetation code	Vegetation association description	Landform	Sampling locations and extent (ha)	Photograph
<i>Eucalyptus</i> open woodland (EmW)	<p><i>Eucalyptus miniata</i>, <i>Corymbia cadophora</i> subsp. <i>cadophora</i>, <i>Brachychiton diversifolius</i> open low woodland over <i>Calytrix exstipulata</i>, <i>Grevillea agrifolia</i> subsp. <i>agrifolia</i>, <i>Buchanania obovata</i> tall sparse shrubland over <i>Calytrix exstipulata</i>, <i>Bridelia tomentosa</i>, <i>Acacia stigmatophylla</i> sparse shrubland over <i>Dodonaea hispidula</i>, <i>Hibbertia oblongata</i>, <i>Acacia hippuroides</i> low shrubland over <i>Triodia bynoei</i> and <i>T. pungens</i> hummock grassland over <i>Sorghum plumosum</i>, <i>Heteropogon contortus</i>, <i>Eriachne avenacea</i>, <i>Cymbopogon</i> sp. sparse tussock grassland over <i>Trachymene didiscoides</i> isolated herbs over <i>Cassythia candida</i>, <i>Gossypium costulatum</i> and often *<i>Passiflora foetida</i> open vineland.</p> <p>Aligns with association 8001 (Beard 1977).</p>	Hillslope, cliffs, valleys and gullies	<p>Extent: 151.46 ha</p> <p>Sites: Q02, Q04, Q05, Q10, Q13, Q14, Q16, Q21, R03, R04, R05, R06, R07, R08</p>	

Vegetation code	Vegetation association description	Landform	Sampling locations and extent (ha)	Photograph
<i>Dioscorea</i> Vineland (DtV) and <i>Eucalyptus</i> open woodland (EmW) mosaic	<i>Canarium australianum</i> subsp. <i>australianum</i> , <i>Sersalisia sericea</i> woodland with <i>Eucalyptus</i> <i>miniata</i> , <i>Corymbia cadophora</i> isolated trees over <i>Pavetta kimberleyana</i> , <i>Grevillea agrifolia</i> subsp. <i>agrifolia</i> mid- to tall open shrubland with <i>Dioscorea</i> <i>transversa</i> , <i>Ampelocissus acetosa</i> , <i>Tinospora</i> <i>smilacina</i> , <i>Flagellaria indica</i> vineland over open herbland of <i>Tacca leontopetaloides</i> .	Limited to very small areas in a valleys	Extent: 1.35 ha	
Mixed <i>Acacia</i> shrubland (AS)	<i>Acacia colei</i> var. <i>colei</i> , <i>Acacia tumida</i> var. <i>tumida</i> tall regrowth shrubland.	Dam, embankment and hillslope	Extent: 2.17 ha  Sites: Q15	
Highly disturbed/ cleared			Extent: 46.34 ha	

### 4.1.3 Other significant vegetation

The DPaW has identified mangroves, riparian forests and rainforest patches as 'special landscapes and ecosystems' which can be considered as equivalent to the 'other significant vegetation' as described by the EPA (2016b). These vegetation types can act as resource centres for fauna that are dependent on the archipelago of patches. They also provide a dry season refuge for a variety of animals (DEC 2009).

The survey area supports several small patches that have species distinctive of rainforest patches, but do not form discrete communities. These areas were mapped as '*Dioscorea* Vineland (DtV) and *Eucalyptus* open woodland (EmW) mosaic', and are likely to represent other significant vegetation as they have a restricted distribution, represent local endemism in restricted habitats and act as a refuge.

### 4.1.4 Vegetation condition

The vegetation condition within the survey was rated from Very Good to Completely Degraded. Areas of *Eucalyptus* open woodland in the eastern and western parts of the survey area were rated as Very Good. In these areas, the vegetation structure was intact, and disturbances included repeated fires and the presence relatively non-aggressive weeds and occasional vehicle tracks. Several areas adjacent to the existing airstrip and/or mine were rated as Good to Poor; these areas showed more obvious impacts to the vegetation structure, and disturbances included partial clearing and the presence of more aggressive weeds. Areas associated with the TSF were rated as Poor; this area has been previously cleared and comprised natural regrowth limited to several *Acacia* species.

The extents of the vegetation condition ratings mapped within the survey area are detailed in Table 8 with the vegetation condition of the survey area mapped in Figure 4, Appendix A.

**Table 8 Extent of vegetation condition ratings within the survey area**

Condition rating	Extent (ha)
Very Good	135.54
Good	10.19
Poor	7.58
Degraded	1.67
Completely Degraded	46.34
<b>Total</b>	<b>201.32</b>

### 4.1.5 Flora diversity

One hundred and thirty flora taxa (including subspecies and varieties) representing 50 families and 94 genera have been recorded in the survey area based on the field survey and previous survey data. This total comprises 124 native taxa and six introduced taxa.

Dominant families recorded from the survey area included:

- Fabaceae (23 taxa)
- Poaceae (14 taxa)
- Malvaceae (12 taxa).

The floristic diversity recorded within the survey area is consistent with data collected from previous surveys on Cockatoo Island (as discussed in section 3.4.1), however, is greater than that recorded on *NatureMap*.

A flora species list for the survey area is provided in Appendix D.

#### 4.1.6 Conservation significant flora

##### *EPBC Act/ WC Act-listed flora taxa*

No EPBC Act or WC Act-listed flora taxa were recorded within the survey area during the GHD surveys. Furthermore, no EPBC Act or WC Act-listed flora taxa have been previously recorded on Cockatoo Island.

##### *DPaW Priority-listed flora*

One DPaW Priority-listed flora has been previously recorded within the survey area, *Triodia* sp. Hidden Island (T. Handasyde TH 6109). An additional Priority-listed species, *Solanum vansittartense* has been previously recorded on Cockatoo Island, but outside of the survey area.

##### *Triodia* sp. Hidden Island (T. Handasyde TH 6109) (Priority 1)

*Triodia* sp. Hidden Island is a perennial, tussock-forming grass with spreading/open spikelets (Plate 2). The taxon is known from seven collections on Hidden Island (which is approximately 22 km south-west of Cockatoo Island), with the collection on Cockatoo Island representing the first record in another location.



**Plate 2** *Triodia* sp. Hidden Island habit and inflorescence

##### *2014 and 2016 flora survey*

*Triodia* sp. Hidden Island was collected from one location (in the central part of the survey area) by GHD in 2014. The plant was located adjacent to a track, north of the airport in an area that had historically been used as a material dump (believed to be back in the 1950s). No information on the number or extent of the taxon was recorded at the time of survey in 2014. GHD revisited the location during the 2016 field survey, however, the site had been burnt and the *Triodia* could not be re-located.

##### *Targeted survey May 2017*

During the targeted survey (section 2.2.2) in May 2017 GHD revisited the material dump site, however the *Triodia* spp. within the burn site was too immature to differentiate or identify. Survey efforts were extended outside the survey area concentrating on the only know habitat of *Triodia* sp. Hidden Island – cliff faces and/or rocky outcrops (WA Herbarium 1998- ).

*Triodia* sp. Hidden Island was recorded at a number of locations on Cockatoo Island (Figure 3, Appendix A). It is estimated that between 1300 and 1400 individuals were recorded within the targeted survey area. The waypoint locations and densities at each point are listed in Appendix D.

On the eastern side of Cockatoo Island the species was recorded around the edges of an old tailings dam, quarry and gully; the gully was orientated in a southwards direction towards the sea. The *Triodia* sp. Hidden Island continued to dominate the gully walls out to a south eastern rocky cliff face. The population was seen extending around the southern edge of the cliff face and out of view.

Several populations of *Triodia* sp. Hidden Island were recorded near and within the existing accommodation area. The largest was a population which lined the wall of a rocky gully that sloped from the road westward to the beach. Scattered populations were located in disturbed sections of the accommodation area where rocks were piled and along roads; specifically the one-way road that heads from the mess to the haul road.

On the far western side of Cockatoo Island, populations of *Triodia* sp. Hidden Island were recorded lining the ridgeline track to the west end and on a rocky north facing cliffs near a beach.

### ***Solanum vansittartense* (Priority 2)**

*Solanum vansittartense* is an erect shrub to approximately 3 m high with purple and yellow flowers. The species is known from 15 collections and has previously been collected from Vansittart Bay, Admiralty Gulf and the Mitchell Plateau in the Northern Kimberley IBRA bioregion.

Although collected from Cockatoo Island in 2008, this species has only been recently recorded as occurring on the Island (*FloraBase* update in December 2016). Specimen details indicate it was collected by A. Mitchell from the west end of the Island (near the accommodation) from disturbed soil with weedy herbs and grasses. No information on the number or extent of the species was recorded. No other surveys have identified *S. vansittartense* on the island.

### **4.1.7 Other significant flora**

Two species identified within the survey area are considered ‘other significant flora’ as defined by the EPA (2016b). These species, *Flemingia parviflora* and *Chlorophytum laxum* represent range extensions (summarised in Table 9). In addition, one species, *Alloteropsis semialata*, which was previously noted as representing a range extension and therefore considered ‘other significant flora’ by GHD (2014), was recorded during the field survey. This species has been since recorded south-west of Cockatoo Island, and its record on the Island is no longer considered a range extension.

**Table 9 Species recorded as range extensions and their current known range**

Species	Known locations (WA Herbarium 1998– and DPaW 2007–)
<i>Flemingia parviflora</i>	11 locations including the Mitchell Plateau, Beverley Springs Station and near King Edward River, with the nearest record approximately 200 km north-east of the study area.
<i>Chlorophytum laxum</i>	Recorded within the Mitchell IBRA subregion; with the nearest record approximately 200 km east of the study area.

### **4.1.8 Introduced flora**

Six introduced (weed) species were recorded within the survey area during the field survey. These species are largely associated with disturbed areas, with the exception of Stinking Passion Flower (*\*Passiflora foetida*) and *\*Melinis repens* which are more widespread across the survey area. None of the introduced species recorded are Declared Pests under the BAM Act or listed as WoNS.

## 4.2 Fauna

### 4.2.1 Fauna habitat types

Two broad fauna habitat types were identified within the survey area and included woodlands (with rocky ridgelines and exposed rocky areas) and regrowth shrublands (Figure 5, Appendix A). The fauna habitat types align closely with the vegetation associations described within the survey area, and are described in Table 10. Several small areas of vineland and woodland mosaic were recorded in valleys within the survey area. These patches are very small and are not considered large enough to support any fauna specific to this habitat type. The survey area also contained areas that have been cleared/highly disturbed or developed (46.34 ha). These areas provide little to no habitat value and comprise mining disturbance, the airstrip, roads/tracks, and other infrastructure.

**Table 10 Fauna Habitat types within the survey area**

Habitat Type and description	Representative photo
<p><b>Woodlands (with rocky ridgelines and exposed rocky areas)</b></p> <p>Corresponding vegetation associations: EmW and DtV &amp; EmW mosaic</p> <p>Extent: 152.81 ha</p> <p>The survey area is dominated by the woodland habitat type, which consists of <i>Eucalyptus</i> and <i>Corymbia</i> species over scattered shrubs and a moderately dense understorey of shrubs, grasses and herbs. Large areas of this habitat type had been recently burnt with only small patches of unburnt vegetation remaining. In the burnt areas there is little ground cover, with minimal litter and scattered burnt logs present.</p> <p>In its current form, this habitat type would support few conservation significant species, however it may be opportunistically used for foraging.</p> <p><b>Conservation Significant Species</b></p> <p>Likely to provide foraging habitat for all bat species and the Masked Owl.</p>	
<p><b>Regrowth shrublands</b></p> <p>Corresponding vegetation associations: AS</p> <p>Extent: 2.17 ha</p> <p>In the eastern part of the survey area, there is a patch of regrowth <i>Acacia</i> shrubland on and adjacent to the tailings dam. This area had previously been cleared and comprised native regrowth dominated by <i>Acacia</i> species.</p> <p><b>Conservation Significant Species</b></p> <p>No conservation significant species were recorded in the survey area and they would they be unlikely to utilise this habitat type.</p>	

A large portion of the woodland habitat had been recently burnt (fire in May 2016). In these burnt areas, most of the vegetation cover had been reduced, providing little cover for fauna species. The rocky nature of the area does provide some refugia, however this would be limited to rock dwelling species. Similarly, many of the large, hollow-bearing trees have been burnt reducing the habitat available.

There are no permanent waterbodies located within the survey area, however there is seasonal pooling around small rock areas and the historical tailings dam in the eastern part of the survey area. Gullies bisect portions of the survey area and form minor drainage lines that have limited surface water run-off.

#### **4.2.2 Fauna diversity**

Several fauna surveys have been undertaken on Cockatoo Island including Warham (1957), Aprasia Wildlfe (2009) and GHD (2014). In total 175 vertebrate species have previously been recorded on and in the vicinity of Cockatoo Island, including five mammals, 13 reptiles, 155 birds and two amphibian species.

The 2016 field survey identified 34 birds, eight reptiles, one amphibian and three mammals, including two bird species not previously recorded on or in the vicinity of the Island. Due to the recently burnt habitat, the number of species observed was greatly reduced compared to what was expected.

#### **4.2.3 Conservation significant fauna**

One conservation significant fauna species was recorded in the survey area: the Northern Leaf-nosed Bat (*Hipposideros stenotus*), which is listed as Priority 2 by the DPaW.

Previous surveys of Cockatoo Island have recorded an additional four conservation significant terrestrial fauna species including:

- Ghost Bat (*Macroderma gigas*) – listed as Vulnerable under the EPBC Act and WC Act
- Masked Owl (northern sub-species) (*Tyto novaehollandiae* subsp. *kimberli*) – listed as Vulnerable under the EPBC Act and Priority 1 by the DPaW
- Little North-western Mastiff Bat (*Mormopterus loriae* subsp. *cobourgiana*) – listed as Priority 1 by the DPaW
- Water Rat (*Hydromys chrysogaster*) – listed as Priority 4 by DPaW.

#### **Northern Leaf-nosed Bat**

The Northern Leaf-nosed Bat is considered rare throughout its distribution in northern Western Australia, the Northern Territory and north-western Queensland. This species occurs throughout a variety of habitats, and forages in woodland, dense vinelands and open spinifex grasslands with rocky outcrops (van Dyck *et al.* 2013). The Northern Leaf-nosed Bat typically roosts in shallow cracks and caves, boulder piles and disused mines, and forages in a variety of habitats including woodlands, grasslands and vine thickets. It is considered likely that this species can tolerate a wide range of environmental conditions, and is well distributed down the west Kimberley coast. There are records of the Northern Leaf-nosed Bat from Koolan Island, Irvine Island and Bathurst Island, which suggests the individuals on Cockatoo Island form part of a locally significant population.

The Northern Leaf-nosed Bat has been previously recorded on Cockatoo Island, and echolocation calls were recorded at one location in the western part of the survey area on the recent field survey. The species is likely to utilise the survey area for foraging, however, no small caves and limited rocky crevices (breeding habitat) were observed within the survey area.

## Ghost Bat

The present distribution of the Ghost Bat is widespread but intermittent throughout northern Australia, where it occupies a diverse range of habitats from the arid Pilbara to northern rainforests. During the day, Ghost Bats generally roost in large, often complex cave systems with several entrances, deep rock fissures, boulder piles, or mines. Individuals have been observed roosting in shallow rocky overhangs and sheds. The bats emerge from the roosts approximately one hour after sunset to forage (van Dyck *et al.* 2013).

Ghost Bats are known to occur on nearby Koolan Island, and throughout other islands in the Buccaneer Archipelago. Echolocation calls of the Ghost Bat have been previously recorded from one location on Cockatoo Island, just outside of the survey area. The occurrence of the species on Cockatoo Island indicates that there is likely to be a significant refuge for the species in close proximity to both Koolan and Cockatoo Islands. No Ghost Bat roosts or maternity caves were recorded within the survey area during the field survey. However, one cave potentially suitable to support the species is present in the rocky coastal cliffs. This cave is approximately 100 m from the north-west boundary of the survey area. It is unknown if this cave is affected by the tidal movements (i.e. partially or completely fills with water) and/or is utilised by any bat species.

## Masked Owl (northern sub-species)

The distribution of the northern sub-species of the Masked Owl is poorly known, however it is thought to occur in three subpopulations including the Kimberley, Northern Territory and Cape York. In the Kimberley region, the species occurs from Yampi Sound north-east to Cambridge Gulf, including Windjana Gorge and Augustus Island. The Masked Owl inhabits a variety of habitats from riparian forest, rainforest, open forest, *Melaleuca* swamps and the edges of mangroves, as well as along the margins of sugar cane fields (DotEE 2017b).

The Masked Owl has been previously recorded on the eastern side of the Island in the woodland habitat. In its current form (i.e. recently burnt), the woodland habitat within the survey area may provide foraging habitat for the Masked Owl. Nine trees with large hollows were recorded in the survey area, and these may be utilised by the species, however none of the hollows showed evidence of existing or historical use (i.e. owl pellets, scats or hollow scarring).

## Little North-western Mastiff Bat

The Little North-western Mastiff Bat is known from 12 locations in Western Australia and four in the Northern Territory. Within this distribution it is restricted to a few localised habitats, and can appear to be locally common because it aggregates. In Western Australia, this species inhabits mangrove stands, and has been recorded roosting in hollows and or crevices in mangroves (van Dyck *et al.* 2013). There are records of the Little North-western Mastiff Bat from mangroves near Cape Leveque and on the Dampier Peninsula.

Echolocation calls of the Little North-western Mastiff Bat have been previously recorded from one location on Cockatoo Island, outside of the survey area. Given the lack of mangrove areas within the survey area, and very minimal extent of mangrove areas throughout Cockatoo Island, it is likely that this species roosts in mangrove habitat on the nearby islands (Irvine Island in particular) or on the mainland. The Little North-western Mastiff Bat may utilise the survey area for opportunistic foraging.

## Water Rat

The Water Rat has a broad distribution around much of coastal Australia and inland up the more substantial rivers. In WA the species has a disjunct distribution that includes the Kimberley, Pilbara coast and offshore islands, Bernier and Dorre Islands, and the South-west. This species generally occurs in permanent fresh or brackish water, but can also be found in marine environments, mangroves, sheltered coastal beaches and offshore islands. The Water Rat has been recorded on Irvine Island and Margaret Island, and is also known from other Kimberley Islands to the north of Cockatoo Island such as Bigge and Prudhoe Islands (Bamford Consulting Ecologists 2012). It is likely that a population of Water Rats utilise the coastal margins of Cockatoo Island, including the small extent of coastal margins within the survey area.

## Migratory Species

Three species listed as Migratory under the EPBC Act and/or under Schedule 5 of the WC Act were recorded from the survey area during the surveys. These included:

- Eastern Osprey (*Pandion cristatus*)
- Lesser Frigatebird (*Fregata ariel*)
- Common Sandpiper (*Tinga hypoleucos*).

These species were observed flying over the survey area, are considered highly mobile and would opportunistically utilise the survey area for foraging.

### 4.2.4 Introduced fauna

No introduced fauna species were recorded in the survey area during the field survey.

## 4.3 Short range endemic invertebrate fauna

Twenty-two SRE invertebrate species from 12 families and five classes have been previously recorded in the survey area based on the field survey and previous survey data. Due to the recent fire, there was minimal SRE habitat present throughout much of the survey area.

Taxonomic assessment indicated that no confirmed SRE were recorded within the survey area, however, three likely and 15 potential SRE species were collected. The remaining four species recorded during the survey have a widespread distribution (have no SRE status). The distribution of all likely and potential SRE species is shown in Figure 6, Appendix A.

Species were identified to the lowest practical taxonomic level, taking into consideration that the taxonomic framework of many invertebrate groups are incomplete and often in need of substantial revision to enable accurate identification. SRE status was assigned using all available published information and information from the WAM database and discussion with appropriate taxonomic authorities for various invertebrate groups.

The most widely occurring potential SRE species recorded was Gastropoda: Camaenidae: *Torresitrachia* aff. *bathurstensis*, that was recorded from eight discrete sites (Figure 6), followed by Gastropoda: Helicarionidae: *Westracystis lissus* (six discrete sites). The remaining 20 species were recorded from three or fewer sites, with 12 species recorded from single locations only. Table 11 summarises of invertebrate species identified in the survey area.

**Table 11 Invertebrate species recorded within the survey area**

Species	SRE Status	GHD Record Site
Gastropoda: Camaenidae: <i>Kimboraga cf. yampiensis</i>	Potential SRE	2014: SREP3, SREF9
Gastropoda: Camaenidae: <i>Torresitrachia aff. bathurstensis</i>	Potential SRE	2014: SREP5, SREF5, SREF8, SREF9, SREF10, SREF13 2016: SREF4, SREF5
Gastropoda: Helicarionidae: <i>Westracystis lissus</i>	Widespread	2014: SREP3, SREF8, SREF10 2016: SREF3, SREF4, SREF5
Crustacea: Isopoda: Armadillidae: <i>Buddelundia '82'</i>	Likely SRE	2014: SREF10 2016: SREF1
Crustacea: Isopoda: Philosciidae: <i>Philosciidae 'cockatoo island'</i>	Likely SRE	2014: SREF9
Crustacea: Isopoda: Philosciidae sp. indet.	Likely SRE	2014: SREF17
Chilopoda: Geophilida: Chileneophilidae	Potential SRE	2014: SREF10, SREF11
Chilopoda: Geophilida: Mecistocephalidae	Potential SRE	2014: SREF9, SREF17
Chilopoda: Scolopendrida: Cryptopidae: <i>Cryptops</i> sp.	Potential SRE	2014: SREF9, SREF10
Chilopoda: Scolopendrida: Scolopendridae: <i>Rhysida polyacantha</i>	Widespread	2014: SREP5
Chilopoda: Scolopendrida: Scolopendridae: <i>Scolopendra laeta</i>	Widespread	2014: SREF10
Chilopoda: Scolopendrida: Scolopendridae: Scolopendridae genus indet. sp.	Potential SRE	2014: SREP5
Chilopoda: Scutigera: Scutigera: genus indet. sp.	Potential SRE	2014: SREP5
Chilopoda: Scutigera: Scutigera: <i>Parascutigera?</i> sp	Potential SRE	2014: SREP6
Chilopoda: Scutigera: Scutigera: <i>Thereuopoda</i> sp.	Potential SRE	2014: SREP3, SREP5
Diplopoda: Polydesmida: Paradoxosomatidae: genus indet. (juvenile) and sp. indet. (juvenile)	Potential SRE	2014: SREF5
Arachnida: Pseudoscorpiones: Olpiidae: <i>Xenolpium</i> sp.	Potential SRE	2014: SREF5, SREF9
Arachnida: Scorpiones: Buthidae: <i>Lychas bituberculatus</i> Pocock, 1891	Widespread	2016: SREF6
Possibly juvenile Arachnida: Araneae: Barychelidae: <i>Synothele</i> sp. juv.	Potential SRE	2016: SREF4
Arachnida: Araneae: Ctenizidae: <i>Conothele</i> sp female	Potential SRE	2014: SREF5
Arachnida: Acari: Trombidioidea: <i>Trombidioidea</i>	Potential SRE	2014: SREF9, SREF10 2016: SREF5
Arachnida: Opiliones: Assamiidae: <i>Dampetrus?</i>	Potential SRE	2014: SREF11

## 5. Conclusions

### 5.1 Vegetation and flora

The survey area comprised three vegetation associations, *Eucalyptus* open woodland (EmW), Mixed *Acacia* shrubland (AS) and several small patches of *Dioscorea* Vineland (DtV) and EmW mosaic, as well as highly disturbed/cleared areas. A recent fire (May 2016) throughout the western parts of the survey area has altered the vegetation structure, with all stratum layers burnt. However, this is likely a temporal change with extensive natural regeneration observed. The vegetation types are not considered representative of any Commonwealth or State listed TECs or PECs, however, the small patches of DtV and EmW mosaic are likely to represent other significant vegetation as they have a restricted distribution, represent local endemism in restricted habitats and act as a refuge.

The majority of vegetation within the survey area was rated as Very Good in condition. Several areas adjacent to the existing airstrip and/or mine were rated as Good to Good-Poor; these areas showed more obvious impacts compared with other areas of vegetation within the survey area. Areas associated with the tailings dam were rated as Degraded, with all highly disturbed/cleared areas rated as Completely Degraded.

No EPBC Act or WC Act-listed flora taxa were recorded within the survey area, or have been previously recorded on Cockatoo Island. One DPaW Priority-listed flora species has been previously recorded within the survey area, *Triodia* sp. Hidden Island (T. Handasyde TH 6109) (Priority 1). An additional Priority-listed species, *Solanum vansittartense* (Priority 2) has been previously recorded on the island, but outside of the survey area. The current extent of *Solanum vansittartense* (Priority 2) across the survey area (and island) is unknown. The targeted *Triodia* sp. Hidden Island survey confirmed the presence of multiple populations outside the survey area.

### 5.2 Fauna

Two broad fauna habitat types were identified within the survey area and included woodlands (with rocky ridgelines and exposed rocky areas) and regrowth shrublands. Several small areas of vineland and woodland mosaic were recorded in valleys within the survey area. These patches are very small and are not considered large enough to support any fauna specific to this habitat type.

One conservation significant fauna species was recorded in the survey area, the Northern Leaf-nosed Bat (*Hipposideros stenotus*) which is listed as Priority 2 by the DPaW. Previous surveys of Cockatoo Island have recorded an additional four conservation significant terrestrial fauna species including:

- Ghost Bat (*Macroderma gigas*) – listed as Vulnerable under the EPBC Act and WC Act
- Masked Owl (northern sub-species) (*Tyto novaehollandiae* subsp. *kimberli*) – listed as Vulnerable under EPBC Act and Priority 1 by the DPaW
- Little North-western Mastiff Bat (*Mormopterus loriae* subsp. *cobourgiana*) – listed as Priority 1 by the DPaW
- Water Rat (*Hydromys chrysogaster*) – listed as Priority 4 by the DPaW.

There is no/limited breeding habitat present within the survey area for the Northern Leaf-nosed Bat, Ghost Bat and Little North-western Mastiff Bat. Furthermore, in its current form (i.e. recently burnt), the woodland habitat within survey area provides limited breeding habitat for the Masked Owl (northern sub-species). Nevertheless, all of the above species are likely to utilise the survey area opportunistically for foraging.

Although not observed, the Water Rat is likely to be present around the coastal margins of the survey area.

Three species listed as Migratory under the EPBC Act and/or under Schedule 5 of the WC Act were recorded from the survey area during the surveys. These included:

- Eastern Osprey (*Pandion cristatus*)
- Lesser Frigatebird (*Fregata ariel*)
- Common Sandpiper (*Tinga hypoleucos*).

These species were observed flying over the survey area, are considered highly mobile and would opportunistically utilise the survey area for foraging.

### **5.3 SRE**

Twenty-two SRE invertebrate species from twelve families and five classes have been previously recorded in the survey area based on the field survey and previous survey data. Although no confirmed SRE species have been recorded this should not be interpreted that none are present within the survey area. The survey results found three species considered *likely* to be SRE species and 15 *potential* SRE species. The majority of the uncertainty surrounding these species is related to deficient data with regards to geographic distribution and/or a lack of adequate taxonomic frameworks. Several specimens belong to taxonomic groups that contain numerous SRE taxa but were either juvenile or the incorrect sex to enable full identification.

## 6. References

- Aprasia Wildlife 2009, Fauna Assessment of Cockatoo Island (Desktop Review), Unpublished report prepared for Cockatoo Mining, July 2009.
- Astron Environmental Services 2012, Cockatoo Island Weed Survey, Unpublished report prepared for HWE/Cockatoo Mining, June 2012.
- Bamford Consulting Ecologists 2012, Irvine Island Fauna Habitat Assessment with respect to proposed Pluton Iron Ore Project, Unpublished report prepared for Strategen, January 2012.
- Beard, JS 1977, *Vegetation Survey of Western Australia: Kimberley*, map and explanatory memoir 1:1,000,000 series, Nedlands, University of Western Australia Press.
- Beard, JS 1990, *Plant Life of Western Australia*, Perth, Kangaroo Press.
- Bureau of Meteorology (BoM) 2017, Climatic Statistics for Cygnet Bay, retrieved February 2017, from [http://www.bom.gov.au/climate/averages/tables/cw\\_003057.shtml](http://www.bom.gov.au/climate/averages/tables/cw_003057.shtml).
- Christidis, L and Boles, WE 2008, *Systematics and Taxonomy of Australian Birds*, Melbourne, CSIRO Publishing.
- Department of Environment and Conservation (DEC) 2009, Protecting the Kimberley, A synthesis of scientific knowledge to support conservation management in the Kimberley region of Western Australia, Perth, DEC.
- Department of the Environment and Energy (DotEE), 2016, EPBC Protected Matters Search tool, retrieved December 2016, from <http://www.environment.gov.au/erin/ert/epbc/>.
- Department of the Environment and Energy (DotEE) 2017a, Environment Protection and Biodiversity Conservation Act 1999 List of Threatened Flora, from <http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl?wanted=flora>.
- Department of the Environment and Energy (DotEE) 2017b, *Species Profile and Threats Database*, retrieved February 2017, <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>.
- Department of Parks and Wildlife (DPaW), 2007–, NatureMap: Mapping Western Australia's biodiversity, Department of Parks and Wildlife, retrieved December 2016, from <http://NatureMap.dpaw.wa.gov.au/default.aspx>.
- ENV Australia 2008, Cockatoo Island Declared Rare and Priority Flora Species Search, Unpublished report prepared for Henry Walker Eltin and Portman Mining, February 2008.
- Environmental Protection Authority (EPA) 2016a. Environmental Factor Guideline: Flora and Vegetation.
- Environmental Protection Authority (EPA) 2016b. Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment.
- Environmental Protection Authority (EPA) 2016c. Technical Guidance – Sampling methods for terrestrial vertebrate fauna.
- Environmental Protection Authority (EPA) 2016d. Technical Guidance – Sampling of short range endemic invertebrate fauna.
- Environmental Protection Authority (EPA) 2016e. Technical Guidance – Terrestrial fauna surveys.
- Environmental Protection Authority (EPA) 2016f. Environmental Factor Guideline – Terrestrial Fauna.

Executive Steering Committee for Australian Vegetation Information (ESCAVI) 2003, 'Australian Vegetation Attribute Manual: National Vegetation Information System, Version 6.0', Canberra, Department of the Environment and Heritage.

GHD Pty Ltd (GHD) 2014, Cockatoo Island, Flora, Fauna and SRE Surveys, Unpublished survey data collected for Pluton Resources, 2014.

Government of Western Australia (GoWA) 2015, 2015 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full report), Current as of June 2015, Perth Western Australia, Department of Parks and Wildlife, retrieved February 2017, from <https://www2.landgate.wa.gov.au/web/guest/downloader>.

Graham, G 2001, North Kimberley 1 (NK1 – Mitchell subregion) in Department of Conservation and Land Management (ed), A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002, pp 724.

Harvey, MS 2002, *Short-range endemism in the Australian fauna: some examples from non-marine environments*, Invertebrate Systematics, vol. 16, pp 555–570.

Keighery, BJ 1994. *Bushland plant survey. A guide to plant community survey for the community*. Wildflower Society of WA (Inc.). Nedlands, Western Australia.

Outback Ecology Services 2009, Cockatoo Island Rehabilitation Planning, Unpublished report prepared for Cockatoo Mining, September 2009.

Payne, A and Schoknecht, N 2011, *Land Systems of the Kimberley Region, Western Australia*, Technical Bulletin No. 98, South Perth, Department of Agriculture and Food.

Shepherd, DP, Beeston, GR, and Hopkins, AJM 2002, *Native Vegetation in Western Australia – Extent, Type and Status*, Resource Management Technical Report 249, Perth, Department of Agriculture, Western Australia.

van Dyck, S, Gynther, I and Baker, A 2013, *Field Companion to the Mammals of Australia*, First edition, New Holland Publishing, Sydney Australia.

Waples, K 2007, Kimberley Biodiversity Review, Department of Environment and Conservation, Unpublished report prepared for the EPA Services Unit and the Environmental Management Branch.

Warham, J 1957, *Cockatoo Island Birds*, The Emu, vol 54(4), pp 225-231.

W A Herbarium 1998–, FloraBase—the Western Australian Flora. Department of Parks and Wildlife, retrieved July 2013 & May 2017, from <http://florabase.dpaw.wa.gov.au/>

Western Australian Museum (WAM) 2014, WAMTS263 and WAMTS294: Arachnida/Myriapoda. Arachnids/Myriapods from Cockatoo Island, Western Australia. Unpublished report for GHD.

# Appendices

# **Appendix A – Figures**

**Figure 1 Project location**

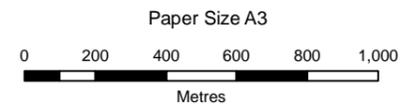
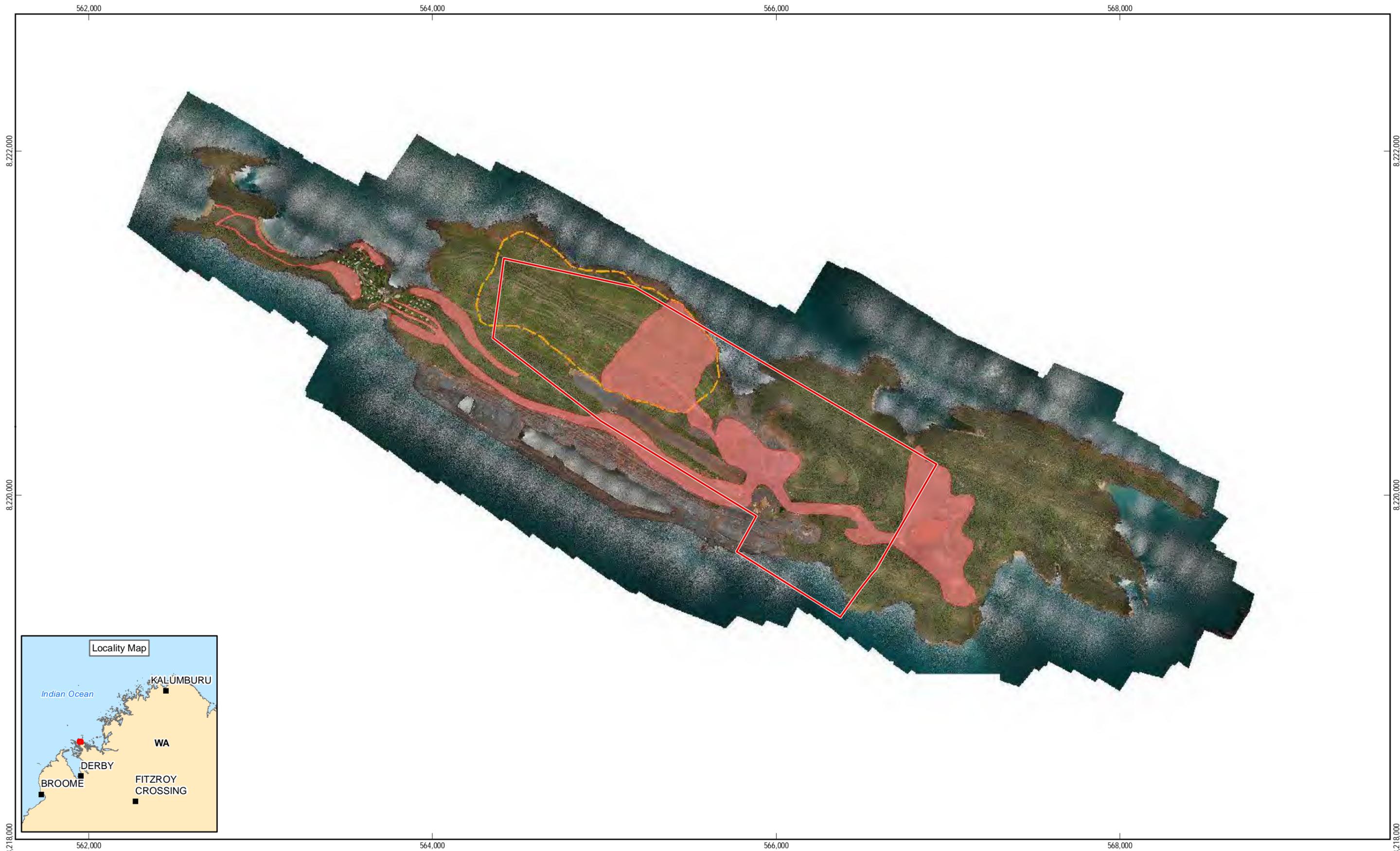
**Figure 2 Sample locations**

**Figure 3 Vegetation associations and conservation significant flora locations**

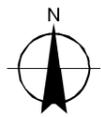
**Figure 4 Vegetation condition**

**Figure 5 Fauna habitats and conservation significant fauna locations**

**Figure 6 Likely and potential SRE invertebrates**



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 51



- LEGEND**
- 2016 Survey Area
  - 2017 Targeted Survey Area
  - May 2016 Fire Scar

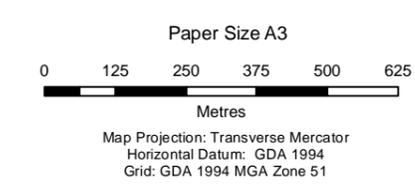
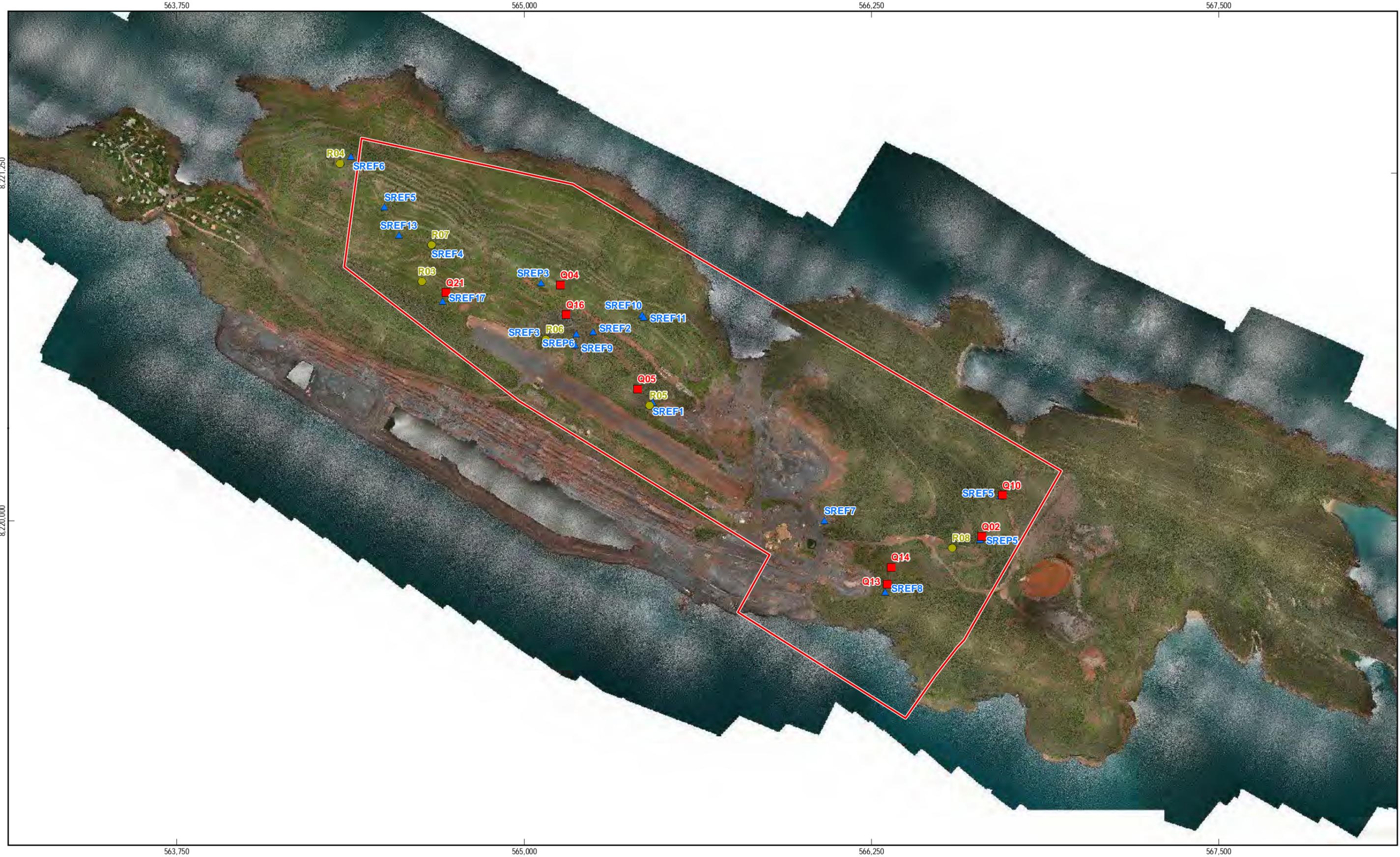


Kimberley Technology  
 Solutions Pty Ltd  
 Cockatoo Island Multi-User Supply Base

Job Number	61-35178
Revision	0
Date	14 Jun 2017

Project Location

Figure 1



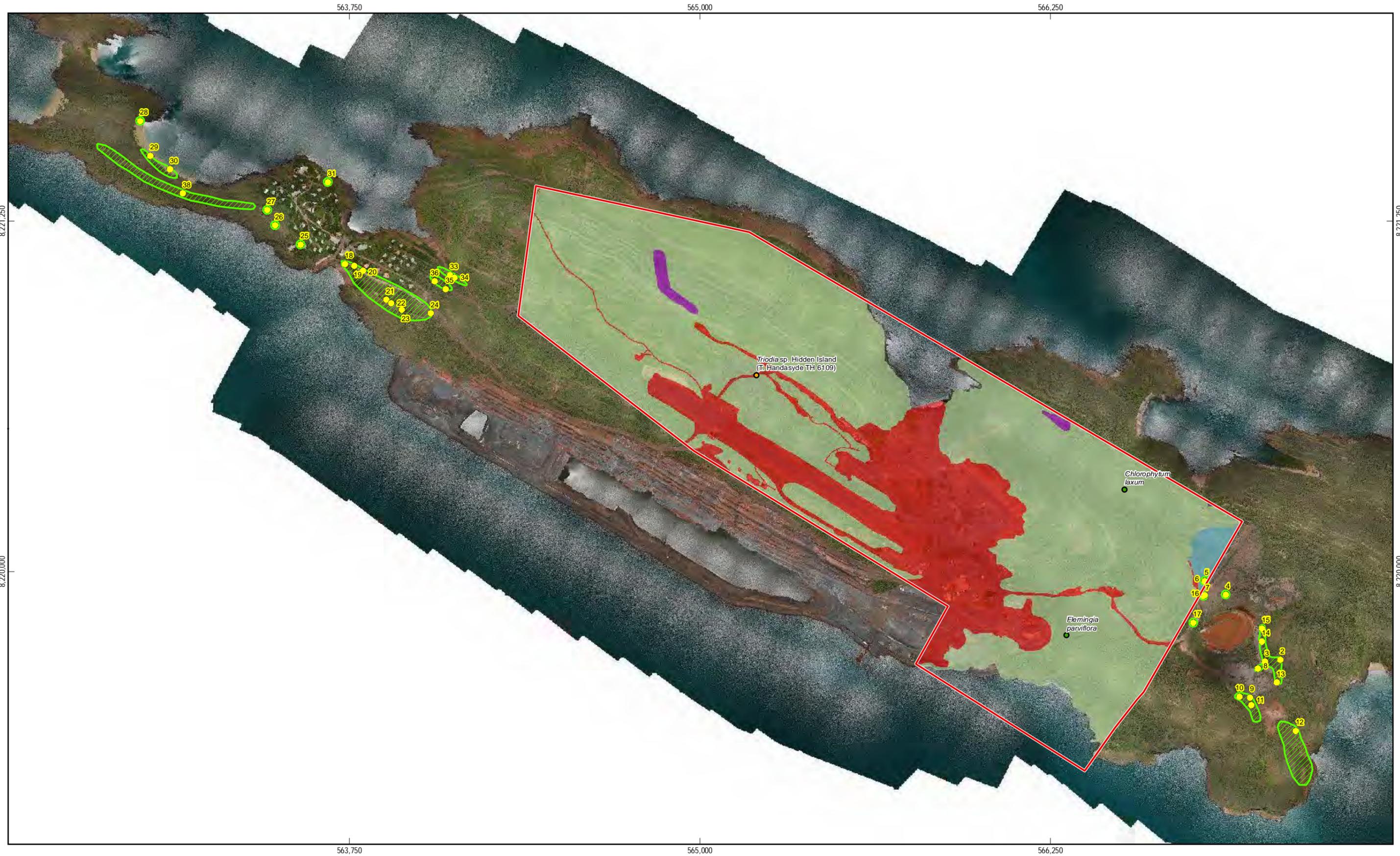
**LEGEND**

<span style="color: red;">■</span> Quadrat	<span style="border: 1px solid red; display: inline-block; width: 20px; height: 10px;"></span> Survey Area
<span style="color: yellow;">●</span> Releves	
<span style="color: blue;">▲</span> SRE Site	



Kimberley Technology Solutions Pty Ltd Cockatoo Island Multi-User Supply Base	Job Number 61-35178 Revision 0 Date 14 Jun 2017
--	---

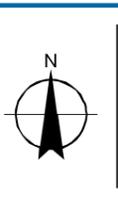
Sample Locations Figure 2



Paper Size A3

0 200 400  
Metres

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 51



**LEGEND**

- Conservation Significant Flora**
- *Triodia* sp. Hidden Island P1 (GHD 2014)
  - Range Extension (GHD 2014)
  - *Triodia* sp. Hidden Island P1 (GHD 2017)

- 2016 Survey Area
- Triodia* sp. Hidden Island cluster (GHD 2017)

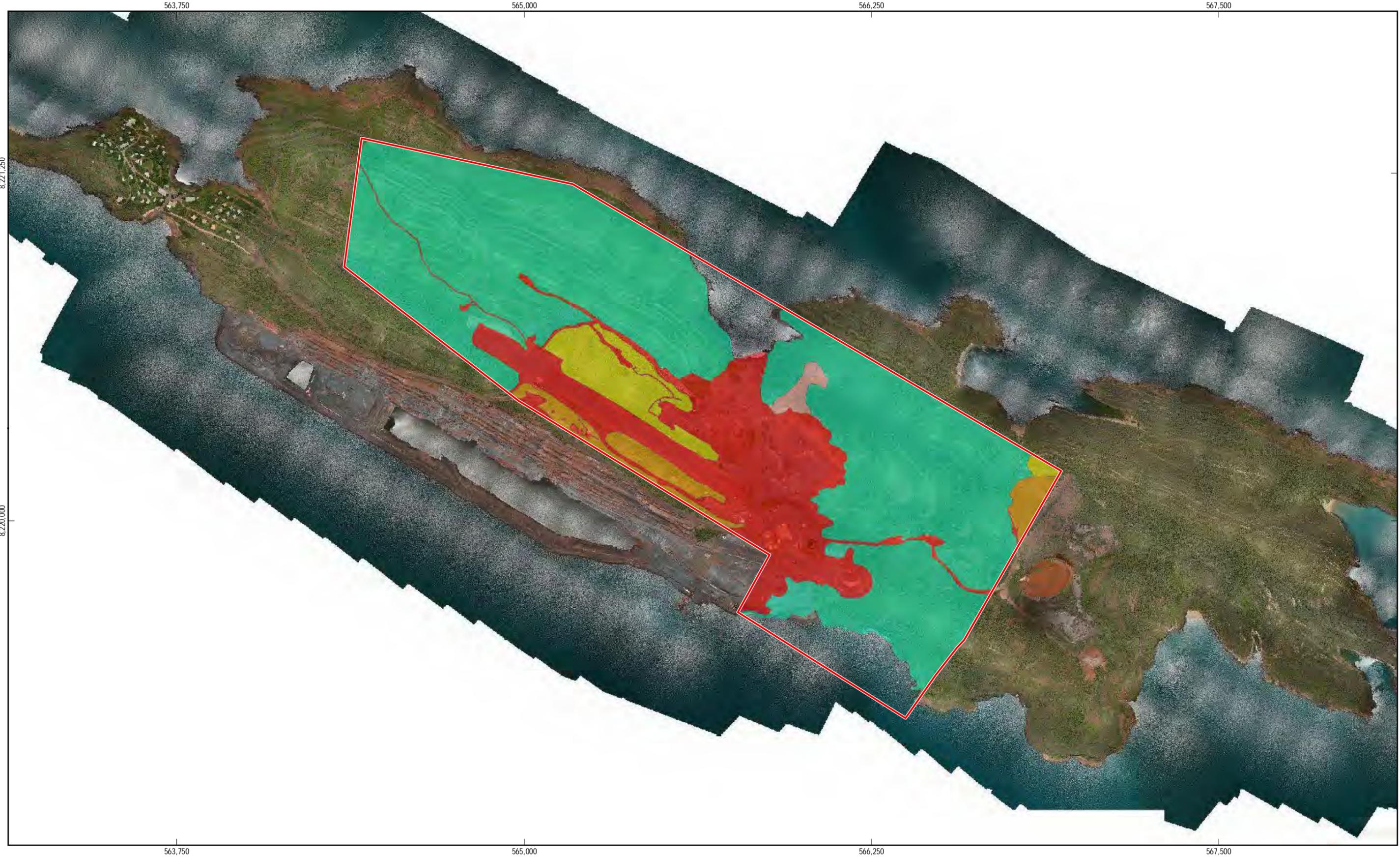
- Vegetation Types**
- Mosaic *Eucalyptus* open woodland (EmW) and *Dioscorea* Vineland (DTV)
  - Eucalyptus* open woodland (EmW)
  - Mixed *Acacia* shrubland (AS)
  - Highly disturbed/cleared



Kimberley Technology Solutions Pty Ltd  
Cockatoo Island Multi-User Supply Base

Job Number 61-35178  
Revision 0  
Date 14 Jun 2017

Vegetation Associations and Conservation Significant Flora Locations **Figure 3**



Paper Size A3  
 0 125 250 375 500 625  
 Metres  
 Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 51



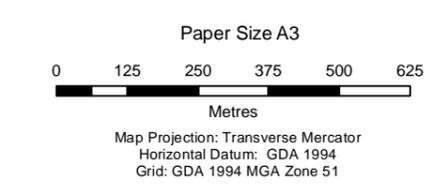
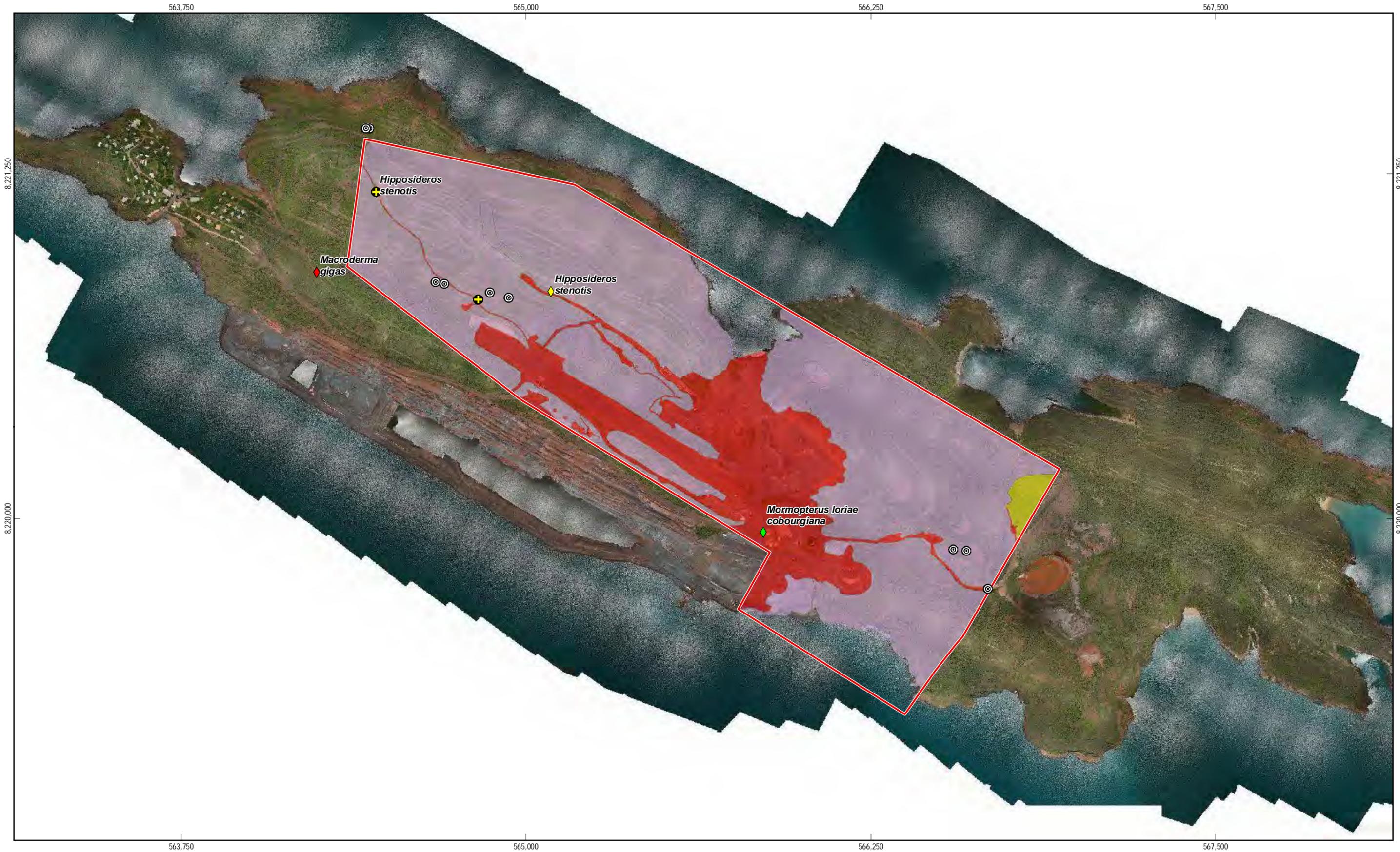
**LEGEND**

Vegetation Condition		Survey Area
2. Excellent	3-4	5-6
2-3	4. Good	6. Degraded
3. Very Good	4-5	6-7
	5. Poor	7. Completely Degraded



Kimberley Technology Solutions Pty Ltd Cockatoo Island Multi-User Supply Base	Job Number 61-35178
	Revision 0
	Date 14 Jun 2017

Vegetation Condition **Figure 4**



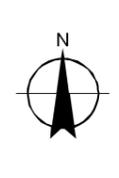
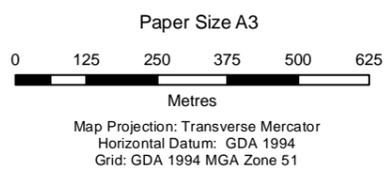
**LEGEND**

<ul style="list-style-type: none"> <li> Bat Detectors</li> <li> Large Tree with Hollow</li> </ul>	<p><b>Conservation Significant Fauna</b></p> <ul style="list-style-type: none"> <li> P1</li> <li> P2</li> <li> V</li> </ul>	<p><b>Fauna Habitats</b></p> <ul style="list-style-type: none"> <li> Regrowth Shrubland</li> <li> Woodland</li> <li> Highly disturbed/cleared</li> </ul>	<ul style="list-style-type: none"> <li> Survey Area</li> </ul>
---	---	--	--



Kimberley Technology Solutions Pty Ltd Cockatoo Island Multi-User Supply Base	Job Number 61-35178 Revision 0 Date 14 Jun 2017
--	---

**Fauna Habitats and Conservation Significant Fauna Locations** **Figure 5**



**LEGEND**

▭ Survey Area



Kimberley Technology  
Solutions Pty Ltd  
Cockatoo Island Multi-User Supply Base

Job Number	61-35178
Revision	0
Date	14 Jun 2017

**Likely and Potential  
SRE Invertebrates**

**Figure 6**

# **Appendix B** – Relevant legislation, background information and conservation codes

## Relevant legislation

### **Federal *Environment Protection and Biodiversity Conservation Act 1999***

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Federal Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as Matters of National Environmental Significance (MNES).

The biological aspects listed as MNES include:

- Nationally threatened flora and fauna species and ecological communities
- Migratory species

A person must not undertake an action that has, will have, or is likely to have a significant impact (direct or indirect) on MNES, without approval from the Federal Minister for the Environment.

The EPBC Act is administered by the Department of the Environment and Energy (DotEE).

### **State *Environmental Protection Act 1986***

The *Environmental Protection Act 1986* (EP Act) is the primary legislative Act dealing with the protection of the environment in Western Australia. The Act allows the Environmental Protection Authority (EPA), to prevent, control and abate pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing. Part IV of the EP Act is administered by the EPA and makes provisions for the EPA to undertake environmental impact assessment of significant proposals, strategic proposals and land use planning schemes.

The Department of Environment Regulation (DER) is responsible for administering the clearing provisions of the EP Act (Part V). Clearing of native vegetation in Western Australia requires a permit from the DER, unless exemptions apply. Applications for clearing permits are assessed by the Department and decisions are made to grant or refuse the application in accordance with the Act. When making a decision the assessment considers clearing against the ten clearing principles as specified in Schedule 5 of the EP Act:

- a) Native vegetation should not be cleared if it comprises a high level of biodiversity.
- b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a significance habitat for fauna indigenous to Western Australia.
- c) Native vegetation should not be cleared if it includes, or is necessary, for the continued existence of rare flora.
- d) Native vegetation should not be cleared if it comprises the whole or part of native vegetation in an area that has been extensively cleared.
- 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.
- f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.
- g) 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.
- h) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

- 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.
- j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

Exemptions for clearing include clearing that is a requirement of a written law or authorised under certain statutory processes (listed in Schedule 6 of the EP Act) and exemptions for prescribed low impact day-to-day activities (prescribed in the Environmental Protection (Clearing of Native Vegetation) Regulations 2004); these exemptions do not apply in environmentally sensitive areas (ESAs).

### **State Biodiversity and Conservation Act 2016**

The Biodiversity Conservation Bill 2015 was introduced to State Parliament in November 2015, and passed in September 2016. The Bill became the *Biodiversity Conservation Act 2016* (BC Act) upon receiving Assent on 21 September 2016. The BC Act will eventually fully replace both the *Wildlife Conservation Act 1950* (WC Act) and the *Sandalwood Act 1929* (Sandalwood Act).

Several parts of the BC Act were proclaimed by the State Governor in the Government Gazette and came into effect on 3 December 2016. However, provisions that replace those existing under the WC Act and Sandalwood Act (including threatened species listings and controls over the taking and keeping of native species) and their associated Regulations cannot be brought into effect until the necessary Biodiversity Conservation Regulations have been made. It is hoped the new Regulations will be completed and ready to commence by late 2017.

### **State Wildlife Conservation Act 1950**

The WC Act provides for the conservation and protection of wildlife. It is administered by the Department of Parks and Wildlife (DPaW) and applies to both flora and fauna. Any person wanting to capture, collect, disturb or study fauna requires a permit to do so. A permit is required under the WC Act if removal of threatened species is required.

### **State Biosecurity and Agriculture Management Act 2007**

The *Biosecurity and Agriculture Management Act 2007* (BAM Act) and associated regulations are administered by the Department of Agriculture and Food Western Australia (DAFWA) and replace the repealed *Agriculture and Related Resources Protection Act 1976*. The main purposes of the BAM Act and its regulations are to:

- Prevent new animal and plant pests (vermin and weeds) and diseases from entering WA
- Manage the impact and spread of those pests already present in the state
- Safely manage the use of agricultural and veterinary chemicals
- Increased control over the sale of agricultural products that contain violative chemical residues

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act. A Declared Pest is a prohibited organism or an organism for which a declaration under Section 22(2) of the Act is in force. Declared Pests may be assigned a control category including: C1 (exclusion), C2 (eradication) and C3 (management). The category may apply to the whole of the State, LGAs, districts, individual properties or even paddocks, and all landholders are obliged to comply with the specific category of control. Categories of control are defined below.

## DAFWA Categories for Declared Pests under the BAM Act

Control class code	Description
C1 (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

## Background information

### Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are declared by the Minister for Environment under Section 51B of the EP Act. The Table below outlines the aspects of areas declared as ESA in the Environmental Protection (Environmentally Sensitive Areas) Notice 2005.

### Aspects of ESAs

Aspects of Environmentally Sensitive Areas
A declared World Heritage property as defined in Section 13 of the EPBC Act.
An area that is included on the Register of the National Estate (RNE), because of its natural values, under the <i>Australian Heritage Commission Act 1975</i> of the Commonwealth (the RNE was closed in 2007 and is no longer a statutory list – all references to the RNE were removed from the EPBC Act on 19 February 2012).
A defined wetland and the area within 50 m of the wetland. Defined wetlands include Ramsar wetlands, conservation category wetlands and nationally important wetlands.
The area covered by vegetation within 50 m of rare flora, to the extent to which the vegetation is continuous with the vegetation in which the rare flora is located.
The area covered by a Threatened Ecological Community.
A Bush Forever Site listed in “Bush Forever” Volumes 1 and 2 (2000), published by the Western Australia Planning Commission, except to the extent to which the site is approved to be developed by the Western Australia Planning Commission.
The areas covered by the <i>Environmental Protection (Gnangara Mound Crown Land) Policy 1992</i> .
The areas covered by the <i>Environmental Protection (Western Swamp Tortoise Habitat) Policy 2002</i> .
The areas covered by the lakes to which the <i>Environmental Protection (Swan Coastal Plain Lakes) Policy 1992</i> (EPP Lakes) applies.
Protected wetlands as defined in the <i>Environmental Protection (South West Agricultural Zone Wetlands) Policy 1998</i> .

### Reserves and conservation areas

#### Department of Parks and Wildlife managed lands and waters

DPaW manages lands and waters throughout Western Australia to conserve ecosystems and species, and to provide for recreation and appreciation of the natural environment. DPaW managed lands and waters include national parks, conservation parks and reserves, marine parks and reserves, regional parks, nature reserves, State forest and timber reserves. DPaW managed conservation estate, is vested with the Conservation Commission of Western Australia. Access to, or through, some areas of DPaW managed lands may require a permit or could be restricted due to management activities. Proposed land use changes and development proposals that abut DPaW managed lands will generally be referred to DPaW throughout the assessment process.

#### Wetlands

Wetlands include not only lakes with open water, but areas of seasonally, intermittently or permanently waterlogged soil.

## Ramsar Listed Wetlands

The Convention of Wetlands of International Importance was signed in 1971 at the Iranian town of Ramsar. The Convention has since been referred to as the Ramsar Convention. Ramsar Listed wetlands are “sites containing representative, rare or unique wetlands, or wetlands that are important for conserving biological diversity ... because of their ecological, botanical, zoological, limnological or hydrological importance” (DotEE 2017b). Once a Ramsar Listed Wetland is designated, the country agrees to manage its conservation and ensure its wise use. Under the Convention, wise use is broadly defined as “maintaining the ecological character of a wetland” (DotEE 2017b).

## Nationally important wetlands

Wetlands of national significance are listed under the Directory of Important Wetlands in Australia. Nationally important wetlands are wetlands which meet at least one of the following criteria (DotEE 2017a):

- It is a good example of a wetland type occurring within a biogeographic region in Australia
- It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail
- The wetland supports one percent or more of the national populations of any native plant or animal taxa
- The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level
- The wetland is of outstanding historical or cultural significance

## Vegetation extent and status

The National Objectives and Targets for Biodiversity Conservation 2001–2005 (Commonwealth of Australia 2001) recognise that the retention of 30 percent or more of the pre-clearing extent of each ecological community is necessary if Australia’s biological diversity is to be protected. This is the threshold level below which species loss appears to accelerate exponentially and loss below this level should not be permitted. This level of recognition is in keeping with the targets recommended in the review of the National Strategy for the Conservation of Australia’s Biological Diversity (ANZECC 2000).

The extent of remnant native vegetation in WA has been assessed by Shepherd et al. (2002) and the GoWA (2015), based on broadscale vegetation association mapping by Beard (various publications). The GoWA produces Statewide Vegetation Statistics Reports that are used for a number of purposes including conservation planning, land use planning and when assessing development applications. The reports are updated at least every two years.

## Vegetation condition

The vegetation condition can be assessed in accordance with the vegetation condition rating scale for the Eremaean and Northern Botanical Provinces (EPA and DPaW 2015). The scale recognises the intactness of vegetation and consists of six rating levels as outlined below.

## Vegetation condition rating scale for the Eremaean and Northern Botanical Provinces

Condition	Eremaean and Northern Botanical Provinces description
Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds
Poor	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds..
Degraded	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

## Conservation codes

Species of significant flora, fauna and communities are protected under both Federal and State Acts. The Federal EPBC Act provides a legal framework to protect and manage nationally important flora and communities. The State WC Act is the primary wildlife conservation legislation in Western Australia. Information on the conservation codes is summarised in the following sections.

### Ecological communities

#### Conservation significant communities

Ecological communities are defined as naturally occurring biological assemblages that occur in a particular type of habitat (English and Blyth 1997). Federally listed Threatened Ecological Communities (TECs) are protected under the EPBC Act. The DPaW also maintains a list of TECs for Western Australia; some of which are also protected under the EPBC Act. TECs are ecological communities that have been assessed and assigned to one of four categories related to the status of the threat to the community, i.e. Presumed Totally Destroyed, Critically Endangered, Endangered and Vulnerable.

Possible TECs that do not meet survey criteria are added to the DPaW Priority Ecological Community (PEC) List under Priorities 1, 2 and 3. These are ecological communities that are adequately known; are rare but not threatened, or meet criteria for Near Threatened. PECs that have been recently removed from the threatened list are placed in Priority 4. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in Priority 5. PECs are not listed under any formal Federal or State legislation, however, may be listed as TECs under the EPBC Act.

#### Conservation codes and definitions for TECs listed under the EPBC Act or endorsed by the WA Minister for the Environment

Categories	Definition
<b>Federal Government Conservation Categories (EPBC Act)</b>	
Critically Endangered (CR)	An ecological community if, at that time, is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)
Endangered (EN)	An ecological community if, at that time: A) is not critically endangered; and B) is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)
Vulnerable (VU)	An ecological community if, at that time: A) is not critically endangered or endangered; and B) is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)
<b>Western Australia Conservation Categories</b>	
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

Categories	Definition
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

### Conservation categories and definitions for PECS as listed by the DPaw

Category	Description
Priority 1	<p>Poorly known ecological communities.</p> <p>Ecological communities that are known from very few occurrences with a very restricted distribution (generally <math>\leq 5</math> occurrences or a total area of <math>\leq 100</math> ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.</p>
Priority 2	<p>Poorly known ecological communities.</p> <p>Communities that are known from few occurrences with a restricted distribution (generally <math>\leq 10</math> occurrences or a total area of <math>\leq 200</math> ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.</p>
Priority 3	<p>Poorly known ecological communities.</p> <p>(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:</p> <p>(ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;</p> <p>(iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.</p> <p>Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.</p>

Category	Description
Priority 4	<p>Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.</p> <p>(i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.</p> <p>(ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.</p> <p>(iii) Ecological communities that have been removed from the list of threatened communities during the past five years.</p>
Priority 5	<p>Conservation Dependent ecological communities.</p> <p>Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.</p>

### Other significant vegetation

Vegetation may be significant for a range of reasons other than a statutory listing. The EPA and DPaW (2015) states that significant vegetation may include vegetation that includes the following:

- Restricted distribution
- Degree of historical impact from threatening processes
- Local endemism in restricted habitats
- Novel combinations of taxa
- A role as a refuge
- A role as a key habitat for Threatened species or large population representing a significant proportion of the local to regional total population of a species
- Being representative of a vegetation unit in 'pristine' condition in a highly cleared landscape, recently discovered range extensions, or isolated outliers of the main range)
- Being poorly reserved

This may apply at a number of levels, so the unit may be significant when considered at the fine-scale (intra-locality), intermediate-scale (locality or inter-locality) or broad-scale (local to region).

### Flora and fauna

#### Conservation significant flora and fauna

Species of significant flora are protected under both Federal and State legislation. Any activities that are deemed to have a significant impact on species that are recognised by the EPBC Act, and/or the WC Act can warrant referral to the DotEE and/or the EPA.

The Federal conservation level of flora and fauna species and their significance status is assessed under the EPBC Act. The significance levels for fauna used in the EPBC Act are those recommended by the International Union for Conservation of Nature (IUCN).

The EPBC Act also protects land and migratory species that are listed under International Agreements. The list of migratory species established under section 209 of the EPBC Act comprises:

- Migratory species which are native to Australia and are included in the appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals Appendices I and II)
- Migratory species included in annexes established under the Japan-Australia Migratory Bird Agreement (JAMBA) and the China–Australia Migratory Bird Agreement (CAMBA)
- Native, migratory species identified in a list established under, or an instrument made under, an international agreement approved by the Minister, such as the republic of Korea–Australia Migratory Bird Agreement (ROKAMBA)

The State conservation level of Threatened flora and fauna has been published as Specially Protected under the WC Act, and listed under Schedules 1 to 7 of the Wildlife Conservation (Specially Protected Fauna) Notice 2015 for Threatened Fauna and under Schedules 1 to 4 of the Wildlife Conservation (Rare Flora) Notice 2015 for Threatened (Declared Rare) Flora. The schedules align with the categories of the EPBC Act Threatened Fauna and Threatened Flora Lists. Threatened species are those species which have been adequately searched for and are deemed to be, in the wild, either rare, under identifiable threat of extinction, or otherwise in need of special protection, and have been gazetted as such.

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

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. These species require regular monitoring.

For the purposes of this assessment, all species listed under the EPBC Act, WC Act and DPaW Priority species are considered conservation significant.

### **Conservation categories and definitions for EPBC Act listed flora and fauna species**

Conservation category	Definition
Extinct	There is no reasonable doubt that the last member of the species has died.
Extinct in the Wild	A) A species known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or B) A species that 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.
Critically Endangered	A species facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000).
Endangered	A) A species not critically endangered; and B) A species facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.

Conservation category	Definition
Vulnerable	A) A species not critically endangered or endangered; and B) A species facing a high risk of extinction in the wild in the medium-term, as determined in accordance with the prescribed criteria.
Conservation Dependent	A) The species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or B) The following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that Section 180 provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

### Conservation codes and descriptions for WC Act listed flora and fauna species

Conservation category	Schedule and definition
Threatened species (T)	Published as Specially Protected under the WC Act, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.  <b>Threatened fauna</b> is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the WC Act.  <b>Threatened flora</b> is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the WC Act.
Critically Endangered (CR)	Schedule 1: Threatened species considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	Schedule 2: Threatened species considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	Schedule 3: Threatened species considered to be facing a high risk of extinction in the wild.
Presumed Extinct (EX)	Schedule 4: Species which have been adequately searched for and there is no reasonable doubt that the last individual has died.
International Agreement (IA)	Schedule 5: Migratory birds protected under an international agreement
Conservation Dependent (CD)	Schedule 6: Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
Other Specially Protected (OS)	Schedule 7: Fauna otherwise in need of special protection to ensure their conservation.

## Conservation codes for DPaW listed Priority flora and fauna

Priority category	Definition
Priority 1	<p>Poorly-known taxa</p> <p>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. Such species are in urgent need of further survey.</p>
Priority 2	<p>Poorly-known taxa</p> <p>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. Such species are in urgent need of further survey.</p>
Priority 3	<p>Poorly-known taxa</p> <p>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. Such species are in need of further survey.</p>
Priority 4	<p>Rare, Near Threatened and other taxa in need of monitoring</p> <p>A. Rare: Taxa 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 taxa are usually represented on conservation lands.</p> <p>B. Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.</p> <p>C. Taxa that have been removed from the list of threatened taxa during the past five years for reasons other than taxonomy.</p>

### Other significant flora

Flora species, subspecies, varieties, hybrids and ecotypes may be significant for a range of reasons, other than a statutory listing. The EPA and DPaW (2015) states that significant flora may include taxa that have:

- A keystone role in a particular habitat for threatened or Priority flora or fauna species, or large populations representing a considerable proportion of the local or regional total population of a species
- Relictual status, being representation of taxonomic or physiognomic groups that no longer occur widely in the broader landscape
- Anomalous features that indicate a potential new discovery

- Being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- The presence of restricted subspecies, varieties, or naturally occurring hybrids
- Local endemism (a restricted distribution) or association with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems)
- Being poorly reserved

#### **Other significant fauna**

Fauna species may be significant for a range of reasons other than those protected by international agreement or treaty, Specially Protected or Priority Fauna. Significant fauna may include short-range endemic species, species that have declining populations or declining distributions, species at the extremes of their range, or isolated outlying populations, or species which may be undescribed (EPA 2016).

#### **Introduced plants (weeds)**

##### **Declared Pests**

Information on species considered to be Declared Pests is provided under *State Biosecurity and Agriculture Management Act 2007*.

##### **Weeds of National Significance**

The spread of weeds across a range of land uses or ecosystems is important in the context of socio-economic and environmental values. The assessment of Weeds of National Significance (WoNS) is based on four major criteria:

- Invasiveness
- Impacts
- Potential for spread
- Socio-economic and environmental values

Australian state and territory governments have identified thirty-two Weeds of National Significance (WoNS); a list of 20 WoNS was endorsed in 1999 and a further 12 were added in 2012.

## References

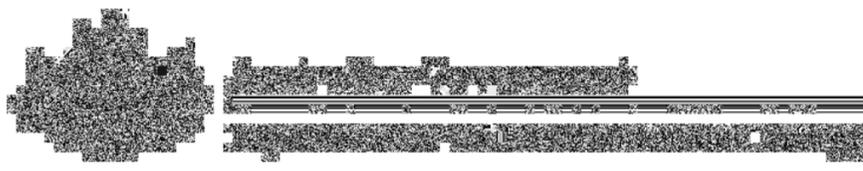
- ANZECC 2000, *Core Environmental Indicators for Reporting on the State of Environment*, ANZECC State of the Environment Reporting Task Force.
- Commonwealth of Australia 2001, *National Targets and Objectives for Biodiversity Conservation 2001–2005*, Canberra, AGPS.
- DotEE 2017a, *Criteria for determining nationally important wetlands*, retrieved 2017, from <http://www.environment.gov.au/topics/water/water-our-environment/wetlands/australian-wetlands-database/directory-important>.
- DotEE 2017b, *The Ramsar Convention on Wetlands*, retrieved 2017, from <http://www.environment.gov.au/topics/water/water-our-environment/wetlands/ramsar-convention-wetlands>.
- English, V and Blyth, J 1997, *Identifying and Conserving Threatened Ecological Communities in the South West Botanical Province*, Perth, Department of Conservation and Land Management.
- EPA 2016, *Technical Guide – Terrestrial Fauna Surveys*, Perth, WA.
- EPA and DPaW 2015, *Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment*, (ed. K Freeman, G Stack, S Thomas and N Woolfrey), Perth, WA.
- GoWA 2015, *Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full report)*, Current as of June 2015, Perth Western Australia, Department of Environment and Conservation, retrieved 2017, from <https://www2.landgate.wa.gov.au/web/guest/downloader>.
- Shepherd, DP, Beeston, GR & Hopkins, AJM 2002, *Native Vegetation in Western Australia – Extent, Type and Status, Resource Management Technical Report 249*, Perth, Department of Agriculture.

# **Appendix C** – Desktop searches

EPBC Act PMST Report

NatureMap Flora Report

NatureMap Fauna Report



# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 24/01/17 17:57:40

[Summary](#)

[Details](#)

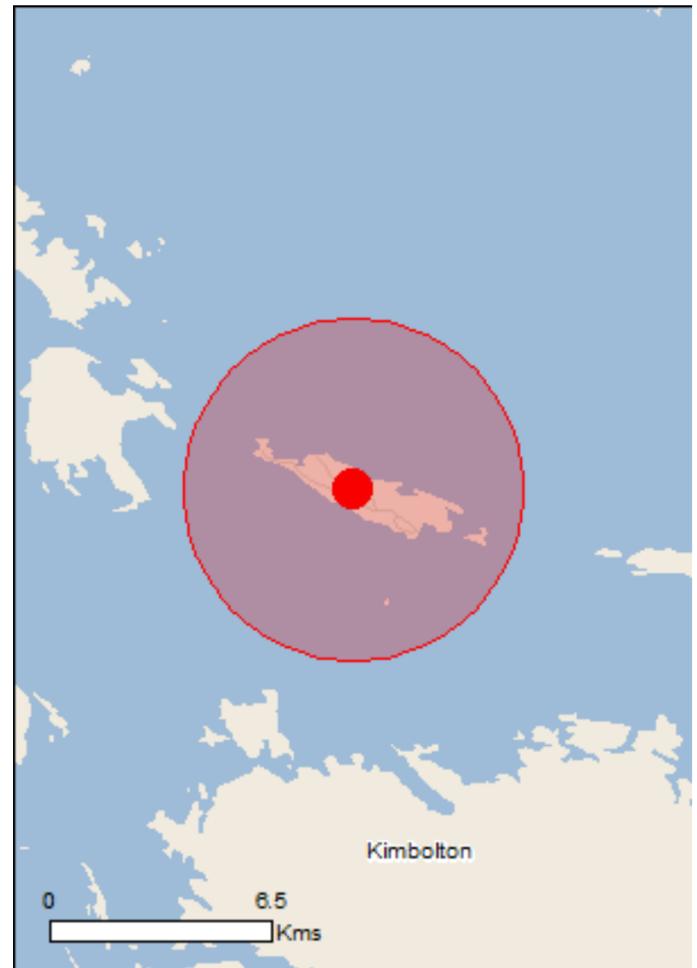
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

[Coordinates](#)

[Buffer: 5.0Km](#)



# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	1
<a href="#">Wetlands of International Importance:</a>	None
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Area:</a>	None
<a href="#">Listed Threatened Ecological Communities:</a>	None
<a href="#">Listed Threatened Species:</a>	16
<a href="#">Listed Migratory Species:</a>	34

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

<a href="#">Commonwealth Land:</a>	None
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	63
<a href="#">Whales and Other Cetaceans:</a>	11
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Commonwealth Reserves Marine:</a>	None

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

<a href="#">State and Territory Reserves:</a>	None
<a href="#">Regional Forest Agreements:</a>	None
<a href="#">Invasive Species:</a>	1
<a href="#">Nationally Important Wetlands:</a>	None
<a href="#">Key Ecological Features (Marine)</a>	None

# Details

## Matters of National Environmental Significance

National Heritage Properties		[ Resource Information ]
Name	State	Status
Natural		
<a href="#">The West Kimberley</a>	WA	Listed place

Listed Threatened Species		[ Resource Information ]
Name	Status	Type of Presence

### Birds

<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
---	-----------------------	--

<a href="#">Erythrotriorchis radiatus</a> Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area
--	------------	--

<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
---	-----------------------	--

### Mammals

<a href="#">Megaptera novaeangliae</a> Humpback Whale [38]	Vulnerable	Breeding known to occur within area
---	------------	-------------------------------------

<a href="#">Saccolaimus saccolaimus nudicluniatus</a> Bare-rumped Sheath-tailed Bat, Bare-rumped Sheath-tail Bat [66889]	Vulnerable	Species or species habitat may occur within area
---	------------	--

### Reptiles

<a href="#">Caretta caretta</a> Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
---	------------	---

<a href="#">Chelonia mydas</a> Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
---	------------	--

<a href="#">Dermochelys coriacea</a> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
--	------------	--

<a href="#">Eretmochelys imbricata</a> Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
---	------------	--

<a href="#">Natator depressus</a> Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
--	------------	--

### Sharks

<a href="#">Carcharodon carcharias</a> White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
--	------------	--

Name	Status	Type of Presence
<a href="#">Glyphis garricki</a> Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat may occur within area
<a href="#">Pristis clavata</a> Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pristis pristis</a> Largetooth Sawfish, Freshwater Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pristis zijsron</a> Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Rhincodon typus</a> Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

### Listed Migratory Species [ [Resource Information](#) ]

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
<b>Migratory Marine Birds</b>		
<a href="#">Anous stolidus</a> Common Noddy [825]		Species or species habitat likely to occur within area
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Fregata ariel</a> Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
<a href="#">Fregata minor</a> Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
<a href="#">Sula sula</a> Red-footed Booby [1023]		Breeding known to occur within area
<b>Migratory Marine Species</b>		
<a href="#">Balaenoptera edeni</a> Bryde's Whale [35]		Species or species habitat may occur within area
<a href="#">Carcharodon carcharias</a> White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
<a href="#">Caretta caretta</a> Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
<a href="#">Chelonia mydas</a> Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
<a href="#">Crocodylus porosus</a> Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
<a href="#">Dermochelys coriacea</a> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
<a href="#">Dugong dugon</a> Dugong [28]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
<a href="#">Eretmochelys imbricata</a> Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Manta alfredi</a> Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
<a href="#">Manta birostris</a> Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
<a href="#">Megaptera novaeangliae</a> Humpback Whale [38]	Vulnerable	Breeding known to occur within area
<a href="#">Natator depressus</a> Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
<a href="#">Orcaella brevirostris</a> Irrawaddy Dolphin [45]		Species or species habitat may occur within area
<a href="#">Orcinus orca</a> Killer Whale, Orca [46]		Species or species habitat may occur within area
<a href="#">Pristis clavata</a> Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pristis pristis</a> Largetooth Sawfish, Freshwater Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pristis zijsron</a> Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Rhincodon typus</a> Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
<a href="#">Sousa chinensis</a> Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
<a href="#">Tursiops aduncus (Arafura/Timor Sea populations)</a> Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
<b>Migratory Terrestrial Species</b>		
<a href="#">Cecropis daurica</a> Red-rumped Swallow [80610]		Species or species habitat may occur within area
<a href="#">Cuculus optatus</a> Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
<a href="#">Hirundo rustica</a> Barn Swallow [662]		Species or species habitat may occur within area
<a href="#">Motacilla cinerea</a> Grey Wagtail [642]		Species or species habitat may occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat may occur within area
<b>Migratory Wetlands Species</b>		

Name	Threatened	Type of Presence
<a href="#">Acrocephalus orientalis</a> Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Pandion haliaetus</a> Osprey [952]		Breeding known to occur within area

## Other Matters Protected by the EPBC Act

### Listed Marine Species [\[ Resource Information \]](#)

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
<b>Birds</b>		
<a href="#">Acrocephalus orientalis</a> Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
<a href="#">Anous stolidus</a> Common Noddy [825]		Species or species habitat likely to occur within area
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
<a href="#">Calidris ferruginea</a> Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Cuculus saturatus</a> Oriental Cuckoo, Himalayan Cuckoo [710]		Species or species habitat may occur within area
<a href="#">Fregata ariel</a> Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
<a href="#">Fregata minor</a> Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
<a href="#">Haliaeetus leucogaster</a> White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
<a href="#">Hirundo daurica</a> Red-rumped Swallow [59480]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
<a href="#">Hirundo rustica</a> Barn Swallow [662]		Species or species habitat may occur within area
<a href="#">Motacilla cinerea</a> Grey Wagtail [642]		Species or species habitat may occur within area
<a href="#">Motacilla flava</a> Yellow Wagtail [644]		Species or species habitat may occur within area
<a href="#">Numenius madagascariensis</a> Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Pandion haliaetus</a> Osprey [952]		Breeding known to occur within area
<a href="#">Sula sula</a> Red-footed Booby [1023]		Breeding known to occur within area
<b>Fish</b>		
<a href="#">Campichthys tricarinatus</a> Three-keel Pipefish [66192]		Species or species habitat may occur within area
<a href="#">Choeroichthys brachysoma</a> Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
<a href="#">Choeroichthys suillus</a> Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
<a href="#">Corythoichthys amplexus</a> Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
<a href="#">Corythoichthys flavofasciatus</a> Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
<a href="#">Cosmocampus banneri</a> Roughridge Pipefish [66206]		Species or species habitat may occur within area
<a href="#">Doryrhamphus excisus</a> Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
<a href="#">Doryrhamphus janssi</a> Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
<a href="#">Halicampus brocki</a> Brock's Pipefish [66219]		Species or species habitat may occur within area
<a href="#">Halicampus grayi</a> Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
<a href="#">Halicampus spirostris</a> Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
<a href="#">Haliichthys taeniophorus</a> Ribbioned Pipehorse, Ribbioned Seadragon [66226]		Species or species habitat may occur within area
<a href="#">Hippichthys penicillus</a> Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species

Name	Threatened	Type of Presence
<a href="#">Hippocampus histrix</a> Spiny Seahorse, Thorny Seahorse [66236]		habitat may occur within area  Species or species habitat may occur within area
<a href="#">Hippocampus kuda</a> Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
<a href="#">Hippocampus planifrons</a> Flat-face Seahorse [66238]		Species or species habitat may occur within area
<a href="#">Hippocampus spinosissimus</a> Hedgehog Seahorse [66239]		Species or species habitat may occur within area
<a href="#">Micrognathus micronotopterus</a> Tidepool Pipefish [66255]		Species or species habitat may occur within area
<a href="#">Solegnathus hardwickii</a> Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
<a href="#">Solegnathus lettiensis</a> Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
<a href="#">Solenostomus cyanopterus</a> Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
<a href="#">Solenostomus paegnius</a> Rough-snout Ghost Pipefish [68425]		Species or species habitat may occur within area
<a href="#">Syngnathoides biaculeatus</a> Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
<a href="#">Trachyrhamphus bicoarctatus</a> Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
<a href="#">Trachyrhamphus longirostris</a> Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
<b>Mammals</b>		
<a href="#">Dugong dugon</a> Dugong [28]		Species or species habitat likely to occur within area
<b>Reptiles</b>		
<a href="#">Acalyptophis peronii</a> Horned Seasnake [1114]		Species or species habitat may occur within area
<a href="#">Aipysurus duboisii</a> Dubois' Seasnake [1116]		Species or species habitat may occur within area
<a href="#">Aipysurus eydouxii</a> Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
<a href="#">Aipysurus laevis</a> Olive Seasnake [1120]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
<a href="#">Astrotia stokesii</a> Stokes' Seasnake [1122]		Species or species habitat may occur within area
<a href="#">Caretta caretta</a> Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
<a href="#">Chelonia mydas</a> Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
<a href="#">Crocodylus johnstoni</a> Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile [1773]		Species or species habitat may occur within area
<a href="#">Crocodylus porosus</a> Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
<a href="#">Dermochelys coriacea</a> Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
<a href="#">Disteira kingii</a> Spectacled Seasnake [1123]		Species or species habitat may occur within area
<a href="#">Disteira major</a> Olive-headed Seasnake [1124]		Species or species habitat may occur within area
<a href="#">Emydocephalus annulatus</a> Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
<a href="#">Eretmochelys imbricata</a> Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Hydrelaps darwiniensis</a> Black-ringed Seasnake [1100]		Species or species habitat may occur within area
<a href="#">Hydrophis elegans</a> Elegant Seasnake [1104]		Species or species habitat may occur within area
<a href="#">Hydrophis mcdowellii</a> null [25926]		Species or species habitat may occur within area
<a href="#">Hydrophis ornatus</a> Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
<a href="#">Lapemis hardwickii</a> Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
<a href="#">Natator depressus</a> Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
<a href="#">Pelamis platurus</a> Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

## Whales and other Cetaceans

[ [Resource Information](#) ]

Name	Status	Type of Presence
Mammals		

Name	Status	Type of Presence
<a href="#">Balaenoptera edeni</a> Bryde's Whale [35]		Species or species habitat may occur within area
<a href="#">Delphinus delphis</a> Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
<a href="#">Grampus griseus</a> Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
<a href="#">Megaptera novaeangliae</a> Humpback Whale [38]	Vulnerable	Breeding known to occur within area
<a href="#">Orcaella brevirostris</a> Irrawaddy Dolphin [45]		Species or species habitat may occur within area
<a href="#">Orcinus orca</a> Killer Whale, Orca [46]		Species or species habitat may occur within area
<a href="#">Sousa chinensis</a> Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
<a href="#">Stenella attenuata</a> Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
<a href="#">Tursiops aduncus</a> Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
<a href="#">Tursiops aduncus (Arafura/Timor Sea populations)</a> Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
<a href="#">Tursiops truncatus s. str.</a> Bottlenose Dolphin [68417]		Species or species habitat may occur within area

## Extra Information

### Invasive Species [\[ Resource Information \]](#)

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
<b>Plants</b>		
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area

# Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

# Coordinates

-16.094 123.61067

# Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- [-Other groups and individuals](#)

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

# NatureMap Flora Species Report 5 km

Created By Guest user on 24/01/2017

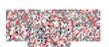
Kingdom Plantae  
Current Names Only Yes  
Core Datasets Only Yes  
Method 'By Circle'  
Centre 123° 36' 46" E, 16° 05' 40" S  
Buffer 5km  
Group By Family

Family	Species	Records
Amaranthaceae	1	2
Anacardiaceae	1	1
Apocynaceae	2	4
Araliaceae	1	2
Asparagaceae	1	1
Asphodelaceae	1	1
Asteraceae	4	5
Boraginaceae	1	1
Burseraceae	1	2
Casuarinaceae	1	2
Caulerpaceae	3	5
Celastraceae	1	1
Combretaceae	2	3
Convolvulaceae	2	4
Dilleniaceae	1	1
Droseraceae	1	1
Ebenaceae	1	1
Euphorbiaceae	3	5
Fabaceae	13	19
Flagellariaceae	1	1
Goodeniaceae	1	2
Loranthaceae	1	1
Malvaceae	7	9
Meliaceae	1	1
Moraceae	1	1
Moringaceae	1	3
Myrtaceae	3	3
Passifloraceae	1	2
Phyllanthaceae	1	1
Plantaginaceae	1	1
Poaceae	8	11
Rubiaceae	2	2
Santalaceae	1	2
Sapotaceae	2	2
Solanaceae	1	1
Verbenaceae	2	5
<b>TOTAL</b>	<b>76</b>	<b>109</b>

Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
<b>Amaranthaceae</b>				
1.	2705 <i>Ptilotus capitatus</i>			
<b>Anacardiaceae</b>				
2.	4719 <i>Mangifera indica</i> (Mango)	Y		
<b>Apocynaceae</b>				
3.	6569 <i>Catharanthus roseus</i> (Pink Periwinkle)	Y		
4.	12683 <i>Cryptostegia madagascariensis</i>	Y		
<b>Araliaceae</b>				
5.	6270 <i>Trachymene didiscoides</i>			
<b>Asparagaceae</b>				
6.	1505 <i>Agave americana</i> (Century Plant)	Y		
<b>Asphodelaceae</b>				
7.	36276 <i>Aloe vera</i>	Y		
<b>Asteraceae</b>				
8.	19063 <i>Cyanthillium cinereum</i>			
9.	38441 <i>Sphagneticola trilobata</i>	Y		
10.	8252 <i>Tridax procumbens</i> (Tridax, Tridax Daisy)	Y		



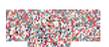
Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
11.	<i>Vernonia elliptica</i>			Y
<b>Boraginaceae</b>				
12.	10992 <i>Heliotropium glabellum</i>			
<b>Burseraceae</b>				
13.	11617 <i>Canarium australianum</i> var. <i>glabrum</i>			
<b>Casuarinaceae</b>				
14.	19842 <i>Casuarina equisetifolia</i>	Y		
<b>Caulerpaceae</b>				
15.	44547 <i>Caulerpa lamourouxii</i>			
16.	26576 <i>Caulerpa serrulata</i>			
17.	26579 <i>Caulerpa taxifolia</i>			
<b>Celastraceae</b>				
18.	4722 <i>Denhamia obscura</i>			
<b>Combretaceae</b>				
19.	5297 <i>Quisqualis indica</i>	Y		
20.	<i>Terminalia catappa</i>			
<b>Convolvulaceae</b>				
21.	6644 <i>Merremia aegyptia</i>	Y		
22.	6646 <i>Merremia dissecta</i>	Y		
<b>Dilleniaceae</b>				
23.	5151 <i>Hibbertia oblongata</i>			
<b>Droseraceae</b>				
24.	14919 <i>Drosera ordensis</i>			
<b>Ebenaceae</b>				
25.	6497 <i>Diospyros maritima</i>			
<b>Euphorbiaceae</b>				
26.	17342 <i>Euphorbia cyathophora</i>	Y		
27.	4629 <i>Euphorbia hirta</i> (Asthma Plant)	Y		
28.	18124 <i>Euphorbia tirucalli</i>	Y		
<b>Fabaceae</b>				
29.	3241 <i>Acacia bivenosa</i>			
30.	16174 <i>Acacia elachantha</i>			
31.	3371 <i>Acacia hippuroides</i>			
32.	13359 <i>Acacia oligoneura</i>			
33.	3580 <i>Acacia translucens</i> (Poverty Bush, Banmung)			
34.	17574 <i>Alysicarpus ovalifolius</i>	Y		
35.	17146 <i>Alysicarpus vaginalis</i>	Y		
36.	3769 <i>Clitoria ternatea</i>	Y		
37.	17433 <i>Cullen badocanum</i>			
38.	3857 <i>Desmodium tortuosum</i> (Florida Beggarweed)	Y		
39.	11158 <i>Gompholobium subulatum</i>			
40.	3613 <i>Leucaena leucocephala</i> (Leucaena)	Y		
41.	4280 <i>Tephrosia rosea</i> (Flinders River Poison, Bungoo'dah)			
<b>Flagellariaceae</b>				
42.	1055 <i>Flagellaria indica</i> (Gadji)			
<b>Goodeniaceae</b>				
43.	7623 <i>Scaevola macrostachya</i>			
<b>Loranthaceae</b>				
44.	13700 <i>Amyema bifurcata</i>			
<b>Malvaceae</b>				
45.	13010 <i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>			
46.	18412 <i>Corchorus puberulus</i>			
47.	4913 <i>Gossypium hirsutum</i> (Upland Cotton)	Y		
48.	4916 <i>Gossypium populifolium</i>			
49.	5054 <i>Melochia umbellata</i>			
50.	14961 <i>Triumfetta carteri</i>			
51.	17530 <i>Triumfetta coronata</i>			
<b>Meliaceae</b>				
52.	32097 <i>Khaya senegalensis</i>	Y		
<b>Moraceae</b>				
53.	<i>Ficus benjamina</i>			



Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
<b>Moringaceae</b>				
54.	19717 <i>Moringa oleifera</i>	Y		
<b>Myrtaceae</b>				
55.	16784 <i>Corymbia dendromerinx</i>			
56.	5599 <i>Eucalyptus confluens</i> (Kimberley Gum)			
57.	5715 <i>Eucalyptus miniata</i> (Woollybutt, Manawan)			
<b>Passifloraceae</b>				
58.	5226 <i>Passiflora foetida</i> (Stinking Passion Flower)	Y		
<b>Phyllanthaceae</b>				
59.	4603 <i>Bridelia tomentosa</i>			
<b>Plantaginaceae</b>				
60.	7101 <i>Stemodia lythriifolia</i> (Bunu Bunu)			
<b>Poaceae</b>				
61.	258 <i>Cenchrus ciliaris</i> (Buffel Grass)	Y		
62.	29721 <i>Cenchrus setiger</i> (Birdwood Grass)	Y		
63.	266 <i>Chloris barbata</i> (Purpletop Chloris)	Y		
64.	272 <i>Chloris virgata</i> (Feathertop Rhodes Grass)	Y		
65.	414 <i>Eriachne obtusa</i> (Northern Wandarrie Grass)			
66.	14985 <i>Melinis repens</i>	Y		
67.	<i>Triodia</i> sp.			
68.	10865 <i>Urochloa subquadrifera</i>			
<b>Rubiaceae</b>				
69.	7335 <i>Morinda citrifolia</i>			
70.	7364 <i>Timonius timon</i>			
<b>Santalaceae</b>				
71.	11169 <i>Exocarpos latifolius</i> (Broad-leaved Cherry)			
<b>Sapotaceae</b>				
72.	6492 <i>Mimusops elengi</i> (Walara)			
73.	31172 <i>Sersalisia sericea</i> (Nangi)			
<b>Solanaceae</b>				
74.	7042 <i>Solanum vansittartense</i>		P2	
<b>Verbenaceae</b>				
75.	6733 <i>Lantana camara</i> (Common Lantana)	Y		
76.	13104 <i>Stachytarpheta cayennensis</i>	Y		

**Conservation Codes**  
T - Rare or likely to become extinct  
X - Presumed extinct  
IA - Protected under international agreement  
S - Other specially protected fauna  
1 - Priority 1  
2 - Priority 2  
3 - Priority 3  
4 - Priority 4  
5 - Priority 5

<sup>1</sup> For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.



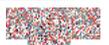
# NatureMap Fauna Species Report 5 km

Created By Guest user on 24/01/2017

**Kingdom** Animalia  
**Current Names Only** Yes  
**Core Datasets Only** Yes  
**Method** 'By Circle'  
**Centre** 123° 36' 41" E, 16° 05' 38" S  
**Buffer** 5km  
**Group By** Species Group

Species Group	Species	Records
Bird	60	187
Fish	27	49
Invertebrate	1	1
Mammal	7	100
Reptile	22	231
<b>TOTAL</b>	<b>117</b>	<b>568</b>

Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
<b>Bird</b>				
1.	25536 <i>Accipiter fasciatus</i> (Brown Goshawk)			
2.	24719 <i>Aprosmictus erythropterus</i> (Red-winged Parrot)			
3.	25567 <i>Artamus leucorhynchus</i> (White-breasted Woodswallow)			
4.	24354 <i>Artamus leucorhynchus subsp. leucopygialis</i> (White-breasted Woodswallow)			
5.	24355 <i>Artamus minor</i> (Little Woodswallow)			
6.	25716 <i>Cacatua sanguinea</i> (Little Corella)			
7.	24727 <i>Cacatua sanguinea subsp. westralensis</i> (Little Corella)			
8.	24730 <i>Calyptorhynchus banksii subsp. macrorhynchus</i> (Red-tailed Black-Cockatoo)			
9.	25600 <i>Centropus phasianinus</i> (Pheasant Coucal)			
10.	<i>Chroicocephalus novaehollandiae</i>			
11.	24566 <i>Conopophila rufogularis</i> (Rufous-throated Honeyeater)			
12.	25568 <i>Coracina novaehollandiae</i> (Black-faced Cuckoo-shrike)			
13.	25569 <i>Coracina papuensis</i> (White-bellied Cuckoo-shrike, Little Cuckoo-shrike)			
14.	24420 <i>Cracticus nigrogularis</i> (Pied Butcherbird)			
15.	25673 <i>Daphoenositta chrysoptera</i> (Varied Sittella)			
16.	25607 <i>Dicaeum hirundinaceum</i> (Mistletoebird)			
17.	25604 <i>Eudynamys scolopacea</i> (Common Koel)			
18.	25621 <i>Falco berigora</i> (Brown Falcon)			
19.	24478 <i>Fregata ariel</i> (Lesser Frigatebird)		IA	
20.	24402 <i>Geopelia humeralis</i> (Bar-shouldered Dove)			
21.	25585 <i>Geopelia striata</i> (Zebra Dove)			
22.	25533 <i>Gerygone olivacea</i> (White-throated Gerygone)			
23.	24443 <i>Grallina cyanoleuca</i> (Magpie-lark)			
24.	25627 <i>Haematopus fuliginosus</i> (Sooty Oystercatcher)			
25.	24293 <i>Haliaeetus leucogaster</i> (White-bellied Sea-Eagle)		IA	
26.	25541 <i>Haliastur indus</i> (Brahminy Kite)			
27.	24297 <i>Hamirostra melanosternon</i> (Black-breasted Buzzard)			
28.	25571 <i>Lalage leucomela</i> (Varied Triller)			
29.	25661 <i>Lichmera indistincta</i> (Brown Honeyeater)			
30.	24583 <i>Manorina flavigula</i> (Yellow-throated Miner)			
31.	24585 <i>Melithreptus albogularis</i> (White-throated Honeyeater)			
32.	24598 <i>Merops ornatus</i> (Rainbow Bee-eater)		IA	
33.	25693 <i>Microeca fascinans</i> (Jacky Winter)			
34.	25611 <i>Myiagra rubecula</i> (Leadon Flycatcher)			
35.	25612 <i>Myiagra ruficollis</i> (Broad-billed Flycatcher)			
36.	25748 <i>Ninox novaeseelandiae</i> (Boobook Owl)			
37.	25564 <i>Nycticorax caledonicus</i> (Rufous Night Heron)			
38.	24608 <i>Oriolus sagittatus</i> (Olive-backed Oriole)			
39.	25680 <i>Pachycephala rufiventris</i> (Rufous Whistler)			
40.	<i>Pandion cristatus</i>			
41.	25543 <i>Pandion haliaetus</i> (Osprey)			



Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
42.	24627 <i>Pardalotus rubricatus</i> (Red-browed Pardalote)			
43.	25682 <i>Pardalotus striatus</i> (Striated Pardalote)			
44.	24658 <i>Petroica cucullata</i> (Hooded Robin)			
45.	25699 <i>Phalacrocorax varius</i> (Pied Cormorant)			
46.	25667 <i>Philemon argenticeps</i> (Silver-crowned Friarbird)			
47.	25668 <i>Philemon citreogularis</i> (Little Friarbird)			
48.	24749 <i>Platycercus venustus</i> (Northern Rosella)			
49.	25588 <i>Ptilinopus regina</i> (Rose-crowned Fruit-dove)			
50.	25725 <i>Ptilonorhynchus nuchalis</i> (Great Bowerbird)			
51.	25614 <i>Rhipidura leucophrys</i> (Willie Wagtail)			
52.	25616 <i>Rhipidura rufiventris</i> (Northern Fantail)			
53.	30949 <i>Sterna nilotica</i> (Gull-billed Tern)			
54.	25754 <i>Sula leucogaster</i> (Brown Booby)		IA	
55.	30872 <i>Taeniopygia bichenovii</i> (Double-barred Finch)			
56.	<i>Thalasseus bengalensis</i>			
57.	<i>Thalasseus bergii</i>			
58.	24844 <i>Threskiornis molucca</i> (Australian White Ibis)			
59.	25549 <i>Todiramphus sanctus</i> (Sacred Kingfisher)			
60.	24857 <i>Zosterops luteus</i> (Yellow White-eye)			

### Fish

61.	<i>Amblygobius bynoensis</i>			
62.	<i>Amphiprion percula</i>			
63.	<i>Amphiprion rubrocinctus</i>			
64.	<i>Antennarius nummifer</i>			
65.	<i>Apogon rueppellii</i>			
66.	<i>Centrogenys vaigiensis</i>			
67.	<i>Chaetodermis penicilligera</i>			
68.	<i>Dischistodus darwiniensis</i>			
69.	<i>Epinephelus bilobatus</i>			
70.	<i>Epinephelus coioides</i>			
71.	<i>Halophryne diemensis</i>			
72.	<i>Halophryne</i> sp.			Y
73.	<i>Hyporhamphus quoyi</i>			
74.	<i>Istiblennius meleagris</i>			
75.	<i>Liocranium praepositum</i>			
76.	<i>Lophiocharon trisignatus</i>			
77.	<i>Opistognathus darwiniensis</i>			
78.	<i>Parascorpaena picta</i>			
79.	<i>Plotosus lineatus</i>			
80.	<i>Pomacentrus tripunctatus</i>			Y
81.	<i>Pterapogon mirifica</i>			
82.	<i>Strongylura leiura</i>			
83.	<i>Toxotes jaculatrix</i>			
84.	<i>Trachinotus botla</i>			Y
85.	<i>Tragulichthys jaculiferus</i>			
86.	<i>Valenciennea muralis</i>			
87.	<i>Yongeichthys nebulosus</i>			

### Invertebrate

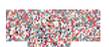
88. *Trichocycclus worora*

### Mammal

89.	24253 <i>Capra hircus</i> (Goat)	Y		
90.	24215 <i>Hydromys chrysogaster</i> (Water-rat)		P4	
91.	24051 <i>Megaptera novaeangliae</i> (Humpback Whale)		T	
92.	24172 <i>Pteropus alecto</i> (Black Flying-fox)			
93.	24175 <i>Taphozous georgianus</i> (Common Sheathtail-bat)			
94.	24203 <i>Vespadelus caurinus</i> (Western Cave Bat)			
95.	24248 <i>Zyromys argurus</i> (Common Rock-rat)			

### Reptile

96.	25317 <i>Antaresia childreni</i> (Children's Python)			
97.	25017 <i>Carlia triacantha</i> (Desert Rainbow Skink)			
98.	24919 <i>Crenadactylus ocellatus</i> subsp. <i>horni</i> (Clawless Gecko)			
99.	24859 <i>Crocodylus porosus</i> (Salt-water Crocodile)		S	
100.	25020 <i>Cryptoblepharus plagiocephalus</i>			
101.	25048 <i>Ctenotus inornatus</i>			
102.	25088 <i>Cyclodomorphus maximus</i> (Giant Slender Blue-tongue)			
103.	24996 <i>Delma borea</i>			
104.	25325 <i>Dendrelaphis punctulata</i> (Green Tree Snake)			
105.	42404 <i>Eremiascincus isolepis</i>			

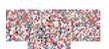


Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
106.	24952 <i>Gehyra australis</i>			
107.	24955 <i>Gehyra occidentalis</i>			
108.	24961 <i>Heteronotia binoei</i> (Bynoe's Gecko)			
109.	24963 <i>Heteronotia planiceps</i>			
110.	25139 <i>Lerista greeri</i>			
111.	25005 <i>Lialis burtonis</i>			
112.	25239 <i>Liasis olivaceus</i> subsp. <i>olivaceus</i> (Olive Python)			
113.	25194 <i>Morethia ruficauda</i> subsp. <i>ruficauda</i>			
114.	25261 <i>Pseudechis australis</i> (Mulga Snake)			
115.	25208 <i>Tiliqua scincoides</i> subsp. <i>intermedia</i>			
116.	25217 <i>Varanus glauerti</i> (Kimberley Rock Monitor)			
117.	25213 <i>Varanus glebopalma</i> (Black-palmed Rock Monitor)			

**Conservation Codes**

T - Rare or likely to become extinct  
 X - Presumed extinct  
 IA - Protected under international agreement  
 S - Other specially protected fauna  
 1 - Priority 1  
 2 - Priority 2  
 3 - Priority 3  
 4 - Priority 4  
 5 - Priority 5

<sup>1</sup> For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.



# **Appendix D** – Flora data

Flora Species list

Conservation significant flora locations

## Flora species list

Family	Taxon	Status	AS	DtV & EmW	EmW
Acanthaceae	<i>Dicliptera armata</i>				x
Amaranthaceae	<i>Ptilotus capitatus</i>				x
Anacardiaceae	<i>Buchanania obovata</i>			x	x
Apocynaceae	<i>Wrightia saligna</i>				x
Araliaceae	<i>Trachymene didiscoides</i>				x
Asparagaceae	<i>Chlorophytum laxum</i>				x
Asteraceae	<i>Cyanthillium cinereum</i>				x
Asteraceae	<i>Pterocaulon paradoxum</i>				x
Asteraceae	<i>Pterocaulon serrulatum</i> var. <i>velutinum</i>				x
Bignoniaceae	<i>Dolichandrone heterophylla</i>				x
Boraginaceae	<i>Heliotropium cunninghamii</i>				x
Boraginaceae	<i>Heliotropium glabellum</i>				x
Burseraeae	<i>Canarium australianum</i> var. <i>australianum</i>			x	x
Capparaceae	<i>Capparis spinosa</i>				x
Celastraceae	<i>Denhamia obscura</i>				x
Cleomaceae	<i>Cleome viscosa</i>				x
Combretaceae	<i>Terminalia canescens</i>			x	x
Convolvulaceae	<i>Evolvulus alsinoides</i> var. <i>decumbens</i>				x
Convolvulaceae	<i>Jacquemontia paniculata</i>				x
Convolvulaceae	<i>Jacquemontia</i> sp.				x
Convolvulaceae	<i>Merremia aegyptia</i>	*			x
Cyperaceae	<i>Bulbostylis barbata</i>				x
Cyperaceae	<i>Cyperus microcephalus</i> subsp. <i>microcephalus</i>				x
Dilleniaceae	<i>Hibbertia oblongata</i>			x	x
Dioscoreaceae	<i>Dioscorea transversa</i>				x
Ebenaceae	<i>Diospyros maritima</i>				x
Erythroxylaceae	<i>Erythroxylum ellipticum</i>				x
Euphorbiaceae	<i>Euphorbia armstrongiana</i> var. <i>distans</i>				x
Euphorbiaceae	<i>Microstachys chamaelea</i>				x
Fabaceae	<i>Acacia colei</i> var. <i>colei</i>		x		x
Fabaceae	<i>Acacia hippuroides</i>			x	x
Fabaceae	<i>Acacia holosericea</i>				x
Fabaceae	<i>Acacia multisiliqua</i>				x
Fabaceae	<i>Acacia stigmatophylla</i>			x	x
Fabaceae	<i>Acacia translucens</i>				x
Fabaceae	<i>Acacia tumida</i> var. <i>tumida</i>		x		x
Fabaceae	<i>Acacia wickhamii</i> subsp. <i>wickhamii</i>				x
Fabaceae	<i>Cajanus cinereus</i>			x	x
Fabaceae	<i>Cajanus scarabaeoides</i> var. <i>pedunculatus</i>				x
Fabaceae	<i>Canavalia rosea</i>			x	x
Fabaceae	<i>Christia australasica</i>			x	x
Fabaceae	<i>Clitoria ternatea</i>				x
Fabaceae	<i>Gompholobium subulatum</i>				x

Family	Taxon	Status	AS	DtV & EmW	EmW
Fabaceae	<i>Indigofera trita</i>				x
Fabaceae	<i>Leucaena leucocephala</i> subsp. <i>leucocephala</i>	*		x	x
Fabaceae	<i>Senna goniodes</i>				x
Fabaceae	<i>Templetonia hookeri</i>			x	x
Fabaceae	<i>Tephrosia leptoclada</i>				x
Fabaceae	<i>Tephrosia rosea</i>				x
Fabaceae	<i>Tephrosia virens</i>				x
Fabaceae	<i>Vigna lanceolata</i> var. <i>filiformis</i>			x	x
Fabaceae	<i>Flemingia parviflora</i>				x
Flagellariaceae	<i>Flagellaria indica</i>			x	x
Goodeniaceae	<i>Goodenia sepalosa</i>				x
Goodeniaceae	<i>Scaevola macrostachya</i>				x
Haloragaceae	<i>Gonocarpus leptothecus</i>			x	x
Lamiaceae	<i>Clerodendrum floribundum</i> var. <i>coriaceum</i>			x	x
Lauraceae	<i>Cassytha candida</i>				x
Lauraceae	<i>Cassytha filiformis</i>				x
Lauraceae	<i>Cassytha</i> sp.			x	
Loranthaceae	<i>Amyema benthamii</i>				x
Loranthaceae	<i>Amyema bifurcata</i>				x
Loranthaceae	<i>Amyema sanguinea</i>				x
Loranthaceae	<i>Dendrophthoe acacioides</i>				x
Malvaceae	<i>Brachychiton diversifolius</i>			x	x
Malvaceae	<i>Brachychiton viscidulus</i>			x	x
Malvaceae	<i>Corchorus leptocarpus</i>				x
Malvaceae	<i>Gossypium costulatum</i>			x	x
Malvaceae	<i>Grewia brevifolia</i>				x
Malvaceae	<i>Grewia retusifolia</i>				x
Malvaceae	<i>Hibiscus leptocladus</i>				x
Malvaceae	<i>Melhania oblongifolia</i>				x
Malvaceae	<i>Melochia umbellata</i>			x	
Malvaceae	<i>Triumfetta carteri</i>				x
Malvaceae	<i>Triumfetta incana</i>				x
Malvaceae	<i>Waltheria indica</i>				x
Menispermaceae	<i>Tinospora smilacina</i>			x	x
Moraceae	<i>Ficus aculeata</i> var. <i>indecora</i>				x
Moraceae	<i>Ficus platypoda</i>				x
Myrtaceae	<i>Calytrix brownii</i>				x
Myrtaceae	<i>Calytrix exstipulata</i>			x	x
Myrtaceae	<i>Corymbia cadophora</i>			x	x
Myrtaceae	<i>Corymbia confertiflora</i>			x	x
Myrtaceae	<i>Eucalyptus miniata</i>			x	x
Myrtaceae	<i>Eucalyptus</i> sp.			x	x
Oleaceae	<i>Jasminum didymum</i> subsp. <i>didymum</i>				x
Oleaceae	<i>Jasminum didymum</i> subsp. <i>lineare</i>				x

Family	Taxon	Status	AS	DtV & EmW	EmW
Orchidaceae	? <i>Cymbidium canaliculatum</i>				x
Orobanchaceae	<i>Buchnera urticifolia</i>				x
Passifloraceae	<i>Passiflora foetida</i>	*		x	x
Phyllanthaceae	<i>Breynia cernua</i>			x	x
Phyllanthaceae	<i>Bridelia tomentosa</i>			x	x
Phyllanthaceae	<i>Phyllanthus aridus</i>				x
Phyllanthaceae	<i>Phyllanthus exilis</i>			x	x
Phyllanthaceae	<i>Phyllanthus maderaspatensis</i>				x
Phyllanthaceae	<i>Sauropus trachyspermus</i>				x
Plantaginaceae	<i>Stemodia lythrifolia</i>				x
Poaceae	<i>Alloteropsis semialata</i>				x
Poaceae	<i>Cenchrus echinatus</i>	*			x
Poaceae	<i>Chloris barbata</i>	*			x
Poaceae	<i>Cymbopogon ambiguus</i>				x
Poaceae	<i>Cymbopogon</i> sp.				x
Poaceae	<i>Eriachne avenacea</i>				x
Poaceae	<i>Eriachne ciliata</i>				x
Poaceae	<i>Heteropogon contortus</i>				x
Poaceae	<i>Melinis repens</i>	*		x	x
Poaceae	<i>Poaceae</i> sp.			x	x
Poaceae	<i>Sorghum plumosum</i>			x	x
Poaceae	<i>Triodia bynoei</i>				x
Poaceae	<i>Triodia pungens</i>			x	x
Poaceae	<i>Triodia</i> sp. Hidden Island (T. Handasyde TH 6109)				x
Proteaceae	<i>Grevillea agrifolia</i> subsp. <i>agrifolia</i>			x	x
Proteaceae	<i>Grevillea heliosperma</i>				x
Proteaceae	<i>Grevillea pyramidalis</i>				x
Proteaceae	<i>Grevillea refracta</i> subsp. <i>refracta</i>			x	x
Proteaceae	<i>Persoonia falcata</i>				x
Pteridaceae	<i>Cheilanthes caudata</i>			x	
Rubiaceae	<i>Pavetta kimberleyana</i>			x	
Santalaceae	<i>Exocarpos latifolius</i>				x
Santalaceae	<i>Santalum lanceolatum</i>				x
Sapindaceae	<i>Dodonaea hispidula</i>			x	x
Sapotaceae	<i>Mimusops elengi</i>			x	
Sapotaceae	<i>Sersalisia sericea</i>			x	x
Solanaceae	<i>Solanum ?echinatum</i>				x
Solanaceae	<i>Solanum</i> sp.				x
Stylidiaceae	<i>Stylidium semipartitum</i>				x
Taccaceae	<i>Tacca leontopetaloides</i>			x	x
Violaceae	<i>Hybanthus aurantiacus</i>			x	x
Violaceae	<i>Hybanthus enneaspermus</i>				x
Vitaceae	<i>Ampelocissus acetosa</i>			x	x

## Conservation significant flora locations

	Family	Taxon	Status	Figure 3 Label	Easting	Northing	Density	
2016 Survey	Asparagaceae	<i>Chlorophytum laxum</i>	Range extension	●	566515	8220291	1	
	Fabaceae	<i>Flemingia parviflora</i>	Range extension	●	566307	8219772	1	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	●	565202	8220700	1	
2017 Targeted Survey	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	2	567070	8219686	200*	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	3	567015	8219680		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	8	566990	8219655		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	13	567058	8219606		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	14	567005	8219751		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	15	567003	8219798		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	4	566875	8219919	10	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	5	566800	8219967	13	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	6	566801	8219968	8	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	7	566795	8219914	7	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	9	566961	8219552	100*	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	10	566925	8219555		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	11	566966	8219525	200*	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	12	567125	8219433		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	16	566801	8219916	11	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	17	566759	8219818	13	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	18	563734	8221098	200*	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	19	563766	8221091		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	20	563798	8221075		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	21	563881	8220970		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	22	563899	8220959		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	23	563937	8220935		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	24	564040	8220922	39	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	25	563575	8221167		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	26	563484	8221236	100*	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	27	563457	8221290	34	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	28	563004	8221608	11	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	29	563040	8221484	100*	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	30	563110	8221437		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	31	563673	8221390	12	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	33	564109	8221058	100*	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	34	564125	8221049	100*	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	35	564094	8221009		
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	36	564055	8221037	100*	
	Poaceae	<i>Triodia</i> sp. Hidden Island	Priority 1	38	563155	8221350	100*	
	<b><i>Triodia</i> sp. Hidden Island</b>				<b>Estimated Total</b>		<b>1359*</b>	

\* An approximate count due to the large number of plants at certain waypoints

# **Appendix E** – Fauna data

Fauna species list

Bat analysis

## Fauna species list

Family	Genus	Species	Common Name	Status	GHD August 2013	GHD February 2014	GHD December 2016
<b>Birds</b>							
Acanthizidae	<i>Gerygone</i>	<i>albogularis</i>	White-throated Gerygone		X	X	X
Acanthizidae	<i>Gerygone</i>	<i>chloronata</i>	Green-backed Gerygone		X	X	
Acanthizidae	<i>Smicromnis</i>	<i>brevirostris</i>	Weebill		X	X	X
Accipitridae	<i>Accipiter</i>	<i>cirrocephalus cirrocephalus</i>	Collared Sparrowhawk		X	X	X
Accipitridae	<i>Accipiter</i>	<i>fasciatus fasciatus</i>	Brown Goshawk		X	X	
Accipitridae	<i>Aquila</i>	<i>audax</i>	Wedge-tailed Eagle			X	
Accipitridae	<i>Elanus</i>	<i>axillaris</i>	Black Shouldered Kite			X	
Accipitridae	<i>Haliaeetus</i>	<i>leucogaster</i>	White-bellied Sea-eagle		X	X	X
Accipitridae	<i>Haliastur</i>	<i>indus</i>	Brahminy Kite		X	X	X
Accipitridae	<i>Haliastur</i>	<i>sphenurus</i>	Whistling Kite			X	
Accipitridae	<i>Hieraetus</i>	<i>morphnoides</i>	Little Eagle				X
Accipitridae	<i>Pandion</i>	<i>cristatus</i>	Eastern Osprey	Ma, S5	X	X	X
Artamidae	<i>Artamus</i>	<i>cinereus</i>	Black-faced Woodswallow			X	
Artamidae	<i>Artamus</i>	<i>leucorhynchus</i>	White-breasted Woodswallow		X	X	X
Artamidae	<i>Artamus</i>	<i>minor</i>	Little Woodswallow		X	X	X
Artamidae	<i>Cracticus</i>	<i>nigrogularis</i>	Pied Butcherbird		X		
Ardeidae	<i>Butorides</i>	<i>striata</i>	Striated Heron		X	X	
Ardeidae	<i>Egretta</i>	<i>sacra</i>	Eastern Reef Egret		X	X	X
Cacatuidae	<i>Cacatua</i>	<i>galerita</i>	Sulphur-crested Cockatoo		X		
Cacatuidae	<i>Cacatua</i>	<i>sanguinea westralensis</i>	Little Corella		X	X	
Cacatuidae	<i>Eolophus</i>	<i>roseicapillus</i>	Galah		X		
Campephagidae	<i>Coracina</i>	<i>novaehollandiae</i>	Black-faced Cuckoo-Shrike		X	X	X
Campephagidae	<i>Coracina</i>	<i>papuensis</i>	White-bellied Cuckoo-Shrike		X		

Family	Genus	Species	Common Name	Status	GHD August 2013	GHD February 2014	GHD December 2016
Campephagidae	<i>Lalage</i>	<i>leucomela</i>	Varied Triller		X	X	
Campephagidae	<i>Lalage</i>	<i>sueurii</i>	White-winged Triller		X	X	
Cisticolidae	<i>Cisticola</i>	<i>exilis</i>	Golden-headed Cisticola			X	
Columbidae	<i>Geopelia</i>	<i>cuneata</i>	Diamond Dove			X	
Columbidae	<i>Geopelia</i>	<i>humeralis</i>	Bar-shouldered Dove		X	X	X
Columbidae	<i>Geopelia</i>	<i>striata</i>	Peaceful Dove		X	X	
Columbidae	<i>Ocyphaps</i>	<i>lophotes</i>	Crested Pigeon			X	
Columbidae	<i>Phaps</i>	<i>chalcoptera</i>	Common Bronzewing		X	X	
Columbidae	<i>Ptilinopus</i>	<i>regina</i>	Rose-crowned Fruit Dove		X	X	X
Corvidae	<i>Corvus</i>	<i>orru</i>	Torresian Crow		X		
Cuculidae	<i>Centropus</i>	<i>phasianinus</i>	Pheasant Coucal		X	X	X
Cuculidae	<i>Chalcites</i>	<i>basalis</i>	Horsefield Bronze Cuckoo		X	X	
Cuculidae	<i>Chalcites</i>	<i>minutillus</i>	Little Bronze Cuckoo		X	X	
Estrildidae	<i>Taeniopygia</i>	<i>bichenovii</i>	Double-barred Finch		X	X	X
Falconidae	<i>Falco</i>	<i>berigora</i>	Brown Falcon		X		
Fregatidae	<i>Fregata</i>	<i>ariel</i>	Lesser Frigatebird	Mi, Ma, S5	X	X	X
Haematopodidae	<i>Haematopus</i>	<i>fuliginosus</i>	Sooty Oystercatcher			X	
Halcyonidae	<i>Todiramphus</i>	<i>chloris</i>	Collared Kingfisher		X		X
Laridae	<i>Gelochelidon</i>	<i>nilotica</i>	Gull-billed Tern	Mi, Ma, S5	X		
Maluridae	<i>Malurus</i>	<i>lamberti</i>	Variiegated Fairy-wren		X		
Meliphagidae	<i>Conopophila</i>	<i>rufogularis</i>	Rufous-throated Honeyeater		X		
Meliphagidae	<i>Lichmera</i>	<i>indistincta</i>	Brown Honeyeater		X	X	X
Meliphagidae	<i>Manorina</i>	<i>flavigula</i>	Yellow-throated Miner		X	X	
Meliphagidae	<i>Melithreptus</i>	<i>albogularis</i>	White-throated Honeyeater		X	X	X
Meliphagidae	<i>Philemon</i>	<i>argenteiceps</i>	Silver-crowned Friarbird		X	X	X
Meliphagidae	<i>Philemon</i>	<i>citreogularis</i>	Little Friarbird		X	X	

Family	Genus	Species	Common Name	Status	GHD August 2013	GHD February 2014	GHD December 2016
Meropidae	<i>Merops</i>	<i>ornatus</i>	Rainbow Bee-eater		X	X	X
Monarchidae	<i>Myiagra</i>	<i>nana</i>	Restless Flycatcher				X
Monarchidae	<i>Myiagra</i>	<i>rubecula</i>	Leaden's Flycatcher		X	X	X
Monarchidae	<i>Myiagra</i>	<i>ruficollis</i>	Broad-billed Flycatcher		X	X	
Nectariniidae	<i>Dicaeum</i>	<i>hirundinaceum</i>	Mistletoebird		X	X	X
Oriolidae	<i>Oriolus</i>	<i>sagittatus</i>	Olive-backed Oriole		X		X
Pachycephalidae	<i>Oreoica</i>	<i>gutturalis</i>	Crested Bellbird			X	
Pachycephalidae	<i>Pachycephala</i>	<i>rufiventris</i>	Rufous Whistler		X	X	X
Pachycephalidae	<i>Colluricincla</i>	<i>harmonica</i>	Grey Shrike-thrush			X	
Pardalotidae	<i>Pardalotus</i>	<i>rubricatus</i>	Red-browed Pardalote		X	X	X
Pardalotidae	<i>Pardalotus</i>	<i>striatus melanocephalus</i>	Striated Pardalote		X	X	X
Petroicidae	<i>Melanodryas</i>	<i>cucullata picata</i>	Hooded Robin		X		
Petroicidae	<i>Microeca</i>	<i>fascinans</i>	Jacky Winter		X	X	
Petroicidae	<i>Microeca</i>	<i>flavigaster</i>	Lemon-bellied Flycatcher			X	
Psittacidae	<i>Aprosmictus</i>	<i>erythropterus</i>	Red-winged Parrot		X	X	X
Ptilonorhynchidae	<i>Ptilonorhynchus</i>	<i>nuchalis</i>	Great Bowerbird		X	X	X
Rhipiduridae	<i>Rhipidura</i>	<i>leucophrys</i>	Willie Wagtail		X	X	X
Rhipiduridae	<i>Rhipidura</i>	<i>rufiventris</i>	Northern Fantail		X	X	X
Scolopacidae	<i>Numenius</i>	<i>phaeopus</i>	Whimbrel	Mi, Ma, S5		X	
Scolopacidae	<i>Tinga</i>	<i>nebularia</i>	Common Greenshank	Mi, Ma, S5		X	
Strigidae	<i>Ninox</i>	<i>rufa</i>	Rufous Owl (?)			X	
Strigidae	<i>Ninox</i>	<i>novaeseelandiae</i>	Southern Boobook Owl		X	X	X
Tytonidae	<i>Tyto</i>	<i>novaehollandiae kimberli</i>	Masked Owl (Kimberley race)	Vu, P1		X	
<b>Reptiles</b>							
Boidae	<i>Antaresia</i>	<i>childreni</i>	Children's Python		X	X	
Boidae	<i>Liasis</i>	<i>olivaceus olivaceus</i>	Olive Python		X	X	

Family	Genus	Species	Common Name	Status	GHD August 2013	GHD February 2014	GHD December 2016
Colubridae	<i>Dendrelaphis</i>	<i>punctulata</i>	Common Tree Snake		X		
Crocodylidae	<i>Crocodylus</i>	<i>porosus</i>	Saltwater Crocodile	Mi, Ma, S4	X		
Diplodactylidae	<i>Crenadactylus</i>	<i>ocellatus rostralis</i>	Clawless Gecko		X		
Elapidae	<i>Pseudechis</i>	<i>australis</i>	Mulga Snake		X		
Elapidae	<i>Pseudechis</i>	<i>weigeli</i>	Pygmy Mulga		X	X	
Gekkonidae	<i>Gehyra</i>	<i>australis</i>	Northern Dtella		X	X	
Gekkonidae	<i>Gehyra</i>	<i>nana</i>	Northern Spotted-rock Dtella		X	X	X
Gekkonidae	<i>Gehyra</i>	<i>occidentalis</i>	Kimberley Plateau Dtella		X	X	X
Gekkonidae	<i>Hemidactylus</i>	<i>frenatus</i>	Asian House Gecko	intro	X	X	
Gekkonidae	<i>Heteronotia</i>	<i>planiceps</i>	North-west Prickerly Gecko		X	X	X
Pygopodidae	<i>Delma</i>	<i>borea</i>	Rusty Topped Delma		X	X	
Pygopodidae	<i>Lialis</i>	<i>burtonis</i>	Burtons Legless Lizard		X	X	
Scincidae	<i>Carlia</i>	<i>triacantha</i>	Desert Rainbow Skink		X	X	X
Scincidae	<i>Ctenotus</i>	<i>inornatus</i>	Northern Ctenotus		X	X	X
Scincidae	<i>Cyclodomorphus</i>	<i>maximus</i>	Giant Slender Blue-tongue		X		
Scincidae	<i>Eremiascincus</i>	<i>isolepis</i>	Northern Bar-lipped Skink		X	X	X
Scincidae	<i>Lerista</i>	<i>greeri</i>	Greer's Slider		X	X	
Scincidae	<i>Morethia</i>	<i>ruficauda ruficauda</i>	Fire-tailed Skink		X	X	X
Typhlopidae	<i>Anilius</i>	<i>kimberleyensis</i>	Kimberley Blindsnake		X	X	
Scincidae	<i>Tiliqua</i>	<i>scincoides intermedia</i>	Northern Blue-tongue Skink		X	X	
Varanidae	<i>Varanus</i>	<i>glauerti</i>	Kimberley Rock Monitor		X	X	
Varanidae	<i>Varanus</i>	<i>glebopalma</i>	Black-handed Rock Monitor		X	X	X
<b>Amphibia</b>							
Hylidae	<i>Litoria</i>	<i>caerulea</i>	Green Tree frog		X	X	X
<b>Mammals</b>							
Emballonuridae	<i>Ozimops</i>	<i>georgianus</i>	Common Sheath-tail-bat		X	X	X, detector

Family	Genus	Species	Common Name	Status	GHD August 2013	GHD February 2014	GHD December 2016
Hipposideridae	<i>Hipposideros</i>	<i>stenotis</i>	Northern Leaf-nosed Bat	P2	X	X	detector
Megadermatidae	<i>Macroderma</i>	<i>gigas</i>	Ghost Bat		X		
Molossidae	<i>Chaerephon</i>	<i>jobensis</i>	Northern Freetail Bat			X	
Molossidae	<i>Mormopterus</i>	<i>beccarii</i>	Beccari's Freetail Bat		X		
Molossidae	<i>Mormopterus</i>	<i>loriae cobourgiana</i>	Little North-western Mastiff Bat	P1		X	
Muridae	<i>Hydromys</i>	<i>chrysogaster</i>	Water Rat	P4	X	X	
Muridae	<i>Zyomys</i>	<i>argurus</i>	Common Rock Rat		X	X	X
Pteropodidae	<i>Pteropus</i>	<i>alecto</i>	Black Flying Fox		X		X
Vespertilionidae	<i>Mineopterus</i>	<i>schreibersii</i>	Common Bent-wing Bat		X	X	
Vespertilionidae	<i>Vespadelus</i>	<i>caurinus</i>	Western Cave Bat		X	X	detector
Vespertilionidae	<i>Pipistrelle/Miniopterus</i>	<i>westralis/ orianae</i>	Either species				detector

## Bat call analysis

WAC files were viewed and bat calls were identified using Kaleidoscope Viewer (version 4, Wildlife Acoustics Inc. 2016) by visually comparing the Kaleidoscope Viewer spectrogram and call characteristics (e.g. characteristic frequency and call shape) with reference calls and/or species call descriptions from available reference material (McKenzie and Bullen 2009; 2012, Armstrong and Coles 2007). The spectrogram displayed each call sequence (see below for call definition) with information on the number and timing of calls.

The call identification was also assisted by consulting distribution information for possible species (McKenzie *et al* 1995, McKenzie and Bullen 2012, Atlas of Living Australia and DPAW NatureMap records) and previous GHD surveys within the region of the survey area. No reference calls were collected during the survey.

A call (pass) was defined as a sequence of three or more consecutive pulses of similar frequency and shape. Calls with less than three defined consecutive pulses of similar frequency and shape were not unambiguously identified to a species but were used as part of the activity count for the survey area.

The exceptions to this call definition are the Pilbara Leaf-nosed Bat (*Rhinonictoris aurantia*) and *Hipposideros* species as the pulse structure is constant frequency (CF). Their echolocation calls are readily identifiable from the characteristic (or more accurately the maximum or peak) frequency and pulse shape, enabling even short call sequences with few pulses to be successfully recognised. Therefore identification can sometimes be confirmed from a minimum of two good quality consecutive pulses within the frequency range of the species.

Due to variability in the quality of calls, the lack of published information regarding non-search phase calls and the difficulty in distinguishing some species the identification of each call was assigned a confidence rating (see Mills *et al.* 1996 & Duffy *et al.* 2000) as summarised in the table below. Due to the absence of reference calls from the study area and the poor quality of some the recordings and known overlap in call characteristics between some species, a conservative approach was taken when analysing calls.

Species nomenclature follows Armstrong (2011), then van Dyck *et al.* (2013).

## Confidence ratings applied to calls

Identification	Description
D - Definite	Species identification not in doubt. Call sequence contains three or more consecutive pulses of similar frequency and shape. Call characteristics match those in referenced material or species reference calls.
PR - Probable	Call most likely to represent a particular species, but there exists a low probability of confusion with species of similar call type or call lacks sufficient detail (e.g. number of pulses).
SG - Species Group	X = Call made by one of two or more species. Call characteristics overlap making it too difficult to distinguish between species

## Summary of results and survey effort

Microchiropteran bat detector surveys were completed for two nights during December 2016 at two locations in the survey area.

Two species were positively (Definite) identified of the 12 species that are known to occur from this area of the Pilbara region (McKenzie *et al.* 1995, McKenzie and Bullen 2012, Atlas of Living Australia and DPAW NatureMap records). As many as two other species may also have been recorded using bat detectors, but poor data quality and/or interspecific call similarities precluded reliable identification of additional species.

## Species list for survey area

Species / Group	Date		Notes regarding activity
	14-15/12/2016	15-16/12/16	
<i>Taphozous georgianus</i>	D	D	Common, frequent calls
<i>Vespadelus caurinus</i>	D	D	Common, frequent calls
<i>Hipposideros stenotis</i>		Pr	1 call of poor quality – tentative identification however only species to call at C. 100 kHz
<i>Pipistrelle westralis/Miniopterus orianae</i>	X	X	< 5 calls
Survey effort	1 night	1 night	Moderate level of bat activity both nights

### Table notes

Total number of species recorded for each night/site is based on definite (D) identification only. Total number of D species for each night.

See Table 1 for confidence rating e.g. D or Pr, - = not recorded. X = species group present

CE, E, VU – species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* or the *Wildlife Conservation Act 1950*

P1- 4 (priority species) listed by DPaW – current as of November 2015.

## Qualifications

Craig Grabham has completed microchiropteran bat surveys and assessments in WA, NSW, QLD, Vic, Tasmania and the NT employing a variety of methods including harp trapping, light tagging, habitat surveys (e.g. cave assessments), roost surveillance (using infrared and thermal video cameras), and echolocation survey (Wildlife Acoustic's SongMeter and Eco Meter devices and Titley Electronic Anabat devices) and analysis (Wildlife Acoustic's SongScope and Chris Corben's Analook). He has completed bat surveys for infrastructure, residential, and mining projects. Craig has also completed bat inventory surveys for National Parks, Nature Reserves, catchment management areas and private land conservation projects. His honours project investigated the use of remnant and revegetated habitats by microchiropteran bats across a fragmented rural landscape in the Eastern Billabong Catchment (south-west slopes) in NSW.

Craig has completed the following training courses with regard to ultrasonic call recording and analysis:

- Anabat system training course – Titley Scientific (December 2012)
- Wildlife Acoustic's Song Meter and SongScope training – Faunatech/Austbat (July 2015).

To date Craig has completed echolocation analysis and reporting for more than 102 projects from WA, NSW, NT, QLD and Victoria since joining GHD in 2006 from calls collected during field surveys from Anabat detectors and/or Song Meter units and identified using Analook or SongScope software.

## References

Armstrong, K. N. (2011). The current status of bats in Western Australia. In: 'The biology and conservation of Australasian bats.' (Eds B. Law, P. Eby, D. Lunney and L. Lumsden.) pp. 257–269. (Royal Zoological Society of New South Wales: Mosman.)

Armstrong, K. N., and Coles, R. B. (2007). Echolocation call frequency differences between geographic isolates of *Rhinonictes aurantia* (Chiroptera: Hipposideridae): implications of nasal chamber size. *Journal of Mammalogy* **88**, 94-104.

Duffy, AM, Lumsden, LF, Caddle, CR, Chick, RR & Newell, GR (2000). The efficacy of Anabat ultrasonic detectors and harp traps for surveying microchiropterans in southeastern Australia, *Acta Chiropterologica* 2: 127-144.

Mills, DJ, Norton, TW, Parnaby, HE, Cunningham, RB & Nix, HA (1996). Designing surveys for microchiropteran bats in complex forest landscapes – a pilot study from south-east Australia. *Forest Ecology and management* 85(1-3):149-161.

McKenzie, N., Fontanini, L., Lindus, N. and Williams, M. (1995). Biological Inventory of Koolan Island, Western Australia 2) Zoological Notes. *Records of the Western Australian Museum* 17: 249-266.

McKenzie, N. L., and Bullen, R. D. (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. *Records of the Western Australian Museum Supplement* 78: 123–155.

McKenzie, N. L., and Bullen, R. D. (2012). An acoustic survey of zoophagic bats on islands in the Kimberley, Western Australia, including data on the echolocation ecology, organisation and habitat relationships of regional communities. *Records of the Western Australian Museum Supplement* 81: 67–108.

van Dyke, S, Gynther, I, and Baker, A. (2013). *Field Companion to The Mammals of Australia*. New Holland Publishers.

# **Appendix F – SRE Sample Locations**

## SRE sample locations

Site	Species Recorded
SRE Sample site 1 51K 564264 E, 8220871 N Eucalyptus open woodland Foraged 10th August 2013	Crustacea: Isopoda: Armadillidae: <i>Buddelundia</i> '82'
SRE Sample site 2 51K 564507 E, 8221446 N Eucalyptus open woodland Foraged 10th August 2013	No potential SRE
SRE Sample site 3 51K 565061 E, 8220856 N Eucalyptus open woodland Foraged 10th August 2013	Gastropoda: : Helicarionidae: <i>Westracystis lissus</i>
SRE Sample site 4 51K 567006 E, 8220126 N Eucalyptus open woodland Foraged 12th August 2013	Gastropoda: Camaenidae: <i>Torresitrachia</i> aff. <i>bathurstensis</i> Gastropoda: Helicarionidae: <i>Westracystis lissus</i> Possibly juv. Arachnida: Araneae: Barychelidae: <i>Synothele</i> `sp`
SRE Sample site 5 51K 566641E, 8219932 N Eucalyptus open woodland Foraged 10th August 2013	Gastropoda: Helicarionidae: <i>Westracystis lissus</i> Gastropoda: Camaenidae: <i>Torresitrachia</i> aff. <i>bathurstensis</i> Arachnida: Acari: Trombidioidea: <i>Trombidioidea</i>
SRE Sample site 6 Only surveyed during Phase 2 51K 565188 E, 8220672N Eucalyptus open woodland Foraged 11th August 2013	Arachnida: Scorpiones: Buthidae: <i>Lychas bituberculatus</i> Pocock, 1891
SRE Sample site 7 Only surveyed during Phase 2 51K 565188 E, 8220672N Eucalyptus open woodland Foraged 11th August 2013	No potential SRE

GHD

Level 10  
999 Hay Street

T: 61 8 6222 8222 F: 61 8 6222 8555 E: [permail@ghd.com](mailto:permail@ghd.com)

© GHD 2017

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

6135178-

33068/[https://projects.ghd.com/oc/WesternAustralia/kimberleysupplychain/Delivery/Documents/6135178-REP-A\\_Flora and Fauna Assessment.docx](https://projects.ghd.com/oc/WesternAustralia/kimberleysupplychain/Delivery/Documents/6135178-REP-A_Flora and Fauna Assessment.docx)

Document Status

Rev	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	J Tindiglia G Gaikhorst A Benkovic	A Napier		I McCardle		23/06/17

[www.ghd.com](http://www.ghd.com)

