Cervantes 1 Conventional Well

Level 1 Fauna Survey, Reconnaissance and Targeted Flora and Vegetation Survey

RCMA AUSTRALIA PTY LTD

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Photo: Coastal Sands dominated by *Acacia rostellifera, Eucalyptus oraria* and *Eucalyptus obtusiflora* (Geraldton Area) P1 Priority Ecological Community (PEC) within Development Envelope.

DOCUMENT REVISION AND STATUS

Revision	Status	Originator	Internal Reviewer	Internal Review Date	Client Reviewer	Client Review Date
A	Draft Report	AS/LF	GW	25/03/2020	AW	30/3/20
B	Report	LF	GW	1/4/20	AW	2/4/20
0	Final Report	LF	GW	2/4/20	AW	3/6/20
1	Final Report	LF	CG/AS	3/7/20	AW	7/07/20
2	Updated Fauna and maps	DW			AW	05/10/2020

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The desktop assessment identified a total of 19 significant flora taxa or habitat for significant taxa, which are known from within the Desktop Study Area including 13 Department of Biodiversity Conservation and Attractions (DBCA) classified Priority flora, and six Threatened flora taxa. A likelihood of occurrence assessment completed during the desktop analysis identified five significant flora taxa considered to potentially occur in the Development Envelope including *Anthocercis intricata* (P3), *Dampiera tephrea* (P2), *Eucalyptus zopherophloia* (P4), *Haloragis foliosa* (P3) and *Thryptomene* sp. Lancelin (M.E. Trudgen 14000) (P3). The field survey undertaken in February 2020 did not record any occurrences of these taxa within the Development Envelope and it is therefore considered unlikely that they are present.

Of the four vegetation types mapped within the Development Envelope one (W1) has been confirmed as a Priority Ecological Community (PEC); Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora* (P1). Only 1 % (7 ha) of the total area mapped as vegetation type W1 (681 ha) during the Denison 3D Seismic Survey (Woodman 2005) is located within the Development Envelope.

The desktop study identified 207 fauna species as potentially occurring in the Development Envelope including nine frogs, 50 reptiles, 122 birds, 16 native and ten introduced mammals including a total of 15 vertebrate species of significance and four invertebrate species of significance.

Significant vertebrate species that are likely to occur in the Development Envelope regularly were confirmed during field investigations, these include the Black-striped Snake (P3), Carnaby's Black-Cockatoo (Threatened - Endangered), Brush Wallaby (P4) and an additional six species considered of local significance. There is a slight possibility of the Western Ground Parrot and Woma persisting in the area. The Carnaby's Black-Cockatoo is expected to be a regular migrant to the area; however, the Development Envelope is unlikely to support critical foraging habitat and the species is unlikely to roost or breed in the Development Envelope.

Four Vegetation and Substrate Associations have been mapped within the Development Envelope which are considered to be common along the coastal belt throughout the region. The Development Envelope is comprised mostly of heath vegetation which will support a rich reptile assemblage and understorey-associated birds. The strip of Melaleuca thickets (T2) in the east may support additional middle-storey birds and some larger mammals. The small area of mallee woodland (W1) in the east is expected to support woodland-associated species.

1. INTRODUCTION

1.1 Project Overview

RCMA Australia (RCMA) is proposing to undertake conventional drilling operations within the Cervantes oil prospect in the L14 production licence ("L14") (the Project), located in the northern onshore Perth Basin, 3km south of the Jingemia oil field.

RCMA plan to drill the Cervantes 1 exploration well in Q1 2021. The project will include the following key stages:

- Site preparation:
  - Establishment of hygiene station as per Hygiene Procedure [RCMA-02-EM-PRO-001]
  - Clearing and preparation of access tracks and drill site
  - Levelling, sheeting and preparation of surfaces to support compressive loads and limit erosion to the existing landscape
  - Conductor drilling
  - Construction of lined mud sump, turkey's nest, vertical seismic profile (VSP) pit and well cellar
  - Baseline monitoring (soil and groundwater)
- Mobilisation of drilling package, ancillary services, site office, personnel and supplies
- Drilling exploration program:
  - Conducting the exploration drilling activities
  - Completion (and test) or abandonment of well
- Demobilisation of drilling package, ancillary services, site office, personnel and supplies
- Decommissioning and rehabilitation:
  - Restoration of the site following the completion of activities, if not considered commercially viable
  - Handover site to operations for care and maintenance
  - Rehabilitation of decommissioned infrastructure

Impacts (and expected timeframes) may include:

- Clearing of <2.7 ha of vegetation fringing an existing access track; to remain clear for a period of up to 3 months;
- Disturbance of 2.6 ha of vegetation in a previously uncleared vegetated swale; to remain clear for a period of up to 6 months;
- Vehicle movements on access tracks over a period of 90 days with most movements over two ten-day periods prior to and post drilling;
- Noise associated with drilling rig for up to 40 days;
- Light emissions during drilling activities for a period up to 40 days; and
- Temporary localised effects of dust (to be mitigated by watering).

Note that there will be no de-watering or ground water abstraction, and ground disturbance and impact on subterranean environments will be limited to the immediate vicinity of the well bore.

Clearing of vegetation is required to widen the existing access track and clear the well pad area (Table 1). Native vegetation will be cleared and stockpiled to the side of the cleared location.

Table 1: Project Disturbance

Aspect	Project Area	Previously Disturbed	Vegetation Clearing
Wellpad	2.6 ha	0 ha	2.6 ha
Access Track	5.1 ha	2.4 ha	2.7 ha
TOTAL	7.7 ha	2.4 ha	5.3 ha

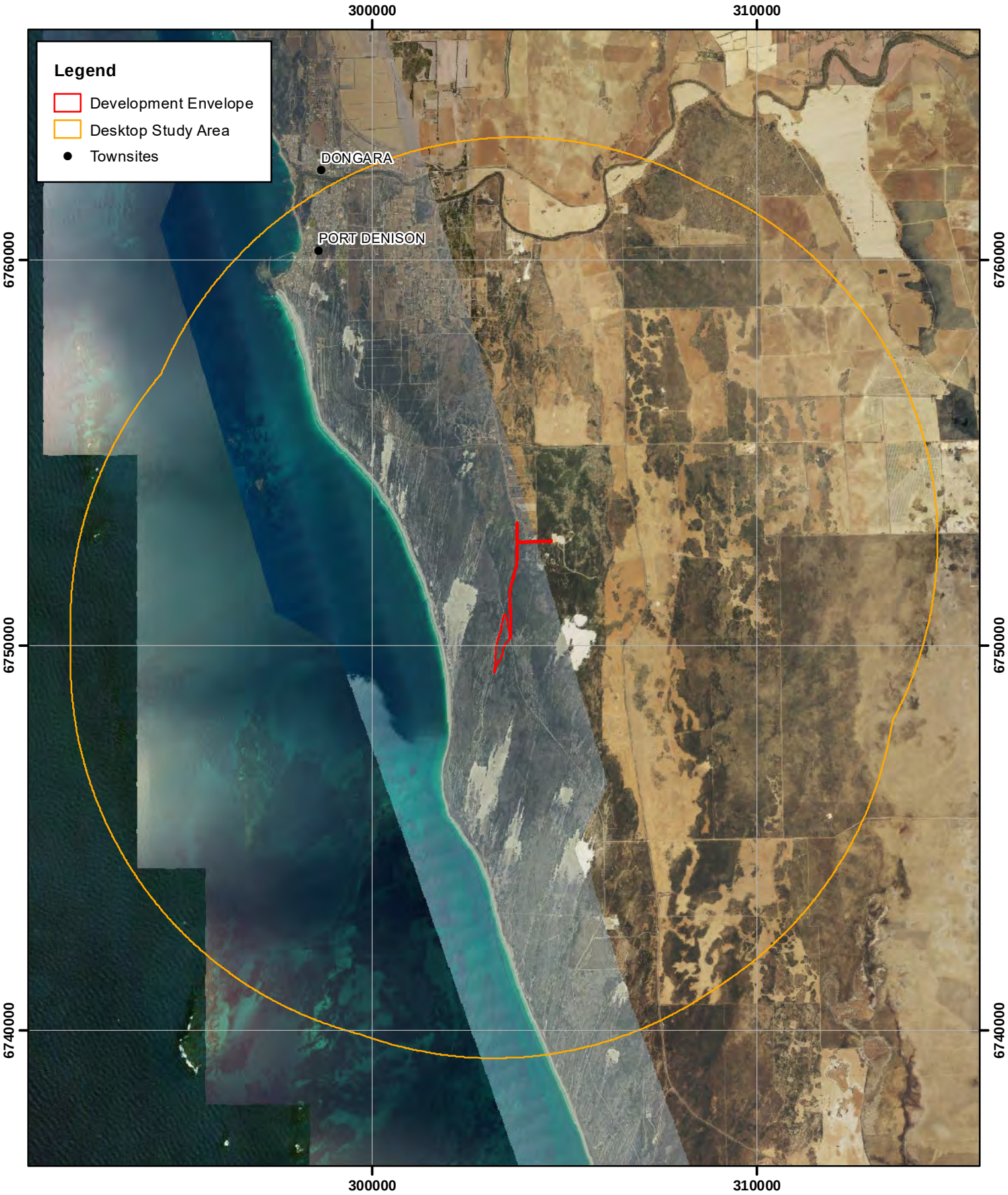
RCMA have commissioned Woodman Environmental Consulting Pty Ltd (Woodman Environmental) to undertake a flora, vegetation and fauna targeted and reconnaissance surveys as per the recommendations provided by Woodman Environmental (2020) in the desktop review and risk assessment for the project, to support the environmental approvals process.

1.2 Project Area Definition

The Project is located within the Shire of Irwin, approximately 300 km north-west of Perth, south-east of Dongara / Port Denison (Figure 1). The Development Envelope of approximately 157 ha is located approximately 13 kilometres (km) south of Dongara, 3 km west of Brand Highway, and 300 km north of Perth. An existing access track to be used in the project extends north along the Eneabba to Geraldton railway line

A Desktop Study Area (for flora and vegetation purposes) has been defined encompassing the Development Envelope with a 10 km buffer, also as shown on Figure 1, for the purposes of conducting database searches and identifying species and communities of conservation significance that may occur nearby.

The Development Envelope where direct impacts such as clearing are planned, are shown on Figure 1, includes a wellpad and access track. The access track mainly follows an existing track of varying widths that will be widened to a full width of 12m to allow rig access.



Desktop Study Area and Development Envelope	Author: Leah Firth	
	WEC Ref: Metgasco20-11-01	
WOODMAN ENVIRONMENTAL	Filename: Metgasco20-11-01-f01	**Figure**
	Scale: 1:130,000 (A4)	1
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report Metgasco 20-11-01.	Revision: 2 - 02 July 2020	

1.3 Aim and Objectives

The aim of the assessment is to provide relevant flora, vegetation and fauna information to support the EIA process. This report presents and builds on the results of the previous desktop assessment (Woodman Environmental 2020).

The overall objectives of the assessment were to:

- Undertake a targeted flora survey to determine the presence and extent of significant flora taxa identified in the risk assessment provided in Woodman Environmental (2020), within the Development Envelope, that are one of the following (hereafter referred to as significant flora taxa), to provide context for impact assessment:
  - Listed Threatened species under the *Environment Protection and Biodiversity Conservation* Act *1999* (EPBC Act) (Commonwealth);
  - Threatened flora under the *Biodiversity Conservation Act 2016* (BC Act) (WA);
  - Priority flora taxa as classified by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA); and
  - Other significant flora taxa as defined by the Environmental Protection Authority (EPA) (2016a; b).
- Confirm the presence and extent of vegetation types (plant communities) mapped within the Development Envelope;
- Undertake a targeted survey to confirm the presence/absence and extent of vegetation that occurs within the Development Envelope that is one of the following (hereafter referred to as significant vegetation), to provide context for impact assessment:
  - Listed Threatened Ecological Communities (TEC) under the EPBC Act;
  - TEC as classified by DBCA and endorsed by the Western Australia (WA) Minister for the Environment;
  - Priority Ecological Communities (PEC) as classified by DBCA;
  - Area of wetland or riparian vegetation that is ground or surface water-dependent; and
  - Other significant vegetation as defined by EPA (2016a; b).
- Characterise the fauna and faunal assemblages present within Development Envelope;
- Identify the Vegetation and Substrate Associations (VSAs) within the Development Envelope;
- Identify habitat and foraging value of vegetation within the Development Envelope for vertebrate fauna species that are one of the following:
  - Listed Threatened or Migratory species under the EPBC Act;
  - Fauna listed under Schedules 1-7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*;
  - Priority fauna as classified by DBCA; and
  - Locally significant fauna, defined as species that are not protected under legislation, but may be locally important due to their distribution or habitat preferences;

- Identify any ecological processes in the Development Envelope upon which fauna may depend;

The survey and reporting works comply with the following documents:

- Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a);
- Environmental Factor Guideline – Flora and Vegetation (EPA 2016b);
- Technical Guidance – Terrestrial Fauna Surveys (EPA 2016c);
- Environmental Factor Guideline – Terrestrial Fauna (EPA 2016d);
- Matters of National Environmental Significance: Significant Impact Guidelines 1.1 (Commonwealth of Australia 2013).

1.4 Level of Assessment

1.4.1 Flora and Vegetation

This flora and vegetation assessment of the Development Envelope conforms to the requirements of a Desktop Study, Reconnaissance Survey and Targeted Survey as defined in sections 3, 4.1 and 4.2 of EPA (2016a). The Desktop Study was initially conducted to determine the current knowledge of the flora and vegetation factors potentially located in the Desktop Study Area (Woodman Environmental 2020), to inform the level of required for field survey.

A Reconnaissance survey (section 4.1 of EPA (2016a)) with regards to determination of vegetation factors has been undertaken within the Study Area. A reconnaissance survey provides broad information in an area where the vegetation and flora values are well defined. The Study Area is located within a wider survey area which had been structurally mapped by Woodman Environmental (2005); that survey included relevé data points located in close proximity to the Study Area; in addition, inspection of aerial photography concluded that the vegetation structure had not altered significantly since the original mapping work had been conducted. A Reconnaissance survey, including inspection and establishment of relevés within the Study Area, and data collection pertinent to the verification of the presence of one potential Priority Ecological Community (PEC) in the area was determined to be adequate for the purposes of this survey.

A Targeted flora survey (section 4.2 of EPA (2016a)) was undertaken to determine the size and extent of all significant flora populations or vegetation. No Targeted survey of significant flora taxa had been undertaken during previous surveys of the Study Area.

1.4.2 Fauna

This fauna assessment of the Development Envelope conforms to the requirements of Level 1 survey as defined in Appendix 2 of EPA (2016c). A level 1 approach is consistent with guidance from the EPA (2002) for the region (Geraldton Sandplain) and for a project with low impact (small scale, temporary). This includes a desktop study, followed by a reconnaissance survey to verify the accuracy of the desktop study, to characterise fauna and faunal assemblages and identify potential impacts.

The desktop assessment includes a review of the general fauna assemblage and conservation significant species (particularly EPBC-listed species) considered likely to occur in the project area, and providing descriptions of environments that provide habitat for fauna based on vegetation studies conducted by Woodman Environmental. The desktop assessment was supplemented by a reconnaissance visit to the project area and targeted field investigations. Where there are apparent interactions between fauna values and exploration works, comments on potential impacts on fauna and recommendations to minimise these impacts are made.

2. BACKGROUND

2.1 Climate

The Development Envelope is located within Irwin Botanical District (Northern Sandplains Region), within the Southwest Botanical Province as classified by Beard (1990). The climate is classified as dry, warm Mediterranean, with predominantly winter precipitation (300 – 500 mm) and seven to eight dry months per year (Beard 1990).

Figure 2 presents the long-term average monthly maximum temperatures for Geraldton Airport (1941-2014) and long-term average monthly precipitation data for Dongara (1884-2019), the most relevant meteorological stations to the Development Envelope (Bureau of Meteorology 2020).

Long term monthly maximum temperatures at Geraldton peak in February (32.6°C) (data from 1941-2014). Long-term average monthly rainfall at Dongara peaks from late autumn to early spring (May-September), with the highest rainfall on average received in June (108.3 mm). Rainfall received at Dongara in 2019, the year proceeding the reconnaissance survey (February 2020), was below the long-term annual average (454.1 mm), with only 243.6 mm received. Average monthly maximum temperatures recorded for 2019 were above the long-term monthly averages in every month except for January and February, which recorded temperatures just below the long term averages.

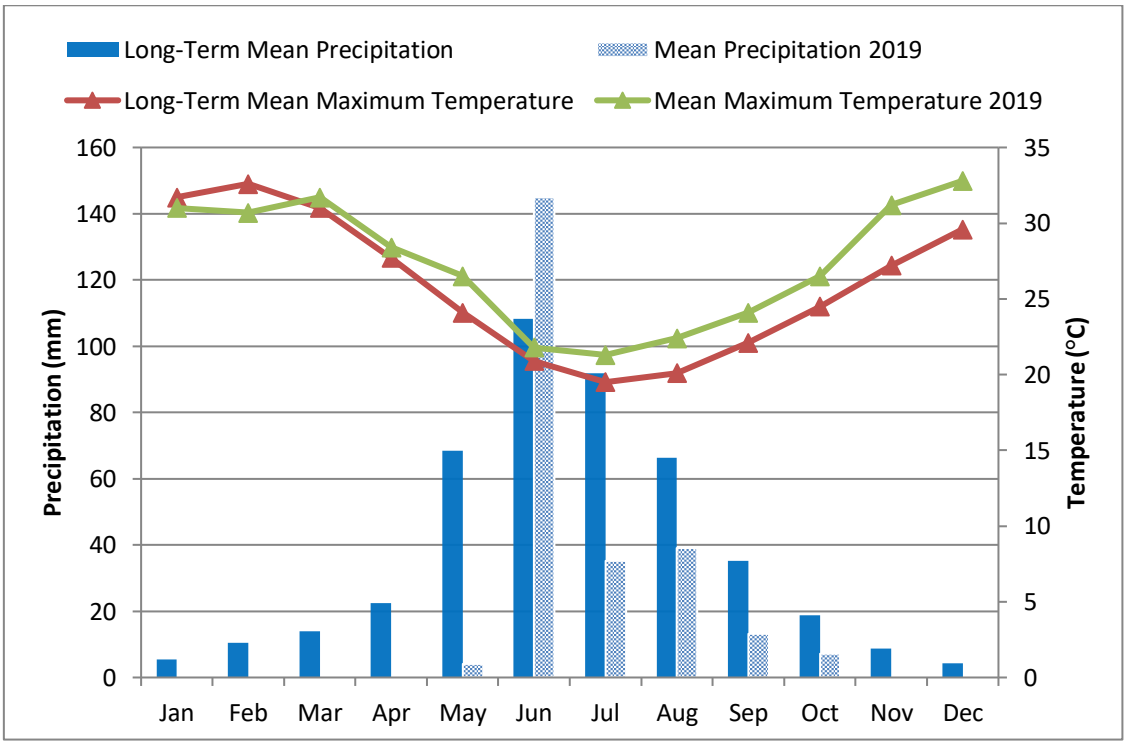


Figure 2: Average Maximum Temperature and Total Precipitation for January – December 2019, and Long-Term Average Monthly Maximum Temperature and Precipitation, for Geraldton (Temperature) and Dongara (Rainfall) (Bureau of Meteorology 2020)

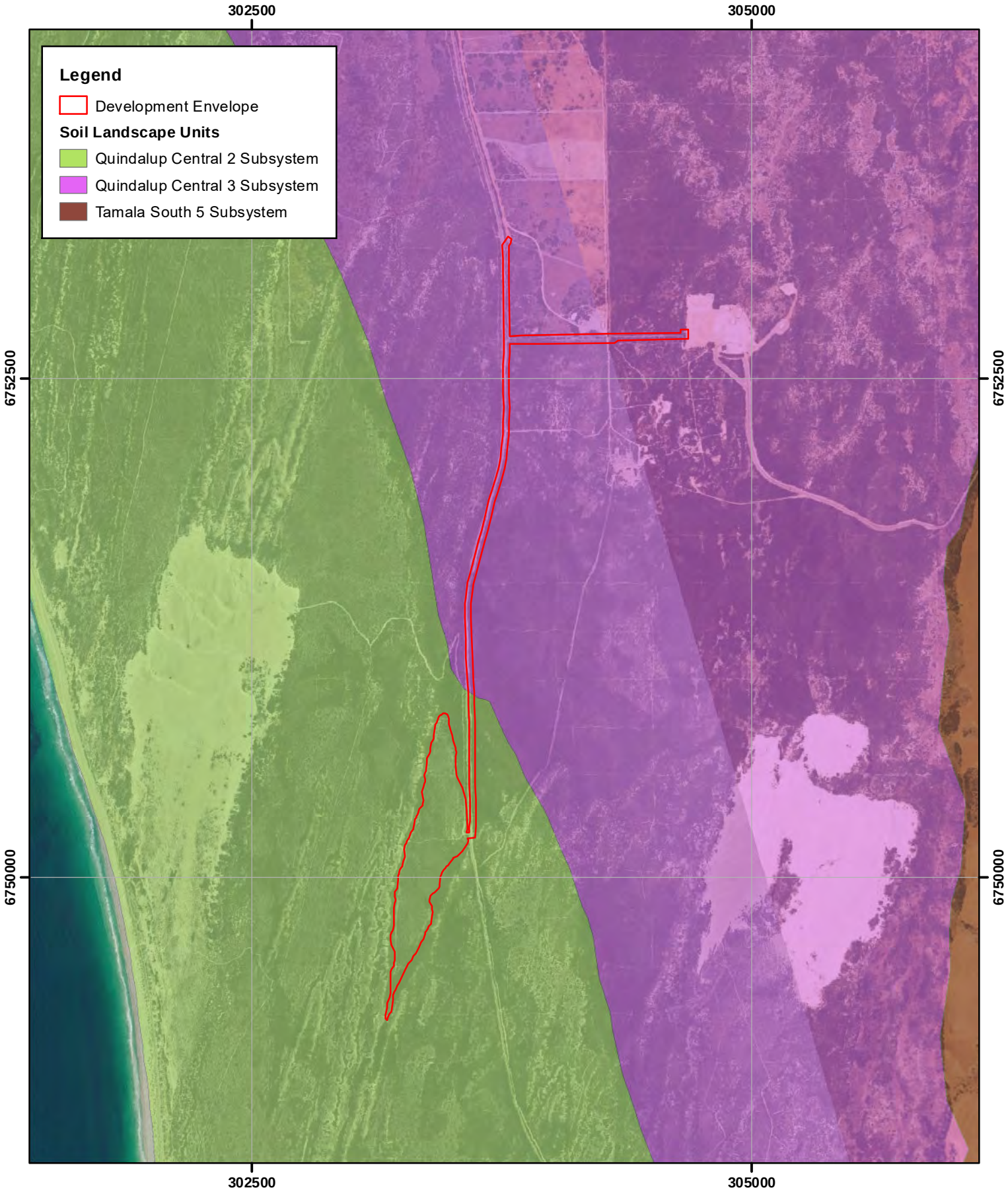
2.2 Geology, Landforms and Soils

The Development Envelope is located in the Northern Sandplains region as defined by Beard (1990); which is broadly equivalent to the Geraldton Sandplains Interim Biogeographic Regionalisation for Australia (IBRA) region (Commonwealth of Australia 2012). The Northern Sandplains region consists of mainly sedimentary basins exposing Permian to Cretaceous sediments and horsts of Proterozoic rocks. Sandplains are covered with leached sandy soils near the coast, and yellow sands with an earthy fabric further inland, both overlying laterite (Beard 1990).

The Development Envelope occurs within the Geraldton Coastal Soil-Landscape Zone of the Greenough Province which consists of dunes with alluvial plains and sand sheets, low hills of Pleistocene Tamala Limestone and recent calcareous and siliceous dunes (Purdie *et al.* 2004). A total of two soil-landscape units are mapped within the Development Envelope as presented in Table 2 and Figure 3 (Department of Primary Industries and Development (DPIRD) (2018)).

Table 2: Soil Landscape Units of the Estate (Department of Primary Industries and Development 2018)

Unit Name	Description
Quindalup Central 2 Subsystem	Coastal dune system, no fixed drainage.
Quindalup Central 3 Subsystem	Coastal dune system, no fixed drainage.

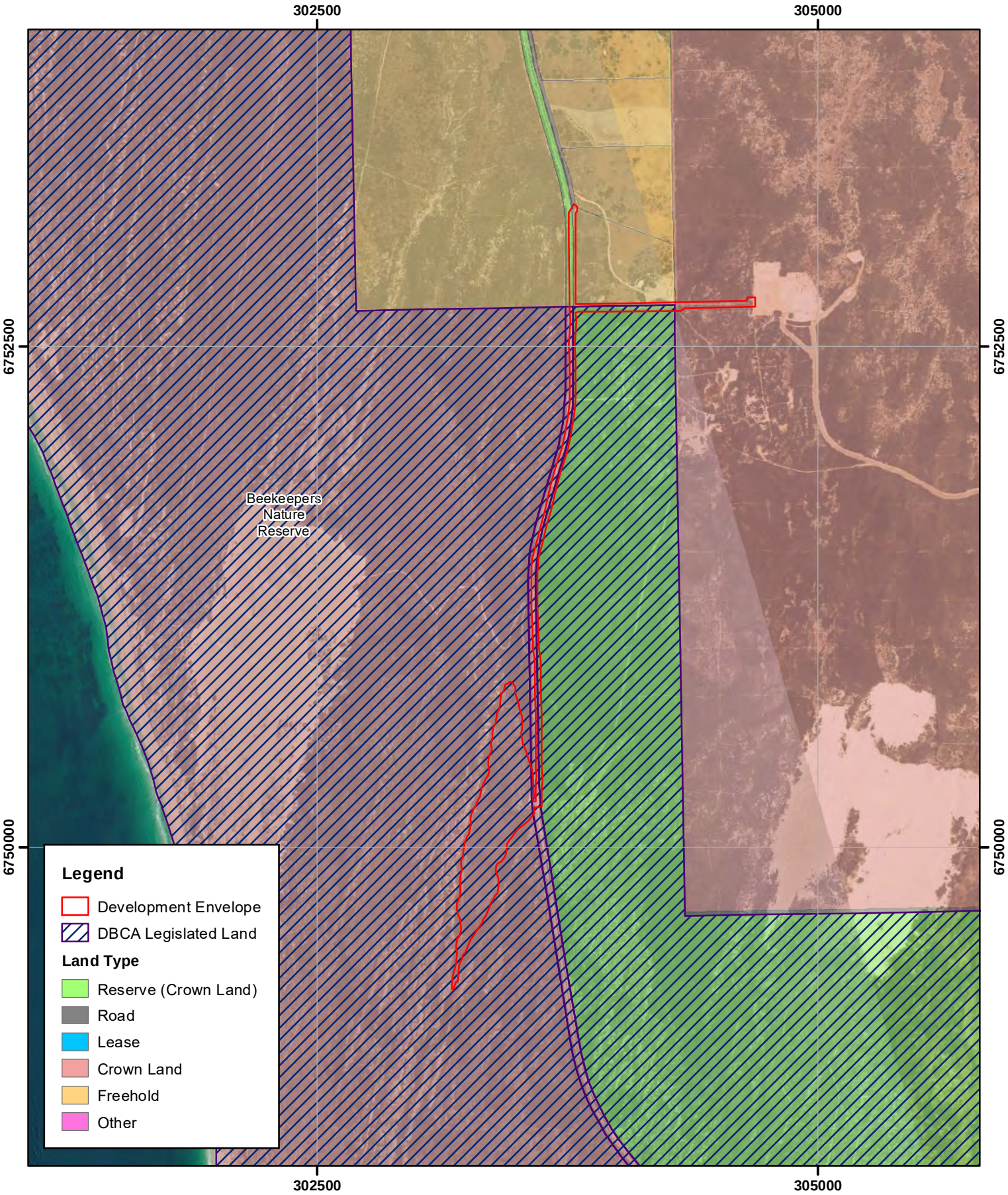


Soil Landscape Units of the Development Envelope	Author: Leah Firth	N
	WEC Ref: Metgasco20-11-01	
WOODMAN ENVIRONMENTAL	Filename: Metgasco20-11-01-f03	**Figure**
	Scale: 1:25,000 (A4)	3
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report Metgasco 20-11-01.	Revision: 2 - 02 July 2020	

2.3 Land Tenure

The majority of the Development Envelope is situated within Beekeepers Nature Reserve as shown on Figure 4. There are also smaller areas of freehold land and crown land.

There are two reserves within the Desktop Study Area (Beekeepers Nature Reserve and Yardanogo Nature Reserve). There are also extensive areas of freehold land and crown land (Figure 4).



Land Tenure of the Development Envelope	Author: Leah Firth	
	WEC Ref: Metgasco20-11-01	
WOODMAN ENVIRONMENTAL	Filename: Metgasco20-11-01-f04	**Figure**
	Scale: 1:25,000 (A4)	4
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report Metgasco 20-11-01.	Revision: 2 - 02 July 2020	

3 METHODS

3.1 Flora and Vegetation

3.1.1 Flora and Vegetation Desktop Study

A review of all publicly available flora and vegetation data relevant to the Desktop Study Area was undertaken during the Desktop Assessment of the Project. This included interrogation of relevant regional databases and other sources as listed in Table 3, as well as obtaining and reviewing copies of reports of previous flora and vegetation surveys undertaken within the vicinity of the Desktop Study Area (where available), including interrogation of the Index of Biodiversity Surveys for Assessments (IBSA) website.

Table 3: Flora and Vegetation Searches Undertaken for the Desktop Study

Source	Search Attributes	Search Purpose
DBCA Threatened and Priority Ecological Communities Database (DBCA 2019d)	Database interrogated using Desktop Study Area boundary	Obtain records of DBCA-classified TECs and/or DBCA-classified PECs within the Desktop Study Area
DBCA TEC and PEC lists (DBCA 2018; DBCA 2019b)	Review of current DBCA TEC and PEC lists	Identify whether there are any DBCA listed TECs or PECs that could occur within the Desktop Study Area
DBCA Significant Flora Databases (WA Herbarium specimen database and Threatened and Priority Flora (TPFL) database) (DBCA 2019c)	Database interrogated using Desktop Study Area boundary	Obtain records of listed significant flora within the Desktop Study Area
Department of the Environment and Energy (DoEE) Species Profile and Threats (SPRAT) Database (interrogated using the Protected Matters Search Tool) (DoEE 2020)	Database interrogated using approximate Desktop Study Area boundary (exact boundary cannot be used)	Identify Matters of National Environmental Significance (MNES), including Threatened flora and TECs, listed under the EPBC Act, that occur or have the potential to occur within the Desktop Study Area
DBCA *NatureMap* (WA Herbarium and TPFL records) (DBCA 2007-)	Database interrogated using approximate Desktop Study Area boundary (exact boundary cannot be used)	Obtain records of listed significant flora and introduced flora within the Desktop Study Area
2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Government of Western Australia 2019)	Development Envelope	Identify extent of Vegetation System Associations within the Development Envelope

3.1.2 Personnel and Licensing

Table 4 lists the personnel involved in both fieldwork and plant identifications for the survey. The Project Manager (Leah Firth) was guided and mentored by Greg Woodman, who has extensive previous experience (> 10 years) in conducting similar flora surveys in the Geraldton Sandplains IBRA region. Plant identifications were undertaken by personnel with extensive previous experience in undertaking plant identifications of flora of the Northern Sandplains. All plant material was collected under the *Flora Taking (Biological Assessment) licences* and *Authorisation to Take or Disturb Threatened Species* pursuant to the *Biodiversity Conservation Act* 2016, sections 40, 274 and 275, as listed in Table 4.

Table 4: Personnel and Licensing Information

Personnel	Flora Collecting Permit (BC Act/WC Act)	Role
Greg Woodman BSc (Environmental Science) (Hons)	FB62000053 TFL19-1819	Project Director
Leah Firth BSc (Conservation Biology)	FB62000055	Project Manager / Field manager
Marlee Starcevich BSc (Environmental Science) (Hons)	FB62000056 TFL26-1819	Field survey
David Coultas BSc (Environmental Biology) (Hons)	FB62000051 TFL23-1819	Plant identifications

3.1.3 Flora and Vegetation Field Survey Methods

The vegetation reconnaissance survey and targeted searching for significant flora was undertaken during one field visit from Monday 24th to Friday 28th February 2020.

The Development Envelope was accessed by vehicle using existing access tracks and via foot transects. A total of four non-permanent flora survey quadrats were established and surveyed within the potential PEC vegetation type (W1) and eleven relevés were established and surveyed within the remaining vegetation types within the Development Envelope. All quadrats measured 10 m x 10 m covering an area of 100 m^2. The quadrat size used is the indicative size for flora and vegetation surveys in the Geraldton Sandplains Bioregion, as outlined in Table 1 of the Technical Guidance for Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a). A minimum of three relevés were assessed in each vegetation type (except W1, which was assessed with quadrats), with data collected from an area of approximately 10 m radius around a central point.

All vascular flora taxa that were visually identifiable within each quadrat were recorded, with only dominant taxa recorded in relevés. At least one reference specimen of most taxa encountered (excluding common, distinctive taxa) was collected for verification and identification purposes. The following information was recorded at each quadrat and relevé:

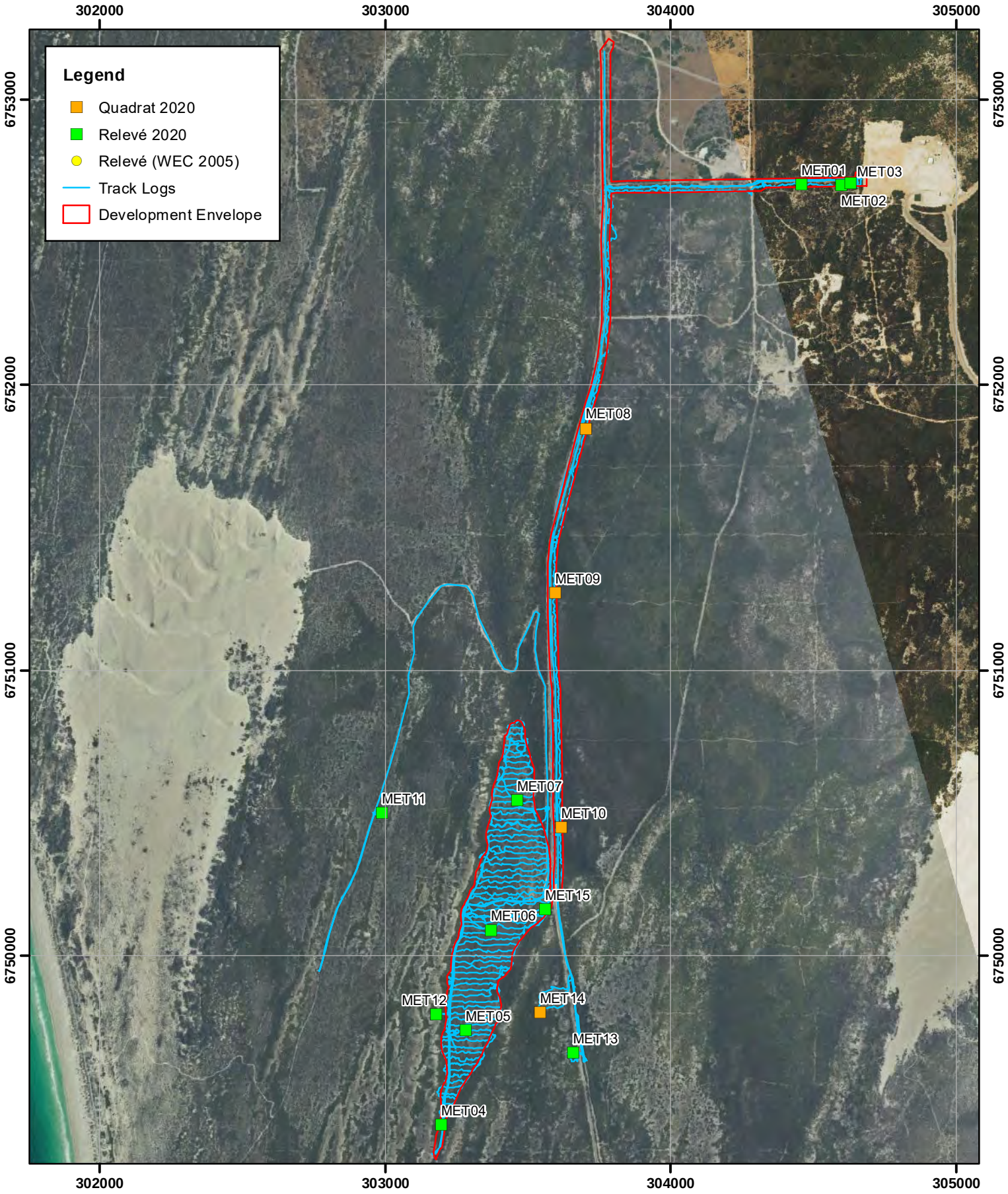
- Personnel;
- Unique quadrat / relevé number;
- Date of survey;
- GPS (Global Positioning System) coordinates at start corner of quadrat or at centre of relevé;
- Site photograph/s, taken diagonally into quadrat from start corner or to all four directions of the compass for relevés;
- Compass bearing for two sides of quadrat that commence at start corner of quadrat;
- Topography (including landform type and aspect);
- Soil colour and type (including the presence of any rock outcropping and surface stones);
- Vegetation condition (EPA 2016a; scale presented in Section 3.1.6);
- Approximate time since fire;
- Presence and type of disturbance (if any);

- Percentage foliage cover (for each vascular plant taxon, including cover within the quadrat of individuals rooted outside of the quadrat);
- Height (m) (average for each taxon, excluding climbers/aerial shrubs);
- Total percentage foliage cover (quadrats only);
- Percentage vegetation litter and bare soil cover (quadrats only); and
- Additional flora taxa present immediately outside of the quadrat.

Notes on vegetation pattern boundaries and distribution were also recorded while traversing the Development Envelope, including a GPS location at the point where the notes were taken, a brief description of the vegetation including dominant and characteristic taxa, and a photograph. These notes were used to confirm previous mapping of polygons of vegetation patterns and to make minor alterations to boundaries where required.

Targeted survey for significant flora taxa was undertaken, with a list of significant flora taxa likely to be encountered compiled as part of the desktop study (section 5.1.8). The entire Development Envelope was transected on foot, at 20 m intervals. If populations of known significant flora taxa were identified, a representative collection of material was made, and the abundance and spatial distribution of individuals within each population was recorded using a standard Garmin GPS for priority and listed Threatened taxa.

Traverses in the Development Envelope are mapped as track logs on Figure 5 along with quadrat and relevé locations. Please note that relevé locations from Woodman Environmental (2005) are also displayed on Figure 5.



GPS Track Logs, Releve and Quadrat Locations	Author: Leah Firth	
	WEC Ref: Metgasco20-11-01	
WOODMAN ENVIRONMENTAL	Filename: Metgasco20-11-01-f05.mxd	**Figure**
	Scale: 1:17,500 (A4)	5
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report Metgasco 20-11.	Revision: 2 - 1st April 2020	

3.1.4 Plant Collection and Identification

Specimens of any unknown taxa that were collected were pressed for later identification at the WA Herbarium. External experts of particular families or genera were consulted for any specimens considered to be difficult to identify or of taxonomic interest.

Taxon nomenclature generally follows *FloraBase* (WA Herbarium 1998-) with all names checked against the current DBCA Max database to ensure their validity. However, in cases where names of plant taxa have been published recently in scientific literature but have not yet been adopted on *FloraBase* due to time constraints (WA Herbarium 1998-), nomenclature in the published literature is followed. The conservation status of each taxon was checked against *FloraBase*, which provides the most up-to-date information regarding the conservation status of flora taxa in Western Australia.

Specimens of interest, including significant flora taxa, range extensions of taxa and potential new taxa, will be sent to the WA Herbarium for consideration for vouchering as soon as practicable. However, this process is via donation, and the WA Herbarium may not voucher all specimens, in accordance with its own requirements. The specimen vouchering will be supported by completed Threatened and Priority Flora Report Forms submitted to DBCA (Species and Communities Branch) in the case of listed significant flora (e.g. Threatened and Priority flora taxa).

3.1.5 Vegetation Unit Definition, Mapping and Description

The vegetation within the Development Envelope was originally mapped during the *Denison 3D Seismic Survey Flora and Vegetation Study* (Woodman Environmental 2005), a Level 2 survey (EPA 2004), conducted in August-September 2004, prepared to inform a Public Environmental Review (PER). Although flora and vegetation surveys and survey reporting included in that assessment were not subject to as stringent guidelines as are currently required under the EPA Technical Guidance (EPA 2016a), the results are considered both reliable and relatively comprehensive, based on data collected through relevés (rather than quadrats) and extensive field verification.

Woodman Environmental (2005) assessed a total of 257 detailed recording sites (relevés) throughout the Denison 3D study area, with the following information recorded within a 20 m radius:

- Site location (including GPS co-ordinates)
- Soil type and presence of outcropping
- Position of site in the landscape
- Site condition, including fire history and presence of any disturbance
- Height and cover of any tree species present
- Height and cover of dominant vascular understorey plant species present
- Presence of any other vascular plant species

The results of the detailed site recordings, combined with additional foot traverses through the Denison 3D study area, were used to produce final map boundaries and community descriptions (Woodman 2005). The Muir (1977) classification of vegetation structure was

used to describe the plant communities, typical of the majority of historical vegetation studies in the region in 2004.

Constraints in relation to the use of the data presented in Woodman Environmental (2005) included the use of detailed recording sites (relevés) to collect data relevant to vegetation, in conjunction with the age of the data (data collected in 2004). The data collected at the time was consistent with what would be considered to be a Level 2 survey (EPA 2004a); however, would be considered a Reconnaissance survey as per section 4.1 of EPA (2016a).

The reconnaissance survey conducted in February 2020 collected further information from additional quadrats, relevés and transects within the Development Envelope. The locations of quadrats and/or relevés within each vegetation type (VT) were used in conjunction with aerial photograph interpretation and field notes taken during survey to confirm the presence and extent of these VT mapping polygon boundaries. The original VT mapping polygon boundaries were then updated where necessary using Geographic Information System (GIS) software.

Vegetation type descriptions have been updated to align with the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 6.0 (Executive Steering Committee for Australian Vegetation Information (ESCAVI) 2003), as stipulated by EPA (2016a). This model follows nationally-agreed guidelines to describe and represent VTs, so that comparable and consistent data are produced nation-wide.

3.1.6 Vegetation Condition

Vegetation condition within the Development Envelope is described using the vegetation condition scale presented in EPA (2016a) as presented in Table 5.

Table 5: Vegetation Condition Scale for the South-West and Interzone Botanical Provinces (EPA 2016a)

Condition Ranking	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.

Condition Ranking	Description
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

3.1.7 Significant Flora and Vegetation

3.1.7.1 Significant Flora

As per EPA (2016b), flora taxa may be significant for a range of reasons, including, but not limited to the following:

- Being identified as a Threatened or Priority species (formally listed significant taxa – includes taxa listed under both State and Commonwealth legislation, and classified as Priority by DBCA);
- Locally endemic or associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems);
- New species or species with anomalous features that indicate a potential new species;
- Representative of the range of a species (particularly at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- Unusual species, including restricted subspecies, varieties or naturally occurring hybrids; and
- Relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

Significant taxa recorded within the Development Envelope are discussed in Section 5.1.4 with reference to the above categories.

3.1.7.2 Introduced Flora

Introduced flora for the purposes of this report are defined as those which are not native to Western Australia. Some flora species which are native to Western Australia but not endemic to the area in question can also be classified as weeds, as they behave in an invasive manner which outside their natural environment. Weeds which are listed as Weeds of National Significance (WoNS) or otherwise listed as Declared Pests under the *Biosecurity and Agricultural Management Act 2016* (BAM Act) for the region in which the study area is located are identified as such in this report.

3.1.7.3 Significant Vegetation

As per EPA (2016b), vegetation may be significant for a range of reasons, including, but not limited to the following:

- Being identified as a TEC or PEC (formally listed significant vegetation – includes vegetation listed under Commonwealth legislation, endorsed as a TEC by the Western Australian Government, or classified as a PEC by DBCA);
- Having restricted distribution;
- Degree of historical impact from threatened processes;
- A role as a refuge; and

- Providing an important function required to maintain ecological integrity of a significant ecosystem.

Significant vegetation recorded within the Desktop Study Area are discussed in Section 5.1.6 with reference to the above categories.

3.2 Fauna

3.2.1 Fauna Desktop Study

Information on the fauna assemblage of the Development Envelope was drawn from a wide range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the Atlas of Living Australia (ALA), the WA Department of Biodiversity, Conservation and Attractions (DBCA) NatureMap (incorporating the Western Australian Museum's FaunaBase and the DBCA Threatened and Priority Fauna Database), BirdLife Australia's Birdata (Atlas) Database (BA), the EPBC Protected Matters Search Tool and the Bamford Consulting Ecologists (BCE) Database (Table 6).

Information from the above sources was supplemented with species expected in the area based on general patterns of distribution and extensive studies conducted by BCE in the region. Sources of information used for these general patterns were:

- Frogs: Tyler *et al.* (2000);
- Reptiles: Storr *et al.* (1983); Storr *et al*. (1990); Storr *et al*. (1999); Storr *et al.* (2002) and Wilson & Swan (2008);
- Birds: Blakers *et al*. (1984); Johnstone and Storr (1998, 2004) and Barrett *et al.* (2003); and
- Mammals: Menkhorst and Knight (2001); Churchill (2008); and Van Dyck and Strahan (2008).

Table 6: Sources of Information Used for the Fauna Desktop Assessment

Database	Type of records held on database	Area searched
Atlas of Living Australia (ALA 2020)	Records provided by collecting institutions, individual collectors and community groups	29°21'45"S, 114°58'14"E – plus 20 km buffer
NatureMap (DBCA 2007-)	Records in the WAM and DPaW databases. Includes historical data and records on Threatened and Priority species in WA.	29°21'45"S, 114°58'14"E – plus 20 km buffer
BirdLife Australia Atlas Database (Birdlife Australia 2020)	Records of bird observations in Australia, 1998-2020.	Species list for one-degree cell containing: 29°21'45"S, 114°58'14"E
EPBC Protected Matters (DoEE 2020)	Records on matters of national environmental significance protected under the EPBC Act.	29°21'45"S, 114°58'14"E – plus 20 km buffer

3.2.2 Previous Fauna Surveys

Bamford Consulting Ecologists (BCE) has conducted multiple Level 1 and Level 2 fauna assessments and surveys throughout the region, and there have been studies by other consultants in the region, particularly for the Eneabba mineral sands mine to the south. Species records from these studies are contained in the NatureMap database which was

consulted as part of the desktop assessment. In addition, BCE maintains a detailed database and annotated species lists for all its previous assessment (some of which pre-date NatureMap) and these were consulted for reference as part of the desktop assessment. The main relevant studies which are referred to in this report are:

- Fauna assessment of Waitsia Wells (Bamford *et al.* 2015); located 10 km east of Development Envelope.
- Fauna assessment of Arrowsmith North (Bamford *et al.* 2019a) and Arrowsmith Central (Bamford *et al.* 2019b); located 16 km southeast of Development Envelope.
- Fauna assessment of Tiwest's Dongara project (Metcalf and Bamford 2011); located 17 km southeast of Development Envelope.

Other previous reports consulted for background information include Harris *et al.* (2008), Metcalf and Bamford (2008), Bamford (2009), Bamford (2012), Everard and Bamford (2014) and Bamford and Chuk (2017).

3.2.3 Fauna Field Survey Methods

An inspection of the Development Envelope was conducted on the 22nd February 2020 by:

- Dr Wes Bancroft BSc (Zoology/Microbiology), Hons (Zoology), PhD (Zoology); and
- Mr Andrew Moore BSc (Botany/Geography), BApSc (Environmental Studies), MSc (Renewable Energy).

The aims of this inspection were to:

- provide further detail on the potential use of the site by black-cockatoos listed under state and federal environmental legislation (the *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Biodiversity Conservation Act 2016*).
- to verify the accuracy of the desktop study;
- to further delineate and characterise the fauna and faunal assemblages present in the survey area; and
- to assist in the identification of potential impacts.

The survey area was visited by suitably qualified personnel to undertake selective, low intensity sampling of the fauna and faunal assemblages, and to supplement habitat descriptions and habitat mapping with field observations. Wes Bancroft has over 23 years of experience in field surveys for environmental impact assessment (including more than 14 years of experience in black-cockatoo assessment). Andrew Moore has over 10 years of experience in field surveys for environmental impact assessment (including black-cockatoo assessments throughout that period).

The Department of Agriculture, Water and the Environment (DAWE; formerly the Department of the Environment and Energy and the Department of Sustainability, Environment, Water, Population and Communities) provides guidelines for the referral of actions that may result in impact to black-cockatoos. The survey and analysis reported here have been conducted with strong reference to both the existing guidelines (DSEWPaC 2012a) as well as the recently revised draft guidelines (DEE 2017). In addition, survey methodology followed the recommendations listed on the DAWE's Species Profile and Threats Database (DAWE 2020).

Ecological values for black-cockatoos within the site were based on the definitions of breeding, foraging and roosting habitat as per the EPBC Act referral guidelines for black-cockatoos (DSEWPaC, 2012), with foraging and nesting values assessed using systems developed by Bamford Consulting.

Field methods are expanded below.

3.2.3.1 Breeding Tree Assessment

The aim of the breeding survey was to record all potential hollow-bearing trees (suitable for black-cockatoo nesting) within the survey area. The entire Development Envelope (Figure 1) was examined for the presence of these trees. The following information was recorded for every tree considered suitable for black-cockatoo nesting with a diameter at breast height (DBH) equal to or greater than 500 mm (or 300 mm for Salmon Gum and Wandoo):

- tree location;
- tree species;
- life status;
- DBH; and
- nest-tree rank: trees were assessed (from the ground) for the potential presence/quality of nest-hollows and allocated a nesting rank (developed by BCE) as described in Table 7.

BCE has also developed a tree measurement protocol, based on Federal guidelines, and this is outlined in Appendix A.

Table 7: Ranking System for the Assessment of Potential Nesting-Trees for Black-Cockatoos.

Rank	Description of tree and hollows/activity
1	Active nest observed; adult (or immature) bird seen entering or emerging from hollow.
2	Hollow of suitable size and angle (i.e. near-vertical) visible with chew marks around entrance.
3	Potentially suitable hollow visible but no chew marks present; or potentially suitable hollow present (as suggested by structure of tree, such as large, vertical trunk broken off at a height of >10m).
4	Tree with large hollows or broken branches that might contain large hollows but hollows or potential hollows are not vertical or near-vertical; thus a tree with or likely to have hollows of sufficient size but not to have hollows of the angle preferred by black-cockatoos.
5	Tree lacking large hollows or broken branches that might have large hollows; a tree with more or less intact branches and a spreading crown.
x	Where a hollow that is (otherwise) potentially suitable for black-cockatoo nesting has been colonised by feral Honey Bees (*Apis mellifera*), and therefore rendered unusable, the nest-tree rank is preceded by 'x' (e.g. x2, x3, x4). Note that hollows can be abandoned by Bees and will then be again available to black-cockatoos.

Note: As per DAWE (2020) guidance, a potential nest-tree is any tree with a diameter at breast height >500 mm (or >300 mm for *Eucalyptus salmonophloia* and *E. wandoo*).

3.2.3.2 Foraging Habitat Assessment

For foraging value for black-cockatoos, the site was assessed by inspecting the vegetation and calculating a foraging score as outlined in Appendix B. The foraging score provides a numerical value that reflects the significance of vegetation as foraging habitat for black-cockatoos, and this numerical value is designed to provide the sort of information needed by the Federal DAWE to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area, and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed in Appendix B. These three components are drawn from the DEE offset calculator but with the scoring approach developed by BCE:

- A score out of six for the vegetation composition, condition and structure.
- A score out of three for the context of the site.
- A score out of one for species density.

Foraging value can thus be assigned a score out of six, based upon site vegetation characteristics, or a score out of 10 if context and species density are also considered. The score out of 10 is calculated only for vegetation of at least Low to Moderate foraging value (vegetation characteristics score of ≥3). Vegetation with No, Negligible or Low foraging value is effectively assigned context and species density scores of '0' because the context and species density are of little relevance if the vegetation does not support regular foraging by the birds. Foraging value scores are calculated differently for the three black-cockatoo species (Appendix B) depending upon the vegetation present, but only Carnaby's Black-Cockatoo is expected in the survey area.

3.2.3.3 Roosting Habitat Assessment

Vegetation was assessed for roosting habitat potential based on tree species present and on the occurrence of local confirmed or potential roosting sites (based upon records from the Great Cocky Count (Peck et al. 2019).

3.2.3.4 Opportunistic Observations

Opportunistic observations were recorded at all times when conducting field investigations. These may include casual observations of fauna, records of road-killed animals or indirect evidence of fauna (e.g. scats, tracks, diggings or foraging evidence). Observations were made along all existing tracks within the survey area. Figures 6 and 7 show the route followed during the field inspection.

3.2.4 Fauna Taxonomy and Nomenclature

As per the recommendations of EPA (2016c), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) Checklist of the Fauna of Western Australia (2017). The authorities used for each vertebrate group were:

- Amphibians (Doughty *et al.* 2016a), reptiles (Doughty *et al*. 2016b);
- Birds (Johnstone and Darnell 2016); and
- Mammals (Travouillon 2016).

In some cases, more widely recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place

(e.g. the BirdLife Australia working list of names for Australian Birds). English names of species where available are used throughout the text; Latin species names are presented with corresponding English names in tables in the appendices.

3.2.5 Interpretation of Fauna Species Lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from environments not represented in the Development Envelope. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the environment within the Development Envelope, meant that it was highly unlikely that these species would be present. Some are also known to be regionally extinct. In general, however, species returned by the desktop review process are considered to be potentially present in the Development Envelope whether or not they were recorded during field surveys, and whether or not the Development Envelope is likely to be important for them. This is because fauna are highly mobile, often seasonal and frequently cryptic. This is particularly important for significant species that are often rare and hard to find.

Interpretation of species lists generated through the desktop review included assigning an expected status within the Development Envelope to species of conservation significance. This is particularly important for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive. The status categories used are:

- Resident: species with a population permanently present in the Development Envelope;
- Regular migrant or visitor: species that occur within the Development Envelope regularly in at least moderate numbers, such as part of annual cycle;
- Irregular Visitor: species that occur within the Development Envelope irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the Development Envelope in at least moderate numbers and for some time;
- Vagrant: species that occur within the Development Envelope unpredictably, in small numbers and/or for very brief periods. Therefore, the Development Envelope is unlikely to be of importance for the species; and
- Locally extinct: species that has not been recently recorded in the local area and therefore is almost certainly no longer present in the Development Envelope.

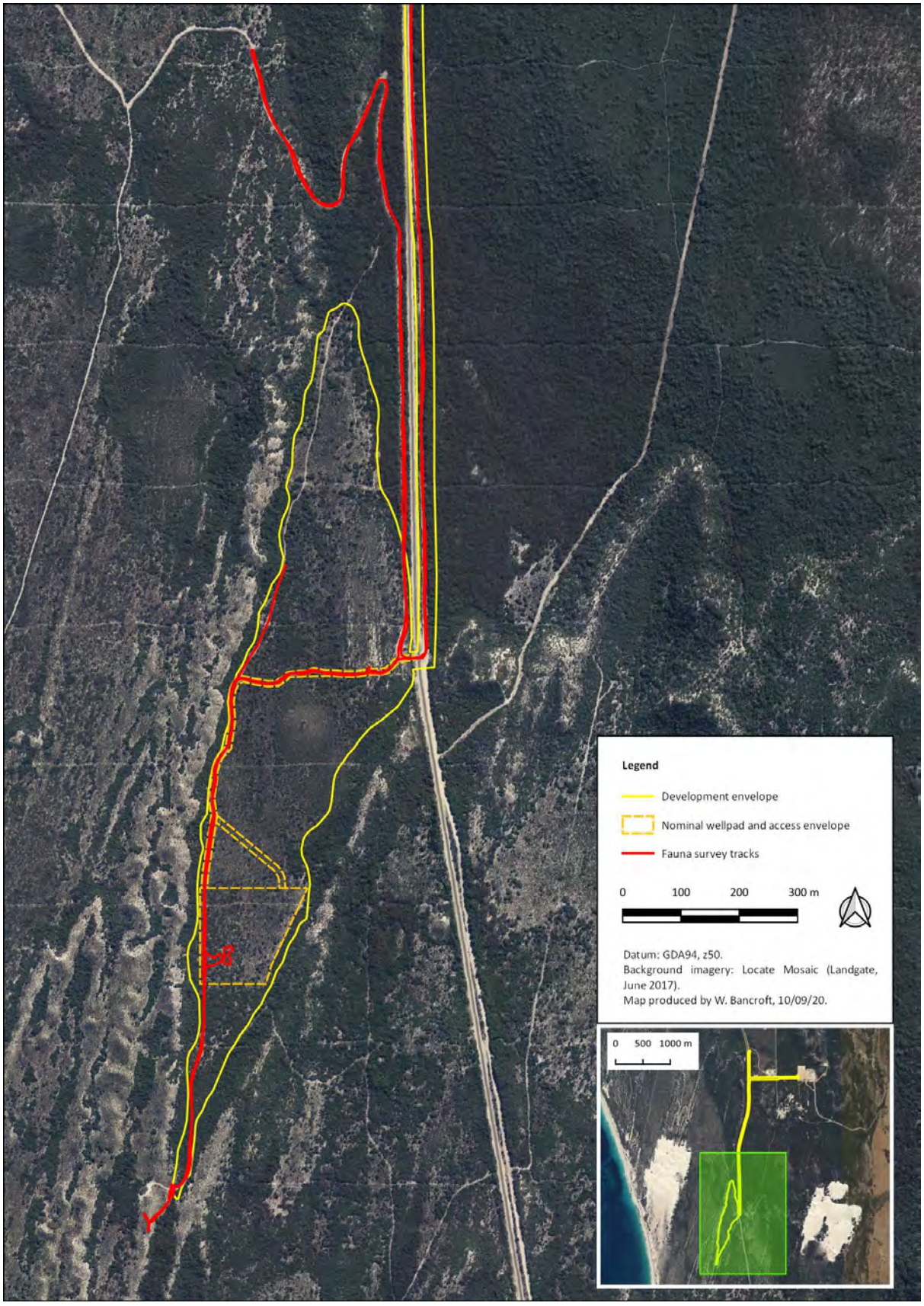


Figure 6: Route Followed during Site Inspection in the southern project area

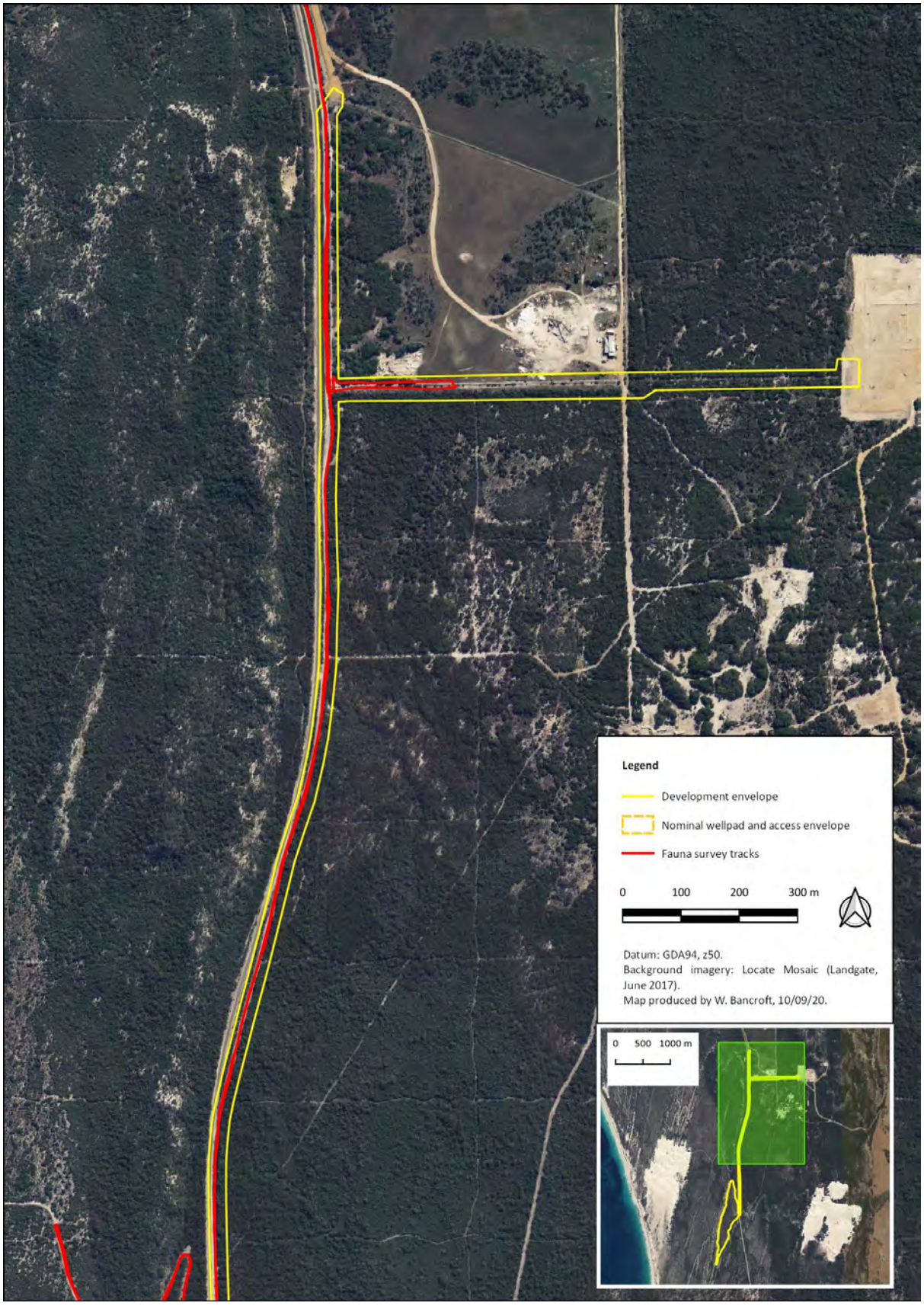


Figure 7: Route Followed during Site Inspection in the northern project area

4 LIMITATIONS

4.1 Flora and Vegetation

Table 8 presents the limitations of the flora and vegetation survey of the Development Envelope in accordance with EPA (2016a), as applicable to Reconnaissance and Targeted Survey.

Table 8: Flora and Vegetation Survey Table of Limitations

Limitation	Limitation of Survey	Comment
Effort and Extent	No	Reconnaissance survey (as defined in section 4.1 of EPA (2016a)) was undertaken across the entire Development Envelope. A Reconnaissance survey was deemed adequate to place the background (desktop) vegetation information into context; the vegetation of the general location of the Study Area is generally well-known and well-surveyed, although historical data is relatively old (2004). Multiple relevés were established in each vegetation pattern identified through a combination of aerial photography interpretation and historical mapping polygons within the Development Envelope. Transects were also walked through historical mapping boundaries to confirm these boundaries. Targeted Survey (as defined in Section 4.2 of EPA (2016a)) to confirm the presence of the potential PEC (Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora* (Geraldton area) was undertaken in the Development Envelope where relevant (vegetation type W1). Quadrat data was collected in these areas to ensure confirmation of the presence or absence of the PEC. Targeted survey (as defined in section 4.2 of EPA (2016a)) was conducted for significant flora taxa, based on the results of the flora desktop review. A Targeted survey was considered appropriate as no survey for significant flora taxa has previously been undertaken within the Development Envelope. During the Targeted Survey the Development Envelope was searched on foot in their entirety, with transects generally undertaken at 20 m intervals. A 20 m interval was considered to be adequate to provide appropriate data on the distribution of significant flora taxa within the survey area. Due to the intensity of survey method used the numbers of individuals presented are considered to be an accurate estimate of the numbers of individuals actually present. No constraints prevented appropriate sampling techniques (quadrat establishment, foot transects) being employed. Relative ease of access within the Development Envelope enabled detailed vegetation type and condition mapping to be undertaken throughout the Development Envelope via foot and vehicle transects. Mapping reliability is therefore considered to be high.

Limitation	Limitation of Survey	Comment
Competency /experience of the team carrying out the survey	No	At least one of the field team members has had previous experience (>3 years) in conducting similar assessments on the Geraldton Sandplains, with the project director providing supervision and guidance throughout the project. Personnel conducting plant identifications have had >10 years' experience in plant identification in the Geraldton Sandplains. Relevant experts at the WA Herbarium were consulted regarding taxonomic identifications where required. The experience and competency of personnel is therefore not considered to be a limitation of the survey.
Proportion of flora identified, recorded and/or collected	Minor	A full census of flora within quadrats in vegetation type W1 was undertaken to confirm the presence and extent of the potential PEC. Only dominant species were recorded within relevés in other vegetation types, as this data was considered suitable to allow confirmation of previous vegetation type mapping.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	No	Reasonable contextual information for the Development Envelope was available prior to the survey. Sources of information used included government databases (DBCA), which are known to have been extensively populated with data from numerous surveys conducted in the general vicinity of the Development Envelope, as well as numerous general sources pertaining to the climate, geomorphology, flora and vegetation of the Geraldton Sandplains. Several surveys have been conducted in the local area, including one vegetation mapping survey that completely overlapped the Development Envelope. That survey was conducted in 2004 and therefore was 16 years old at time of the Desktop Review. However,
Age of data	No	The majority of the flora and vegetation data is over 15 years old (Woodman 2005). Supplementary data was collected in 2020 to confirm the presence and extent of this historical vegetation mapping data. In addition to this the entire area was searched for conservation significant flora in 2020. The recent survey results have confirmed the accuracy of the historical survey data and therefore the age of the data does not appear to be a limitation.
Timing/weather/season/cycle	Minor	Although the survey was not conducted within what is considered to be the most appropriate season for survey in the Geraldton Sandplains bioregion (spring), dominant taxa were able to be identified to allow for examination and verification of the vegetation type mapping previously undertaken within the Development Envelope. Rainfall received in 2019 was significantly below the long-term average, which may have reduced the number of annual taxa identifiable during the survey, however annual taxa are not utilised for vegetation mapping analysis and therefore is not considered a limitation. Conservation significant flora taxa identified as potentially occurring within the Development Envelope through Desktop Study prior to the field survey are all perennial taxa and could be identified during the field timing of the targeted survey.

Limitation	Limitation of Survey	Comment
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey	No	The vegetation in the Development Envelope is mostly in excellent condition due to its protection within the Beekeepers Nature Reserve. Small areas of disturbance along vehicle tracks have not impacted on the results of the survey, or the ability to define vegetation types or search for significant flora taxa.
Remoteness and/or access problems	No	The Development Envelope was accessed either via the roads, tracks or on foot. There was no impediment to access of the entire Development Envelope.

4.2 Fauna

Various factors can limit the effectiveness of a fauna survey. Pursuant to the "Technical Guidance - Terrestrial Fauna Surveys" (EPA 2016c), these factors have been identified and their potential to impact on the effectiveness of the surveys has been assessed in Table 9 below. All fauna surveys have limitations, and not all fauna species present on a site are likely to be sampled during a survey. Fauna may not be recorded because they are rare, they are difficult to trap or observe, or because they are only present on the site for part of the year.

Table 9: Fauna Survey Table of Limitations

Limitation	Limitation of Survey	Comment
Competency /experience of the team carrying out the survey	No	Ecologists have extensive experience in conducting desktop reviews and reconnaissance surveys for environmental impact assessment fauna studies, and have undertaken a number of studies within the immediate region.
Proportion of fauna identified, recorded and/or collected.	No	All fauna observed were identified. Although, except for birds, only a small proportion of the fauna were recorded, the purpose of a level 1 survey is to place the results of the desktop study in context, not to inventory all vertebrate fauna.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	No	Abundant information from databases and previous studies. Fauna surveys have been undertaken for other developments in the region, and the records are available on the Fauna Survey Returns Database, as accessed through NatureMap (DBCA 2018).
Timing/weather/season/cycle	No	Level 1 surveys and targeted surveys for habitat and secondary signs may be undertaken at any time of the year.
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey	No	No disturbances noted during the field survey.
Intensity (in retrospect, was the intensity adequate)	No	Sufficient time was allowed to survey all habitats within the Development Envelope.
Completeness (e.g. was relevant area fully surveyed)	No	Good coverage over entire Development Envelope with every habitat surveyed.
Resources (e.g. degree of expertise available in animal identification to taxon level)	No	No taxonomic issues were encountered.
Remoteness and/or access problems	No	Entire Development Envelope accessible on foot.

Limitation	Limitation of Survey	Comment
Availability of contextual (e.g. biogeographic) information on the region	No	The NatureMap database provides context for surveys in this bioregion. The fauna of the Geraldton Sandplains are relatively well known.

5 DESKTOP STUDY RESULTS

5.1 Flora and Vegetation

5.1.1 Regional Flora

The interrogation of the DBCA WA Herbarium specimen database and TPFL database (DBCA 2019c) returned a total of 13 significant vascular flora taxa that have records within the Desktop Study Area, all of which are priority listed taxa. These are presented in Table 10. None of the records returned occur within the Development Envelope.

A search of these databases using *NatureMap* (DBCA 2007-) was also undertaken as part of the Desktop Study to check for any recently added records and to confirm the records returned from the DBCA WA Herbarium specimen database and TPFL database search. As per Table 3, the database was interrogated using the approximate Desktop Study Area boundary. The *NatureMap* search did not return any additional significant flora taxa. Appendix C presents conservation codes for Western Australia flora (DBCA 2019a).

Table 10: Significant Flora Returned from DBCA Database Searches

Taxon	Status	Source*
Acacia telmica	P3	DBCA; NatureMap
Anthocercis intricata	P3	DBCA; NatureMap
Baeckea sp. Walkaway (A.S. George 11249)	P3	DBCA; NatureMap
Beyeria gardneri	P3	DBCA; NatureMap
Dampiera tephrea	P2	DBCA; NatureMap
Eucalyptus ebbanoensis subsp. *photina*	P4	DBCA; NatureMap
Eucalyptus zopherophloia	P4	DBCA; NatureMap
Haloragis foliosa	P3	DBCA; NatureMap
Liparophyllum congestiflorum	P4	DBCA; NatureMap
Scholtzia calcicola	P2	DBCA; NatureMap
Stawellia dimorphantha	P4	DBCA; NatureMap
Stylidium sp. Three Springs (J.A. Wege & C. Wilkins JAW 600)	P2	DBCA; NatureMap
Thryptomene sp. Lancelin (M.E. Trudgen 14000)	P3	DBCA; NatureMap

*Sources are:
DBCA – DBCA WA Herbarium and TPFL Databases (2019c);
NatureMap – (DBCA 2007-).

The search of Department of the Environment and Energy (DoEE) Species Profile and Threats (SPRAT) Database was undertaken to identify Matters of National Environmental Significance (MNES), including Threatened flora taxa. The search returned six flora taxa listed as Threatened Species, or habitat for Threatened Species, that are likely to occur in the Desktop Study Area as listed below:

- *Caladenia hoffmanii* (Endangered);
- *Conostylis dielsii* subsp. *teres* (Endangered);
- *Conostylis micrantha* (Endangered);
- *Eucalyptus impensa* (Endangered);
- *Tetratheca nephelioides* (Critically Endangered); and
- *Wurmbea tubulosa* (Endangered).

The search of the DoEE database also identified five significant invasive introduced flora taxa, or habitat for these taxa, as likely to occur within the Desktop Study Area as listed below:

- *Asparagus asparagoides*;
- *Cenchrus ciliaris*;
- *Lantana camara*;
- *Lycium ferocissimum*; and
- *Tamarix aphylla.*

The full results of the DoEE database search are presented in Appendix D.

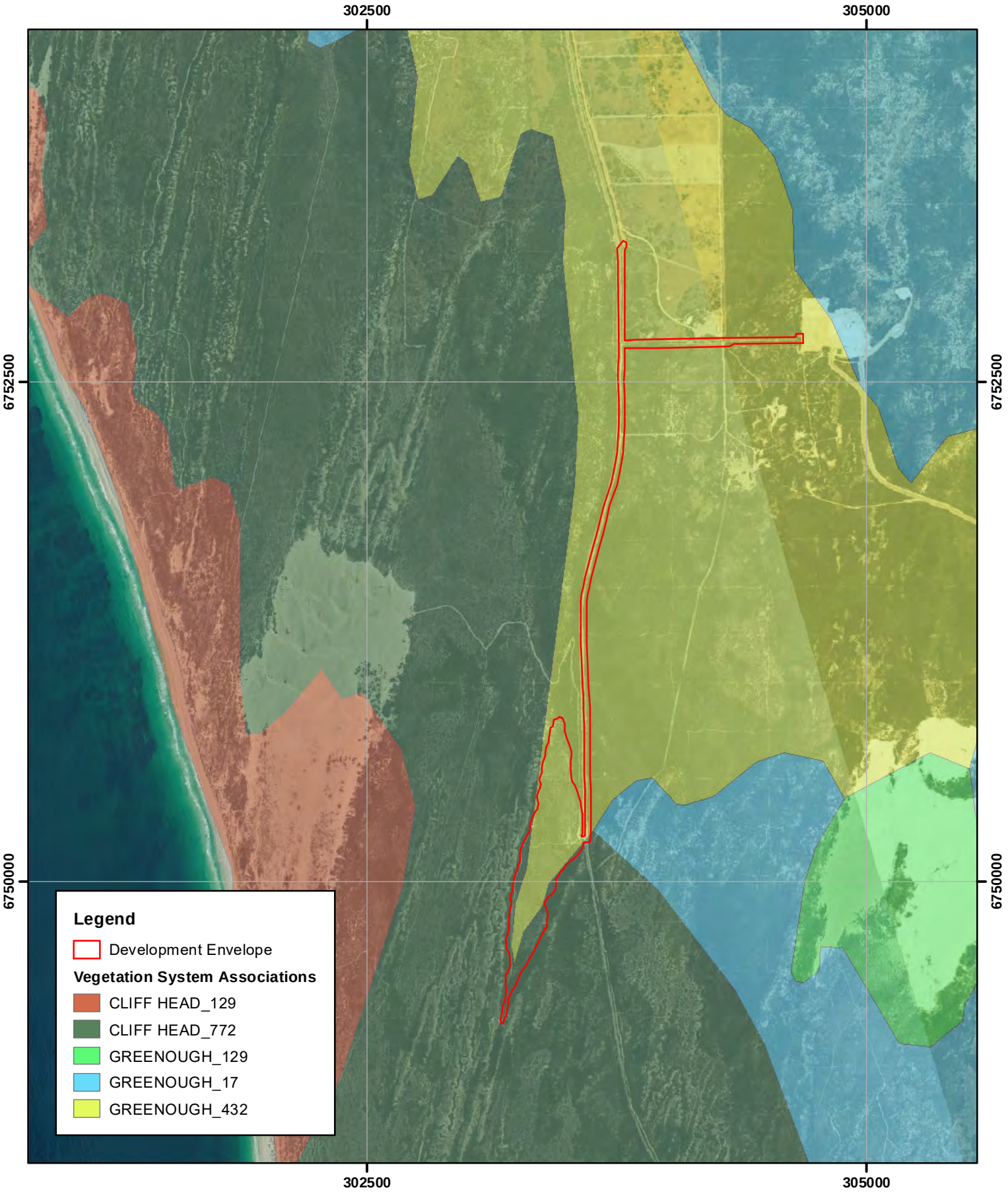
A search of the WA Herbarium specimen database for records of introduced taxa within the Desktop Study Area was performed using *NatureMap* as per Section 3.1.1. A total of 23 introduced taxa were returned from the search. These taxa are presented in Section 5.1.5. Of these, *Echium plantagineum* is a Declared Pest listed under the BAM Act (DPIRD 2019), and *Lycium ferocissimum* is a listed WoNS (Australian Weeds Committee (AWC) 2019) (Section 5.1.5).

5.1.2 Regional Vegetation

As previously mentioned, the Development Envelope is located in the Geraldton Sandplains IBRA region, specifically within the GES02 Lesueur Sandplain IBRA subregion (Commonwealth of Australia 2012). The Geraldton Sandplains bioregion comprises mainly of proteaceous scrub-heaths, rich in endemics (Desmond and Chant 2001).

Beard (1976) mapped vegetation of the Dongara area (including the Development Envelope) related to physiognomy, at a scale of 1:1250,000. The vegetation mapping by Beard (1976) was used by Shepherd *et al.* (2002) and further updated in Beard *et al.* (2013) to describe vegetation system associations, at a scale of 1:250,000. A total of four vegetation system associations occur in the Development Envelope, as summarised in Table 11 and presented on Figure 8**.**

Table 11 also presents the current extent of each vegetation system association in relation to its pre-European extent (Government of Western Australia 2018), and the percentage of the current extent of each vegetation system association currently protected for conservation. There is over 70% of the pre-European extent of Cliff Head_772 and Greenough_432 associations remaining, both of which have less than 4 % within the Development Envelope.



Vegetation System Associations of the Development Envelope	Author: Leah Firth	
	WEC Ref: Metgasco20-11-01	
WOODMAN ENVIRONMENTAL	Filename: Metgasco20-11-01-f08	**Figure**
	Scale: 1:25,000 (A4)	8
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report Metgasco 20-11-01.	Revision: 2 - 02 July 2020	

Table 11: Vegetation System Associations within the Development Envelope

Vegetation System Association	Description	Area in Development Envelope (ha)	Current Extent (ha)	Pre-European Extent Remaining (%)	Current Extent Protected for Conservation (%)
Cliff Head_772	Shrublands; *Acacia lasiocarpa* and *Melaleuca acerosa* heath	6.08	4,615.26	95.61	81.15
Greenough_432	Shrublands; *Acacia rostellifera* and *Melaleuca cardiophylla* thicket	30.41	883.22	73.19	22.54

The interrogation of the DBCA TEC and PEC Database (DBCA 2019d) returned one significant community that has a record in the Desktop Study Area (Table 12). This community is located approximately 9 km north of the Development Envelope. Appendix E presents definitions, categories and criteria for TECs and PECs (DBCA 2013).

Table 12: Significant Vegetation Returned from DBCA Database Searches

Community	Conservation Status (W.A.)	EPBC Act Ranking
Subtropical and Temperate Coastal Saltmarsh	Priority 3	Vulnerable

The Subtropical and Temperate Coastal Saltmarsh TEC/PEC is described as an assemblage of plants, animals and micro-organisms associated with saltmarsh in coastal regions of sub-tropical and temperate Australia under tidal influence (DBCA 2019b).

The search of the DoEE SPRAT for MNES listed under the EPBC Act database did not return any TECs listed under the EPBC Act, which occur or have the potential to occur within the vicinity of the Desktop Study Area. As per Table 3, the search was undertaken using the approximate Desktop Study Area boundary (DoEE 2020).

5.1.3 Local Flora and Vegetation Surveys

A number of publicly available flora and vegetation survey reports have been undertaken within the Desktop Study Area as outlined in Table 13. These surveys were all undertaken 15 - 16 years ago. In addition, the majority of plant specimen collections vouchered with the WA Herb in the Development Envelope are also over 15 years old (WA Herbarium) 1998-).

Table 13: Summary of Flora and Vegetation Surveys Previously Conducted in the Desktop Study Area

Report Title and Author	Location	Key Findings
Proposed EP 413 Denison 3D Seismic Survey Flora and Fauna Investigation - prepared for Origin Energy by Hart, Simpson and Associates Pty Ltd. (HAS) (2003).	10 km SSE of Dongara, west of Brand Hwy Overlaps the Development Envelope	• Recorded 161 taxa. • 20 detailed recording sites assessed. • Field survey was conducted in June, September and October 2003. • Three priority flora taxa were recorded. *Anthocercis intricata* (P3), *Eucalyptus zopherophloia* (P4) and *Haloragis foliosa* (P3). • 27 introduced taxa were recorded. • 20 plant assemblages were recorded.
Cliff Head Development Oil Pipeline and Processing Plant Flora, Vegetation and *Phytophthora cinnamomi* Survey – prepared for ROC Oil Company Ltd. (ROC Oil) by Woodman Environmental (2003)	20 km SSE of Dongara, west of Brand Hwy 7 km SSE of Development Envelope	• Recorded 106 taxa from 47 families. • 30 detailed recording sites assessed (data collected from a 10m radius). • Field survey was conducted in spring 2003. • No significant flora taxa were recorded. • 18 introduced taxa were recorded. • 6 plant communities were mapped. • No communities described were considered to be equivalent to represent a state / EPBC listed TEC at the time of the survey. • The condition of vegetation varied between Very Poor and Excellent.
Denison 3D Seismic Survey Flora and Vegetation Study – prepared for ARC Energy Pty Ltd / Origin Energy by Woodman Environmental (2005)	North and South of Dongara (including Dongara, majority of Yardanogo Nature Reserve and northern part of Beekeepers Nature Reserve (39,400 ha in total, including 21,355 ha of native vegetation Covers entire Development Envelope	• Recorded 515 taxa from 81 families. • 257 detailed recording sites assessed (data collected from a 20m radius). • Field survey was conducted in August - September 2004. • Nine priority taxa were recorded, six of which were within the Desktop Study Area including; *Anthocercis intricata* (P3), *Baeckea* sp. Walkaway (A.S. George 11249) (P3), *Dampiera tephrea* (P2), *Eucalyptus zopherophloia* (P4), *Stawellia dimorphantha* (P4) and *Thryptomene* sp. Lancelin (M.E. Trudgen 14000) (P3). • 68 introduced taxa were recorded. • 34 plant communities were mapped. • No communities described were considered to be equivalent to represent a state / EPBC listed TEC at the time of the survey. Community W1 has affinities to one currently listed PEC - Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora* (Geraldton area) (P1). • The condition of vegetation varied between Very Poor and Excellent.

The Development Envelope occurs on four mapped plant communities (Woodman Environmental (2005)):

- W1 (Low Woodland of mixed mallees);
- T2 (Thicket of *Melaleuca huegelii* subsp. *huegelii* and *Melaleuca cardiophylla* over mixed shrubs on grey sand on dune crests);
- T3 (Dense Thicket dominated by *Melaleuca cardiophylla* over herbs and grasses) and
- H8 (Heath dominated by *Melaleuca leuropoma*, *Melaleuca huegelii* subsp. *huegelii*, *Acacia* spp. and *Santalum acuminatum* over sedges on grey sand with limestone outcropping in swales).

All of these plant communities were recognized as being representative of the Quindalup System (Woodman Environmental 2005). Although no historical relevés were established within the Development Envelope, six relevés were established in nearby vegetation as displayed on Figure 5.

5.1.4 Summary of Significant Flora

A summary of significant flora taxa, or habitat for significant taxa, known from within the Desktop Study Area is presented in The record of *Stawellia dimorphantha* (P4) located north-west of the Development Envelope is incorrect. This record is a TPFL record listed as being from Woodman Environmental (2005). However, this location is not listed in the Woodman Environmental (2005) report and it is located outside of the range of this taxon, with all other records located in different vegetation associations to the east. Therefore, the coordinates of the record in the TPFL database are erroneous. The coordinates of this record should plot within Yardanogo Nature Reserve. There are several records of this taxon within the Desktop Study Area, however all are located east of the Development Envelope.
Table 14. This list has been compiled from the results of the desktop searches of the DBCA WA Herbarium and TPFL Databases (DBCA 2019c), DBCA *NatureMap* (DBCA 2007-), DoEE's SPRAT Database (DoEE 2020) and the results of local surveys as outlined in Section 5.1.3.

A total of 19 significant taxa or habitat for significant taxa, are known from within the Desktop Study Area including 16 DBCA-classified Priority flora, and six Threatened flora. No significant flora taxa are known from within the Development Envelope itself. Figure 9 presents the known locations of significant flora taxa in the Desktop Study Area.

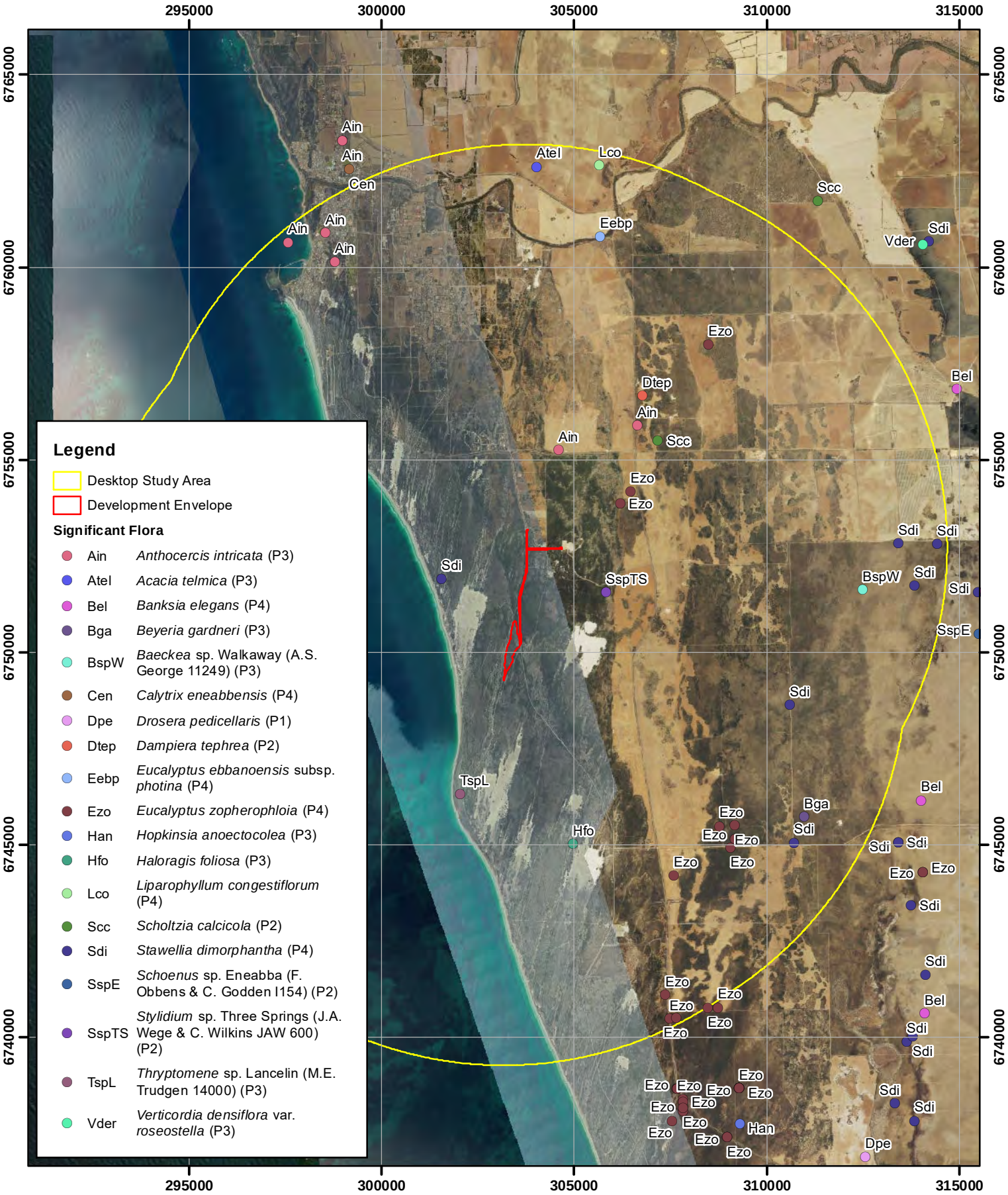
The record of *Stawellia dimorphantha* (P4) located north-west of the Development Envelope is incorrect. This record is a TPFL record listed as being from Woodman Environmental (2005). However, this location is not listed in the Woodman Environmental (2005) report and it is located outside of the range of this taxon, with all other records located in different vegetation associations to the east. Therefore, the coordinates of the record in the TPFL database are erroneous. The coordinates of this record should plot within Yardanogo Nature Reserve. There are several records of this taxon within the Desktop Study Area, however all are located east of the Development Envelope.

Table 14: Significant Flora Taxa Known from Within the Desktop Study Area

Taxon	Status	Source*
Acacia telmica	P3	DBCA
Anthocercis intricata	P3	DBCA; HAS; WEC

Taxon	Status	Source*
Baeckea sp. Walkaway (A.S. George 11249)	P3	DBCA; WEC
Beyeria gardneri	P3	DBCA
Caladenia hoffmanii	Threatened	DoEE
Conostylis dielsii subsp. *teres*	Threatened	DoEE
Conostylis micrantha	Threatened	DoEE
Dampiera tephrea	P2	DBCA; WEC
Eucalyptus ebbanoensis subsp. *photina*	P4	DBCA
Eucalyptus impensa	Threatened	DoEE
Eucalyptus zopherophloia	P4	DBCA; HAS; WEC
Haloragis foliosa	P3	DBCA; HAS
Liparophyllum congestiflorum	P4	DBCA
Scholtzia calcicola	P2	DBCA
Stawellia dimorphantha	P4	DBCA; WEC
Stylidium sp. Three Springs (J.A. Wege & C. Wilkins JAW 600)	P2	DBCA
Tetratheca nephelioides	Threatened	DoEE
Thryptomene sp. Lancelin (M.E. Trudgen 14000)	P3	DBCA; WEC
Wurmbea tubulosa	Threatened	DoEE

*Sources are:
DBCA – DBCA WA Herbarium and TPFL Databases (2019c); *NatureMap* – (DBCA 2007-);
DoEE – DoEE (2020)
HAS –Hart, Simpson and Associates (2003);
WEC – Woodman Environmental (2005).



Desktop Study Area **Significant Flora Records**	Author: Leah Firth	
	WEC Ref: Metgasco20-11-01	
WOODMAN ENVIRONMENTAL	Filename: Metgasco20-11-01-f09	**Figure**
	Scale: 1:130,000 (A4)	9
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report Metgasco 20-11-01.	Revision: 2 - 02 July 2020	

5.1.5 Summary of Introduced Flora

A list of introduced flora taxa or habitat for such taxa known from within the Desktop Study Area is presented in Table 15. The information presented has been compiled from the DBCA *NatureMap* search (DBCA 2007-), DoEE's SPRAT Database (DoEE 2020) and the results of local surveys (where data is available) as outlined in Section 5.1.3. A total of 75 introduced taxa or habitat for such taxa are known to occur in the Desktop Study Area. Of these four are Declared Pests (DPIRD 2019) and four are listed WoNS (AWC 2019) as presented in Table 15.

Table 15: Introduced Flora Taxa Known from Within the Desktop Study Area

Taxon	Common Name	Source*	Comments
Agave americana	Century Plant	DBCA; WEC	
Alternanthera pungens	Khaki Weed	DBCA	
Arctotheca calendula	Cape Weed	WEC	
Asparagus asparagoides	Bridal Creeper	DoEE	Declared Pest; WoNS
Asphodelus fistulosus	Onion Weed	DBCA; WEC	
Avena barbata	Bearded Oat	WEC	
Brassica tournefortii	Mediterranean Turnip	WEC	
Briza maxima	Blowfly Grass	WEC	
Briza minor	Shivery Grass	WEC	
Bromus diandrus	Great Brome	WEC	
Cakile maritima	Sea Rocket	DBCA; WEC	
Cenchrus ciliaris	Buffel Grass	DoEE	
Cenchrus echinatus	Burrgrass	DBCA	
Cenchrus longisetus	Feathertop	WEC	
Cenchrus setaceus	Fountain Grass	DBCA; WEC	
Chenopodium murale	Nettle-leaf Goosefoot	DBCA	
Centaurea melitensis	Maltese Cockspur	WEC	
Chenopodium murale	Nettle-leaf Goosefoot	WEC	
Cotula bipinnata	Ferny Cotula	WEC	
Cuscuta epithymum	Lesser Dodder	WEC	
Cynodon dactylon	Couch	WEC	
Dischisma arenarium	Dischisma	DBCA; WEC	
Echium plantagineum	Paterson's Curse	DBCA; WEC	Declared Pest
Eragrostis curvula	African Lovegrass	DBCA	
Erodium cicutarium	Common Storksbill	WEC	
Euphorbia peplus	Petty Spurge	WEC	
Euphorbia terracina	Geraldton Carnation Weed	DBCA; WEC	
Galium murale	Small Goosegrass	DBCA	
Glebionis coronaria	Summer Chrysanthemum	DBCA	
Hordeum leporinum	Barley Grass	WEC	
Hyparrhenia hirta	Tambookie Grass	DBCA	
Hypochaeris glabra	Smooth Cats-ear	WEC	
Lamarckia aurea	Goldentop	WEC	
Lantana camara	Common Lantana	DoEE	Declared Pest; WoNS
Lolium rigidum	Wimmera Ryegrass	WEC	

Taxon	Common Name	Source*	Comments
Lycium ferocissimum	African Boxthorn	DBCA; DoEE; WEC	WoNS
Lysimachia arvensis	Pimpernel	WEC	
Medicago polymorpha	Burr Medic	WEC	
Melilotus indicus	-	WEC	
Melinis repens	-	WEC	
Monoculus monstrosus	-	WEC	
Nicotiana glauca	Tree Tobacco	DBCA	
Oenothera drummondii subsp. *drummondii*	Beach Evening Primrose	DBCA	
Oenothera stricta subsp. *stricta*	Common Evening Primrose	DBCA	
Oxalis pes-caprae	Soursob	WEC	
Parentucellia latifolia	Common Bartsia	WEC	
Pelargonium capitatum	Rose Pelargonium	WEC	
Pentameris airoides	False Hairgrass	WEC	
Petrorhagia dubia	-	WEC	
Phoenix dactylifera	Date Palm	WEC	
Piptatherum miliaceum	Rice Millet	WEC	
Polycarpon tetraphyllum	Fourleaf Allseed	WEC	
Raphanus raphanistrum	Wild Radish	WEC	
Reichardia tingitana	False Sowthistle	DBCA	
Ricinus communis	Castor Oil Plant	WEC	
Schinus molle	Peppercorn Tree	DBCA	
Schismus barbatus	Kelch Grass	DBCA	
Schinus terebinthifolia	-	WEC	
Sisymbrium orientale	Indian Hedge Mustard	WEC	
Solanum nigrum	Black Berry Nightshade	WEC	
Sonchus oleraceus	Common Sowthistle	DBCA; WEC	
Spergula arvensis	Corn Spurry	WEC	
Spergula pentandra	Five Anther Spurry	WEC	
Spergularia ?rubra	Sand Spurry	WEC	
Symphyotrichum squamatum	Bushy Starwort	WEC	
Tamarix aphylla	Athel Tree	DoEE	Declared Pest; WoNS
Taraxacum khatoonae	Dandelion	WEC	
Tetragonia decumbens	Sea Spinach	WEC	
Trifolium arvense	Hare's Foot Clover	WEC	
Trifolium campestre	Hop Clover	WEC	
Trifolium hirtum	Rose Clover	WEC	
Ursinia anthemoides	Ursinia	WEC	
Verbesina encelioides	Crownbeard	DBCA	
?Vulpia bromoides	Squirrel Tail Fescue	WEC	
Vulpia muralis	-	WEC	

*Sources are:
DoEE – DoEE (2020);
DBCA – DBCA (2007-);
WEC – Woodman Environmental (2003, 2005).

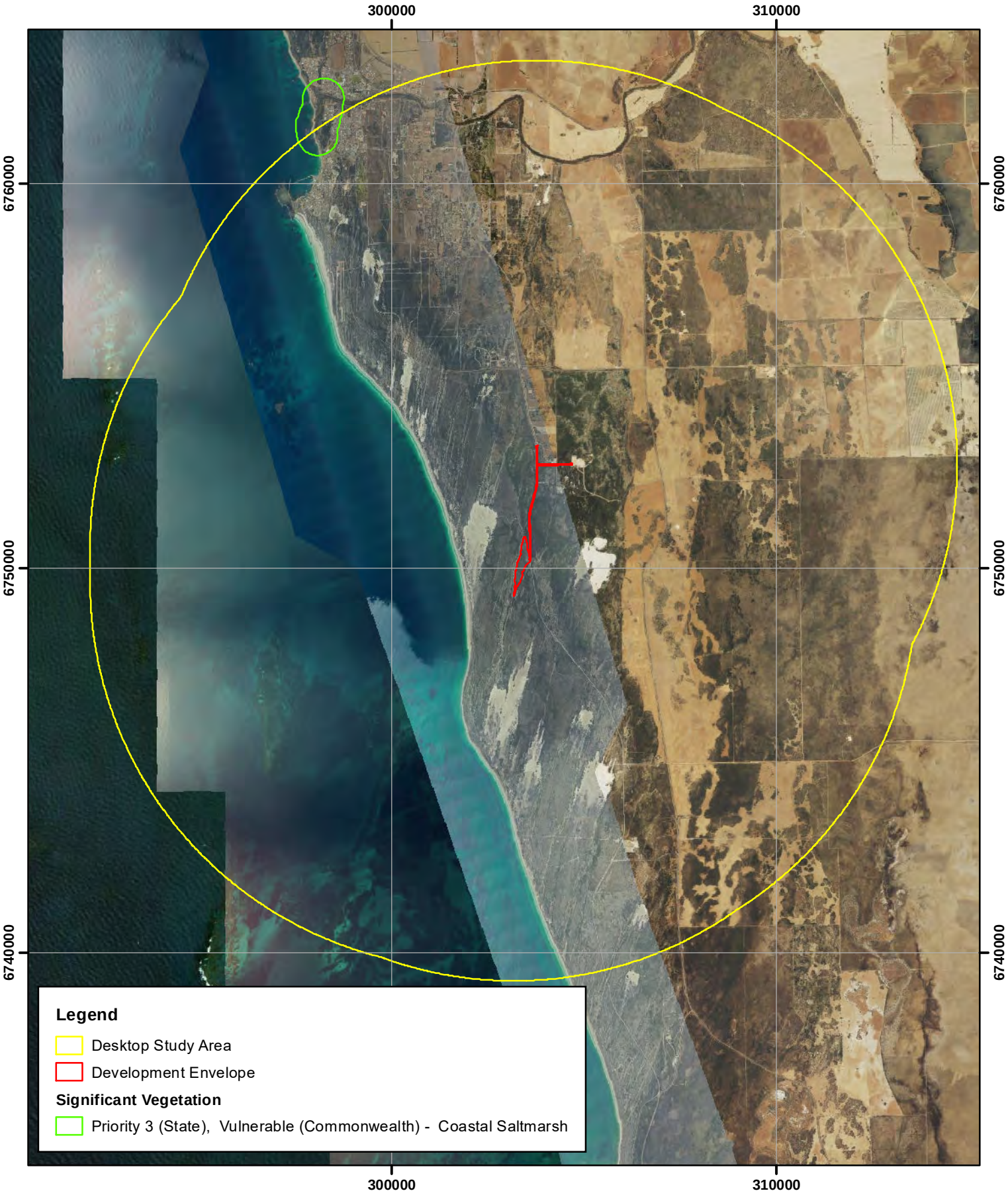
5.1.6 Summary of Significant Vegetation

Two significant vegetation units are known to occur within the Desktop Study Area as presented in Table 16. This list has been compiled from the desktop searches of the DBCA TEC and PEC database search (DBCA 2019d), DoEE's SPRAT Database (DoEE 2020) and the results of local surveys as outlined in Section 5.1.3. Figure 10 presents the known locations of significant vegetation in the Desktop Study Area. Although the PEC 'Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora*' is not a mapped occurrence within the Desktop Study Area as per the DBCA TEC and PEC databases (and is therefore not mapped on Figure 10), a community which matches the description of the PEC was mapped by Woodman Environmental (2005) within the Desktop Study Area. This is discussed in more detail in Section 5.1.7.

Table 16: Significant Vegetation Known from Within the Vicinity of the Study Area

Community	Conservation Status (W.A.)	EPBC Act Ranking	Source
Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora* (Geraldton area)	Priority 1	-	WEC
Subtropical and Temperate Coastal Saltmarsh	Priority 3	Vulnerable	DBCA

*Sources are:
DBCA – DBCA WA TEC PEC Databases (2019d);
WEC – Woodman Environmental (2005).



Desktop Study Area **Significant Vegetation**	Author: Leah Firth	
	WEC Ref: Metgasco20-11-01	
WOODMAN ENVIRONMENTAL	Filename: Metgasco20-11-01-f10	**Figure**
	Scale: 1:130,000 (A4)	10
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report Metgasco 20-11-01.	Revision: 2 - 02 July 2020	

5.1.7 Summary of Known Flora and Vegetation Values of the Development Envelope

The vegetation of the entire Development Envelope has been previously mapped as part of the Denison ARC Energy / Origin Energy 3D Seismic Survey Flora and Vegetation Study (Woodman Environmental 2005) (see section 5.1.3). The Denison 3D Seismic Survey Study Area was 39,400 ha in total, including 21,355 ha of vegetated lands. A total of four plant communities have been mapped within the Development Envelope. A summary of the plant communities is presented in Table 17. A species by community matrix for these plant communities is presented in Appendix F.

Of the plant communities mapped within the Development Envelope (community W1) matches the description of the PEC 'Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora*' (P1). This PEC is described as floristically similar to other *Acacia rostellifera* communities but is differentiated on structure, being dominated by mallee eucalypts. The community occurs on limestone ridges, in some swales in the coastal dunes between Cape Burney and Dongara, on the Greenough Alluvial Flats on limestone soil and near Tarcoola Beach. Some very small occurrences have also been recorded on the limestone scarp north of the Buller River (DBCA 2019b). This community was mapped as part of the Geraldton Regional Flora and Vegetation Survey (plant communities 9 and 11) (Department of Planning and Ecoscape Pty Ltd (Ecoscape) 2010).

Detailed condition mapping was not undertaken within the Development Envelope during the Denison ARC Energy / Origin Energy 3D Seismic Survey Flora and Vegetation Study (Woodman Environmental 2005). However, the flora and vegetation survey by Woodman Environmental (2005) did map degraded areas of the plant communities. No degraded communities were mapped within the Development Envelope and the majority of vegetation within Northern Beekeepers Reserve was described as being in Excellent condition. In addition, no evidence of Dieback Disease was identified by field observations within the nature reserves and large areas of intact native vegetation during the survey (Woodman Environmental 2005).

No significant flora taxa are currently known from within the Development Envelope.

Table 17: Summary of Plant Communities Mapped within the Development Envelope During the Denison 3D Seismic Survey (Woodman Environmental 2005)

Community Code	Summary	Total Area Mapped in Denison 3D Seismic Survey Study Area:
H8	**Description:** Heath dominated by *Melaleuca systena**, *Melaleuca huegelii* subsp. *huegelii*, *Acacia* spp. and *Santalum acuminatum* over sedges on grey sand with limestone outcropping in swales	2261.78 ha
T2	**Description:** Thicket of *Melaleuca huegelii* subsp. *huegelii* and *Melaleuca cardiophylla* over mixed shrubs on grey sand on dune crests	1528.11 ha

Community Code	Summary	Total Area Mapped in Denison 3D Seismic Survey Study Area:
T3	**Description:** Dense Thicket dominated by *Melaleuca cardiophylla* over herbs and grasses	591.54 ha
W1	**Description:** Low Woodland of mixed mallees (includes *Eucalyptus obtusiflora* subsp. *dongarraensis* and *Eucalyptus oraria*)	681.07ha

*Original identification in WEC (2005) was *Melaleuca leuropoma* – this has been re-identified as *Melaleuca systena*

5.1.8 Likelihood of Occurrence of Significant Flora Taxa

As detailed in Section 5.1.4, a total of 19 listed significant flora taxa, or habitat for such taxa are known from the Desktop Study Area, none of which have records within the Development Envelope itself. It is considered that all taxa were identifiable during the previous survey period (Woodman Environmental 2005), either because the survey period coincided with the taxon's flowering period or the taxon can be identified reliably when in fruit or sterile.

It is considered that five Priority flora taxa could potentially occur in the Development Envelope as suitable habitat may be present. These are indicated in Table 18. The remaining 14 taxa are considered unlikely to occur in the Development Envelope, primarily because suitable habitat is not considered to be present (Table 18).

Table 18: Likelihood of Occurrence of Significant Flora Taxa in the Development Envelope

Taxon	Status	Flowering Period (WA Herbarium 1998-)	Habitat (WA Herbarium 1998-)	Nearest Known Location to Development Envelope (DBCA 2007-)	Identifiable During Previous Survey*?	Likelihood of Occurrence in Development Envelope
Acacia telmica	P3	July to September	Low-lying seasonally moist areas on sand, loam or loamy clay.	9.8 km	Yes	Unlikely not recorded by previous surveys in Development Envelope. Habitat not present.
Anthocercis intricata	P3	June to September	Consolidated sand dunes on sand or loam over limestone	3 km north	Yes	**Possible** – recorded by previous surveys in Desktop Study Area. Potential habitat present.
Baeckea sp. Walkaway (A.S. George 11249)	P3	November, December or January	Undulating plains, hillslopes on yellow/brown or white sand	8 km east – records within or east of Illyarrie system	Yes, although can be difficult to identify without flowers	Unlikely – not recorded by previous surveys in Development Envelope. Habitat not present.
Beyeria gardneri	P3	August to September	Sandplains and hillsides on yellow sand.	8 km SE	Yes	Unlikely – not recorded by previous surveys in Development Envelope. Habitat not present.
Caladenia hoffmanii	T	August to October	Clay, loam, laterite, granite. Rocky outcrops and hillsides, ridges, swamps and gullies.	70 km NW	Yes	Unlikely – not recorded by previous surveys in Development Envelope or known from Desktop Study Area. Habitat not present.
Conostylis dielsii subsp. *teres*	T	July to August	White, grey or yellow sand, gravel. Low open woodland.	16 km NE	Yes	Unlikely – not recorded by previous surveys in Development Envelope or known from Desktop Study Area. Habitat not present.
Conostylis micrantha	T	July to August	Sandplains with white or grey sand.	18 km NE	Yes	Unlikely – not recorded by previous surveys in Development Envelope. Habitat not present.

Taxon	Status	Flowering Period (WA Herbarium 1998-)	Habitat (WA Herbarium 1998-)	Nearest Known Location to Development Envelope (DBCA 2007-)	Identifiable During Previous Survey*?	Likelihood of Occurrence in Development Envelope
Dampiera tephrea	P2	August to October	Flats, riverbanks and slopes with sand or loam, often with limestone.	4.5 km NE	Yes	**Possible** – recorded by previous survey in Desktop Study Area. Potential habitat present.
Eucalyptus ebbanoensis subsp. *photina*	P4	September to December, January to March	Lateritic breakaways, sandplains with sandy clay or red sand.	8 km NNE	Yes	Unlikely – not recorded by previous surveys in Development Envelope. Habitat not present.
Eucalyptus impensa	T	August to September	Lateritic hills with yellow sand.	70 km SE	Yes	Unlikely – not recorded by previous surveys in Development Envelope or known from Desktop Study Area. Habitat not present.
Eucalyptus zopherophloia	P4	October to December, January	Slopes and dunes with grey/white sand. Often with limestone. Coastal areas.	2 km NE	Yes	**Possible** – recorded by previous surveys in Desktop Study Area. Potential habitat present.
Haloragis foliosa	P3	December	Dunes, slopes and swales with white/grey sand often with limestone.	5 km south	Yes	**Possible** – recorded by previous survey in Desktop Study Area. Potential habitat present.
Liparophyllum congestiflorum	P4	September to October	Flats, drainage lines and winter-wet areas with sand	9.5 km NNE	Yes	Unlikely – not recorded by previous surveys in Development Envelope. Habitat not present.
Scholtzia calcicola	P2	September to December	Slopes, undulating plains with grey or yellow sand often with limestone.	3.5 km NE	Yes	Unlikely – not recorded by previous surveys in Development Envelope. Habitat not present.
Stawellia dimorphantha	P4	June to November	Undulating plains and slopes with white, grey, yellow sand.	7 km SE^	Yes	Unlikely – not recorded by previous surveys in Development Envelope. Habitat not present.

Taxon	Status	Flowering Period (WA Herbarium 1998-)	Habitat (WA Herbarium 1998-)	Nearest Known Location to Development Envelope (DBCA 2007-)	Identifiable During Previous Survey*?	Likelihood of Occurrence in Development Envelope
Stylidium sp. Three Springs (J.A. Wege & C. Wilkins JAW 600)	P2	September	Rocky slopes, flats and outcrops with clay-sand or loam.	1.5 km SE	Yes	Unlikely – not recorded by previous surveys in Development Envelope. Habitat not present.
Tetratheca nephelioides	T	September	Outcrops, undulating hills, ridges with sand or clayey sand, often with gravel and laterite.	69 km SE	Yes	Unlikely – not recorded by previous surveys in Development Envelope or known from Desktop Study Area. Habitat not present.
Thryptomene sp. Lancelin (M.E. Trudgen 14000)	P3	August, September	Dunes and slopes with sand often with limestone.	4 km SSW	Yes –but not significant at the time of survey	**Possible** – recorded by previous surveys in Desktop Study Area. Potential habitat present.
Wurmbea tubulosa	T	June to August	Riverbanks, seasonally-wet places with clay or loam.	16 km NE of Development Envelope	Yes	Unlikely – not recorded by previous surveys in Development Envelope or known from Desktop Study Area. Specific habitat required which is not present in the Development Envelope.

*Woodman Environmental (2005) Survey

^The record on Figure 8 which is located NW of the Development Envelope is considered erroneous as discussed in Section 5.1.4.

5.2 Fauna

5.2.1 Overview of Vertebrate Fauna Assemblage

The desktop study identified 207 vertebrate fauna species as potentially occurring in the Development Envelope (see Table 19 and Appendix G): nine frogs, 50 reptiles, 122 birds, 16 native and ten introduced mammals. An additional 12 native mammal species are considered locally extinct. No fish species are expected in the Development Envelope due to the lack of water systems. Note that this assemblage comes from databases and includes species that may occur occasionally on the site, but for which it is not important (such as birds that rarely fly overhead). The assemblage includes 15 vertebrate species of conservation significance. Note that species returned from databases but which are considered highly unlikely to be present based on their biology have not been included (but are listed in Appendix H). An explanation of fauna values, including assemblage characteristics, Vegetation Substrate Associations (VSAs), patterns of biodiversity across the landscape and the recognition of three classes of species of conservation significance is presented in Appendix I.

The nine frog species consist mostly of burrowing frogs which rely on seasonal flooding for breeding. Such burrowing species are likely to breed in nearby seasonal wetlands but disperse widely through upland vegetation for the rest of the year, except for the Turtle Frog that breeds terrestrially and has no need of free water. Two of the frog species (Motorbike Frog and False Western Froglet) do not burrow and are often confined to permanent or near-permanent wetlands. Therefore, they are considered likely only as visitors.

All of the 50 reptile species expected are considered resident in the Development Envelope except the Woma, which is probably locally extinct. The Lesueur Sandplains Subregion and more broadly the mid-west coast of Western Australia is recognised for its high reptile richness and large numbers of species that are at their distributional limits (Maryan 2005). Previous BCE surveys in the general area have recorded 39 reptile species (Metcalf and Bamford 2008). Due to the sandy substrate, absence of rocky areas and geographic location of the Development Envelope, the expected assemblage is a mix of sand specialists, fossorial species and coastal species along with widespread, generalist species.

The bird assemblage of 122 species includes 39 classed as residents, 40 as regular visitors or migrants, and 42 considered to be irregular visitors or vagrants. One species, the Western Ground Parrot, is probably locally extinct but there are occasional reports that it persists in the area; this species is discussed further below. There is likely to be a high seasonal abundance of nectivorous birds present in the Development Envelope when vegetation is in flower. The Development Envelope is subject to incursions of arid zone bird species in some years. For example, in a 30-year study between Cataby and Badgingarra, the Black Honeyeater was absent most years, but approximately one year in 10 it was among the most abundant of nectarivores (M. Bamford unpublished data). Similarly, the White-fronted Honeyeater, Pied Honeyeater, Red-backed Kingfisher, Masked Woodswallow, Ground Cuckoo-shrike and Budgerigar have each been recorded on fewer than five occasions in the 30-year study north of Cataby. The Development Envelope is also

expected to be rich in resident birds utilising the dense Kwongan heaths and *Acacia* thickets, in particular those that prefer to keep low in the vegetation strata such as the White-browed Scrubwren, White-breasted Robin and Splendid Fairy-wren. The bird assemblage includes four introduced species but these are not expected to be resident or even regular visitors.

The mammal assemblage is depauperate, with 26 native species known generally from the area, but 12 of these being locally extinct due to predation by introduced predators, habitat destruction and changing fire regimes. The extant native mammal assemblage includes 12 residents and three regular visitors (all bats). Three Dunnart species may occur in the area, all of which have fairly restricted distributions on the coastal plain, with one of these of taxonomic interest and discussed below. Ten introduced species are expected to occur in the Development Envelope, including the feral predators Fox and Cat. Goats are resident nearby (Bamford and Chuk 2017) so are also likely to be resident in the Development Envelope.

Key features of the vertebrate fauna assemblage expected in the Development Envelope are:

- Uniqueness: The assemblage is likely to be typical of the coastal belt of the Geraldton Sandplains bioregion, but this overall assemblage is unusual and has a limited distribution from just north of Perth to south of Dongara. There are also different assemblages within the bioregion because many species have distributions that either overlap with only part of the bioregion or have distributions that are smaller than the bioregion.
- Completeness: The assemblage of species from the Development Envelope is missing a number of native mammal species as is common throughout the region.
- Richness: The assemblage is likely to vary annually and seasonally according to climatic conditions, but lies in a region of high biodiversity, particularly for reptiles.

Table 19: Composition of vertebrate fauna assemblage expected to occur within the Development Envelope.

Taxon	Number of species expected	Number of species in each category				
		Resident	Regular visitor or migrant	Irregular visitor	Vagrant	Locally extinct
Fish	0	0	0	0	0	0
Frogs	9	8	1	1	0	0
Reptiles	50	49	0	0	0	1?
Birds	122	39	40	26	16	1?
Native mammals	16	12	3	1	0	12
Introduced mammals	10	5	0	3	2	-
Total	**207 (including 14 int.)**	**113**	**44**	**30**	**18**	**12 (+ 2?)**

*Note: Locally extinct species re not included in the group totals

5.2.2 Overview of Invertebrate Species

The project area sits within DBCA's Midwest management region (DBCA 2020). DBCA (2019) listed 22 threatened or priority invertebrate fauna in this region, as outlined in Table 20. At least 10 of these species are not expected to occur within the project area and the reasons for exclusion are presented in Table 20 (e.g. wholly or locally extinct, absence of suitable habitat in the survey area, distance from known populations). To help ascertain the status of the remaining 12 species, all location records from ALA (2020) and WAM (2020) were compiled, collated and mapped in relation to the project area. A map of these DBCA-listed threatened and priority species is provided in Figure 11.

There are no records of threatened invertebrate fauna within the project area, nor within the regional (12 km) buffer. Only three species have records within 50 km of the project area (as indicated in Table 20 and Figure 11 and these are, therefore, considered to be potential inhabitants of the project area. The Springtime Corroboree Stick Katydid has been collected from near-coastal vegetation near Jurien and Dongara (Rentz 1996) and is thus very likely to be present. The cricket and native bee included in Table 20 are known from the broader area and are included on a precautionary basis. In addition, the millipede *Antichiropus* Eneabba 1 is a short range endemic (SRE) which is found in Eneabba but has also been recorded at Mt Adams, where it is associated with Acacia thickets close to wetlands (Metcalf & Bamford 2008).

Limestone at or close to the surface (such as in vegetation type H8; see section 5.2.4) may have a higher likelihood of supporting SRE species than other areas, but the distribution of SRE invertebrates is likely to be more complicated than this. Vegetation type H8 and other vegetation types are extensive in the area compared with the impact footprint. Underlying limestone may be present throughout and can provide habitat for subterranean invertebrate fauna either above (troglofauna) or below (stygofauna) the groundwater level

Table 20: Conservation significant invertebrate fauna species expected to occur in the Midwest region (as per DBCA 2019, 2020), including conservation status and likely residency status in the project area.

See Appendix J for descriptions of conservation significance levels. The predicted status of each species in the project area is given (as per Section 3.2.5).
EPBC Act listed species: V = Vulnerable, E = Endangered, Cr = Critically Endangered, M = Migratory.
WC Act listed species: S1 - S4 = Schedule 1 - 4, DEC Priority Species: P1 - P5 = Priority 1 - 5.
Species immediately considered as unlikely to occur in the project area are listed in grey font.
Other exclusions (plain black text) followed spatial analysis of current records.
Expected species are highlighted.

Species		Conservation Status	Expected Status in Project Area
Aganippe castellum	Tree-Stem Trapdoor Spider	CS2 (P4)	Absent. Project area more than 200 km outside of species known range.
Austrosaga spinifer	Spiny Katydid (Swan Coastal Plain)	CS2 (P2)	Absent. No records within 50 km of the project area.
Bothriembryon perobesus	A bothriembryontid land snail (Moore River)	CS2 (P1)	Absent. No records within 50 km of the project area.
Bothriembryon whitleyi	Whitley's Bothriembryontid Land Snail (Geraldton)	Extinct	Absent. Extinct.
Branchinella denticulata	A fairy shrimp (Carnavon to Kalgoorlie)	CS2 (P3)	Absent. No wetland habitat.
Branchinella simplex	A fairy shrimp (inland WA)	CS2 (P1)	Absent. No wetland habitat.
Branchinella wellardi	A fairy shrimp (Carnarvon and Murchison)	CS2 (P3)	Absent. No wetland habitat.
Daphnia jollyi	A water flea (inland south west)	CS2 (P1)	Absent. No wetland habitat.
Hemisaga vepreculae	Thorny Bush Katydid (Moora)	CS2 (P2)	If present, resident.
Hylaeus globuliferus	Woollybush Bee	CS2 (P3)	If present, resident.
Idiosoma arenaceum	Geraldton Sandplain Shield-Backed Trapdoor Spider	CS2 (P3)	Absent. No records within 50 km of the project area.
Idiosoma dandaragan	Dandaragan Plateau Shield-Backed Trapdoor Spider	CS2 (P2)	Absent. No records within 50 km of the project area.
Idiosoma gutharuka	Gutha Pintharuka Shield-Backed Trapdoor Spider	CS2 (P1)	Absent. No records within 50 km of the project area.
Idiosoma incomptum	Carnarvon Shield-Backed Trapdoor Spider	CS2 (P3)	Absent. Project area more than 200 km outside of species known range.
Idiosoma kwongan	Kwongan Heath Shield-Backed Trapdoor Spider	CS2 (P1)	Absent. No records within 50 km of the project area.
Idiosoma nigrum	Shield-Backed Trapdoor Spider	CS1 (V, S3)	Absent. Project area more than 200 km outside of species known range.

Species		Conservation Status	Expected Status in Project Area
Neopasiphae simplicior	A short-tongued bee	CS1 (E, S3)	Absent. No records within 50 km of the project area.
Phasmodes jeeba	Springtime Corroboree Stick Katydid (Eneabba)	CS2 (P3)	If present, resident.
Psacadonotus seriatus	A fan-winged katydid (Champion Bay)	CS2 (P1)	Absent. No records within 50 km of the project area.
Synemon gratiosa	Graceful Sunmoth	CS2 (P4)	Absent. No records within 50 km of the project area.
Teyl sp. (BY Main 1953/2683, 1984/13)	Minnivale Trapdoor Spider	CS1 (S1)	Absent. Survey area more than 100 km outside of species known range.
Throscodectes xederoides	Mogumber Bush Cricket, Northern Throsco	CS2 (P3)	Absent. Survey area more than 100 km outside of species known range.
Antichiropus Eneabba 1	A millipede	CS3	If present, resident.

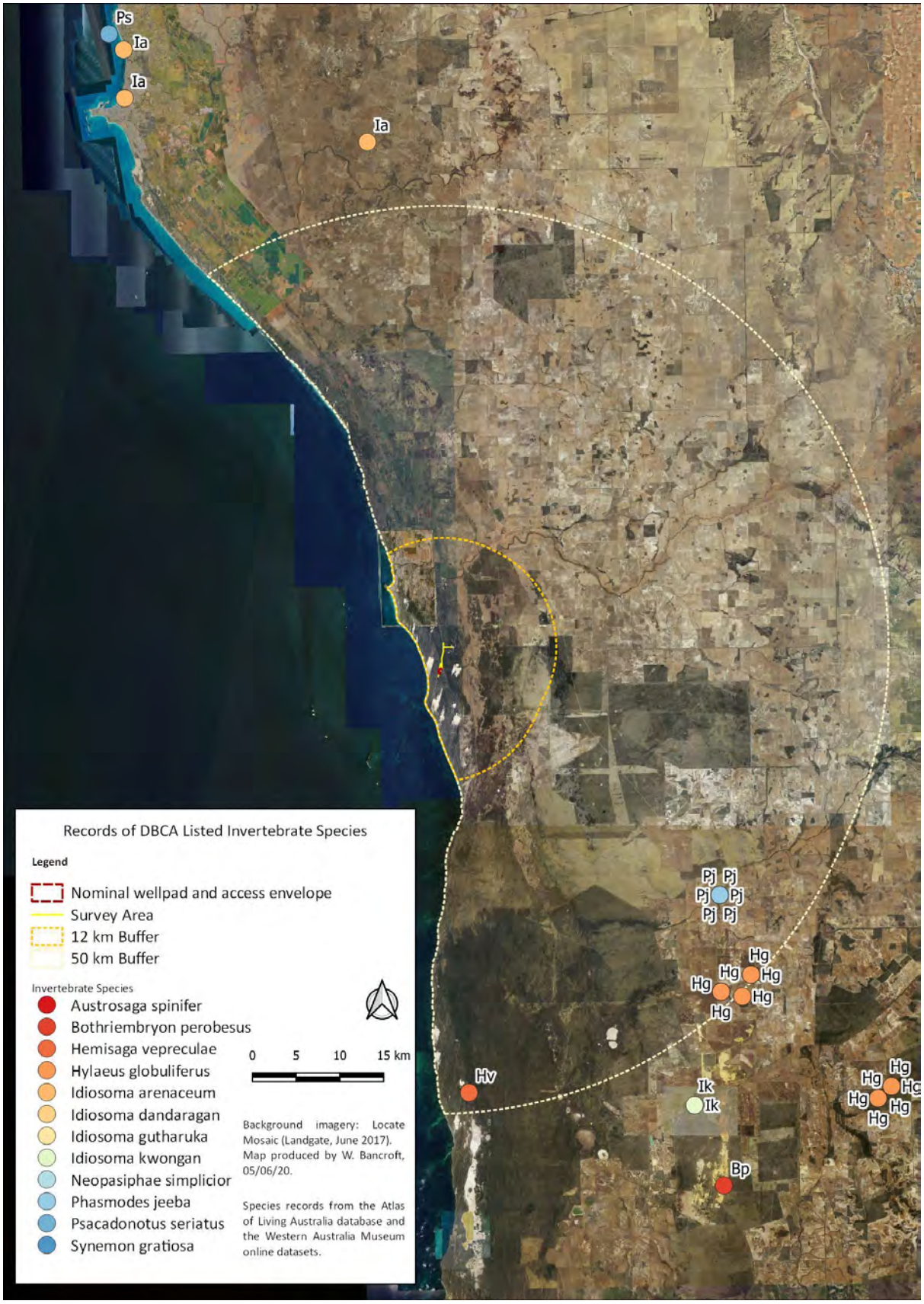


Figure 11: Records of DBCA-listed (threatened or priority) invertebrate species within 50 km of the survey area

5.2.3 Species of Conservation Significance

Details on species of conservation significance returned from the database and expected to occur in the Development Envelope (even as vagrants) are presented in Table 21. This list includes four invertebrate, five reptile, 10 bird species and two mammal species. This does not include locally extinct mammal species (but these are listed in Appendix H) but does include two species that are considered as possibly locally extinct. Significant species are discussed further below.

Table 21: Conservation Significant Fauna Species Expected to Occur in the Development Envelope, Conservation Status and Likely Residency Status

CS Species		Status*	CS Level#	Expected Status^
INVERTEBRATES				
millipede	*Antichiropus Eneabba 1*		CS3	Resident
Bush Cricket	*Hemisaga vepreculae*	P2	CS2	Resident
Springtime Corroboree Stick Katydid	*Phasmodes jeeba*	P3	CS2	Resident
native bee	*Hylaeus globuliferus*	P3	CS2	Resident
REPTILES				
Woma	*Aspidites ramsayi*	P1	CS2	Possibly locally extinct
Carpet Python	*Morelia spilota imbricata*		CS3	Resident
Black-striped Snake	*Neelaps calonotos*	P3	CS2	Resident
BIRDS				
Malleefowl	*Leipoa ocellata*	V S3	CS1	Irregular visitor
Fork-tailed Swift	*Apus pacificus*	M S5	CS1	Regular migrant
Letter-winged Kite	*Elanus scriptus*	P4	CS2	Vagrant
Peregrine Falcon	*Falco peregrinus*	S7	CS1	Irregular visitor
Rainbow Bee-eater	*Merops ornatus*		CS3	Regular migrant
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	E S2	CS1	Regular migrant
Western Ground Parrot	*Pezoporus flaviventris*	Cr S1	CS1	Possibly locally extinct
Rufous Fieldwren	*Calamanthus campestris*		CS3	Resident
Shy Heathwren	*Calamanthus cautus*		CS3	Irregular visitor
Crested Bellbird	*Oreoica gutturalis*		CS3	Resident
MAMMALS				
Little Long-tailed Dunnart	*Sminthopsis* aff. *dolichura*		CS3	Resident
Brush Wallaby	*Notamacropus irma*	P4	CS2	Resident
Total species expected:	**19**			

*See Appendix J for descriptions of conservation significance status for fauna.
#See Appendix I for descriptions of the Conservation Significance (CS) level
^The expected status of each species in the Development Envelope is given (as per Section 3.2.5).
EPBC Act listed species: V = Vulnerable, E = Endangered, Cr = Critically Endangered, M = Migratory.
BC Act listed species: S1 - S7 = Schedule 1 – 7
DBCA Priority Species: P1 – P4 = Priority 1 - 4.

Woma (CS2)

The Woma is classified as Priority 1 by the DBCA and is also listed under Schedule 4 of the BC Act. Cogger *et al*. (1993) classified the south-western population as Endangered, whilst Maryan (2005) suggest it may be critically endangered given the rarity of recent sightings. Possible threats to the species may include increased predation of young individuals by introduced predators (e.g. feral cats and foxes) and loss of habitat (Maryan 2005). The few recent records of this species in the South-West have included records near Watheroo and Badgingarra. The species could be locally extinct but despite being a large python, it can be difficult to detect.

Carpet Python (CS3)

The south-western race of the Carpet Python occurs in south-west Western Australia, from Northampton south to Albany and eastwards to Kalgoorlie. It was formerly listed as a Priority species by the DBCA. It occurs in large undisturbed remnant bushland near Perth and the Darling Ranges including in Banksia woodland, eucalypt woodland, forests, dense coastal scrub, granite and limestone outcrops, and along watercourses (Bush *et al.* 2007). Carpet Pythons are arboreal, terrestrial, and rock-dwelling, and can shelter in burrows made by other animals, hollow tree limbs, or rock crevices. The South-west Carpet Python has declined in distribution due to the loss of habitat (associated with land clearance) and changed fire regimes. Predation by exotic predators (foxes and feral cats) may have also contributed to the decline of python populations (Bush *et al.* 2007). The Carpet Python is observed regularly in the coastal sandplain from north of Perth to south of Dongara (M. Bamford pers. obs.) and is thus considered likely to be resident within the Development Envelope.

Black-striped Snake (CS2)

The Black-striped Snake is restricted to the west coast region from south of Dongara to Mandurah. Bush *et al.* (2007) suggest that the population in the Dongara area is isolated. The species is threatened by encroaching land development and has been recorded from coastal dunes and sandplains with heath and Banksia woodland; as such it could be resident in the Development Envelope.

Carnaby's Black-Cockatoo (CS1)

Carnaby's Black-Cockatoo is considered likely to be a regular migrant in the Development Envelope. The inland subspecies of the Red-tailed Black-Cockatoo may also occur in the area irregularly or as a vagrant but this is not of conservation significance. The Carnaby's Black-Cockatoo forages in proteaceous heath, banksia woodlands and eucalypt woodlands, and based on vegetation descriptions for the Development Envelope provided by Woodman Environmental, the site probably does not support critical foraging habitat. BCE has developed a system for assigning a foraging value score (out of 10) to vegetation with respect to Carnaby's Black-Cockatoo, and the most suitable vegetation in the Development Envelope (Mallee; section 5.2.4) would receive an estimated score of 3 or 4. Other vegetation types would receive a score of 2 or possibly less. The value of the project area for Carnaby's Black-Cockatoo is discussed in 5.2.4.

The Carnaby's Black-Cockatoo is unlikely to roost or breed in the Development Envelope due to the lack of large trees, and the Development Envelope is considered to be located

within the non-breeding range of the species (DSEWPC 2012a). The closest published confirmed roost site is located approximately 17 km east of the Development Envelope, while the closest published confirmed breeding site is located approximately 60 km southeast of the Development Envelope (DBCA 2020).

Western Ground Parrot (CS1)
The Western Ground Parrot is of very high conservation significance and inhabits coastal heathlands with a diverse range of low-growing shrubs, especially where there are patches of vegetation of different ages. The species usually occur in areas that have not been burnt for more than 40 years, though can occur in areas that are regenerating 2–3 years after fire, when unburnt vegetation is nearby (Birdlife Australia 2020. This species once occurred on the coastal plains between Israelite Bay and Dongara, north of Perth. Although unlikely to be present and therefore unlikely to be impacted, the status of this species is becoming critical, with the known population on the south coast ca. 100 birds, and an unconfirmed population on the northern sandplains. A reliable sighting of the Ground Parrot was recorded in 1992 in the region, approximately 19 km southeast of the Development Envelope. Surveys in the region since then (e.g., Metcalf and Bamford 2008, Bamford 2012) have failed to locate this species and it is possibly locally extinct.

Rainbow Bee-eater (CS3)
This species is a common summer breeding visitor to the area. It is widespread and frequently uses disturbed environments. It probably forages and breeds in the Development Envelope.

Fork-tailed Swift (CS1)
The Fork-tailed Swift is largely aerial but may over-fly the Development Envelope occasionally.

Peregrine Falcon (CS1)
This species is found in a variety of habitats, including rocky ledges, cliffs, watercourses, open woodland and acacia shrublands. The distribution of the Peregrine Falcon is often tied to the abundance of prey as this species predates heavily on other birds. The Peregrine Falcon lays its eggs in recesses of cliff faces, tree hollows or in large abandoned nests of other birds (Birds Australia 2020. The Peregrine Falcon mates for life with pairs maintaining a home range of about 20 -30 km square throughout the year. Blakers *et al.* (1984) consider that Australia is one of the strongholds of the species, since it has declined in many other parts of the world. This species could forage over the Development Envelope but there would appear to be no nesting habitat.

Australian Bustard (CS3)
The Australian Bustard was formerly listed as a Priority species by the DBCA and is still very scarce in the southern half of its range. It is nomadic and may range over very large areas, largely dependent on rainfall and hence food availability. It may be an irregular visitor to the Development Envelope.

Rufous Fieldwren, Shy Heathwren and Crested Bellbird

These species were formerly listed as Priority by the DBCA; all have experienced a substantial decline within southern Australia, probably due to a combination of predation by introduced foxes and feral cats, habitat loss/alteration/fragmentation due to clearing for agriculture, grazing and altered fire regimes. They inhabit shrublands and heathlands and suitable habitat is present in the Development Envelope and thus are all considered likely to be resident in the Development Envelope. The Rufous Fieldwren and Shy Heathwren has been recorded 10 km to the east (Bamford *et al.* 2015) and the Crested Bellbird has been recorded 17 km southeast of the Development Envelope (Metcalf and Bamford 2008).

Brush Wallaby

The Brush Wallaby occurs in south-western Australia, from Kalbarri to Cape Arid. It has suffered a large range reduction and fragmentation of populations across this range due to clearing for agriculture and predation by introduced predators (DBCA 2007-). The optimum habitat for the Brush Wallaby is open forest or woodland, in which it favours open, seasonally wet flats with low grasses and open, scrubby thickets (Van Dyck and Strahan 2008), and areas of dense vegetation. It is also found in mallee and heathland (DBCA 2007-), and as such may occur in the Development Envelope, particularly in the *Melaleuca* thickets. The species has been recorded 17 km southeast of the Development Envelope (Metcalf and Bamford 2008).

Little 'Long-tailed' Dunnart

The Little Long-tailed Dunnart is considered locally significant because of its uncertain taxonomic status on the coastal plain. DNA analysis by the Western Australian Museum identify it as *Sminthopsis dolichura,* but it is morphologically distinct in that it lacks the long tail of that taxon. It is considered likely to be a resident in the Development Envelope.

5.2.4 Vegetation and Substrate Associations

Generalisations can be made about the Vegetation and Substrate Associations (VSAs) expected to be present based on plant communities identified in the Development Envelope by Woodman Environmental (Woodman Environmental 2005). The plant communities present in the Development Envelope are:

1. H8 – Heath on grey sand with limestone outcropping in swales
2. T2 – Thicket of *Melaleuca* spp. on grey sand on dune crests
3. T3 - Dense Thicket dominated by *Melaleuca cardiophylla* over herbs and grasses
4. W1 – Low woodland of mixed mallees
5. Cl - Cleared

The majority of the Development Envelope comprises heath vegetation which supports a diverse suite of reptiles and understorey-associated birds. The limestone areas are a limited substrate and may support short range endemic invertebrates, and potentially a subterranean (invertebrate) fauna assemblage. There is a strip of Melaleuca thicket to the east of the Development Envelope which is likely to support additional middle-storey birds and some mammals. On the eastern edge of the Development Envelope and along the access track is mallee woodland and this is expected to further support woodland-associated species, although this area is very small. These VSAs are common along the

coastal belt throughout the region with the Development Envelope providing connectivity between intact vegetation surrounding the Development Envelope. The variety of VSAs contributes to rich fauna assemblage and the largely uncleared nature of the region means that environments that support fauna are more or less continuous and extensive. VSAs are presented in Figure 12 and Figure 13.

5.2.5 Patterns of Biodiversity

Investigating patterns of biodiversity can be complex and are often beyond the scope even of level 2 investigations. They are usually based on the distribution of VSAs and the condition of vegetation. It is expected that the vegetation within the Development Envelope is of good condition due to the lack of development in the immediate area, except for some access tracks. There will almost certainly be slightly different fauna assemblages in different VSAs with the fewest species in near-coastal dunes and probably the most species, particularly of reptiles, in the heath on sand that occupies the majority of the Development Envelope. Mallee areas may have bird species not seen in other VSAs.

Figure 12: Vegetation and Substrate Associations in the northern project area

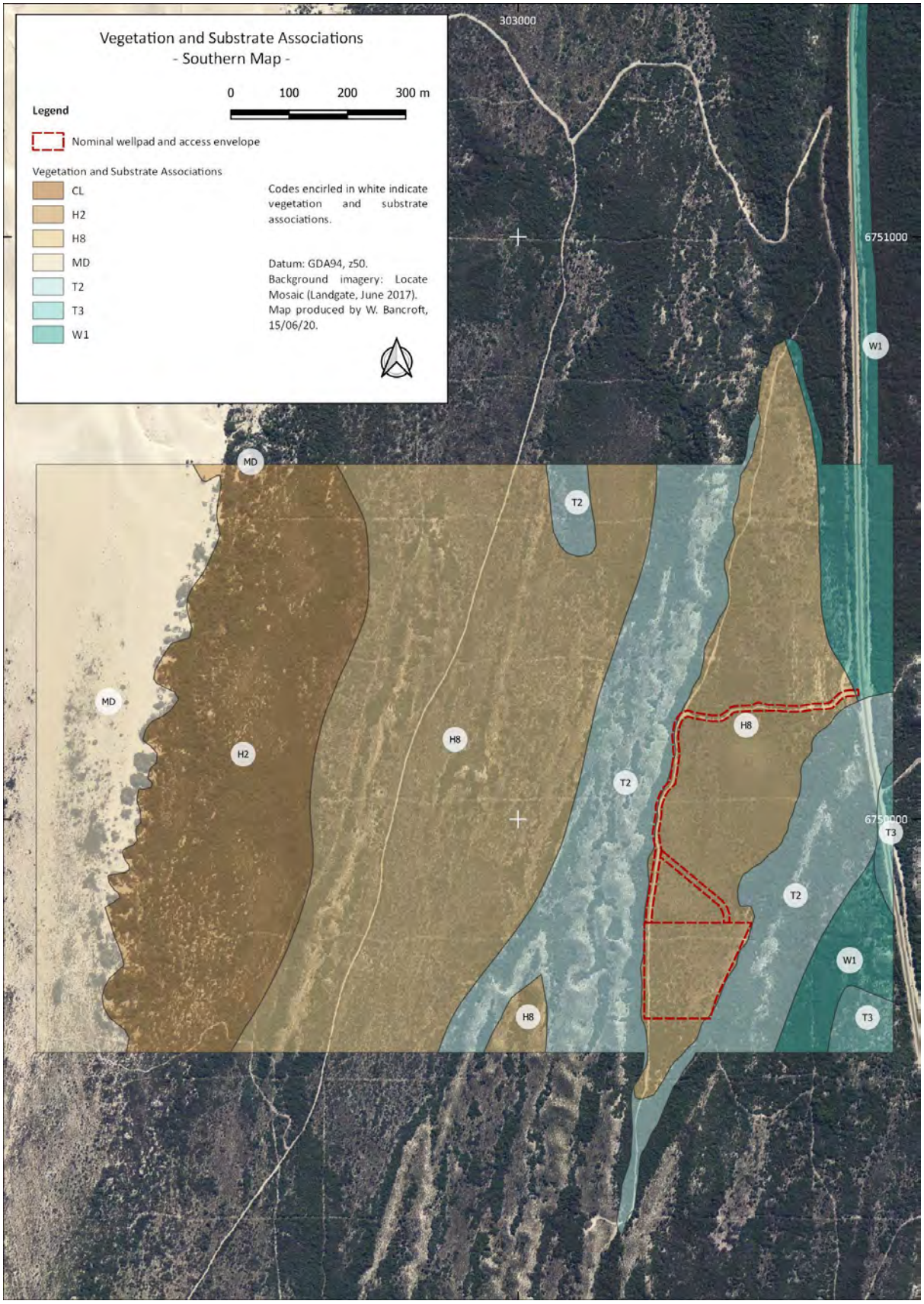


Figure 13: Vegetation and Substrate Associations in the southern project area

6 FIELD SURVEY RESULTS

6.1 Flora and Vegetation

6.1.1 Summary of Significant Flora Taxa

No significant flora was recorded within the Development Envelope during targeted searching in 2020.

6.1.2 Likelihood of Occurrence of Further Significant Flora Taxa

As detailed in section 5.1.4, a total of 19 listed significant flora taxa or habitat for such taxa are known from the Desktop Study Area, none of which have records within the Development Envelope itself. The Desktop assessment found five Priority flora taxa could potentially occur in the Development Envelope as suitable habitat may be present. Targeted searching of the entire Development Envelope at 20 m intervals did not locate any significant taxa. Table 22 presents an assessment of the likelihood of those taxa being present within the Development Envelope.

Table 22: Likelihood of Occurrence of Further Significant Flora Taxa in the Development Envelope

Taxon	Status	Flowering Period (WA Herbarium 1998-)	Habitat (WA Herbarium 1998-)	Nearest Known Location to Development Envelope (DBCA 2007-)	Identifiable During Previous Survey?	Likelihood of Occurrence in Development Envelope
Anthocercis intricata	P3	June to September	Consolidated sand dunes on sand or loam over limestone	3 km north	Yes	Unlikely: habitat present, however all potential habitat inspected during survey.
Dampiera tephrea	P2	August to October	Flats, riverbanks and slopes with sand or loam, often with limestone.	4.5 km NE	Yes	Unlikely: habitat present, however all potential habitat inspected during survey.
Eucalyptus zopherophloia	P4	October to December, January	Slopes and dunes with grey/white sand. Often with limestone. Coastal areas.	2 km NE	Yes	Unlikely: habitat present, however all potential habitat inspected during survey.
Haloragis foliosa	P3	December	Dunes, slopes and swales with white/grey sand often with limestone.	5 km south	Yes	Unlikely: habitat present, however all potential habitat inspected during survey.
Thryptomene sp. Lancelin (M.E. Trudgen 14000)	P3	August, September	Dunes and slopes with sand often with limestone.	4 km SSW	Yes	Unlikely: habitat present, however all potential habitat inspected during survey.

6.1.3 Vegetation Types

The presence and extent of four VTs mapped within the Development Envelope during the *Denison 3D Seismic Survey Flora and Vegetation Study* (Woodman Environmental 2005), were confirmed during the 2020 field survey (Table 23). The original vegetation was described using Muir (1977), the appropriate standard at the time of the initial survey. Vegetation type descriptions have been updated to align with the National Vegetation Information System (NVIS) (ESCAVI 2003), as stipulated by EPA (2016a). The 2020 reconnaissance survey confirmed the vegetation descriptions from the initial survey (Table 23).

Figures 14.1 – 14.4 display the updated vegetation type mapping, which includes minor amendments in vegetation boundaries based on ground truthing during field work conducted in 2020. Appendix K lists the taxa recorded within each vegetation type during the 2020 field survey, with raw data for each quadrat and relevé presented in Appendix L.

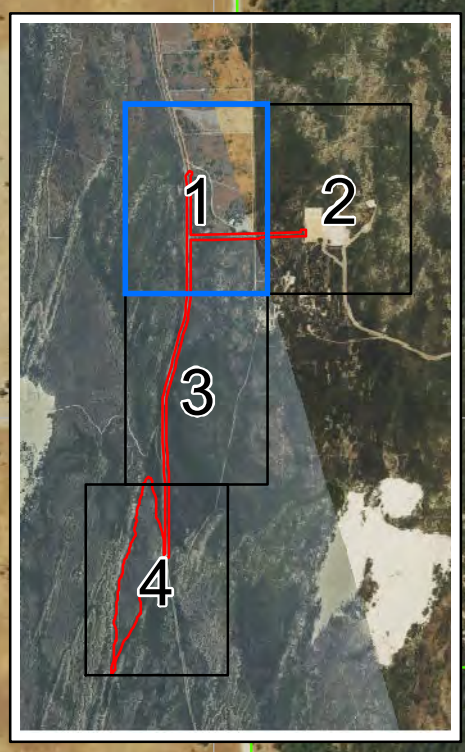
Table 23: Summary of Vegetation Types Confirmed within the Development Envelope 2020

Community Code / VT	Summary	Photograph
H8	**NVIS description:** Tall to mid open shrubland of *Acacia rostellifera, Melaleuca cardiophylla, Melaleuca huegelii* subsp. *huegelii* and *Santalum acuminatum* over low sparse shrubland of *Melaleuca systena* over low open sedgeland of *Gahnia* sp. South West (K.L. Wilson & K. Frank KLW 9266) on grey clayey sand in swales between dunes. **Original Muir (1977) description:** Heath dominated by *Melaleuca systena*, *Melaleuca huegelii* subsp. *huegelii*, *Acacia* spp. and *Santalum acuminatum* over sedges on grey sand with limestone outcropping in swales **Sampling:** 4 relevés (MET05, MET06, MET07, MET11) **Area Mapped and Proportion in Development Envelope:** 20.3 ha (55.6 %) **Area of H8 Mapped in Dension 3D Seismic Survey Project Area:** 2261.8 ha **Proportion of H8 Mapped in the Dension Seismic Survey located in the Development Envelope:** 0.8 %	 **Plate 1: Vegetation Type H8 – Relevé MET06**
T2	**NVIS description:** Tall closed shrubland of *Melaleuca cardiophylla* and/or *Melaleuca huegelii* subsp. *huegelii* on slopes of grey-brown sandy loam. **Original Muir (1977) description:** Thicket of *Melaleuca huegelii* subsp. *huegelii* and *Melaleuca cardiophylla* over mixed shrubs on grey sand on dune crests **Sampling:** 3 relevés (MET04, MET12, MET15) **Area Mapped and Proportion in Development Envelope:** 2.3 ha (6.4 %) **Area of T2 Mapped in Dension 3D Seismic Survey Project Area:** 1528.1 ha **Proportion of T2 Mapped in the Dension Seismic Survey located in the Development Envelope to be impacted by Project:** 0.2 %	 **Plate 2: Vegetation Type T2 – Relevé MET12**
T3	**NVIS description:** Tall closed shrubland to low sparse shrubland of *Acacia rostellifera*, *Melaleuca cardiophylla, Melaleuca huegelii* subsp. *huegelii, Melaleuca systena*, *Olearia* sp. Kennedy Range (G. Byrne 66) over low sedgeland of *Lepidosperma calcicola* on flats of grey-brown sandy loam. **Original Muir (1977) description:** Dense Thicket dominated by *Melaleuca cardiophylla* over herbs and grasses. **Sampling:** 4 relevés (MET01, MET02, MET03, MET13) **Area Mapped and Proportion in Development Envelope**: 0.8 ha (2.1 %) **Area of T3 Mapped in Dension 3D Seismic Survey Project Area:** 591.5 ha **Proportion of T3 Mapped in the Dension Seismic Survey located in the Development Envelope:** 0.1 %	 **Plate 3: Vegetation Type T3 – Relevé MET02**
W1	**NVIS description:** Mid open to closed mallee forest of *Eucalyptus obtusiflora* subsp. *dongarraensis* and *Eucalyptus oraria* over mid to tall sparse shrubland of *Melaleuca cardiophylla* and *Melaleuca huegelii* subsp. *huegelii,* with occasional *Acacia rostellifera* and *Melaleuca lanceolata* on slopes of grey sand. **Original Muir (1977) description:** Low Woodland of mixed mallees (includes *Eucalyptus obtusiflora* subsp. *dongarraensis* and *Eucalyptus oraria*) **Sampling:** 4 quadrats (MET08, MET09, MET10, MET14) **Area Mapped and Proportion in Development Envelope:** 7.0 ha (19.2 %) **Area of W1 Mapped in Dension 3D Seismic Survey Project Area:** 681.1 ha **Proportion of W1 Mapped in the Dension Seismic Survey located in the Development Envelope:** 1.0 %	 **Plate 4: Vegetation Type W1 – Quadrat MET09**

303500 303750 304000 304250

6753500 6753250 6753000 6752750 6752500 6752250

T1 CL T3 H8 T2 T2



Legend

Development Envelope

Plant Community boundaries (Woodman Environmental 2005)

Vegetation Type

CL Cleared

W1 Mid open to closed mallee forest of *Eucalyptus obtusiflora* subsp. *dongarraensis* and *Eucalyptus oraria* over mid to tall sparse shrubland of *Melaleuca cardiophylla* and *Melaleuca huegelii* subsp. *huegelii,* with occasional *Acacia rostellifera* and *Melaleuca lanceolata* on slopes of grey sand

0 100 200 400 Meters

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC project Metgasco20-11-01.

Cervantes 1 Convention Well
Vegetation Type Mapping

Revision: 2 - 02 July 2020 Scale: 1:4,000 (A3)

Author: Leah Firth

WEC Ref: Metgasco20-11-01

Filename: Metgasco20-11-01-f14

Projection: GDA 1994 MGA Zone 50

Figure

14.1

304500 304750 305000 305250

6753500 6753250 6753000 6752750 6752500 6752250

W1 T3 W1 T3 CL CL

1 2 3 4

Legend

Development Envelope

Plant Community boundaries (Woodman Environmental 2005)

Vegetation Type

CL Cleared

T3 Tall closed shrubland to low sparse shrubland of *Acacia rostellifera*, *Melaleuca cardiophylla, Melaleuca huegelii* subsp. *huegelii, Melaleuca systena*, *Olearia* sp. Kennedy Range (G. Byrne 66) over low sedgeland of *Lepidosperma calcicola* on flats of grey-brown sandy loam.

W1 Mid open to closed mallee forest of *Eucalyptus obtusiflora* subsp. *dongarraensis* and *Eucalyptus oraria* over mid to tall sparse shrubland of *Melaleuca cardiophylla* and *Melaleuca huegelii* subsp. *huegelii,* with occasional *Acacia rostellifera* and *Melaleuca lanceolata* on slopes of grey sand

0 100 200 400 Meters

N

WOODMAN ENVIRONMENTAL

This map should only be used in conjunction with WEC project Metgasco20-11-01.

Cervantes 1 Convention Well
Vegetation Type Mapping

Revision: 2 - 02 July 2020 Scale: 1:4,000 (A3)

Author: Leah Firth

WEC Ref: Metgasco20-11-01

Filename: Metgasco20-11-01-f14

Projection: GDA 1994 MGA Zone 50

Figure

14.2

303500 303750 304000 304250

6752000 6751750 6751500 6751250 6751000

H8 T2 H8 W1 H8

1 2 3 4

Legend

Development Envelope

Plant Community boundaries (Woodman Environmental 2005)

Vegetation Type

CL Cleared

H8 Tall to mid open shrubland of *Acacia rostellifera, Melaleuca cardiophylla, Melaleuca huegelii* subsp. *huegelii* and *Santalum acuminatum* over low sparse shrubland of *Melaleuca systena* over low open sedgeland of *Gahnia* sp. South West (K.L. Wilson & K. Frank KLW 9266) on grey clayey sand in swales between dunes

T2 Tall closed shrubland of *Melaleuca cardiophylla* and/or *Melaleuca huegelii* subsp. *huegelii* on slopes of grey-brown sandy loam

W1 Mid open to closed mallee forest of *Eucalyptus obtusiflora* subsp. *dongarraensis* and *Eucalyptus oraria* over mid to tall sparse shrubland of *Melaleuca cardiophylla* and *Melaleuca huegelii* subsp. *huegelii,* with occasional *Acacia rostellifera* and *Melaleuca lanceolata* on slopes of grey sand

0 100 200 400 Meters

303500 303750 304000 304250

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC project Metgasco20-11-01.

Cervantes 1 Convention Well
Vegetation Type Mapping

Revision: 2 - 02 July 2020 Scale: 1:4,000 (A3)

Author: Leah Firth

WEC Ref: Metgasco20-11-01

Filename: Metgasco20-11-01-f14

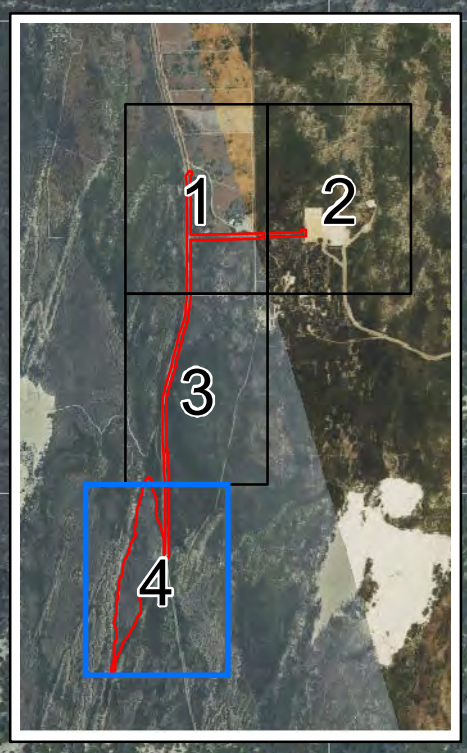
Projection: GDA 1994 MGA Zone 50

Figure

14.3

303000 303250 303500 303750 304000

6750750 6750500 6750250 6749750 6749500 6750000



H8 W1 H8 T2 H8 W1

Legend

- Development Envelope
- Plant Community boundaries (Woodman Environmental 2005)

Vegetation Type

- CL Cleared
- H8 Tall to mid open shrubland of *Acacia rostellifera, Melaleuca cardiophylla, Melaleuca huegelii* subsp. *huegelii* and *Santalum acuminatum* over low sparse shrubland of *Melaleuca systena* over low open sedgeland of *Gahnia* sp. South West (K.L. Wilson & K. Frank KLW 9266) on grey clayey sand in swales between dunes
- T2 Tall closed shrubland of *Melaleuca cardiophylla* and/or *Melaleuca huegelii* subsp. *huegelii* on slopes of grey-brown sandy loam
- W1 Mid open to closed mallee forest of *Eucalyptus obtusiflora* subsp. *dongarraensis* and *Eucalyptus oraria* over mid to tall sparse shrubland of *Melaleuca cardiophylla* and *Melaleuca huegelii* subsp. *huegelii,* with occasional *Acacia rostellifera* and *Melaleuca lanceolata* on slopes of grey sand

0 100 200 400 Meters

303000 303250 303500 303750 304000

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC project Metgasco20-11-01.

Cervantes 1 Convention Well
Vegetation Type Mapping

Revision: 2 - 02 July 2020 Scale: 1:4,000 (A3)

Author: Leah Firth
WEC Ref: Metgasco20-11-01
Filename: Metgasco20-11-01-f14
Projection: GDA 1994 MGA Zone 50

Figure
14.4

6.1.4 Significant Vegetation

Of the VTs described and mapped in the Development Envelope, it is considered that one; W1 'Mid open to closed mallee forest of *Eucalyptus obtusiflora* subsp. *dongarraensis* and *Eucalyptus oraria* over mid to tall sparse shrubland of *Melaleuca cardiophylla* and *Melaleuca huegelii* subsp. *huegelii,* with occasional *Acacia rostellifera* and *Melaleuca lanceolata* on slopes of grey sand' represents the state listed PEC 'Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora*'.

No formal description has been published which outlines specific criteria to determine the requirements of inclusion in the PEC. Our assessment included comparing the vegetation type W1 within the Development Envelope with other vegetation communities identified as being representative of this PEC in previous surveys, namely communities 9 and 11 of the Geraldton Regional Flora and Vegetation Survey (Department of Planning and Ecoscape 2010).

Floristically, the state listed PEC 'Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora*' is similar to other *Acacia rostellifera* communities but is differentiated on structure, being dominated by mallee eucalypts (V. English *pers. comm*.). Vegetation type W1 is dominated by mallee Eucalypts; *Eucalyptus obtusiflora* subsp. *dongarraensis* and *Eucalyptus oraria*, forming an open to closed mallee forest within the Development Envelope.

The dominant plant taxa recorded within the PEC in communities 9 and 11 of the Geraldton Regional Flora and Vegetation Survey (Department of Planning and Ecoscape 2010) are *Eucalyptus obtusiflora, Eucalyptus oraria, Acacia rostellifera, Melaleuca cardiophylla* and *Melaleuca huegelii*. These taxa were also recorded as dominant taxa within vegetation type W1.

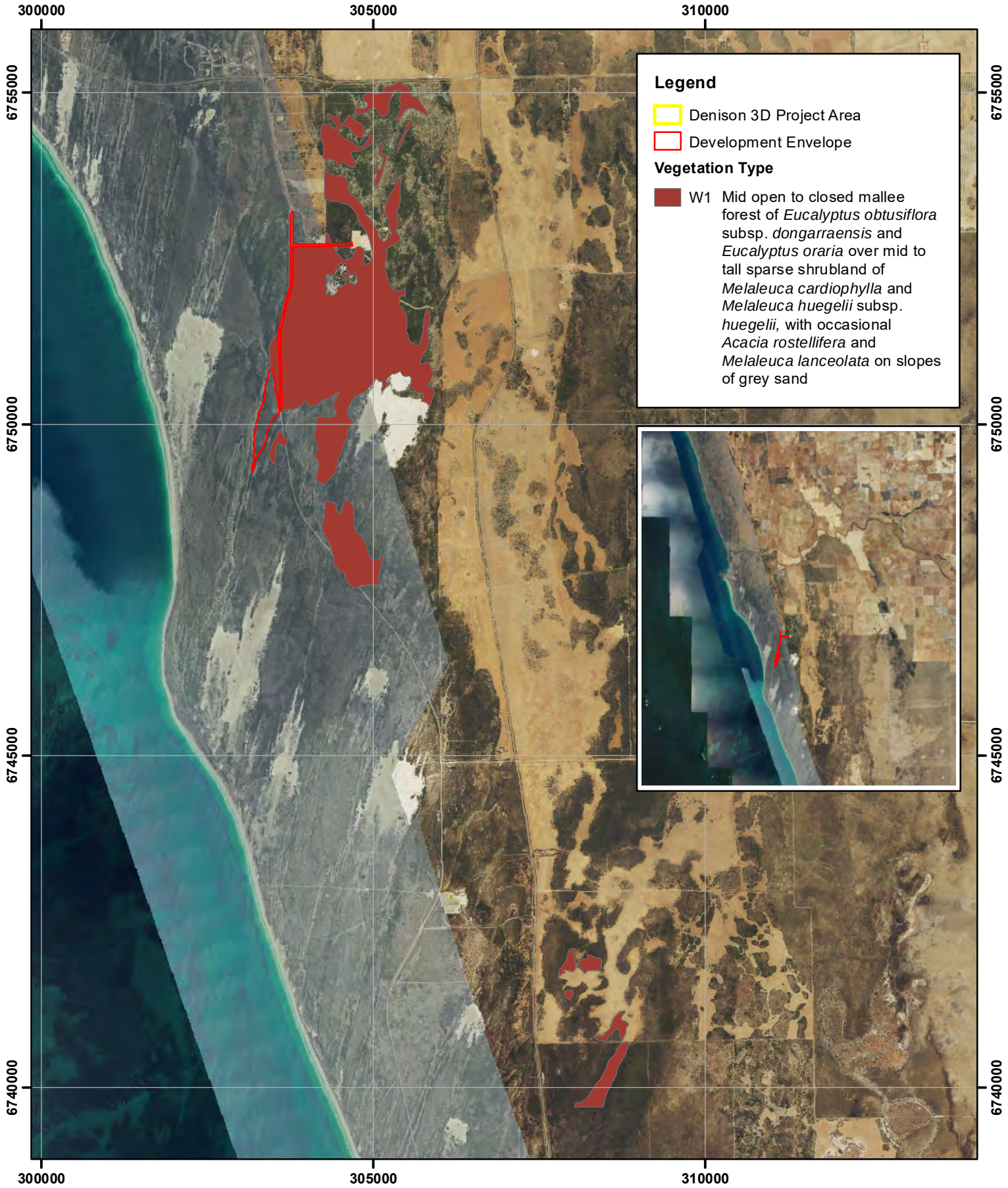
Previous occurrences of this PEC have been located on the following:

- Mostly Tamala and Quindalup soil systems with small areas of Greenough Alluvium and Northampton;
- Grey to white sand or loamy sand;
- No exposed rock, limestone pebbles or cobbles;
- The landform varies from gentle to steep – slope, dune, valley plain or ridge.

Vegetation type W1 is representative of this, being located on mid slopes of the Quindalup soil system on grey sand with no exposed rock or pebbles.

Based on information available on the state listed PEC 'Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora*' vegetation type W1 was assessed as being representative of the PEC.

Vegetation type W1 was mapped widely in the local area during the Dension 3D Seismic Survey, with 681.07 ha mapped (Woodman 2005). Only 1 % (7 ha) of the total area mapped as W1 during the survey is located within the Development Envelope (Figure 15).



Vegetation Type W1 (Priority Ecological Community 'Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora*') within Development Envelope and the Local Area

WOODMAN ENVIRONMENTAL

This map should only be used in conjunction with WEC report Metgasco 20-11-01.

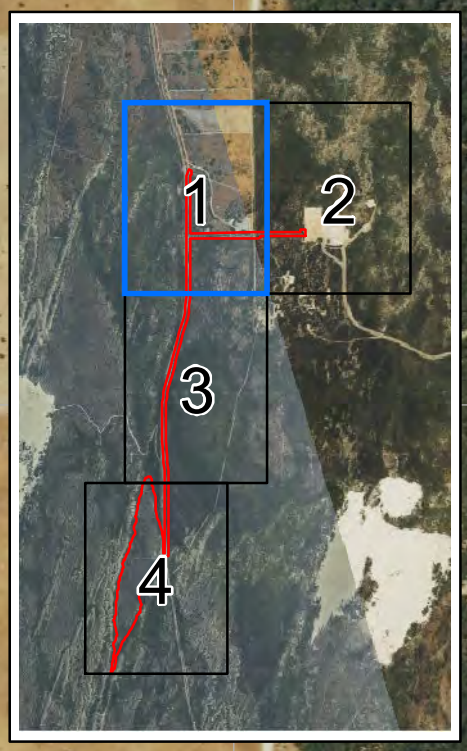
Author: Leah Firth	
WEC Ref: Metgasco20-11-01	
Filename: Metgasco20-11-01-f15	Figure 15
Scale: 1:75,000 (A4)	
Projection: GDA 1994 MGA Zone 50	
Revision: 2 - 02 July 2020	

6.1.5 Vegetation Condition

Vegetation condition mapping polygons are displayed in Figures 16.1 – 16.4. The condition of the majority of the vegetation in the Development Envelope was rated Excellent. Generally, there was little evidence of unnatural disturbance, with weeds generally absent or at very low levels across the Development Envelope. The vegetation condition subjected to edge effects when in proximity to vehicle tracks was generally rated as Good, with small areas rated as Degraded.

303500 303750 304000 304250

6753500 6753250 6753000 6752750 6752500 6752250



Legend

- Development Envelope

Vegetation Condition

- Cleared
- Good
- Excellent

0 100 200 400 Meters

N

WOODMAN ENVIRONMENTAL

This map should only be used in conjunction with WEC project Metgasco20-11-01.

Cervantes 1 Convention Well
Vegetation Condition Mapping

Revision: 2 - 02 July 2020 Scale: 1:4,000 (A3)

Author: Leah Firth

WEC Ref: Metgasco20-11-01

Filename: Metgasco20-11-01-f16

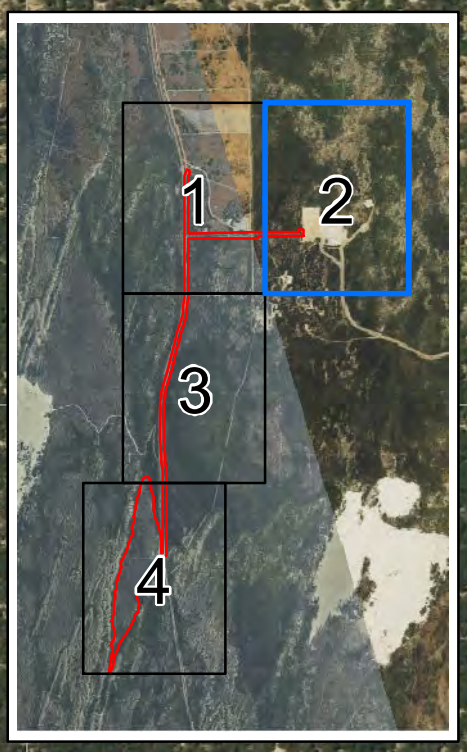
Projection: GDA 1994 MGA Zone 50

Figure

16.1

304500 304750 305000 305250

6753500 6753250 6753000 6752750 6752500 6752250



Legend

- Development Envelope

Vegetation Condition

- Cleared
- Degraded
- Good
- Excellent

0 100 200 400 Meters

N

This map should only be used in conjunction with WEC project Metgasco20-11-01.

Cervantes 1 Convention Well
Vegetation Condition Mapping

Revision: 2 - 02 July 2020 Scale: 1:4,000 (A3)

Author: Leah Firth

WEC Ref: Metgasco20-11-01

Filename: Metgasco20-11-01-f16

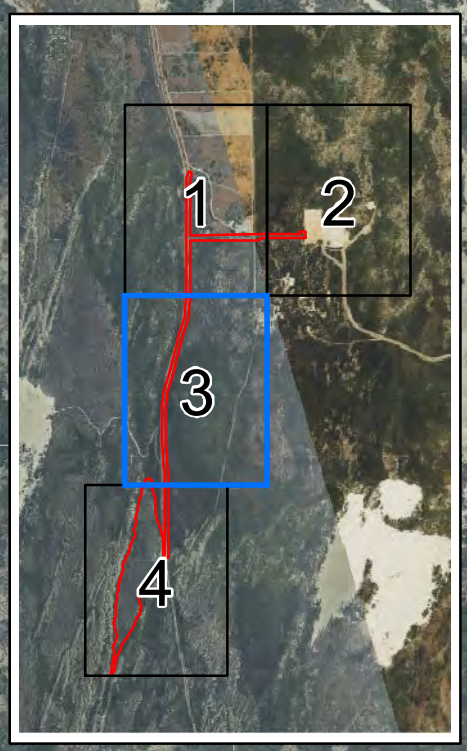
Projection: GDA 1994 MGA Zone 50

Figure

16.2

303500 303750 304000 304250

6752000 6751750 6751500 6751250 6751000



Legend

Development Envelope

Vegetation Condition

Cleared

Good

Excellent

0 100 200 400 Meters

303500 303750 304000 304250

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC project Metgasco20-11-01.

Cervantes 1 Convention Well
Vegetation Condition Mapping

Revision: 2 - 02 July 2020 Scale: 1:4,000 (A3)

Author: Leah Firth

WEC Ref: Metgasco20-11-01

Filename: Metgasco20-11-01-f16

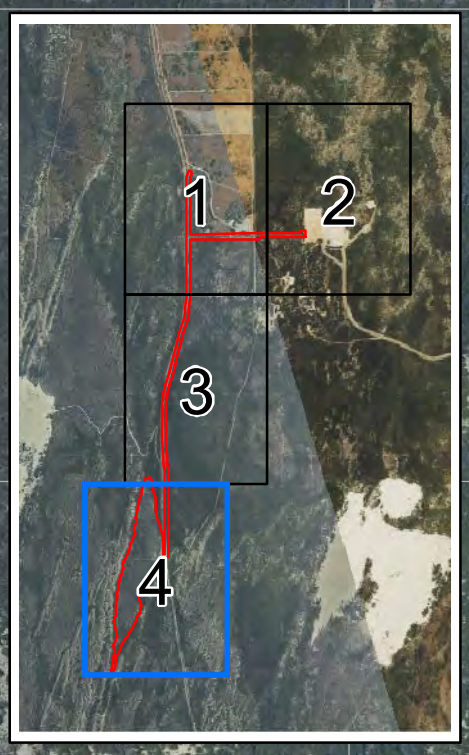
Projection: GDA 1994 MGA Zone 50

Figure

16.3

303000 303250 303500 303750 304000

6750750 6750500 6750250 6750000 6749750 6749500



Legend

Development Envelope

Vegetation Condition

Cleared

Good

Excellent

0 100 200 400 Meters

303000 303250 303500 303750 304000

N

Cervantes 1 Convention Well
Vegetation Condition Mapping

Revision: 2 - 02 July 2020 Scale: 1:4,000 (A3)

Author: Leah Firth

WEC Ref: Metgasco20-11-01

Filename: Metgasco20-11-01-f16

Projection: GDA 1994 MGA Zone 50

Figure

16.4

6.2 Fauna

6.2.1 Fauna Assemblages

Field investigations supported the results of the desktop study, which identified 207 fauna species as potentially occurring in the Development Envelope: nine frogs, 50 reptiles, 122 birds, 16 native and ten introduced mammals. The fauna assemblage is fairly complete except for medium-sized and small mammals which have been lost as is common throughout the region.

6.2.1.1 Black-Cockatoo Habitat Analysis

The only black-cockatoo species of conservation significance black-cockatoo that is likely to occur within the vicinity of the Development Envelope is Carnaby's Black-Cockatoo (see section 5.3.2) therefore, the following results pertain to that species only.

6.2.1.2 Breeding Tree Assessment

There were no potential hollow-bearing trees within the Development Envelope and, as such, it is not expected that Carnaby's Black-Cockatoo will breed within the survey area.

6.2.1.3 Foraging Habitat Assessment

The survey area is expected to provide very little foraging value for Carnaby's Black-Cockatoo. This is predominantly due to the lack of proteaceous species (especially tree banksias) and/or Marri (*Eucalyptus calophylla*) known to be mainstays of the Carnaby's Black-Cockatoo diet. Maps of the vegetation scores of the study area for Carnaby's Black-Cockatoo foraging are presented in Figure 17 and Figure 18. The areas (and percentages) of each vegetation score are shown in Table 24; vegetation foraging scores are either low (2 out of 6) or negligible (1 out of 6). Vegetation in these areas was categorised by WEC as:

- Cleared (CL);
- Tall to mid open shrubland of Acacia and Melaleuca (H8);
- Tall closed shrubland of Melaleuca (T2);
- Tall closed shrubland to low sparse shrubland of Acacia and Melaleuca (T3); and
- Mid open to closed mallee forest of Eucalyptus and Melaleuca (W1).

There are approximately 22,655 ha of remnant native vegetation within 12 km of the survey area which itself has approximately 34 ha of native vegetation. Therefore, the site comprises approximately 0.2% of the native vegetation in the 'local area' (see Appendix B) and it has been assigned a 'context' score of 1 (out of 3). The survey area was assigned a species density score for Carnaby's Black-Cockatoo of 1 (out of 1). These values would ordinarily be added on to the vegetation scores to yield the overall foraging value scores but in this instance, after moderation (see Appendix B), no vegetation had a sufficient score to continue this process. Therefore, final overall foraging value scores are 2 out of 10 (10.6 ha) and 1 out of 10 (25.9 ha). Consistent with these negligible to low foraging values, no evidence of foraging by Carnaby's Black-Cockatoos was noted at the site. Foraging signs can persist for months and even years, so foraging by the species in the Development Envelope is clearly very infrequent.

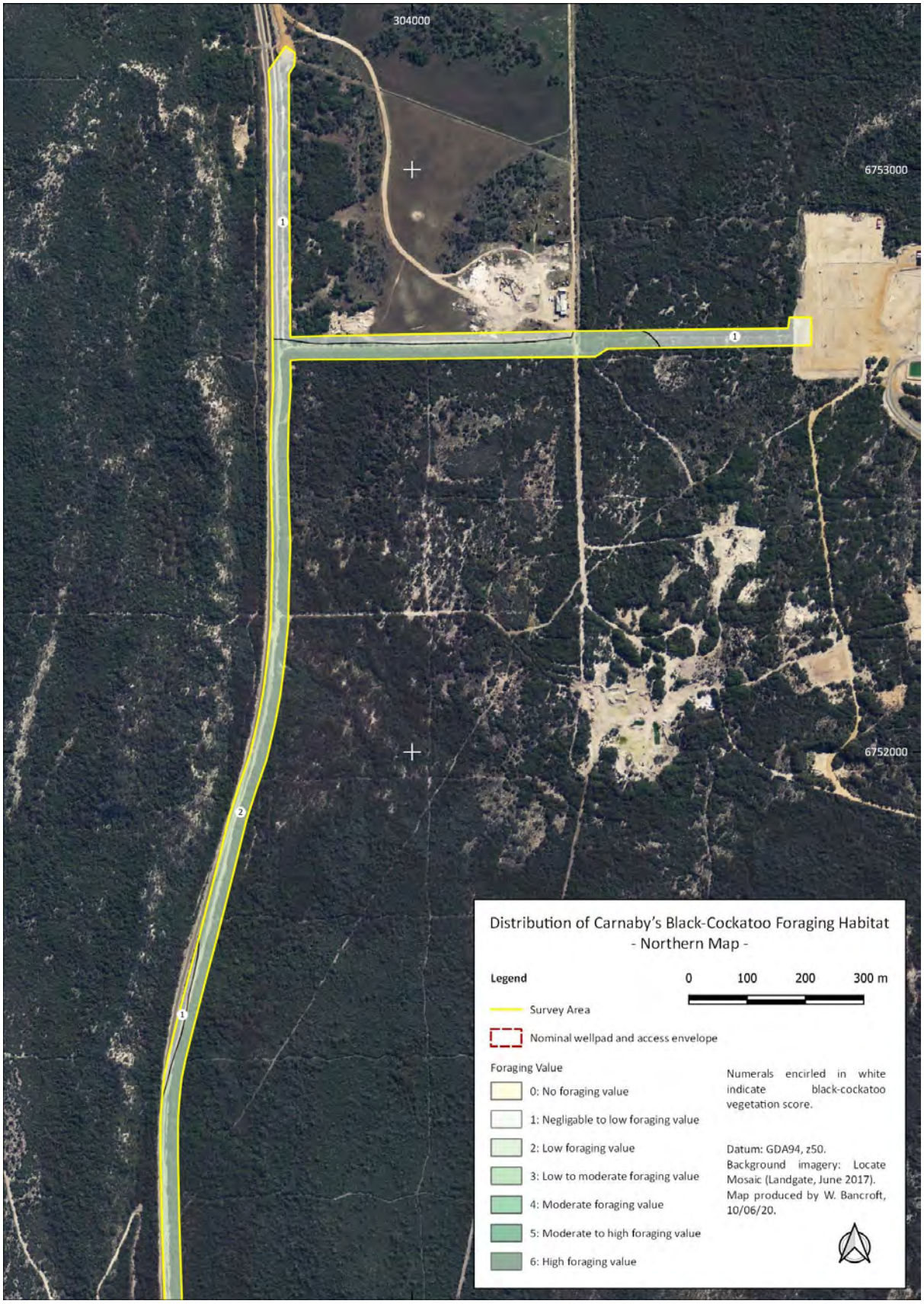


Figure 17: Distribution of Carnaby's Black-Cockatoo foraging habitat in the northern survey area

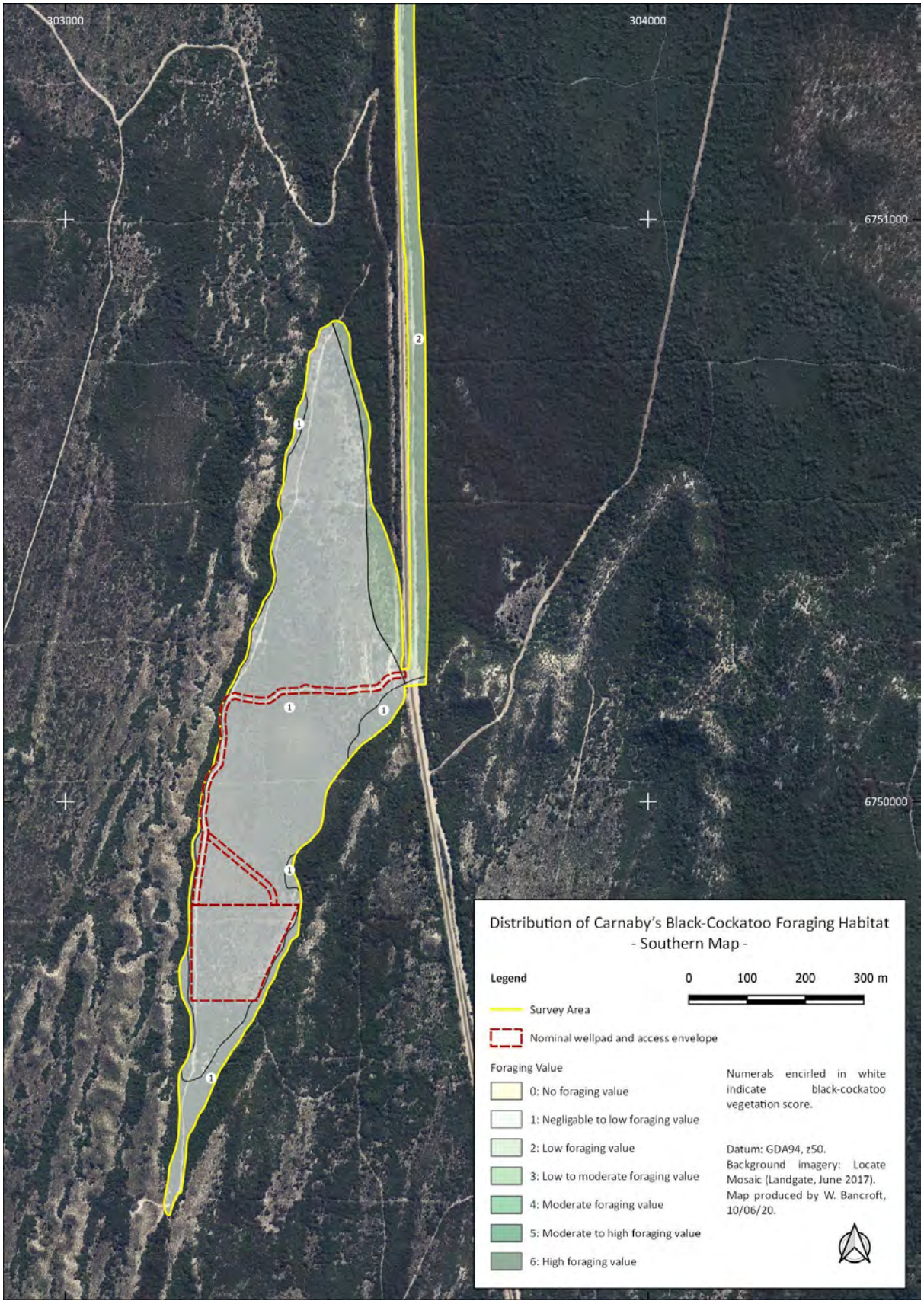


Figure 18: Distribution of Carnaby's Black-Cockatoo foraging habitat in the southern survey area

Table 24: Areas (ha) and Proportions (%) of Each Category (vegetation score, combined foraging score) of Foraging Habitat at the Survey Area for Carnaby's Black-Cockatoo.

Vegetation Score/Value	Area (ha)	%
6: High	0.0	0.0
5: Moderate to High	0.0	0.0
4: Moderate	0.0	0.0
3: Low to Moderate	0.0	0.0
2: Low	10.6	29.0
1: Negligible	25.9	71.0
0: Nil	0.0	0.0
TOTAL	36.5	100.0
Context Score	1	
Species Density Score	1	
Foraging Score		
NA (Vegetation Score < 3)	36.5	100.0
TOTAL	36.5	100.0

See Appendix B for explanation of vegetation, context, species density and (combined) foraging scores.

6.2.1.4 Roosting Habitat Assessment

There was no habitat within the survey area that was considered to be highly desirable for black-cockatoo roosting (*sensu* DAWE 2020). A map of known roost sites surrounding the Development Envelope is presented in Figure 19; one known roost occurs within 12 km of the site. This was in large trees around a wetland near the north-eastern boundary of Yardanogo Nature Reserve at 316325EmE 6752399mS, where 500+ birds were seen in April 2015 (M. Bamford pers. obs.).

6.2.1.5 Opportunistic Observation

Ten species were recorded opportunistically during the field, as indicated in Appendix G. All are common in the region and were expected to occur (from the desktop study). None was of conservation significance.

Figure 19: Known Black-Cockatoo Roost Locations in the Vicinity of the Development Envelope

Cockatoo roosts are those identified by the Great Cocky Count (GCC) and provided by DBCA (2020), and unpublished records from Bamford Consulting (BCE).

6.2.2 Vegetation and Substrate Associations

The Development Envelope is comprised mostly of vegetation type H8, as outlined in section 6.1.3, which will support a rich reptile assemblage and understorey-associated birds. Vegetation type T2 in the east may support additional middle-storey birds and some larger mammals; and the small area of mallee woodland (W1) in the east is expected to support woodland-associated species.

6.2.3 Ecological Processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see Appendix M for descriptions and other ecological processes). These include:

Fire

Vegetation of the Geraldton Sandplains are fire-adapted but the flora and fauna assemblages can be altered by too-frequent fires, fire exclusion, and fire season. The decline of the Western Ground Parrot in the area is likely to be a result of infrequent but extensive fires that have destroyed a former mosaic of fire ages.

Feral species and interactions with over-abundant native species

The fauna assemblage of the Development Envelope has already been impacted by feral species (loss of a major component of the mammal fauna), and feral herbivores are likely leading to degradation of native vegetation.

Hydrology

At least some of the vegetation (and thus fauna habitat) is likely to be reliant on groundwater, and it is likely there is a subterranean fauna assemblage associated with groundwater.

7 DISCUSSION AND CONCLUSIONS

7.1 Flora and Vegetation

The Development Envelope and Desktop Study Area have been subjected to a number of previous surveys which have provided good contextual information for the desktop assessment of the Development Envelope. Although these surveys were undertaken 15 - 16 years ago, the surveys that have been undertaken are considered to be relatively reliable and comprehensive. This includes the Denison 3D Seismic Survey Flora and Vegetation Study (Woodman Environmental 2005) which covers the entire Development Envelope and the majority of intact vegetation in the Desktop Study Area.

The reconnaissance and targeted flora and vegetation survey undertaken in February 2020 confirmed the plant communities present, assessed the presence of significant vegetation (PEC) and searched for significant flora identified as potentially occurring in the Development Envelope. Based on the existing flora and vegetation data available for the Development Envelope and the significant flora identified as potentially occurring in the Development Envelope, a spring-timed survey was not considered necessary.

The desktop assessment identified a total of 19 significant flora taxa or habitat for significant taxa, which are known from within the Desktop Study Area including 13 DBCA-classified Priority flora, and six Threatened flora. A likelihood of occurrence assessment taking into account plant communities mapped within the Development Envelope, identified a total of five significant flora taxa (all priority listed taxa) which are considered to potentially occur in the Development Envelope including *Anthocercis intricata* (P3), *Dampiera tephrea* (P2), *Eucalyptus zopherophloia* (P4), *Haloragis foliosa* (P3) and *Thryptomene* sp. Lancelin (M.E. Trudgen 14000) (P3). The remaining 14 significant taxa are considered unlikely to occur primarily because suitable habitat is not considered to be present in the Development Envelope. The five taxa which were considered as potentially occurring within the Development Envelope (based on the likelihood of occurrence assessment) are perennial taxa which are all identifiable throughout the year. None of these five taxa were recorded during the targeted flora survey in February 2020 and it is therefore considered unlikely that they are present within the Development Envelope.

A total of 75 introduced taxa or habitat for such taxa are known to occur in the Desktop Study Area. Of these five are considered to be significant weeds including *Asparagus asparagoides, Lantana camara, Tamarix aphyllaare* (Declared Pests and WoNS), *Echium plantagineum* (Declared Pest) and *Lycium ferocissimum* (WoNS). Given the high number of introduced taxa known from the Desktop Study Area, weed hygiene practices will be an important component of any potential works to be undertaken for the Project.

A total of four vegetation types / plant communities have been previously mapped over the Development Envelope by Woodman Environmental (2005). The presence and extent of these vegetation types were confirmed within the Development Envelope during the field survey in 2020. One community has affinities with the Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora* PEC (P1). However, this occurrence

has not been formally recognised and mapped by DBCA. The 2020 field survey confirmed the presence and extent of this PEC in the Development Envelope. All plant communities mapped within the Development Envelope, including the PEC (W1), have been mapped widely throughout 3D Denison Project Area with only 1 % (7 ha) of the total area mapped as vegetation type W1 during the Dension 3D Seismic Survey (Woodman 2005) located within the Development Envelope. Table 25 presents the proposed project impact areas with respect to vegetation types of the Development Envelope.

Table 25: Proposed Project Disturbance to Vegetation Types

Vegetation Community		Area to be impacted by Proposal	Area of Community recorded within Denison 3D Seismic Survey Study Area	Percentage Impact on Community
H8	Heath	3.25 ha	2261.78 ha	0.144%
T2	Dense Melaleuca thicket	0.07 ha	1528.11 ha	0.004%
T3	Dense Melaleuca thicket	0.20 ha	591.54 ha	0.034%
W1	Low woodland	1.79 ha	681.07 ha	0.263%
TOTAL		5.31 ha		

There were no degraded communities mapped within the Development Envelope and the majority of vegetation within Northern Beekeepers Reserve was described as being in Excellent condition.

7.2 Fauna

The desktop study identified 207 fauna species as potentially occurring in the Development Envelope: nine frogs, 50 reptiles, 122 birds, 16 native and ten introduced mammals. Field investigations supported the results of the desktop study. Fauna values within the project area can be summarised as follows:

Fauna assemblage

Fairly complete except for medium-sized and small mammals which have been lost as is common throughout the region. A rich and distinctive assemblage that has a limited distribution in the north of the Geraldton Sandplain bioregion. The Development Envelope is small in the context of the coastal belt and region, so the impact of exploration works on the fauna assemblage is expected to be minor and localised.

Species of conservation significance

Significant species of note that are likely to occur in the Development Envelope regularly include the Black-striped Snake, Carnaby's Black-Cockatoo, Brush Wallaby and some CS3 species. The Carnaby's Black-Cockatoo would be present as a regular migrant but only in small numbers, as the vegetation is of low foraging value for the species and there is no

breeding habitat. There is a slight possibility of the Western Ground Parrot and Woma persisting in the area. If present, a population of the Western Ground Parrot would be very important. There may be a subterranean fauna assemblage that could include SRE species.

The loss of foraging habitat for species such as the Carnaby's Black-Cockatoo is expected to be negligible. The overall foraging value scores are negligible to low with no evidence of foraging by Carnaby's Black-Cockatoos noted at the site. Foraging signs can persist for months and even years, so foraging by the species in the Development Envelope is clearly very infrequent.

Vegetation and Substrate Associations

The Development Envelope is comprised mostly of vegetation type H8, as outlined in section 5.3.3, which will support a rich reptile assemblage and understorey-associated birds. Vegetation type T2 in the east may support additional middle-storey birds and some larger mammals; and the small area of mallee woodland (W1) in the east is expected to support woodland-associated species.

Patterns of biodiversity

Detailed patterns of biodiversity could not be examined, but it can be expected that each vegetation type will support a diverse suite of species, with lowest biodiversity expected on the mobile dune in the west.

Key ecological processes

Main processes currently affecting the fauna assemblage in the Development Envelope include fire, feral species and hydrology. There is the potential for increased fires from introduced human presence and activity in the area, and this has the potential to impact both local and surrounding areas and fauna, especially if the fire is not contained. It is recommended to ensure a suitable Emergency Response Plan (with fire mitigation) is in place prior to commencement of works.

Increased human activity has the potential to attract feral animals to the area which may impact fauna through predation and/or competition. Feral animals will also follow tracks which increases their presence in otherwise undisturbed landscapes. It is recommended to develop a Fauna Management Plan (with feral animal management) prior to commencement of works.

Vegetation clearance may lead to fragmentation and loss of connectivity within the local area. However, clearance for exploration works is expected to be small so this impact is likely to be negligible.

7.2.1 Preliminary Fauna Impact Assessment

General preliminary comments can be made on the potential impacts of exploration works on fauna values in the project area. These include the following:

1. Small project area size. The project area is small in the context of the coastal belt and region, so the impact of exploration works on the fauna assemblage is expected to be minor and localised. Vegetation and soils are extensive in the region. The loss of

foraging habitat for species such as the Carnaby's Black-Cockatoo is expected to be negligible due to the small project area size, the low foraging value of the vegetation (desktop assessment of foraging value only) and presence of similar habitat nearby. Referral of the project for this species would be required if >1 ha of quality foraging habitat was to be impacted, but it seems unlikely that the vegetation would qualify as quality forging habitat.

2. Increased fire frequency/intensity. There is the potential for increased fires from introduced human presence and activity in the area, and this has the potential to impact both local and surrounding areas and fauna, especially if the fire is not contained. It is recommended to ensure a suitable Emergency Response Plan (incorporating fire management) is in place prior to commencement of works.
3. Increased feral animals. Increased human activity has the potential to attract feral animals to the area which may impact fauna through predation and/or competition. Feral animals will also follow tracks which increases their presence in otherwise undisturbed landscapes. It is recommended to develop a Fauna Management Plan (incorporating feral animal management) prior to commencement of works.
4. Fragmentation. Vegetation clearance may lead to fragmentation and loss of connectivity within the local area. However, clearance for exploration works is expected to be small and rehabilitation across all cleared areas is proposed, so this impact is likely to be negligible.
5. Hydrological change. The soils are highly porous so surface hydrology should not be affected by the activity. Drilling will not interact with sub-surface hydrology and there will effectively be no vibration, so subterranean fauna will not be impacted in more than the immediate vicinity of the wellbore (<5 m). Surface excavation and soil disturbance are also limited to the immediate vicinity of the wellbore. The EPA (2016b) recommends that if there is a high likelihood of subterranean fauna being present, and where the impact is expected to be low, then low-intensity sampling for subterranean fauna should be carried out. In this case, however, while there is a high likelihood of subterranean fauna being present (extensive sub-surface limestone), this habitat is widespread and the area of impact is extremely small; the impact is therefore considered to be negligible in the context of available habitat.
6. Dust, light, disturbance and noise. Impacts of these are difficult to predict and depend on the level of existing disturbance in the area which is likely to be low. Night operations using lighting may cause an increase in fauna mortality and should be avoided. These impacts will be temporary for the period of exploration activity (c. 90 days (<40 days for light disturbance)).

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Appendix A: Bamford Consulting Ecologists Black-Cockatoo Nesting-Tree Assessment Protocol

Bamford Consulting Ecologists base black-cockatoo nesting-tree assessments on Federal guidelines (DEE 2017; DotE 2018a, b, c) but also refer to the following when undertaking field surveys.

Measuring DBH

While black-cockatoos generally nest towards the crown of a tree, the diameter of a tree at breast-height (DBH) can be indicative of the likelihood of hollow-formation in the upper trunk and can be used in the assessment of the 'value' of a tree to breeding black-cockatoos. A DBH threshold of 500 mm (or 300 mm for Wandoo, *Eucalyptus wandoo*, and Salmon Gum, *E. salmonophloia*) is commonly used to delineate 'potential' nest-trees (DotE 2018a, b, c), however the tree has to be *functionally capable of supporting a nest hollow* and there are several exceptions where trees that meet a strict DBH threshold are excluded (e.g. those with low-forking into narrow-diameter trunks, or those that have been hollowed-out and 'opened' by fire). Thus some discretion needs to be used when assessing trees.

The international standard for 'breast height' is 1.3 m (James and Shugart Jr 1970).

Only occasionally are trees close to perfectly cylindrical. As such, wherever possible, DBH should be 'representative' of the tree. In cases where the tree is approximately oval in cross-section, BCE measures the diameter of the shorter axis. Note that other methods such as circumference, or the quadratic average of the long and short axes are used in some applications, but logistic constraints generally require a more pragmatic approach. DBH should be reflective of the trunk above the nesting threshold (see below). Where a tree spreads at the base along one axis, the axis that best represents the trunk above is chosen for measurement.

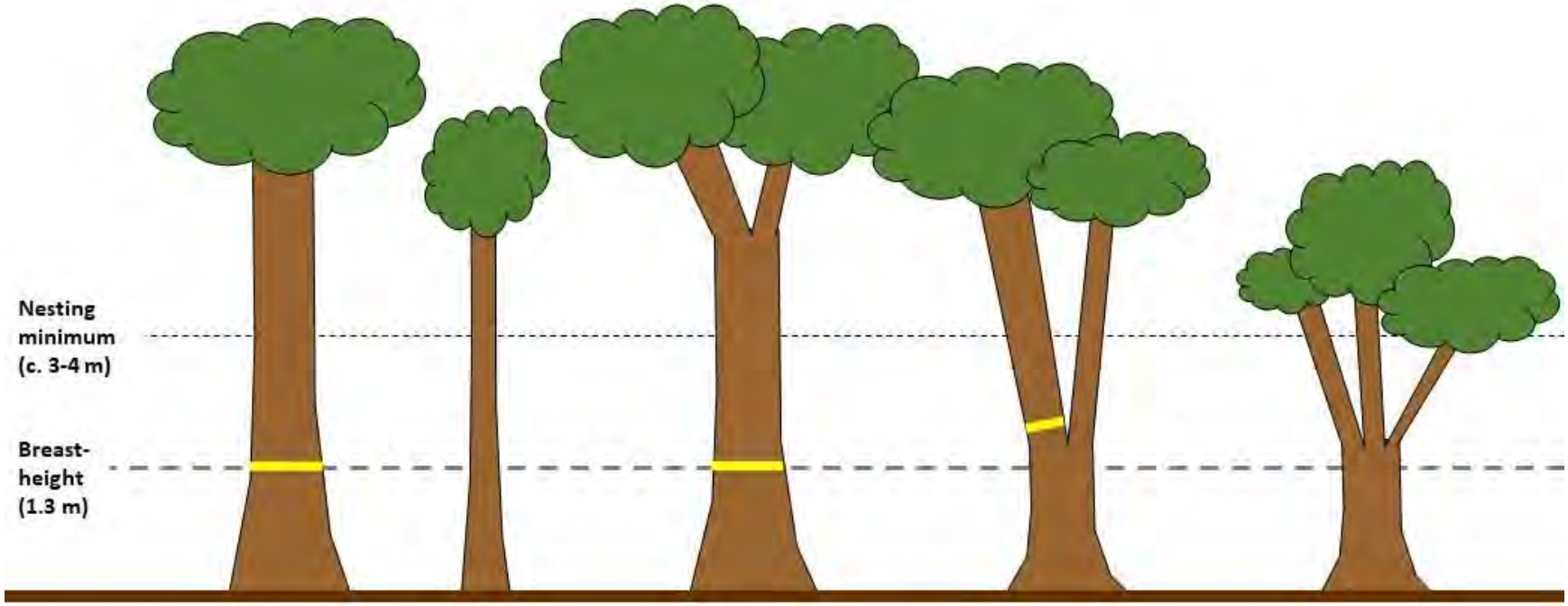
Nest height minima

For Carnaby's Black-Cockatoo, the minimum height of known nests is c. 3 m (Saunders 1979)[1]. For Forest Red-tailed Black-Cockatoo, the minimum height of a known nest is 6.5 m (Johnstone *et al.* 2013). Thus, a 3-4 m threshold seems a pragmatic "general" one to use for the purposes of field surveys where both species are likely and multiple tree species are under consideration.

Tree forms

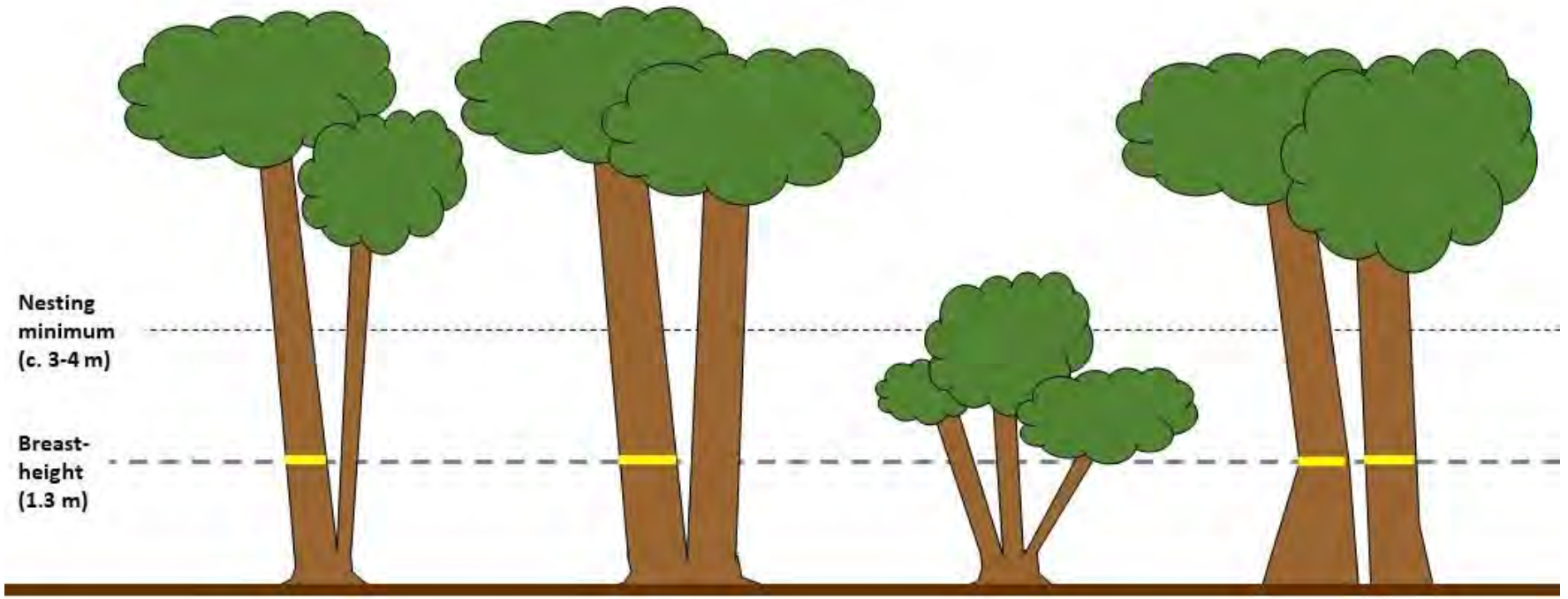
Quite obviously, trees have a range of forms and growth-habits. These can occasionally affect black-cockatoo nesting-tree surveys. As such, the following table has been developed (with reference to the information above) to guide tree assessment.

[1] Although nests as low as 2 m (in Wandoo or Salmon Gum) were recorded, 95% of nests were above 3 m.



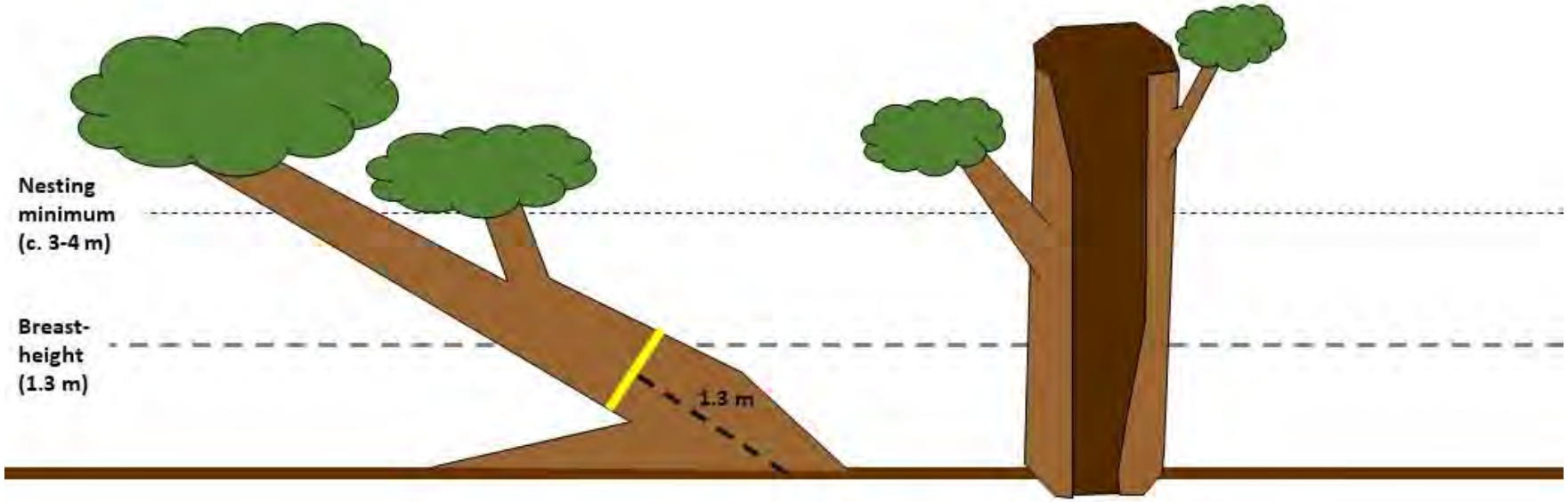
Tree Description:	Straight trunk. DBH > 500 mm*.	Straight trunk. DBH < 500 mm*.	Trunk forks above 3 m. DBH > 500 mm*.	Trunk forks between 1.3 m & 3 m. Diameter of at least one trunk above fork > c. 500 mm*.	Trunk forks between 1.3 m & 3 m. DBH > 500 mm* but no trunks above fork have diameter > c. 500 mm*.
Actions:	Measure DBH. Record species, life status and score for hollows. Waypoint tree.	Do not record.	Measure DBH. Record species, life status and score for hollows. Waypoint tree.	Measure/estimate diameter of widest trunk above fork. Note number of trunks. Record species, life status and score for hollows. Waypoint tree.	Do not record.

* Or 300 mm DBH for Wandoo, Salmon Gum.



Tree Description:	Trunk forks below 1.3 m. Diameter of <u>one</u> trunk above fork > 500 mm*.	Trunk forks below 1.3 m. Diameter of <u>multiple</u> trunks above fork > 500 mm*.	Trunk forks below 1.3 m. DBH of all trunks < 500 mm*.	Two <u>separate</u> trees in very close proximity. Both with DBH > 500 mm.
Actions:	Measure DBH of relevant trunk above fork. Note number of trunks. Record species, life status and score for hollows. Waypoint tree.	Measure DBH of <u>widest</u> trunk above fork. Note number of trunks. Record species, life status and score for hollows. Waypoint tree.	Do not record.	For <u>both</u> trees... Measure DBH. Record species, life status and score for hollows. Waypoint <u>each</u> tree (i.e. 2 separate records).

* Or 300 mm DBH for Wandoo, Salmon Gum.



Tree Description:	Trunk leans dramatically. Diameter > 500 mm* at 1.3m from centre of tree base.	Trunk has been burnt out internally to create an open half-pipe shape (no potential nesting sites). DBH > 500 mm*.
Actions:	Measure diameter at 1.3 m from the central base point, along the midline of the tree. Record species, life status and score for hollows. Waypoint tree.	Do not record.

* Or 300 mm DBH for Wandoo, Salmon Gum.

Appendix B: Scoring System for the Assessment of Foraging Value of Vegetation for Black-Cockatoos

Revised 18th June 2019.

Introduction

Application of the Offset Assessment Guide (offsets guide) developed by the federal environment department for assessing black-cockatoo foraging habitat requires the calculation of a score out of 10. The following system has been developed by Bamford Consulting to provide an objective scoring system that is practical and can be used by trained field zoologists with experience in the environments frequented by the species.

Calculating the total score (out of 10) requires the following steps:

A Determining a score out of six for the vegetation composition, condition and structure; plus

B Determining a score out of three for the context of the site; plus

C Determining a score out of one for species density.

D Determining the total score out of 10, which may require moderation for context and species density with respect to the vegetation composition. This includes consideration of pine plantations as a special case for foraging value.

Calculation of scores and the moderation process are described in detail below.

A. Vegetation composition, condition and structure scoring

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
0	No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples: • Water bodies (e.g. salt lakes, dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
1	Negligible to low foraging value. Examples: • Scattered specimens of known food plants but projected foliage cover of these is < 2%. This could include urban areas with scattered foraging trees; • Paddocks that are partly vegetated with melons or other known food-source weeds (e.g. *Erodium* spp.) that represent a short-term and/or seasonal food source; • Blue Gum plantations (foraging by Carnaby's Black-Cockatoos has been reported but appears to be unusual).	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. This could include urban areas with scattered foraging trees.	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. Could include urban areas with scattered foraging trees.

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
2	Low foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, have < 10% projected foliage cover; • Woodland with tree banksias 2-5% projected foliage cover; • Open eucalypt woodland/mallee of small-fruited species; • Paddocks that are densely vegetated with melons or other known food-source weeds (e.g. *Erodium* spp.) that represent a short-term and/or seasonal food source.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri and Jarrah) 1-5% projected foliage cover; • Urban areas with scattered foraging trees.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri, Jarrah or Sheoak) 1-5% projected foliage cover; • Urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *E. erythrocorys*.
3	Low to Moderate foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, have 10-20% projected foliage cover; • Woodland with tree banksias 5-20% projected foliage cover; • Eucalypt Woodland/Mallee of small-fruited species; • Eucalypt Woodland with Marri < 10% projected foliage cover.	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri) 5-20% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability).	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri and Jarrah) 5-20% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability).

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
4	Moderate foraging value. Examples: • Woodland/forest with tree banksias 20-40% projected foliage cover; • Eucalypt Woodland/Forest with Marri 20-40% projected foliage cover.	Moderate foraging value. Examples: • Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths. • Eucalypt Woodland/Forest with diverse, healthy understorey and known food trees (especially Marri) 10-20% projected foliage cover. • Orchards with highly desirable food sources (e.g. apples, pears, some stone fruits).	Moderate foraging value. Examples: • Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with 40-60% projected foliage cover.
5	Moderate to High foraging value. Examples: • Banksia Forest with 40-60% projected foliage cover; • Banksia Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Pine plantations with trees more than 10 years old (but see pine note below in moderation section).	Moderate to High foraging value. Examples: • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths.	Moderate to High foraging value. Examples: • Marri-Jarrah Forest with 40-60% projected foliage cover; • Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths. • Sheoak Forest with > 60% projected foliage cover.

Site Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
6	High foraging value. Example: • Banksia Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).	High foraging value. Example: • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).	High foraging value. Example: • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).

Vegetation structural class terminology follows Keighery (1994).

B. Site context.

The maximum score is given in situations where foraging habitat is supporting breeding birds. It can also be given in fragmented landscapes where there is little foraging habitat remaining and thus what is left has a high contextual value. The site context score is species-specific as it depends upon factors such as the vegetation type and extent, and the presence of breeding birds, and the following table, developed by Bamford consulting in conjunction with DEE, provides a *guide* to the assignation of site context scores (note that 'local area' is defined as within a 15 km radius of the centre point of the study site):

Site Context Score	Percentage of the existing native vegetation within the 'local' area that the study site represents.	
	'Local' breeding known/likely	'Local' breeding unlikely
3	> 5%	> 10%
2	1 - 5%	5 - 10%
1	0.1 - 1%	1 - 5%
0	< 0.1%	< 0.1%

C. Species density.

Assignation of the species density score (0 or 1) is based upon the black-cockatoo species being either abundant or not abundant, and is species specific. A score of 1 is used where the species is seen or reported regularly and/or there is abundant foraging evidence. Regularly is when the species is seen at intervals of every few days or weeks for at least several months of the year. A score of 0 is used when the species is recorded or reported very infrequently and there is little or no foraging evidence.

Note that context and species density scores are affected by the vegetation score and this is discussed below.

D. Moderation of scores for the calculation of a value out of 10.

The foraging value score provides a numerical value that reflects the significance of vegetation as foraging habitat for Black-Cockatoos, and this numerical value is designed to provide the information needed by the Federal Department of the Environment and Energy (DoEE) to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area, and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed above. These three components are drawn from the DoEE offsets guide but the scoring approach was developed by Bamford Consulting Ecologists.

A A score out of six for the vegetation composition, condition and structure; plus
B A score out of three for the context of the site; plus
C A score out of one for species density.

Foraging value can thus be assigned a score out of six, based upon site vegetation characteristics, or a score out of 10 if context and species density are considered. Assigning a score out of 10 represents step D and may require moderation rather than simple addition.

The score out of six for vegetation characteristics and value can be compared across a site, while a score out of 10 is the overall foraging value and is used for the purposes of aiding offset calculations. The calculation out of 10 requires the vegetation characteristics (out of 6) to be combined with the scores given for context and species density. It is considered that the context and density scores are not independent of vegetation characteristics; otherwise habitat of absolutely no value for black-cockatoo foraging (such as concrete or a wetland) could get a foraging score out of 10 as high as 4 if it occurred in an area where the species breed (context score of 3) and are abundant (species density score of 1). Similarly, vegetation of negligible or low characteristics which could not support black-cockatoos could be assigned a score as high as 6 out of 10. In that case, the score of 6 would be more a reflection of nearby vegetation of high characteristics than of the foraging value of the negligible to low scoring vegetation. The Black-Cockatoos would only be present because of vegetation of high characteristics, so applying the context and species density scores to vegetation of low characteristics would not give a true reflection of their foraging value.

For this reason, the context and species density scores need to be moderated for the vegetation characteristic score to prevent vegetation of little or no foraging value receiving an excessive score out of 10. A simple approach is to assign a context and species density score of zero to sites with a characteristic score of low (2), negligible (1) or none (0), on the basis that birds will not use such areas unless they are adjacent to at least low-moderate quality foraging habitat ($\geq$3). Pine plantations are an exception to this rule (see below). The approach to calculating a score out of 10 can be summarised as follows:

Vegetation composition, condition and structure score	Context score	Species density score
3-6 (low/moderate to high value)	Assessed as per B above	Assessed as per C above
0-2 (no to low value; except pines)	0	0

Pine plantations

Pine plantations are an important foraging resource for Carnaby's Black-Cockatoo (only) but are not directly comparable with native vegetation. In comparing native vegetation with pine plantations for the purpose of calculating offsets, the following should be noted:

- Pine plantations are a commercial crop established with the intention of being harvested and thus have short-term availability (30-50 years), whereas native vegetation is available indefinitely if protected.
- Although pines provide a high abundance of food in the form of seeds, they are a limited food resource compared with native vegetation which provides seeds, insect larvae, flowers and nectar. The value of insect larvae in the diet of Carnaby's Black-Cockatoo has not been quantified, but in the vicinity of Perth, the birds forage very heavily on insect larvae in young cones of *Banksia attenuata* in winter, ignoring the seeds in these cones and seeds in older cones on the same trees (Scott and Black 1981; M. Bamford pers. obs.). This suggests that insect larvae are of high nutritional importance immediately prior to the breeding season.

- Pine plantations have very little biodiversity value other than their importance as a food source for Carnaby's Black-Cockatoos. They inhibit growth of other flora. While this is not a factor for direct consideration with respect to Carnaby's Black-Cockatoo, it is a factor in regional conservation planning of which offsets for the cockatoos are a part.
- Due to the temporary nature of pines as a food source, site context differs between pines and native vegetation.

Taking the above points into consideration, it is possible to assign pine plantations a foraging value as follows:

- Site condition. The actual foraging value of pines is high. Stock *et al.* (2013) report that it takes nearly twice as many seeds of *Pinus pinaster* to meet the daily energy requirements for Carnaby's Black-Cockatoo compared with Marri, and three times as many *P. pinaster* seeds compared with Slender Banksia. However, pines are planted at a high density so the food supply per hectare can be high. Taking account of the lack of variety of food from pines, this suggests a site condition score of 4 or 5 out of 6 (5 is used in Section A above). As a source of food, pines are thus comparable to the best banksia woodland. This site condition score then needs to be adjusted to take account of the short-term nature of the food supply (for pine plantations to be harvested. Where pines are 'ornamental', such as in some urban contexts, they can be treated as with other trees in urban landscapes). The foraging value of a site after pines are harvested will effectively be 0, or possibly 1 if there is some retention. It is proposed that this should approximately halve the site condition score; young pine plantations could be redacted slightly less than old plantations on the basis that a young plantation provides a slightly longer term food supply. If a maximum site condition score of 5 is given, then a young plantation (>10 but <30 years old) could be assigned a score of 3, and an old plantation (>30 years old) could be assigned a score of 2. Plantations <10 years old and thus not producing large quantities of cones could also get a score of 2, but recognising they may increase in value. It also needs to be recognised that pine plantations are of value even if they are old and destined to be harvested in the near future. Therefore, while such a pine plantation might receive a characteristic score of only 2, it would receive a high context and density score reflective of the current value of the vegetation.
- Site context. Although a temporary food source, pines can be very important for Carnaby's Black-Cockatoo in some contexts; they could be said to carry populations in areas where there is little native vegetation. The system for assigning a context score as outlined above (Section B) also applies to pines. Thus, a context score of 3 can be given where pines are a significant proportion of foraging habitat (>5% if breeding occurs; >10% if no breeding), but where pines are a small part of the foraging landscape they will receive a context score of less than this.
- Species density. As outlined above (Section C), pines will receive a species density score of 1 where Carnaby's Black-Cockatoo are regular visitors.

Based on the above, pine plantations that represent a substantial part of the foraging landscape, such as in the region immediately north of Perth, would receive a total score (out of 10) of 6; young plantations

in this area would receive a score of 7. In contrast, isolated and small plantations in rural landscapes could receive a score of just 2 if they are only a small proportion of foraging habitat and Carnaby's Black-Cockatoo are not regularly present.

Appendix C: Conservation Codes for Western Australian Flora and Fauna (DBCA 2019a)

Threatened, Extinct and Specially Protected fauna or flora[1] are species[2] which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016.*

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T Threatened species

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR Critically endangered species

Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

EN Endangered species

Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife*

Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

VU Vulnerable species

Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.

Extinct species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

EW Extinct in the wild species

Species that *"is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory species

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

CD Species of special conservation interest (conservation dependent fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

OS Other specially protected species

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

P Priority species

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 fauna or flora.

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.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

Priority 3: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.
(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.

(c) (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Notes:
[1] The definition of flora includes algae, fungi and lichens
[2]Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

Last updated 3 January 2019

Australian Government
Department of the Environment and Energy

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.

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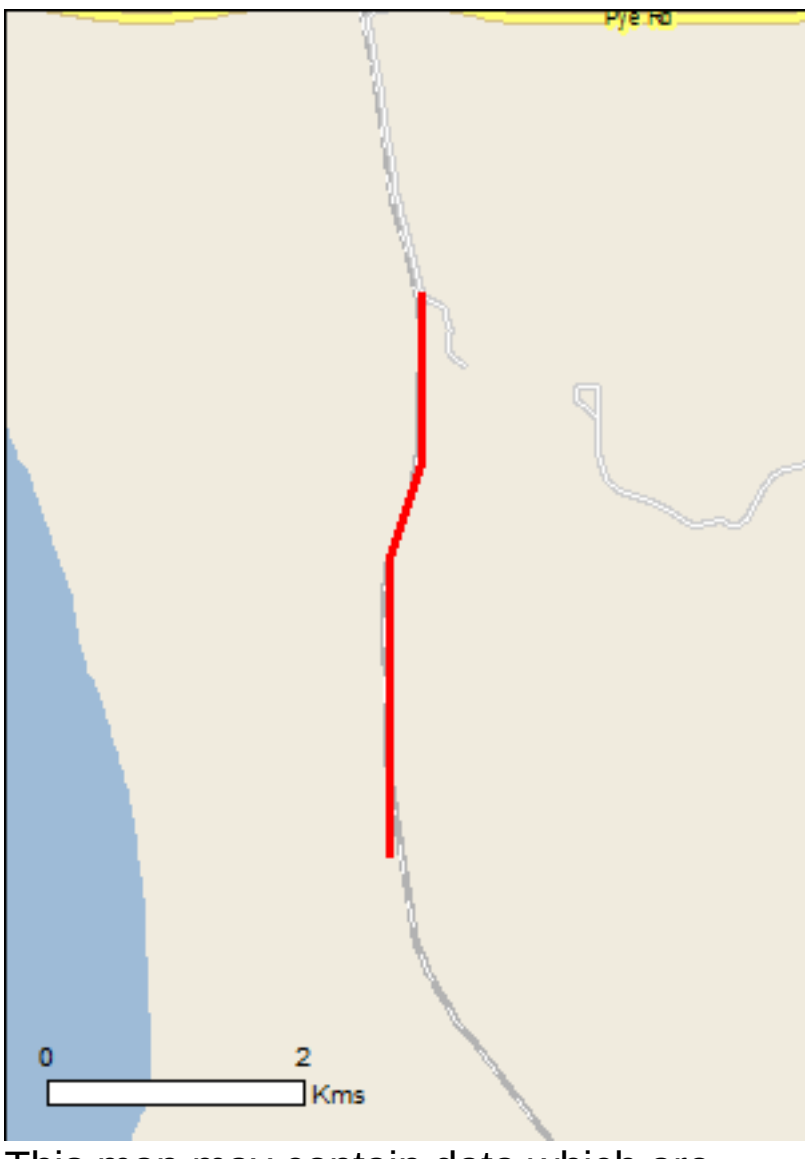

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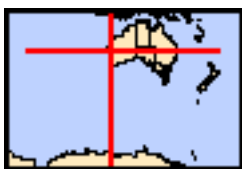

Summary

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.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	42
Listed Migratory Species:	39

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.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	65
Whales and Other Cetaceans:	11
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	2
Regional Forest Agreements:	None
Invasive Species:	14
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	2

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name

EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name

South-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta cauta Shy Albatross [82345]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat may occur within area
Plants		
Caladenia hoffmanii Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat may occur within area
Conostylis dielsii subsp. teres Irwin's Conostylis [3614]	Endangered	Species or species habitat likely to occur within area
Conostylis micrantha Small-flowered Conostylis [17635]	Endangered	Species or species habitat may occur within area
Eucalyptus impensa Eneabba Mallee [56711]	Endangered	Species or species habitat may occur within area
Tetratheca nephelioides [83217]	Critically Endangered	Species or species habitat may occur within area
Wurmbea tubulosa Long-flowered Nancy [12739]	Endangered	Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Egernia stokesii badia Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus 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
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardenna carneipes](#) Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
[Diomedea amsterdamensis](#) Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
[Diomedea epomophora](#) Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
[Diomedea exulans](#) Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
[Diomedea sanfordi](#) Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
[Hydroprogne caspia](#) Caspian Tern [808]		Foraging, feeding or related behaviour known to occur within area
[Macronectes giganteus](#) Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
[Macronectes halli](#) Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
[Thalassarche carteri](#) Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
[Thalassarche cauta](#) Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within area
[Thalassarche impavida](#) Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
[Thalassarche melanophris](#) Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
[Thalassarche steadi](#) White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
[Balaena glacialis australis](#) Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
[Balaenoptera edeni](#) Bryde's Whale [35]		Species or species habitat may occur within area
[Balaenoptera musculus](#) Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
[Carcharodon carcharias](#) White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Pandion haliaetus		
Osprey [952]		Breeding known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat likely 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
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus		
Common Noddy [825]		Species or species habitat may occur within area
Anous tenuirostris melanops		
Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus assimilis Little Shearwater [59363]		Foraging, feeding or related behaviour known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Sterna caspia](#) Caspian Tern [59467]		Foraging, feeding or related behaviour known to occur within area
[Thalassarche carteri](#) Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
[Thalassarche cauta](#) Shy Albatross [89224]	Vulnerable*	Species or species habitat may occur within area
[Thalassarche impavida](#) Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
[Thalassarche melanophris](#) Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
[Thalassarche steadi](#) White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
[Tringa nebularia](#) Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
[Acentronura australe](#) Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
[Campichthys galei](#) Gale's Pipefish [66191]		Species or species habitat may occur within area
[Choeroichthys suillus](#) Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
[Halicampus brocki](#) Brock's Pipefish [66219]		Species or species habitat may occur within area
[Hippocampus angustus](#) Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
[Hippocampus breviceps](#) Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
[Hippocampus subelongatus](#) West Australian Seahorse [66722]		Species or species habitat may occur within area
[Lissocampus fatiloquus](#) Prophet's Pipefish [66250]		Species or species habitat may occur within area
[Maroubra perserrata](#) Sawtooth Pipefish [66252]		Species or species habitat may occur within area
[Mitotichthys meraculus](#) Western Crested Pipefish [66259]		Species or species habitat may occur within area
[Nannocampus subosseus](#) Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Pelamis platurus		
Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata		
Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni		
Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Delphinus delphis		
Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Grampus griseus		
Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat may occur within area
Stenella attenuata		
Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus		
Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str.		
Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Beekeepers	WA
Yardanogo	WA

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 Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		

Name	Status	Type of Presence
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Key Ecological Features (Marine)

[Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Commonwealth marine environment within and	South-west
Western rock lobster	South-west

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

-29.334234 114.978984,-29.339771 114.978984,-29.344559 114.978812,-29.350544 114.976581,-29.363112 114.976752,-29.368797 114.976581,-29.368797 114.976581

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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.

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Appendix E: Definitions, Categories and Criteria for Threatened and Priority Ecological Communities (DBCA 2013)

1. GENERAL DEFINITIONS

Ecological Community: A naturally occurring biological assemblage that occurs in a particular type of habitat.

Note: The scale at which ecological communities are defined will often depend on the level of detail in the information source, therefore no particular scale is specified.

A **threatened ecological community** (TEC) is one which is found to fit into one of the following categories; "presumed totally destroyed", "critically endangered", "endangered" or "vulnerable".

Possible threatened ecological communities that do not meet survey criteria are added to DEC's Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

An **assemblage** is a defined group of biological entities.

Habitat is defined as the areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (eg. substrate and topography), and the biotic factors.

Occurrence: a discrete example of an ecological community, separated from other examples of the same community by more than 20 metres of a different ecological community, an artificial surface or a totally destroyed community.

By ensuring that every discrete occurrence is recognised and recorded future changes in status can be readily monitored.

Adequately Surveyed is defined as follows:
"An ecological community that has been searched for thoroughly in most likely habitats, by relevant experts."

Community structure is defined as follows:
"The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage" (eg. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, eg. dominance by feeders on detritus as distinct from feeders on live plants).

Definitions of Modification and Destruction of an ecological community:
Modification: "changes to some or all of ecological processes (including abiotic processes such as hydrology), species composition and community structure as a direct or indirect result of human activities. The level of damage involved could be ameliorated naturally or by human intervention."

Destruction: "modification such that reestablishment of ecological processes, species composition and community structure within the range of variability exhibited by the original community is unlikely within the foreseeable future even with positive human intervention."

Note: Modification and destruction are difficult concepts to quantify, and their application will be determined by scientific judgement. Examples of modification and total destruction are cited below:

Modification of ecological processes: The hydrology of Toolibin Lake has been altered by clearing of the catchment such that death of some of the original flora has occurred due to dependence on fresh water. The system may be bought back to a semblance of the original state by redirecting saline runoff and pumping waters of the rising underground watertable away to restore the hydrological balance. Total destruction of downstream lakes has occurred due to hydrology being altered to the point that few of the original flora or fauna species are able to tolerate the level of salinity and/or water logging.

Modification of structure: The understorey of a plant community may be altered by weed invasion due to nutrient enrichment by addition of fertiliser. Should the additional nutrients be removed from the system the balance may be restored, and the original plant species better able to compete. Total destruction may occur if additional nutrients continue to be added to the system causing the understorey to be completely replaced by weed species, and death of overstorey species due to inability to tolerate high nutrient levels.

Modification of species composition: Pollution may cause alteration of the invertebrate species present in a freshwater lake. Removal of pollutants may allow the return of the original inhabitant species. Addition of residual highly toxic substances may cause permanent changes to water quality, and total destruction of the community.

Threatening processes are defined as follows:
"Any process or activity that threatens to destroy or significantly modify the ecological community and/or affect the continuing evolutionary processes within any ecological community."

Examples of some of the continuing threatening processes in Western Australia include: general pollution; competition, predation and change induced in ecological communities as a result of introduced animals; competition and displacement of native plants by introduced species; hydrological changes; inappropriate fire regimes; diseases resulting from introduced microorganisms; direct human exploitation and disturbance of ecological communities.

Restoration is defined as returning an ecological community to its pre-disturbance or natural state in terms of abiotic conditions, community structure and species composition.

Rehabilitation is defined as the re-establishment of ecological attributes in a damaged ecological community although the community will remain modified.

2. DEFINITIONS AND CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE ECOLOGICAL COMMUNITIES

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.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B):

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or**

B) All occurrences recorded within the last 50 years have since been destroyed

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.

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii):

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);

ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

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.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

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.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium (within approximately 50 years) to long-term future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

3. DEFINITIONS AND CRITERIA FOR PRIORITY ECOLOGICAL COMMUNITIES PRIORITY ECOLOGICAL COMMUNITY LIST

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities:

Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities:

Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) 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.

Priority Three: Poorly known ecological communities:

(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:

(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 (within approximately 10 years), or;

(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, inappropriate fire regimes, clearing, hydrological change etc.

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.

Priority Four: Ecological communities:

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.

(i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category.

(iii) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities:

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Current as of January 2013

Appendix F: Matrix of Vascular Plant Taxa Recorded within Plant Communities Described in the Project Area (Woodman Environmental 2005)

Taxon	W1	T1	T2	T3	H2	H8
Acacia cyclops			X		X	
Acacia idiomorpha	X					
Acacia lasiocarpa var. *lasiocarpa*	X	X	X	X	X	X
Acacia pulchella var. *pulchella*		X	X		X	X
Acacia rostellifera	X	X	X	X	X	X
Acacia saligna	X		X	X		X
Acacia xanthina	X					
Acanthocarpus preissii	X	X	X	X	X	X
Acrotriche cordata			X			
Allocasuarina lehmanniana subsp. *lehmanniana*			X	X	X	X
Alyogyne huegelii	X	X	X	X	X	X
?Angianthus tomentosus						X
Anthobolus foveolatus	X	X	X	X	X	X
Anthocercis anisantha subsp. *anisantha*	X			X		
Anthocercis littorea			X			X
Apiaceae sp.	X	X	X	X	X	X
Asteraceae sp.	X	X	X	X		X
Atriplex cinerea			X			
Austrodanthonia occidentalis			X			
Austrostipa ?compressa		X	X			X
Austrostipa elegantissima		X	X		X	
Austrostipa flavescens	X	X	X	X		X
Austrostipa sp.	X		X	X		X
**Avena barbata*		X				
Baumea juncea						X
**Brassica tournefortii*		X				
**Bromus diandrus*		X	X			
**Cakile maritima*			X			
Caladenia ?vulgata						X
Caladenia sp.	X					
Calandrinia brevipedata	X	X	X	X	X	X
Calandrinia liniflora	X					
Carpobrotus virescens		X	X	X	X	X
Cassytha ?pomiformis		X				X
Cassytha aurea		X	X			X
Cassytha pomiformis	X	X	X	X	X	X
Cassytha racemosa	X					
Clematis linearifolia	X	X	X		X	X
Comesperma ?integerrimum	X	X		X		X
Comesperma confertum						X
Conostylis ?stylidioides		X	X			X
Conostylis candicans	X	X				

Taxon	W1	T1	T2	T3	H2	H8
Conostylis candicans subsp. *calcicola*	X	X	X	X	X	X
Crassula colorata var. *acuminata*			X			X
Cryptandra mutila					X	X
Cryptandra myriantha	X					
**Cuscuta epithymum*			X			
Desmocladus asper		X	X	X		X
Dianella revoluta	X	X				
Diplolaena ferruginea	X	X				
Diplolaena leemaniana	X	X		X	X	
Diplopeltis petiolaris		X				
**Dischisma arenarium*			X			
Dodonaea aptera	X			X		
Drosera macrantha subsp. *macrantha*			X			X
Erymophyllum ramosum subsp. *involucratum*			X			
**Erodium cicutarium*		X				
Eucalyptus falcata subsp. *opima* ms		X				X
Eucalyptus obtusiflora subsp. *dongarraensis*	X			X		
Eucalyptus oraria	X			X		
**Euphorbia peplus*		X				
**Euphorbia terracina*	X	X	X		X	
Exocarpos sparteus	X	X	X		X	X
Gahnia lanigera						X
Gahnia trifida						X
Gastrolobium nervosum			X		X	X
Gompholobium tomentosum						X
Goodenia berardiana			X			
Guichenotia ledifolia	X	X	X	X		
Gyrostemon ramulosus	X	X				X
Hardenbergia comptoniana		X	X	X	X	X
Hemiandra pungens			X			X
Hibbertia racemosa	X	X	X	X	X	X
Hibbertia subvaginata		X	X			
**Hypochaeris glabra*	X	X				
Isotoma hypocrateriformis			X			X
Isotropis cuneifolia						X
Lasiopetalum angustifolium	X					
Lepidosperma ?pubisquameum	X	X	X	X		X
Lepidosperma gladiatum			X			
Lepidosperma pubisquameum		X	X	X		X
Leptomeria preissiana			X		X	X
Leucopogon insularis			X	X		X
Leucopogon parviflorus	X		X	X		X

Taxon	W1	T1	T2	T3	H2	H8
Logania vaginalis	X	X				
**Lolium rigidum*		X				
Lomandra maritima		X				X
Lysiana casuarinae	X	X				
**Lysimachia arvensis*	X	X				
Melaleuca ?cardiophylla		X				
Melaleuca ?leuropoma	X		X			X
Melaleuca ?systena		X	X			
Melaleuca cardiophylla	X	X	X	X	X	X
Melaleuca huegelii subsp. *huegelii*	X	X	X	X	X	X
Melaleuca lanceolata	X					X
Melaleuca leuropoma	X		X	X	X	X
Melaleuca systena		X	X			X
Muehlenbeckia adpressa	X				X	X
Myoporum insulare		X	X			
?Myoporum insulare			X			
Myoporum tetrandrum			X			
Nuytsia floribunda						X
Olax aurantia						X
Olearia axillaris		X	X	X	X	X
Olearia dampieri subsp. *dampieri* ms	X			X		X
Opercularia spermacocea		X	X	X	X	X
Opercularia vaginata		X				X
**Oxalis pes-caprae*	X					
Parietaria cardiostegia	X	X		X		X
Parietaria debilis			X			
**Pelargonium capitatum*			X			
Phyllanthus calycinus		X	X	X	X	
Phyllanthus scaber	X	X				
Pimelea gilgiana				X		
Pimelea sp.		X				
Pittosporum ligustrifolium		X				
Poa poiformis	X	X	X	X		X
*Poaceae sp.	X	X	X	X	X	X
Podolepis canescens			X			X
Podotheca angustifolia				X		
Podotheca gnaphalioides			X			X
Poranthera microphylla						X
?Prasophyllum sp.	X	X	X	X		X
Pterostylis sp.	X					
Ptilotus divaricatus		X				
Rhagodia ?preissii subsp. *preissii*	X	X	X			

Taxon	W1	T1	T2	T3	H2	H8
Rhagodia baccata		X	X			X
Rhagodia preissii subsp. *obovata*	X	X	X	X	X	
Rhagodia preissii subsp. *preissii*	X	X	X	X	X	X
Rhodanthe citrina			X			X
Rulingia borealis ms	X	X		X		
Santalum acuminatum			X	X	X	X
Scaevola canescens	X					
Scaevola crassifolia			X	X	X	X
Scaevola globulifera		X	X			X
Scaevola thesioides subsp. *thesioides*		X	X		X	X
Schoenus sp.			X			X
Senecio ?lautus subsp. *maritimus*			X			X
Senecio pinnatifolius	X	X	X	X	X	X
**Solanum nigrum*		X				
**Sonchus oleraceus*	X	X		X	X	X
**Sonchus* sp.		X				
Spinifex longifolius			X			
Sporobolus virginicus						X
Spyridium globulosum	X	X	X	X	X	X
Stackhousia monogyna			X			X
Stylobasium spathulatum				X		
**Taraxacum officinale*		X				
Templetonia retusa		X	X	X		X
**Tetragonia decumbens*			X			
Thomasia ?rulingioides	X					
Threlkeldia diffusa	X	X	X	X	X	
Thysanotus ?patersonii	X	X				
Thysanotus patersonii			X			X
Thysanotus sp.	X	X	X		X	X
Trachymene pilosa	X	X	X			X
**Ursinia anthemoides*						X
**?Vulpia bromoides*						X
?Waitzia acuminata			X			
Waitzia podolepis	X	X	X	X		X
Wurmbea dioica subsp. *alba*			X		X	X
Wurmbea monantha	X					
Zygophyllum billardierei		X	X	X	X	X
Zygophyllum fruticulosum				X		

Appendix G: Fauna expected to occur in the Development Envelope and Recorded During the Reconnaissance Survey

These lists are derived from the results of database and literature searches and from previous field surveys conducted in the local area. These are:

- ALA = Atlas of Living Australia, searched January 2020;
- N = Naturemap Database, searched January 2020;
- EPBC = EPBC Protected Matters, searched January 2020;
- BA = Birdlife Australia's Birdata database, searched January 2020;
- BCE = BCE surveys undertaken previously in the general area (BCE database records 1981 to 2019, including Harris et al. (2008), Metcalf and Bamford (2008, 2011), Bamford (2009), Bamford (2012), Everard and Bamford (2014), Bamford et al. (2015), Bamford and Chuk (2015-2017), Bamford and Chuk (2019), Bamford et al. (2019a, 2019b)).

R denotes species recorded opportunistically (by direct observation) during the reconnaissance survey

Table G-1: Conservation significant invertebrate species expected to occur in the Project Area

CS INVERTEBRATES		CS	ALA	N	EPBC	BCE	Expected status in Project Area
DIPLOPODA							
millipede	*Antichiropus Eneabba 1*	CS3					Resident
INSECTA							
Bush Cricket	*Hemisaga vepreculae*	P2	X				Resident
Springtime Corroboree Stick Katydid	*Phasmodes jeeba*	P3	X	X			Resident
native bee	*Hylaeus globuliferus*	P3	X				Resident
Total Number of Species Expected:	**4**	**4**	**3**	**1**	**0**	**0**	

Table G-2: Frog species expected to occur in the Project Area

FROGS		CS	ALA	N	EPBC	BCE	Expected status in Project Area
HYLIDAE							
Motorbike Frog	*Litoria moorei*			X		X	Regular visitor
LIMNODYNASTIDAE							
Western Spotted Frog	*Heleioporus albopunctatus*		X	X		X	Resident
Moaning Frog	*Heleioporus eyrei*		X	X		X	Resident
Sand Frog	*Heleioporus psammophilus*					X	Resident
Banjo Frog	*Limnodynastes dorsalis*					X	Resident
Humming Frog	*Neobatrachus pelobatoides*		X	X		X	Resident
MYOBATRACHIDAE							
False Western Froglet	*Crinia pseudinsignifera*		X	X		X	Irregular visitor
Turtle Frog	*Myobatrachus gouldii*		X			X	Resident
Gunther's Toadlet	*Pseudophryne guentheri*		X	X		X	Resident
Total Number of Species Expected:	**9**	**0**	**6**	**6**	**0**	**9**	

Table G-3: Reptile species expected to occur in the Project Area

REPTILES		CS	ALA	N	EPBC	BCE	Expected status in Project Area
AGAMIDAE							
Western Heath Dragon	*Ctenophorus adelaidensis*		X	X		X	Resident
Spotted Military Dragon	*Ctenophorus maculatus*		X	X		X	Resident
Thorny Devil	*Moloch horridus*					X	Resident
Dwarf Bearded Dragon	*Pogona minor*		X	X		X	Resident
DIPLODACTYLIDAE							
South-Western Clawless Gecko	*Crenadactylus ocellatus*					X	Resident
White-spotted Ground Gecko	*Diplodactylus alboguttatus*	CS3				X	Resident
Ornate Stone Gecko	*Diplodactylus ornatus*						Resident
Spotted Sandplain Gecko	*Diplodactylus polyophthalmus*					X	Resident
South-western Spiny-tailed Gecko	*Strophurus spinigerus*		X	X		X	Resident
GEKKONIDAE							
Marbled Gecko	*Christinus marmoratus*						Resident
Tree Dtella	*Gehyra variegata*		X	X		X	Resident
PYGOPODIDAE							
Sedgelands Worm-Lizard	*Aprasia repens*					X	Resident
Javelin Legless Lizard	*Delma concinna*					X	Resident
Fraser's Delma	*Delma fraseri*		X	X		X	Resident
Side-Barred Delma	*Delma grayii*		X			X	Resident
Burton's Snake-Lizard	*Lialis burtonis*		X	X		X	Resident
Keeled Legless Lizard	*Pletholax gracilis*		X	X			Resident
Common Scaly-Foot	*Pygopus lepidopodus*		X	X		X	Resident
SCINCIDAE							
Buchanan's Snake-Eyed Skink	*Cryptoblepharus buchananii*		X	X		X	Resident
West-coast Ctenotus	*Ctenotus fallens*					X	Resident
Odd-Striped Ctenotus	*Ctenotus impar*					X	Resident
Western Slender Blue-tongue Lizard	*Cyclodomorphus celatus*		X	X		X	Resident
	Lerista christinae					X	Resident
Elegant Slider	*Lerista elegans*		X	X		X	Resident
Dotted-Line Robust Slider	*Lerista lineopunctulata*		X	X			Resident
Keeled Slider	*Lerista planiventralis*		X	X			Resident
Blunt-Tailed West-Coast Slider	*Lerista praepedita*		X	X		X	Resident
Southern Sand-skink	*Liopholis multiscutata*					X	Resident
Common Dwarf Skink	*Menetia greyii*		X	X		X	Resident

REPTILES		CS	ALA	N	EPBC	BCE	Expected status in Project Area
West Coast Morethia Skink	*Morethia lineoocellata*						Resident
Shrubland Morethia Skink	*Morethia obscura*					X	Resident
Western Blue-Tongue	*Tiliqua occipitalis*		X	X		X	Resident
Shingle-Back	*Tiliqua rugosa*		X	X		X	Resident
VARANIDAE							
Gould's Goanna	*Varanus gouldii*		X	X		X	Resident
Black-Headed Monitor	*Varanus tristis*					X	Resident
TYPHLOPIDAE							
Southern Blind Snake	*Anilios australis*		X				Resident
Beaked Blind Snake	*Anilios waitii*						Resident
PYTHONIDAE							
Woma	*Aspidites ramsayi*	P1					Possibly locally extinct
Carpet Python	*Morelia spilota imbricata*	CS3	X	X			Resident
ELAPIDAE							
Narrow-banded Shovel-nosed Snake	*Brachyurophis fasciolata*						Resident
Southern Shovel-nosed Snake	*Brachyurophis semifasciata*						Resident
Yellow-Faced Whip Snake	*Demansia psammophis*		X	X		X	Resident
Bardick	*Echiopsis curta*					X	Resident
Black-naped Snake	*Neelaps bimaculata*						Resident
Black-striped Snake	*Neelaps calonotos*	P3	X	X		X	Resident
Gould's Hooded Snake	*Parasuta gouldii*		X	X		X	Resident
Mulga Snake	*Pseudechis australis*		X	X		X	Resident
Western Brown Snake	*Pseudonaja mengdeni*		X	X		X	Resident
Jan's Banded Snake	*Simoselaps bertholdi*		X	X		X	Resident
West-Coast Banded Snake	*Simoselaps littoralis*		X	X			Resident
Total Number of Species Expected:	**50**	**5**	**29**	**27**	**0**	**36**	

Table G-4: Bird species expected to occur in the Project Area

BIRDS		CS	ALA	N	EPBC	BA	BCE	Expected status in Project Area
CASUARIIDAE								
Emu	*Dromaius novaehollandiae*		X	X		X	X	Resident
MEGAPODIDAE								
Malleefowl	*Leipoa ocellata*	V S3		X	X			Irregular visitor
PHASIANIDAE								
Stubble Quail	*Coturnix pectoralis*		X	X		X	X	Resident
TURNICIDAE								
Painted Button-quail	*Turnix varius*						X	Resident
Little Button-quail	*Turnix velox*						X	Irregular visitor
COLUMBIDAE								
Rock Pigeon	*Columba livia*	Int.	X	X	X	X	X	Vagrant
Crested Pigeon	*Ocyphaps lophotes*		X	X		X	X	Resident
Common Bronzewing **R**	*Phaps chalcoptera*		X	X		X	X	Resident
Brush Bronzewing	*Phaps elegans*		X	X		X	X	Resident
Spotted Dove	*Streptopelia chinensis*	Int.	X					Vagrant
Laughing Dove	*Streptopelia senegalensis*	Int.	X	X	X	X	X	Vagrant
CUCULIDAE								
Fan-tailed Cuckoo	*Cacomantis flabelliformis*		X	X		X	X	Regular migrant
Pallid Cuckoo	*Cacomantis pallidus*		X	X		X	X	Regular migrant
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*		X			X	X	Regular migrant
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*		X	X		X	X	Regular migrant
Black-eared Cuckoo	*Chalcites osculans*				X			Vagrant
APODIDAE								
Fork-Tailed Swift	*Apus pacificus*	M S5	X		X	X		Regular migrant
OTIDIDAE								
Australian Bustard	*Ardeotis australis*			X				Irregular visitor
ACCIPITRIDAE								
Brown Goshawk	*Accipiter fasciatus*		X	X		X	X	Regular visitor
Collared Sparrowhawk	*Accipiter cirrocephalus*		X			X	X	Resident
Wedge-tailed Eagle	*Aquila audax*		X	X		X	X	Regular visitor

BIRDS		CS	ALA	N	EPBC	BA	BCE	Expected status in Project Area
Swamp Harrier	*Circus approximans*		X			X		Vagrant
Spotted Harrier	*Circus assimilis*		X			X	X	Regular visitor
Black-shouldered Kite	*Elanus axillaris*		X	X		X	X	Regular visitor
Letter-winged Kite	*Elanus scriptus*	P4	X					Vagrant
Whistling Kite	*Haliastur sphenurus*		X	X		X	X	Regular visitor
Black-breasted Buzzard	*Hamirostra melanosternon*		X					Irregular visitor
Little Eagle	*Hieraaetus morphnoides*		X	X		X	X	Regular visitor
Square-tailed Kite	*Lophoictinia isura*						X	Irregular visitor
Black Kite	*Milvus migrans*		X	X		X	X	Vagrant
FALCONIDAE								
Brown Falcon	*Falco berigora*		X	X		X	X	Resident
Nankeen Kestrel	*Falco cenchroides*		X	X		X	X	Regular visitor
Australian Hobby	*Falco longipennis*		X	X		X	X	Regular visitor
Peregrine Falcon	*Falco peregrinus*	S7	X	X		X	X	Irregular visitor
STRIGIDAE								
Southern Boobook	*Ninox novaeseelandiae*		X			X		Resident
TYTONIDAE								
Eastern Barn Owl	*Tyto javanica*		X			X	X	Regular visitor
PODARGIDAE								
Tawny Frogmouth	*Podargus strigoides*						X	Resident
CAPRIMULGIDAE								
Spotted Nightjar	*Eurostopodus argus*						X	Regular visitor
AEGOTHELIDAE								
Australian Owlet-nightjar	*Aegotheles cristatus*							Irregular visitor
MEROPIDAE								
Rainbow Bee-eater	*Merops ornatus*	CS3	X	X	X	X	X	Regular migrant
ALCEDINIDAE								
Laughing Kookaburra	*Dacelo novaeguineae*	Int.	X	X		X	X	Irregular visitor
Red-backed Kingfisher	*Todiramphus pyrrhopygius*						X	Irregular visitor

BIRDS		CS	ALA	N	EPBC	BA	BCE	Expected status in Project Area
Sacred Kingfisher	*Todiramphus sanctus*		X	X		X	X	Regular migrant
CACATUIDAE								
Western Corella	*Cacatua pastinator*		X	X		X	X	Regular visitor
Little Corella	*Cacatua sanguinea*		X	X		X		Irregular visitor
Red-tailed Black-Cockatoo (inland subspecies)	*Calyptorhynchus banksii samueli*		X	X		X	X	Irregular visitor
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	E S2	X	X	X	X	X	Regular migrant
Galah	*Eolophus roseicapillus*		X	X		X	X	Regular visitor
Cockatiel	*Nymphicus hollandicus*		X				X	Vagrant
PSITTACIDAE								
Australian Ringneck	*Barnardius zonarius*		X	X		X	X	Resident
Budgerigar	*Melopsittacus undulatus*					X	X	Vagrant
Elegant Parrot	*Neophema elegans*						X	Regular visitor
Scarlet-chested Parrot	*Neophema splendida*						X	Vagrant
Western Ground Parrot	*Pezoporus flaviventris*	Cr S1						Possibly locally extinct
Regent Parrot	*Polytelis anthopeplus*		X	X		X		Irregular visitor
MALURIDAE								
Purple-backed Fairy-wren	*Malurus lambertii assimilis*		X	X		X	X	Resident
Blue-breasted Fairy-wren	*Malurus pulcherrimus*		X	X		X	X	Resident
Splendid Fairy-wren	*Malurus splendens*		X	X		X	X	Resident
White-winged Fairy-wren	*Malurus leucopterus*		X	X		X	X	Resident
Southern Emu-wren	*Stipiturus malachurus*						X	Resident
MELIPHAGIDAE								
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		X	X		X	X	Regular visitor
Western Spinebill	*Acanthorhynchus superciliosus*							Resident
Western Wattlebird	*Anthochaera lunulata*		X				X	Regular visitor
Red Wattlebird	*Anthochaera carunculata*		X	X		X	X	Regular visitor
Pied Honeyeater	*Certhionyx variegatus*		X				X	Irregular visitor

BIRDS		CS	ALA	N	EPBC	BA	BCE	Expected status in Project Area
White-fronted Chat	*Epthianura albifrons*		X			X	X	Irregular visitor
Crimson Chat	*Epthianura tricolor*		X			X	X	Irregular visitor
Tawny-crowned Honeyeater	*Gliciphila melanops*		X	X		X	X	Resident
Singing Honeyeater **R**	*Lichenostomus virescens*		X	X		X	X	Resident
Brown Honeyeater **R**	*Lichmera indistincta*		X	X		X	X	Resident
Yellow-throated Miner	*Manorina flavigula*		X	X		X	X	Regular visitor
Brown-headed Honeyeater	*Melithreptus brevirostris*		X	X		X	X	Regular visitor
White-cheeked Honeyeater	*Phylidonyris niger*		X	X		X	X	Resident
New Holland Honeyeater	*Phylidonyris novaehollandiae*					X	X	Irregular visitor
White-plumed Honeyeater	*Ptilotula penicillata*		X			X		Vagrant
White-fronted Honeyeater	*Purnella albifrons*		X				X	Vagrant
Black Honeyeater	*Sugomel niger*						X	Irregular visitor
PARDALOTIDAE								
Striated Pardalote	*Pardalotus striatus*		X	X		X	X	Regular visitor
Spotted Pardalote	*Pardalotus punctatus*		X			X	X	Vagrant
ACANTHIZIDAE								
Inland Thornbill	*Acanthiza apicalis*		X	X		X	X	Resident
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		X	X		X	X	Resident
Western Thornbill	*Acanthiza inornata*						X	Resident
Rufous Fieldwren	*Calamanthus campestris*	CS3		X			X	Resident
Shy Heathwren	*Calamanthus cautus*	CS3					X	Irregular visitor
Western Gerygone **R**	*Gerygone fusca*		X	X		X	X	Regular visitor
White-browed Scrubwren	*Sericornis frontalis*		X	X		X	X	Resident
Weebill **R**	*Smicrornis brevirostris*		X	X		X	X	Irregular visitor
POMATOSTOMIDAE								
White-browed Babbler	*Pomatostomus superciliosus*		X	X		X	X	Irregular visitor
CAMPEPHAGIDAE								
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		X	X		X	X	Regular visitor

BIRDS		CS	ALA	N	EPBC	BA	BCE	Expected status in Project Area
White-winged Triller	*Lalage sueurii*		X	X		X	X	Regular visitor
PACHYCEPHALIDAE								
Grey Shrike-thrush	*Colluricincla harmonica*		X	X		X	X	Resident
Rufous Whistler	*Pachycephala rufiventris*		X	X		X	X	Resident
Western Whistler	*Pachycephala occidentalis*		X			X	X	Irregular visitor
OREOICIDAE								
Crested Bellbird	*Oreoica gutturalis*	CS3		X		X	X	Resident
ARTAMIDAE								
Black-faced Woodswallow	*Artamus cinereus*		X	X		X	X	Regular visitor
Dusky Woodswallow	*Artamus cyanopterus*		X	X		X	X	Irregular visitor
Masked Woodswallow	*Artamus personatus*						X	Vagrant
Pied Butcherbird	*Cracticus nigrogularis*		X	X		X	X	Resident
Australian Magpie	*Cracticus tibicen*		X	X		X	X	Resident
Grey Butcherbird	*Cracticus torquatus*		X	X		X	X	Resident
Grey Currawong **R**	*Strepera versicolor*		X	X		X	X	Vagrant
RHIPIDURIDAE								
Grey Fantail	*Rhipidura albiscapa*		X	X		X	X	Regular visitor
Willie Wagtail	*Rhipidura leucophrys*		X	X		X	X	Resident
CORVIDAE								
Little Crow	*Corvus bennetti*					X	X	Regular visitor
Australian Raven **R**	*Corvus coronoides*		X	X		X	X	Resident
MONARCHIDAE								
Magpie-Lark	*Grallina cyanoleuca*		X	X		X	X	Resident
Restless Flycatcher	*Myiagra inquieta*						X	Vagrant
PETROICIDAE								
Southern Scrub-robin	*Drymodes brunneopygia*		X	X		X	X	Irregular visitor
White-breasted Robin	*Eopsaltria georgiana*		X	X		X	X	Resident
Hooded Robin	*Melanodryas cucullata*		X				X	Resident
Jacky Winter	*Microeca fascinans*		X	X		X		Irregular visitor
Red-capped Robin	*Petroica goodenovii*		X	X		X	X	Resident
NECTARINIIDAE								
Mistletoebird	*Dicaeum hirundinaceum*		X	X		X	X	Regular visitor

BIRDS		CS	ALA	N	EPBC	BA	BCE	Expected status in Project Area
ESTRILDIDAE								
Zebra Finch	*Taeniopygia guttata*		X	X		X	X	Irregular visitor
MOTACILLIDAE								
Australian Pipit	*Anthus novaeseelandiae*		X			X	X	Resident
MEGALURIDAE								
Brown Songlark	*Cincloramphus cruralis*		X			X	X	Irregular visitor
Rufous Songlark	*Cincloramphus mathewsi*					X	X	Regular visitor
HIRUNDINIDAE								
White-backed Swallow	*Cheramoeca leucosterna*		X	X		X	X	Regular visitor
Welcome Swallow	*Hirundo neoxena*		X	X		X	X	Regular visitor
Fairy Martin	*Petrochelidon ariel*		X	X		X	X	Regular visitor
Tree Martin	*Petrochelidon nigricans*		X	X		X	X	Regular visitor
ZOSTEROPIDAE								
Silvereye **R**	*Zosterops lateralis*		X	X		X	X	Regular visitor
Total Number of Species Expected:	**122**	**14**	**96**	**78**	**7**	**93**	**106**	

Table G-5. Mammal species expected to occur in the Project Area

MAMMALS		CS	ALA	N	EPBC	BCE	Expected status in Project Area
TACHYGLOSSIDAE							
Short-Beaked Echidna	*Tachyglossus aculeatus*					X	Resident
DASYURIDAE							
Chuditch	Dasyurus geoffroii	V S3		X	X		Locally extinct
Dibbler	Parantechinus apicalis	E S2			X		Locally extinct
Fat-tailed Dunnart	Sminthopsis crassicaudata		X	X			Resident
Little 'Long-tailed' Dunnart	*Sminthopsis* aff *dolichura*	CS3				X	Resident
Grey-bellied Dunnart	*Sminthopsis fuliginosa*						Resident
White-tailed Dunnart	*Sminthopsis granulipes*					X	Resident
THYLACOMYIDAE							
Greater Bilby	*Macrotis lagotis*	V S3					Locally extinct
PERAMELIDAE							
Quenda	*Isoodon fusciventer*	P4					Locally extinct
Little Marl (previously Western Barred Bandicoot)	*Perameles bougainville*	En S3					Locally extinct
TARSIPEDIDAE							
Honey Possum	*Tarsipes rostratus*		X	X		X	Resident
PHALANGERIDAE							
Australian Brushtail Possum	*Trichosurus vulpecula*					X	Irregular visitor
POTOROIDAE							
Boodie	*Bettongia lesueur*	Ex V S4 S6					Locally extinct
Woylie	*Bettongia penicillata*	E S1					Locally extinct
MACROPODIDAE							
Tammar Wallaby	*Macropus eugenii*	P4					Locally extinct
Western Grey Kangaroo **R**	*Macropus fuliginosus*					X	Resident
Banded Hare-Wallaby	*Lagostrophus fasciatus*	Ex V S3					Locally extinct
Brush Wallaby	*Notamacropus irma*	P4		X		X	Resident
MEGADERMATIDAE							
Ghost Bat	*Macroderma gigas*	V S3					Locally extinct
MOLOSSIDAE							

MAMMALS		CS	ALA	N	EPBC	BCE	Expected status in Project Area
White-striped Freetail-Bat	*Austronomus australis*					X	Regular visitor
VESPERTILIONIDAE							
Gould's Wattled Bat	*Chalinolobus gouldii*					X	Resident
Chocolate Wattled Bat	*Chalinolobus morio*			X		X	Regular visitor
Lesser Long-eared Bat	*Nyctophilus geoffroyi geoffroyi*					X	Resident
Southern Forest Bat	*Vespadelus regulus*					X	Regular visitor
MURIDAE							
Noodji, Ashy-grey Mouse	*Pseudomys albocinereus*					X	Resident
Shark Bay Mouse, Djoongarri	*Pseudomys fieldi*	V S3					Locally extinct
Moodit, Western Bush Rat	*Rattus fuscipes*					X	Resident
Pale Field Rat	*Rattus tunneyi*						Locally extinct
INTRODUCED MAMMALS							
Dog, Dingo	*Canis lupus familiaris*	Int.			X	X	Irregular visitor
Goat	*Capra hircus*	Int.			X	X	Resident
Horse	*Equus caballus*	Int.	X	X		X	Vagrant
Cat	*Felis catus*	Int.	X	X	X	X	Resident
House Mouse	*Mus musculus*	Int.	X	X	X	X	Resident
Rabbit **R**	*Oryctolagus cuniculus*	Int.			X	X	Resident
Sheep	*Ovis aries*	Int.	X	X			Vagrant
Black Rat	*Rattus rattus*	Int.				X	Irregular visitor
Pig	*Sus scrofa*	Int.			X		Irregular visitor
Red Fox	*Vulpes vulpes*	Int.			X	X	Resident
Total Number of Native Species Expected:	**28**	**23**	**6**	**9**	**9**	**22**	

Annotated List of Species Observed during the Site Inspection

Common Bronzewing	*Phaps chalcoptera*	Several heard throughout site
Singing Honeyeater	*Lichenostomus virescens*	Several heard throughout site
Brown Honeyeater	*Lichmera indistincta*	Several heard throughout site
Western Gerygone	*Gerygone fusca*	One heard in mallee
Weebill	*Smicrornis brevirostris*	Small flock heard in mallee
Grey Currawong	*Strepera versicolor*	One heard towards northern end of site
Australian Raven	*Corvus coronoides*	One or two birds heard throughout
Silvereye	*Zosterops lateralis*	One heard at the northern end of site
Western Grey Kangaroo	*Macropus fuliginosus*	Droppings and tracks
Rabbit	*Oryctolagus cuniculus*	Droppings and tracks

Appendix H: Fauna Species Returned from Database Searches that are Unlikely to Occur in the Development Envelope

Database searches often return species that may have been recorded historically but are now extinct in a region. In addition, databases can include species found nearby but that are unlikely to be present in the project area due to lack of suitable habitat (e.g. aquatic species) or ecological barriers preventing them from reaching the area (e.g. island species). There are also some errors, out-of-date Latin names, zoo specimens and subtleties of distribution that are not recognised in databases. All of the species listed below are considered unlikely to be found in the Project Area (note some birds could occur as vagrants).

Species Name	
INVERTEBRATES	
jewelbox	*Chama asperella*
Horse Hoof Limpet	*Hipponix australis*
FISH	
Western Galaxias	*Galaxias occidentalis*
Mosquitofish	*Gambusia holbrooki*
Green Swordtail	*Xiphophorus helleri*
Southern Pygmy Pipehorse	*Acentronura australe*
Bearded Leatherjacket	*Anacanthus barbatus*
Shaw's Cowfish	*Aracana aurita*
Western Clingfish	*Aspasmogaster occidentalis*
Blackspotted Catshark	*Aulohalaelurus labiosus*
Blackspotted Wrasse	*Austrolabrus maculatus*
Cryptic Bearded Goby	*Barbuligobius boehlkei*
Pinkhead Frogfish	*Batrachomoeus rubricephalus*
Southern Longfin	*Beliops xanthokrossos*
Barred Spiny Basslet	*Belonepterygion fasciolatum*
Foxfish	*Bodianus frenchii*
Gale's Pipefish	*Campichthys galei*
Smoothspine Leatherjacket	*Cantheschenia longipinnis*
Grey Nurse Shark	*Carcharias taurus*
Great White Shark	*Carcharodon carcharias*
Western Talma	*Chelmonops curiosus*
Silver Spot	*Chironemus maculosus*
Baldchin Groper	*Choerodon rubescens*
Muiron Pipefish	*Choeroichthys latispinosus*
Pigsnout Pipefish	*Choeroichthys suillus*
Blackhead Puller	*Chromis klunzingeri*
Western King Wrasse	*Coris auricularis*
Orange Eelpout	*Dipulus caecus*
Breaksea Cod	*Epinephelides armatus*
Bluetail Leatherjacket	*Eubalichthys cyanoura*
Twospot Eviota	*Eviota bimaculata*
Green Moray	*Gymnothorax prasinus*
Tasselled Pipefish	*Halicampus brocki*

Species Name	
Mud Pipefish	*Halicampus grayi*
Brownfield's Wrasse	*Halichoeres brownfieldi*
Blackthroat Threefin	*Helcogramma decurrens*
Rosy Weedfish	*Heteroclinus roseus*
Rainbow Cale	*Heteroscarus acroptilus*
Western Spiny Seahorse	*Hippocampus angustus*
Short-snouted Seahorse	*Hippocampus breviceps*
West Australian Seahorse	*Hippocampus subelongatus*
Banded Seaperch	*Hypoplectrodes nigroruber*
Spotty Seaperch	*Hypoplectrodes wilsoni*
Peacock Rockskipper	*Istiblennius meleagris*
Lined Dottyback	*Labracinus lineatus*
Porbeagle	*Lamna nasus*
Prophet's Pipefish	*Lissocampus fatiloquus*
Largetooth Beardie	*Lotella rhacina*
Reef Manta Ray	*Manta alfredi*
Giant Manta Ray	*Manta birostris*
Sawtooth Pipefish	*Maroubra perserrata*
Yellowstriped Leatherjacket	*Meuschenia flavolineata*
Bluelined Leatherjacket	*Meuschenia galii*
Western Crested Pipefish	*Mitotichthys meraculus*
Bonyhead Pipefish	*Nannocampus subosseus*
Footballer Sweep	*Neatypus obliquus*
Scalyfin Threefin	*Norfolkia brachylepis*
Germain's Blenny	*Omobranchus germaini*
Western Striped Cardinalfish	*Ostorhinchus victoriae*
False Tasmanian Blenny	*Parablennius postoculomaculatus*
Wavy Grubfish	*Parapercis haackei*
Kimberley Catfish	*Paraplotosus muelleri*
Mcculloch's Scalyfin	*Parma mccullochi*
Western Scalyfin	*Parma occidentalis*
Whitenose Pigfish	*Perryena leucometopon*
Leafy Seadragon	*Phycodurus eques*
Weedy Seadragon	*Phyllopteryx taeniolatus*
Miller's Damsel	*Pomacentrus milleri*
Shaggy Cusk	*Porocephalichthys dasyrhynchus*
Silver Trevally	*Pseudocaranx georgianus*
Yellowfin Dottyback	*Pseudochromis wilsoni*
Pugnose Pipefish	*Pugnaso curtirostris*
Whale Shark	*Rhincodon typus*
Rough Leatherjacket	*Scobinichthys granulatus*
Steene's Scorpionfish	*Scorpaenodes steenei*
Sharpnose Weed Whiting	*Siphonognathus caninis*

Species Name	
Gunther's Pipehorse	*Solegnathus lettiensis*
Spotted Pipefish	*Stigmatopora argus*
Widebody Pipefish	*Stigmatopora nigra*
Bluethroat Rainbow Wrasse	*Suezichthys cyanolaemus*
Double-end Pipehorse	*Syngnathoides biaculeatus*
Tasselsnout Flathead	*Thysanophrys cirronasus*
Southern Roughy	*Trachichthys australis*
Hairy Pipefish	*Urocampus carinirostris*
Mother-of-pearl Pipefish	*Vanacampus margaritifer*
Scarlet Cardinalfish	*Vincentia badia*
Orange Cardinalfish	*Vincentia punctata*
viviparous brotula	*Zephyrichthys barryi*
FROGS	
Slender Tree Frog	*Litoria adelaidensis*
REPTILES	
Flat-shelled Tortoise	*Chelodina steindachneri*
Loggerhead Turtle	*Caretta caretta*
Green Turtle	*Chelonia mydas*
Leatherback Turtle	*Dermochelys coriacea*
Flatback Turtle	*Natator depressus*
Goldfields Pebble-Mimic Dragon	*Tympanocryptis pseudopsephos*
Central Netted Dragon	*Ctenophorus nuchalis*
Northern Dotted-line Robust Slider	*Lerista miopus*
Western Spiny-tailed Skink	*Egernia stokesii badia*
Batavia Coast Worm Lizard	*Aprasia clairae*
Western Crowned Snake	*Elapognathus coronatus*
Ringed Brown Snake	*Pseudonaja modesta*
Shark Bay Seasnake	*Aipysurus pooleorum*
Spectacled Seasnake	*Disteira kingii*
Yellow-bellied Seasnake	*Hydrophis platurus*
BIRDS	
Brown Quail	*Coturnix ypsilophora*
Grey Teal	*Anas gracilis*
Northern Mallard	*Anas platyrhynchos*
Pacific Black Duck	*Anas superciliosa*
Australian Wood Duck	*Chenonetta jubata*
Australian Shelduck	*Tadorna tadornoides*
Hardhead	*Aythya australis*
Musk Duck	*Biziura lobata*
Black Swan	*Cygnus atratus*
Pink-eared Duck	*Malacorhynchus membranaceus*
Australasian Shoveler	*Spatula rhynchotis*
Diamond Dove	*Geopelia cuneata*

Species Name	
Eurasian Coot	*Fulica atra*
Buff-banded Rail	*Gallirallus philippensis*
Purple Swamphen	*Porphyrio porphyrio*
Australian Spotted Crake	*Porzana fluminea*
Black-Tailed Native-Hen	*Tribonyx ventralis*
Cattle Egret	*Ardea ibis*
White-necked Heron	*Ardea pacifica*
Great Egret	*Ardea alba*
Little Egret	*Egretta garzetta*
White-faced Heron	*Egretta novaehollandiae*
Eastern Reef Egret	*Egretta sacra*
Australian White Ibis	*Threskiornis moluccus*
Straw-necked Ibis	*Threskiornis spinicollis*
Glossy Ibis	*Plegadis falcinellus*
Yellow-billed Spoonbill	*Platalea flavipes*
Great Crested Grebe	*Podiceps cristatus*
Hoary-headed Grebe	*Poliocephalus poliocephalus*
Australasian Grebe	*Tachybaptus novaehollandiae*
Banded Stilt	*Cladorhynchus leucocephalus*
Red-necked Avocet	*Recurvirostra novaehollandiae*
Black-winged Stilt	*Himantopus leucocephalus*
Red-capped Plover	*Charadrius ruficapillus*
Grey Plover	*Pluvialis squatarola*
Pacific Golden Plover	*Pluvialis fulva*
Red-capped Plover	*Charadrius ruficapillus*
Black-fronted Dotterel	*Elseyornis melanops*
Banded Lapwing	*Vanellus tricolor*
Red-kneed Dotterel	*Erythrogonys cinctus*
Common Sandpiper	*Actitis hypoleucos*
Ruddy Turnstone	*Arenaria interpres*
Sharp-tailed Sandpiper	*Calidris acuminata*
Sanderling	*Calidris alba*
Red Knot	*Calidris canutus*
Curlew Sandpiper	*Calidris ferruginea*
Pectoral Sandpiper	*Calidris melanotos*
Red-necked Stint	*Calidris ruficollis*
Bar-tailed Godwit	*Limosa lapponica*
Eastern Curlew	*Numenius madagascariensis*
Australian Painted Snipe	*Rostratula australis*
Painted Snipe	*Rostratula benghalensis*
Grey-tailed Tattler	*Tringa brevipes*
Common Greenshank	*Tringa nebularia*
Marsh Sandpiper	*Tringa stagnatilis*

Species Name	
Terek Sandpiper	*Xenus cinereus*
Caspian Tern	*Hydroprogne caspia*
Pacific Gull	*Larus pacificus*
Silver Gull	*Chroicocephalus novaehollandiae*
Bridled Tern	*Onychoprion anaethetus*
Roseate Tern	*Sterna dougallii*
Common Tern	*Sterna hirundo*
Little Tern	*Sternula albifrons*
Fairy Tern	*Sternula nereis*
Crested Tern	*Thalasseus bergii*
Australian Pelican	*Pelecanus conspicillatus*
Common Noddy	*Anous stolidus*
Lesser Noddy	*Anous tenuirostris*
Flesh-footed Shearwater	*Ardenna carneipes*
Wedge-tailed Shearwater	*Ardenna pacifica*
Little Shearwater	*Puffinus assimilis*
Australasian Gannet	*Morus serrator*
Soft-plumaged Petrel	*Pterodroma mollis*
Southern Giant-Petrel	*Macronectes giganteus*
Northern Giant Petrel	*Macronectes halli*
Great Skua	*Catharacta skua*
Amsterdam Albatross	*Diomedea amsterdamensis*
Southern Royal Albatross	*Diomedea epomophora*
Wandering Albatross	*Diomedea exulans*
Northern Royal Albatross	*Diomedea sanfordi*
Slender-Billed Thornbill	*Acanthiza iredalei*
Indian Yellow-nosed Albatross	*Thalassarche carteri*
Shy Albatross	*Thalassarche cauta*
Campbell Albatross	*Thalassarche impavida*
Black-browed Albatross	*Thalassarche melanophris*
White-capped Albatross	*Thalassarche steadi*
Australasian Darter	*Anhinga novaehollandiae*
Little Pied Cormorant	*Microcarbo melanoleucos*
Great Cormorant	*Phalacrocorax carbo*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Pied Cormorant	*Phalacrocorax varius*
White-bellied Sea-Eagle	*Haliaeetus leucogaster*
Eastern Osprey	*Pandion cristatus*
Chestnut-rumped Thornbill	*Acanthiza uropygialis*
Grey Wagtail	*Motacilla cinerea*
Little Grassbird	*Poodytes gramineus*
Australian Reed-Warbler	*Acrocephalus australis*
Eurasian Tree Sparrow	*Passer montanus*

Species Name	
MAMMALS	*Pandion haliaetus*
Little Red Flying-Fox	*Pteropus scapulatus*
New Zealand Fur Seal	*Arctocephalus forsteri*
Australian Sea Lion	*Neophoca cinerea*
Minke Whale	*Balaenoptera acutorostrata*
Bryde's Whale	*Balaenoptera edeni*
Blue Whale	*Balaenoptera musculus*
Common Dolphin	*Delphinus delphis*
Southern Right Whale	*Eubalaena australis*
Risso's Dolphin	*Grampus griseus*
Humpback Whale	*Megaptera novaeangliae*
Orca	*Orcinus orca*
Sperm Whale	*Physeter macrocephalus*
Spotted Dolphin	*Stenella attenuata*
Indian Ocean Bottlenose Dolphin	*Tursiops aduncus*
Bottlenose Dolphin	*Tursiops truncatus*
Rakali	*Hydromys chrysogaster*
Total Number of Species:	**216**

Appendix I: Explanation of Fauna Values

Fauna values are the features of a site and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but rather contribute to an understanding of the biodiversity of a site. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a site. For example, a site may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e., has all the species that would have been present at the time of European settlement) or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded site on the mainland).

Richness. This is a measure of the number of species at a site. At a simple level, a species-rich site is more valuable than a species-poor site, but value is also determined by other factors, for example, by the sorts of species present.

Vegetation and Substrate Associations

Vegetation and Substrate Associations (VSAs) combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al.* 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment, which VSAs will recognise. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate

for detailed information on the fauna assemblage. For example, rare, relictual or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna. The disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity, such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Biodiversity Conservation Act 2016* (Biodiversity Conservation Act). In addition, the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report and are outlined below. A full description of the conservation significance levels, schedules and priority levels mentioned below is provided in Appendix 3.

Conservation Significance (CS) level 1: Species listed under State or Commonwealth Acts.

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention). The Biodiversity Conservation Act uses a series of Schedules to classify status, but also recognizes the IUCN categories and ranks species within the Schedules using the categories of Mace and Stuart (1994).

Conservation Significance (CS) level 2: Species listed as Priority by the DBCA but not listed under State or Commonwealth Acts.

In Western Australia, the DBCA has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the Biodiversity Conservation Act but for which the DBCA believes there is cause for concern. Some Priority species are also assigned to the Conservation Dependent category of the IUCN.

Conservation Significance (CS) level 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information and expert judgment, but is used here as it may have links to preserving biodiversity at the genetic level (EPA 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection (now DBCA), used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Bush Forever plan (Government of Western Australia 2000).

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey 2002).

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(schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey 2002).

Introduced species

In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes that affect and maintain fauna populations in an area and as such are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a project may be affected by processes such as fire regime, landscape patterns (such as fragmentation and/or linkage), the presence of feral species and hydrology. Impacts may be significant if processes are altered such that fauna populations are adversely affected, resulting in declines and even localised loss of species. Threatening processes as outlined below are effectively the ecological processes that can be altered to result in impacts upon fauna.

Appendix J: Categories Used in the Assessment of Conservation Status of Fauna

IUCN categories (based on review by Mace and Stuart 1994) as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Biodiversity Conservation Act 2016*.

Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (Ex)	Taxa known to survive only in captivity.
Critically Endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (E)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (V)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern	Taxa that are not Threatened.

Schedules used in the WA *Biodiversity Conservation Act 2016.*

Schedule 1 (S1)	Critically Endangered fauna
Schedule 2 (S2)	Endangered fauna
Schedule 3 (S3)	Vulnerable Migratory species listed under international treaties
Schedule 4 (S4)	Presumed extinct fauna
Schedule 5 (S5)	Migratory birds under international agreement
Schedule 6 (S6)	Conservation dependent fauna
Schedule 7 (S7)	Other specially protected fauna

WA Department of Biodiversity, Conservation and Attractions Priority species (species not listed under the *Biodiversity Conservation Act 2016*, but for which there is some concern).

Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4. (P4)	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5 (P5)	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

Appendix K: Matrix of Vascular Plant Taxa Recorded within Vegetation Types Described in the Development Envelope during Reconnaissance Survey 2020

Taxon	H8	T2	T3	W1
Acacia lasiocarpa var. *lasiocarpa*	X		X	
Acacia rostellifera	X	X	X	X
Acacia sp.			X	
Acanthocarpus preissii				X
Alyogyne huegelii			X	
Amyema preissii	X			
Anthobolus foveolatus			X	
Austrostipa elegantissima			X	
Austrostipa flavescens				X
Avena sp.			X	
Cassytha flava			X	
Cassytha racemosa forma *pilosa*	X		X	X
Comesperma integerrimum		X	X	X
Desmocladus asper	X	X	X	
Dianella revoluta var. *divaricata*			X	X
Diplolaena leemaniana			X	
Eucalyptus obtusiflora subsp. *dongarraensis*				X
Eucalyptus oraria				X
Gahnia sp. South West (K.L. Wilson & K. Frank KLW 9266)	X			X
Hibbertia racemosa			X	
Lepidosperma calcicola			X	
Leucopogon insularis	X			
Leucopogon parviflorus			X	
Logania litoralis	X			
Lomandra maritima	X			
Melaleuca cardiophylla	X	X	X	X
Melaleuca huegelii subsp. *huegelii*	X	X	X	X
Melaleuca lanceolata			X	X
Melaleuca systena	X		X	
Olearia sp. Kennedy Range (G. Byrne 66)			X	
Phyllanthus scaber				X
Rhagodia baccata subsp. *baccata*		X		X
Rhagodia preissii subsp. *obovata*			X	X
Santalum acuminatum	X	X		
Spyridium globulosum	X		X	
Templetonia retusa				X
Threlkeldia diffusa		X	X	X
Thysanotus sp.	X		X	
**Ursinia anthemoides*	X		X	

Appendix L: Raw Data Recorded within Quadrats and Relevés in the Study Area 2020

Site Name:	MET01
Site Type:	RELEVE
Survey Date:	24/02/2020
GPS Location:	GDA94 Zone 50 304456.88E 6752703.56N
Landform Type:	Flat
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Sandy Loam
Soil Colour:	Grey-brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1: *Acacia rostellifera*, *Melaleuca huegelii* subsp. *huegelii*, *Olearia* sp. Kennedy Range (G. Byrne 66)

Mid Stratum 2: *Melaleuca systena*

Lower Stratum 1: *Lepidosperma calcicola*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia rostellifera	4	4
Acacia sp.	0.1	0.1
Austrostipa elegantissima	0.5	0.1
Cassytha flava		0.1
Dianella revoluta var. *divaricata*	0.8	0.5
Lepidosperma calcicola	0.2	2
Melaleuca cardiophylla	0.6	0.1
Melaleuca huegelii subsp. *huegelii*	4	80
Melaleuca systena	1.5	2
Olearia sp. Kennedy Range (G. Byrne 66)	2	2
Spyridium globulosum	0.7	0.2
Threlkeldia diffusa	0.5	0.1
Thysanotus sp.		0.1

PHOTO

Site Name:	MET02
Site Type:	RELEVE
Survey Date:	24/02/2020
GPS Location:	GDA94 Zone 50 304598.36E 6752701.01N
Landform Type:	Flat
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Sandy Loam
Soil Colour:	Grey-brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Melaleuca huegelii* subsp. *huegelii*
Mid Stratum 2:	*Melaleuca systena*, *Olearia* sp. Kennedy Range (G. Byrne 66)
Lower Stratum 1:	*Lepidosperma calcicola*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia rostellifera	2	2.5
Austrostipa elegantissima	0.8	0.2
Avena sp.	0.2	0.1
Cassytha flava		0.1
Dianella revoluta var. *divaricata*	0.2	0.1
Lepidosperma calcicola	0.2	30
Melaleuca huegelii subsp. *huegelii*	5	50
Melaleuca systena	1.5	15
Olearia sp. Kennedy Range (G. Byrne 66)	1.5	15
Spyridium globulosum	1.2	0.5
Threlkeldia diffusa	0.1	0.1
Thysanotus sp.		0.1
**Ursinia anthemoides*	0.1	0.1

PHOTO

Site Name:	MET03
Site Type:	RELEVE
Survey Date:	24/02/2020
GPS Location:	GDA94 Zone 50 304631.18E 6752707.34N
Landform Type:	Flat
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Sandy Loam
Soil Colour:	Grey-brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1: *Acacia rostellifera*, *Melaleuca huegelii* subsp. *huegelii*, *Olearia* sp. Kennedy Range (G. Byrne 66)

Mid Stratum 2: *Melaleuca systena*

Lower Stratum 1: *Lepidosperma calcicola*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia rostellifera	3	4
Anthobolus foveolatus	0.2	0.1
Cassytha flava		0.1
Comesperma integerrimum		0.1
Dianella revoluta var. *divaricata*	0.5	0.1
Lepidosperma calcicola	0.2	30
Melaleuca huegelii subsp. *huegelii*	4	30
Melaleuca systena	1.2	5
Olearia sp. Kennedy Range (G. Byrne 66)	2.5	30
Rhagodia preissii subsp. *obovata*	1	1

PHOTO

Site Name:	MET04
Site Type:	RELEVE
Survey Date:	24/02/2020
GPS Location:	GDA94 Zone 50 303194.78E 6749409.62N
Landform Type:	Lower Slope
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Sandy Loam
Soil Colour:	Grey-brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1: *Acacia rostellifera*, *Melaleuca cardiophylla*, *Melaleuca huegelii* subsp. *huegelii*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia rostellifera	3.5	10
Comesperma integerrimum		0.1
Desmocladus asper	0.2	0.1
Melaleuca cardiophylla	3	70
Melaleuca huegelii subsp. *huegelii*	5	10
Rhagodia baccata subsp. *baccata*	1.4	0.2
Santalum acuminatum		
Threlkeldia diffusa	0.2	0.2

PHOTO

Site Name:	MET05
Site Type:	RELEVE
Survey Date:	25/02/2020
GPS Location:	GDA94 Zone 50 303281.38990508E 6749740.73569662N
Landform Type:	Other, Swale between dunes (other)
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Clayey Sand
Soil Colour:	Grey
Rock Outcrop:	No bedrock exposed
CF Abundance:	<2%
CF Sizes:	2-6mm, 6-20mm
CF Types:	Limestone
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Melaleuca cardiophylla*, *Melaleuca huegelii* subsp. *huegelii*
Lower Stratum 1:	*Melaleuca systena*
Lower Stratum 2:	*Gahnia* sp. South West (K.L. Wilson & K. Frank KLW 9266)

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia lasiocarpa var. *lasiocarpa*	0.4	0.5
Cassytha racemosa forma *pilosa*		0.1
Desmocladus asper	0.1	0.2
Gahnia sp. South West (K.L. Wilson & K. Frank KLW 9266)	0.2	50
Melaleuca cardiophylla	1.8	10
Melaleuca huegelii subsp. *huegelii*	1.5	50
Melaleuca systena	0.6	5
**Ursinia anthemoides*	0.1	0.1

PHOTO

Site Name:	MET06
Site Type:	RELEVE
Survey Date:	25/02/2020
GPS Location:	GDA94 Zone 50 303369.88313318E 6750092.16224395N
Landform Type:	Other, Swale between dunes (other)
Slope Class:	Gently Inclined (3 degrees)
Soil Type:	Clayey Sand
Soil Colour:	Grey
Rock Outcrop:	Limestone, 10-20% bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Limestone
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

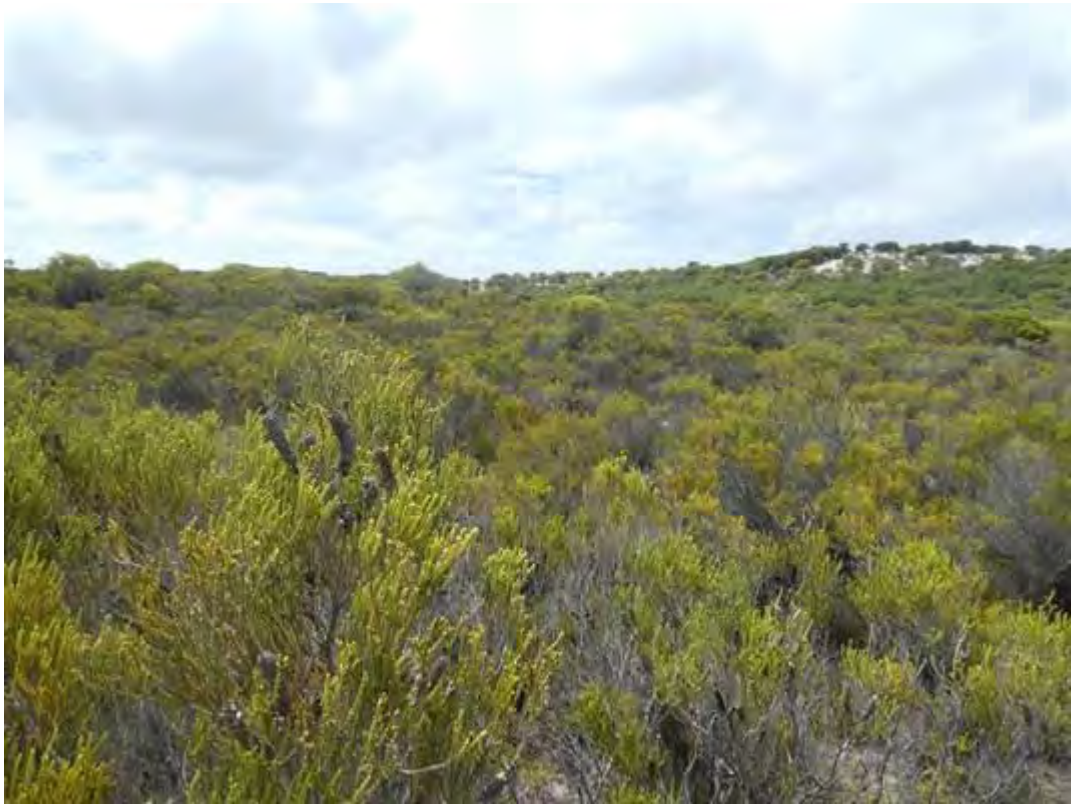
DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Melaleuca huegelii* subsp. *huegelii*
Lower Stratum 1:	*Acacia lasiocarpa* var. *lasiocarpa*, *Melaleuca systena*
Lower Stratum 2:	*Gahnia* sp. South West (K.L. Wilson & K. Frank KLW 9266)

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia lasiocarpa var. *lasiocarpa*	0.7	2
Cassytha racemosa forma *pilosa*		0.1
Desmocladus asper	0.1	0.1
Gahnia sp. South West (K.L. Wilson & K. Frank KLW 9266)	0.4	50
Leucopogon insularis	0.3	0.2
Logania litoralis	0.7	0.1
Lomandra maritima	0.6	0.2
Melaleuca huegelii subsp. *huegelii*	1.2	70
Melaleuca systena	0.5	8
Thysanotus sp.		0.1

PHOTO



Site Name:	MET07
Site Type:	RELEVE
Survey Date:	25/02/2020
GPS Location:	GDA94 Zone 50 303461.82801201E 6750547.75406661N
Landform Type:	Other, Swale between dunes (other)
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Clayey Sand
Soil Colour:	Grey
Rock Outcrop:	No bedrock exposed
CF Abundance:	<2%
CF Sizes:	2-6mm, 6-20mm
CF Types:	Limestone
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Acacia rostellifera*, *Melaleuca huegelii* subsp. *huegelii*, *Santalum acuminatum*
Lower Stratum 1:	*Melaleuca systena*
Lower Stratum 2:	*Gahnia* sp. South West (K.L. Wilson & K. Frank KLW 9266)

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia lasiocarpa var. *lasiocarpa*	0.4	1.5
Acacia rostellifera	2.5	15
Cassytha racemosa forma *pilosa*		0.1
Desmocladus asper	0.1	0.1
Gahnia sp. South West (K.L. Wilson & K. Frank KLW 9266)	0.2	40
Melaleuca huegelii subsp. *huegelii*	2	5
Melaleuca systena	0.4	10
Santalum acuminatum	3	10
**Ursinia anthemoides*	0.1	0.1

PHOTO

Site Name:	MET08
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	26/02/2020
GPS Location:	GDA94 Zone 50 303702.61E 6751848.4N
Landform Type:	Mid Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	ESE
Soil Type:	Sand
Soil Colour:	Grey
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Disturbance:	(other) - Within 10 m of track, minor edge effects.
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus obtusiflora* subsp. *dongarraensis*, *Eucalyptus oraria*
Mid Stratum 1:	*Melaleuca cardiophylla*
Mid Stratum 2:	*Melaleuca huegelii* subsp. *huegelii*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acanthocarpus preissii	0.2	0.1
Austrostipa flavescens	0.2	0.1
Dianella revoluta var. *divaricata*	0.6	0.2
Eucalyptus obtusiflora subsp. *dongarraensis*	7	10
Eucalyptus oraria	7	60
Melaleuca cardiophylla	2.5	5
Melaleuca huegelii subsp. *huegelii*	1	4
Phyllanthus scaber	0.2	0.1
Rhagodia preissii subsp. *obovata*	0.2	0.1

PHOTO

Site Name:	MET09
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	26/02/2020
GPS Location:	GDA94 Zone 50 303597.30278503E 6751271.8498319N
Landform Type:	Mid Slope
Slope Class:	Gently Inclined (3 degrees)
Aspect:	WNW
Soil Type:	Sand
Soil Colour:	Grey
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Disturbance:	(other) - Within 10 m of track, minor edge effects.
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus obtusiflora* subsp. *dongarraensis*, *Eucalyptus oraria*
Mid Stratum 1:	*Melaleuca cardiophylla*, *Melaleuca huegelii* subsp. *huegelii*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia rostellifera	1.5	1
Cassytha racemosa forma *pilosa*		0.1
Eucalyptus obtusiflora subsp. *dongarraensis*	6	15
Eucalyptus oraria	6	65
Melaleuca cardiophylla	2	10
Melaleuca huegelii subsp. *huegelii*	2	20
Rhagodia baccata subsp. *baccata*	0.2	0.1
Templetonia retusa	3.5	1.5

PHOTO

Site Name:	MET10
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	26/02/2020
GPS Location:	GDA94 Zone 50 303616.46E 6750451.43N
Landform Type:	Mid Slope
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Sand
Soil Colour:	Grey
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Disturbance:	(other) - Edge effects
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus obtusiflora* subsp. *dongarraensis*, *Eucalyptus oraria*
Mid Stratum 1:	*Acacia rostellifera*, *Melaleuca huegelii* subsp. *huegelii*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia rostellifera	3	3
Comesperma integerrimum		0.1
Eucalyptus obtusiflora subsp. *dongarraensis*	5	25
Eucalyptus oraria	4	25
Gahnia sp. South West (K.L. Wilson & K. Frank KLW 9266)	0.2	0.1
Melaleuca huegelii subsp. *huegelii*	2.5	30
Rhagodia baccata subsp. *baccata*	0.1	0.1
Threlkeldia diffusa	0.1	0.1

PHOTO

Site Name:	MET11
Site Type:	RELEVE
Survey Date:	27/02/2020
GPS Location:	GDA94 Zone 50 302987.41E 6750501.61N
Landform Type:	Plain
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Sand
Soil Colour:	Grey
Rock Outcrop:	No bedrock exposed
CF Abundance:	<2%
CF Sizes:	2-6mm
CF Types:	Limestone
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Acacia rostellifera*, *Melaleuca huegelii* subsp. *huegelii*
Lower Stratum 1:	*Melaleuca systena*
Lower Stratum 2:	*Gahnia* sp. South West (K.L. Wilson & K. Frank KLW 9266)

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia lasiocarpa var. *lasiocarpa*	0.5	0.5
Acacia rostellifera	2	5
Amyema preissii		0.1
Cassytha racemosa forma *pilosa*		0.1
Desmocladus asper	0.1	0.5
Gahnia sp. South West (K.L. Wilson & K. Frank KLW 9266)	0.3	20
Melaleuca huegelii subsp. *huegelii*	2	15
Melaleuca systena	0.8	5
Spyridium globulosum	1	0.2
**Ursinia anthemoides*	0.1	0.1

PHOTO

Site Name:	MET12
Site Type:	RELEVE
Survey Date:	27/02/2020
GPS Location:	GDA94 Zone 50 303177.07E 6749797.68N
Landform Type:	Upper Slope
Slope Class:	Steep (23 degrees)
Aspect:	E
Soil Type:	Sand
Soil Colour:	Grey
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1: *Melaleuca cardiophylla*, *Melaleuca huegelii* subsp. *huegelii*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia rostellifera	0.5	1.5
Melaleuca cardiophylla	2.5	50
Melaleuca huegelii subsp. *huegelii*	2.5	30
Rhagodia baccata subsp. *baccata*	0.2	0.1
Threlkeldia diffusa	0.1	0.1

PHOTO

Site Name:	MET13
Site Type:	RELEVE
Survey Date:	27/02/2020
GPS Location:	GDA94 Zone 50 303657.72970273E 6749661.00486786N
Landform Type:	Upper Slope
Slope Class:	Gently Inclined (3 degrees)
Soil Type:	Sandy Loam
Soil Colour:	Grey
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Melaleuca cardiophylla*
Mid Stratum 2:	*Acacia rostellifera*
Lower Stratum 1:	*Melaleuca systena*
Lower Stratum 2:	*Lepidosperma calcicola*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Acacia lasiocarpa var. *lasiocarpa*	0.3	1
Acacia rostellifera	1.5	5
Alyogyne huegelii	0.4	0.1
Cassytha racemosa forma *pilosa*		0.1
Desmocladus asper	0.1	0.2
Diplolaena leemaniana	0.4	0.5
Hibbertia racemosa	1	1
Lepidosperma calcicola	0.2	5
Leucopogon parviflorus	0.5	0.1
Melaleuca cardiophylla	3	30
Melaleuca lanceolata		
Melaleuca systena	0.6	5
Olearia sp. Kennedy Range (G. Byrne 66)	1	0.5
Thysanotus sp.		0.1

PHOTO

Site Name:	MET14
Site Type:	QUADRAT
Dimensions:	10m x 10m
Survey Date:	27/02/2020
GPS Location:	GDA94 Zone 50 303543.37194906E 6749804.14855109N
Landform Type:	Other, Undulating plain (other)
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Sandy Loam
Soil Colour:	Grey-brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus obtusiflora* subsp. *dongarraensis*, *Eucalyptus oraria*
Mid Stratum 1:	*Melaleuca cardiophylla*, *Melaleuca huegelii* subsp. *huegelii*, *Melaleuca lanceolata*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Cassytha racemosa forma *pilosa*		0.2
Comesperma integerrimum		0.1
Eucalyptus obtusiflora subsp. *dongarraensis*	6	50
Eucalyptus oraria	6	20
Melaleuca cardiophylla	2	5
Melaleuca huegelii subsp. *huegelii*	2.5	30
Melaleuca lanceolata	3	5
Rhagodia baccata subsp. *baccata*	0.1	0.1

PHOTO

Site Name:	MET15
Site Type:	RELEVE
Survey Date:	27/02/2020
GPS Location:	GDA94 Zone 50 303560.15764427E 6750163.97609415N
Landform Type:	Lower Slope
Slope Class:	Gently Inclined (3 degrees)
Soil Type:	Sandy Loam
Soil Colour:	Grey-brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	<2%
CF Sizes:	2-6mm
CF Types:	Limestone
Vegetation Condition:	Southern Vegetation Condition - 2 - Excellent
Fire:	> 10 years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1: *Melaleuca cardiophylla*

SPECIES LIST

Taxon Name	Avg. Height	Cover Alive
Melaleuca cardiophylla	3	80

PHOTO

Appendix M: Explanation of Threatening and Ecological Processes

Potential impacts of proposed developments upon fauna values can be related to threatening processes. This is recognised in the literature (e.g. Gleeson and Gleeson 2012) and under the EPBC Act, in which threatening processes are listed. Processes that may impact fauna values are discussed below. Rather than being independent of one another, processes are complex and often interrelated. They are the mechanisms by which fauna can be affected by development. Impacts may be significant if large numbers of species or large proportions of populations are affected.

Note that the terms direct and indirect impacts are used by the DotE (2013, SEWPaC (2013) and EPA (2016b), but there is some inconsistency in these definitions. The federal guidance does not define direct impact but has a very broad definition of indirect, and makes the statement (DotE 2013) '*Consideration should be given to all adverse impacts that could reasonably be predicted to follow from the action, whether these impacts are within the control of the person proposing to take the action or not. Indirect impacts will be relevant where they are sufficiently close to the proposed action to be said to be a consequence of the action, and they can reasonably be imputed to be within the contemplation of the person proposing to take the action*.' Indirect impacts therefore can even include what the DotE (2013) calls facilitated impacts, which are the result of third party actions triggered by the primary action. In contrast, the EPA (2016b) defines direct impacts to '*include the removal, fragmentation or modification of habitat, and mortality or displacement of individuals or populations.*' This document then lists as indirect impacts what in many cases are the consequences of the removal, fragmentation or modification of habitat. For example, '*disruption of the dispersal of individuals required to colonise new areas inhibiting maintenance of genetic diversity between populations*' is a consequence of habitat fragmentation. Impacts of light, noise and even roadkill are defined as indirect but they are clearly the result of the action and in control of the person taking the action. Roadkill is as direct a form of mortality as can be observed, but it is considered as an indirect impact in the context of a development presumably because it is not directly linked to land clearing. The EPA (2016b) makes a strong distinction between removal of vegetation (direct impact) and the consequences of such clearing and other aspects of a development (indirect impacts). It is not obvious how this distinction between direct and indirect impacts is helpful in the EIA process, as the key aim is to ensure that all impacts that result from a project are addressed in this assessment process. Interestingly, Gleeson and Gleeson (2012), in a major review of impacts of development on wildlife, do not use the terms direct or indirect. In the following outlines of threatening processes that can cause impacts, the emphasis is upon interpreting how a threatening process will cause an impact. For example, loss of habitat (threatening process) can lead to population decline and to population fragmentation, which are two distinct impacts.

Loss of habitat affecting population survival

Clearing for a development can lead to habitat loss for a species with a consequent decline in population size. This may be significant if the smaller population has reduced viability. Conservation significant species or species that already occur at low densities may be particularly sensitive to habitat loss affecting population survival.

Loss of habitat leading to population fragmentation

Loss of habitat can affect population movements by limiting movement of individuals throughout the landscape as a result of fragmentation (Gleeson and Gleeson 2012, Soule *et al.* 2004). Obstructions associated with the development, such as roads, pipes and drainage channels, may also affect movement of small, terrestrial species. Fragmented populations may not be sustainable and may be sensitive to effects such as reduced gene flow.

Degradation of habitat due to weed invasion leading to population decline

Weed invasion, such as through introduction by human boots or vehicle tyres, can occur as a result of development and if this alters habitat quality, can lead to effects similar to habitat loss.

Increased mortality

Increased mortality can occur during project operations; for example, roadkill, animals striking infrastructure, and entrapment in trenches. Roadkill as a cause of population decline has been documented for several medium-sized mammals in eastern Australia (Dufty 1989, Jones 2000). Increased mortality due to roadkill is often more prevalent in habitats that have been fragmented (Scheick and Jones 1999, Clevenger and Waltho 2000, Jackson and Griffin 2000). Increased mortality of common species during development is unavoidable and may not be significant for a population. However, the cumulative impacts of increased mortality of conservation significant species or species that already occur at low densities may have a significant impact on the population.

Species interactions, including predation and competition

Changes in species interactions often occur with development. Introduced species, including the feral Cat, Red Fox and Rabbit, may have adverse impacts upon native species and development can alter their abundance. In particular, some mammal species are very sensitive to introduced predators and the decline of many mammals in Australia has been linked to predation by the Red Fox, and to a lesser extent, the feral Cat (Burbidge and McKenzie 1989). Introduced grazing species, such as the Rabbit, Goat, Camel and domestic livestock, can also degrade habitats and deplete vegetation that may be a food source for other species.

Changes in the abundance of some native species at the expense of others, due to the provision of fresh watering points, can also be a concern. Harrington (2002) found the presence of artificial fresh waterpoints in the semi-arid mallee rangelands to influence the abundance and distribution of certain bird species. Common, water-dependent birds were found to out-compete some less common, water-independent species. Over-abundant native herbivores, such as kangaroos, can also adversely affect less abundant native species through competition and displacement.

Hydroecology

Interruptions of hydroecological processes can have major effects because they underpin primary production in ecosystems and there are specific, generally rare habitats that are hydrology-dependent. Fauna may be impacted by potential changes to groundwater level and chemistry and altered flow regime. These changes may alter vegetation across large areas and may lead to habitat degradation or loss. Impacts upon fauna can be widespread

and major. Changes to flow regime across the landscape may alter vegetation and may lead to habitat degradation or loss, affecting fauna. For example, Mulga has a shallow root system and relies on surface sheet flow during flood events. If surface sheet flow is impeded, Mulga can die (Kofoed 1998), which may impact on a range of fauna associated with this vegetation type.

Fire

The role of fire in the Australian environment and its importance to vertebrate fauna has been widely acknowledged (Gill et al. 1981, Fox 1982, Bamford and Roberts 2003). It is also one of the factors that has contributed to the decline and local extinction of some mammal and bird species (Burbidge and McKenzie 1989). Fire is a natural feature of the environment but frequent, extensive fires may adversely impact some fauna, particularly mammals and short-range endemic species. Changes in fire regime, whether to more frequent or less frequent fires, may be significant to some fauna. Impacts of severe fire may be devastating to species already occurring at low densities or to species requiring long unburnt habitats to survive. In terms of conservation management, it is not fire *per se* but the fire regime that is important, with evidence that infrequent, extensive and intense fires adversely affect biodiversity, whereas frequent fires that cover small areas and are variable in both season and intensity can enhance biodiversity. Fire management may be considered the responsibility of managers of large tracts of land, including managers of mining tenements.

Dust, light, noise and vibration

Impacts of dust, light, noise and vibration upon fauna are difficult to predict. Some studies have demonstrated the impact of artificial night lighting on fauna, with lighting affecting fauna behaviour more than noise (Rich and Longcore 2006). Effects can include impacts on predator-prey interactions, changes to mating and nesting behaviour, and increased competition and predation within and between invertebrates, frogs, birds and mammals.

The death of very large numbers of insects has been observed around some remote mine sites and attracts other fauna, notably native and introduced predators (M. Bamford, pers. obs). The abundance of some insects can decline due to mortality around lights, although this has previously been recorded in fragmented landscapes where populations are already under stress (Rich and Longcore 2006). Artificial night lighting may also lead to disorientation of migratory birds. Aquatic habitats and open habitats such as grasslands and dunes may be vulnerable to light spill.