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## Abbreviations

Abbreviation	Description
BAM Act	State <i>Biosecurity and Agriculture Management Act 2007</i>
BC Act	State <i>Biodiversity Conservation Act 2016</i>
BoM	Bureau of Meteorology
CLUSTER	Hierarchical Clustering
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attraction
DPIRD	Department of Primary industries and Regional Development
DRF	Declared Rare Flora
ELA	Eco Logical Australia
EP Act	State <i>Environmental Protection Act 1986</i>
EPA	Environmental Protection Authority
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
ESA	Environmentally Sensitive Areas
ha	hectare
IBRA	Interim-Biogeographic Regionalisation for Australia
km	kilometre
m	metre
mm	millimetre
NVIS	National Vegetation Information System
P	Priority
PEC	Priority Ecological Communities
PMST	Protected Matters Search Tool
PRIMER	Plymouth Routines in Multivariate Ecological Research v6
SIMPER	Similarity Percentages
T	Threatened
TEC	Threatened Ecological Communities
VU	Vulnerable
WA	Western Australia
WAH	Western Australian Herbarium
WAM	Western Australian Museums
WAOL	Western Australian Organism List
WoNS	Weed of National Significance

## Executive Summary

Eco Logical Australia was engaged by Australian Gas Infrastructure Group to undertake a Detailed and Targeted flora survey and vegetation condition assessment, a Basic fauna survey, Targeted Black Cockatoo habitat assessment and Targeted Malleefowl survey of the West Erregulla Pipeline Project. The survey area, 212.2 hectares in size, is located approximately 230 kilometres north-east of Perth, and 50 kilometres south-east of Dongara, Western Australia. The initial field survey was undertaken from 7<sup>th</sup> to 10<sup>th</sup> September 2020 by Dr Jeffry Cargill (Senior Botanist), Daniel Brassington (Botanist), Briana Wingfield (Ecologist) and Jeni Morris (Ecologist). In order to capture Threatened and Priority flora known to commence flowering from October onwards, a follow up targeted survey was conducted in areas of suitable habitat identified during the first survey (8<sup>th</sup> to 9<sup>th</sup> October 2020).

A total of 170 taxa (168 native and two introduced) from 93 genera and 39 families were recorded across 26 quadrats established within the survey area (161 taxa) and from Targeted and opportunistic collections (nine taxa). Average species per quadrat was 38.04 species, ranging from a low of 19 species to a high of 57 species. The majority of taxa recorded were representative of the Proteaceae (30), Myrtaceae (23 taxa) and Fabaceae (18 taxa) families. *Banksia* and *Hakea* were the best represented genera throughout the survey area with 8 taxa recorded each.

No Threatened flora species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* or the State *Biodiversity Conservation Act 2016* were recorded from within the current survey area. One Threatened flora species, *Paracaleana dixonii* (Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and Vulnerable under the State *Biodiversity Conservation Act 2016*) was recorded within the survey area in 2011 from one location (24 plants) in a database search. Eight Priority flora species were recorded within the survey area; *Micromyrtus rogeri* (Priority 1), *Lasiopetalum ogilvieanum* (Priority 1), *Guichenotia alba* (Priority 3), *Mesomelaena stygia* subsp. *deflexa* (Priority 3), *Stylidium drummondianum* (Priority 3), *Banksia scabrella* (Priority 4), *Eucalyptus macrocarpa* subsp. *elachantha* (Priority 4), and *Stawellia dimorphantha* (Priority 4).

A total of six vegetation communities were delineated and mapped within the survey area, covering a total of 208.7 hectares (98.35% of the total area surveyed). No vegetation communities delineated within the current survey area were inferred to represent any potential conservation significant communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, the State *Biodiversity Conservation Act 2016* or by the Department of Biodiversity, Conservation and Attractions. Vegetation communities recorded include:

- **AcEbHh:** *Allocasuarina campestris* tall sparse shrubland over *Eremaea beaufortioides*, *Calothamnus quadrifidus* subsp. *angustifolius*, *Isopogon tridens* mid sparse shrubland over *Hibbertia hypericoides*, *Melaleuca leuropoma* low open shrubland and *Ecdeiocolea monostachya* low open sedgeland.
- **EtAhHh:** *Eucalyptus todtiana* mid open woodland over *Allocasuarina humilis*, *Banksia scabrella* (P4), *Calothamnus sanguineus* mid open shrubland over *Hibbertia hypericoides*, *Melaleuca leuropoma* low open shrubland and *Caustis dioica* low open sedgeland.
- **BpDdHh:** *Banksia prionotes* mid open woodland over *Daviesia divaricata*, *Conospermum boreale*, *Allocasuarina humilis* mid open shrubland over *Hibbertia hypericoides* low open shrubland and *Ecdeiocolea monostachya*, *Mesomelaena pseudostygia* low open sedgeland.

- **AcAhGp:** *Allocasuarina campestris* tall sparse shrubland over *Allocasuarina humilis*, *Hakea auriculata*, *Petrophile shuttleworthiana* mid open shrubland over *Gastrolobium plicatum* low open shrubland and *Ecdeiocolea monostachya*, *Schoenus armeria* low open sedgeland.
- **AcDdMI:** *Allocasuarina campestris* tall isolated shrubs over *Daviesia divaricata*, *Conospermum boreale*, *Beaufortia elegans* mid open shrubland over *Melaleuca leuropoma*, *Hibbertia hypericoides* low open shrub over *Ecdeiocolea monostachya* low open sedgeland.
- **EtBaHh:** *Eucalyptus tottiana* mid open woodland over *Banksia attenuata*, *Calothamnus blepharospermus*, *Eremaea beaufortoides* mid open shrubland over *Hibbertia hypericoides*, *Melaleuca leuropoma* low open shrubland and *Ecdeiocolea monostachya* low open sedgeland.

Descriptions of vegetation communities resemble those described by a previous report (Woodman 2013) in a far larger mapped area adjacent to the current survey area. This report also did not infer the presence of any threatened or priority ecological communities.

Vegetation condition within the survey area was Excellent (208.7 hectares; 98.35%) or Cleared (3.5 hectares; 1.65%) based on the vegetation condition scale adapted by Keighery provided in the Environmental Protection Authority *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment*. The primary disturbance within the survey area was a recent prescribed burn, which occurred in April 2019. Post fire regeneration was very good, with majority of species that were expected to occur being recorded. It is noted however, that structural elements of defined vegetation communities may slightly change over time as plant growth and development continue. This includes *Banksia* spp. and *Hakea* spp., Carnaby's Cockatoo (*Calyptorhynchus latirostris*) foraging species, which are predicted to increase in density, quality and structural complexity over time (currently provide low quality foraging habitat).

A total of 35 fauna species were recorded in the survey area, comprising 28 bird species, five mammal species and two reptile species. Introduced fauna species recorded included Cattle (*Bos taurus*), Domestic Dog (*Canis lupus familiaris*), Goat (*Capra hircus*) and European Rabbit (*Oryctolagus cuniculus*). No Threatened or Priority fauna species listed under the Federal *Environment Protections and Biodiversity Conservation Act 1999*, the State *Biodiversity Conservation Act 2016* or by the Department of Biodiversity, Conservation and Attractions were recorded from within the survey area.

Three fauna habitats were delineated and mapped within the survey area; **Fauna habitat 1:** *Allocasuarina campestris* tall sparse shrubland over shrubs and sedgeland on sandy plains, **Fauna habitat 2:** *Banksia* spp. and occasional *Eucalyptus tottiana* mid open woodland over shrubs and sedgeland on sandy plains, **Fauna habitat 3:** *Allocasuarina campestris* tall sparse shrubland over shrubs and sedgeland on stony rises. Fauna habitat 2 was the most commonly occurring fauna habitat, covering 95.2 hectares (44.86%) of the survey area.

No individuals of Carnaby's Cockatoo were recorded within the survey area. No potential or confirmed breeding or roosting trees were recorded as occurring within the survey area. Fauna habitat 2, totalling 95.2 ha (44.86% of the survey area), was assessed as providing 'Low' quality foraging habitat due to the presence of *Banksia* spp. and *Hakea* spp. (SEWPaC 2012; DotEE 2017). The recent fire has decreased the likelihood of the species utilising the survey area in the immediate future; however, *Banksia* spp. and *Hakea* spp. are predicted to increase in density quality and structural complexity over time. The remaining vegetated areas (113.6 ha, 53.53%) are considered as providing 'Negligible' quality foraging

habitat of Carnaby's Cockatoo. Cleared areas (3.4 ha, 1.6%) provide 'Nil' quality foraging habitat for black cockatoo species. No foraging evidence was observed within the survey area.

Whilst the Malleefowl (*Leipoa ocellata*) was targeted in the survey area, the habitat is not considered suitable for the species due to the lack of leaf litter and thicker vegetation. The recent fire has also decreased the likelihood of the species, as the effect of fire on Malleefowl is severe, with breeding in burnt areas usually reduced for at least 30 years (Benshemesh 2007).

For the purposes of the current flora, vegetation and fauna survey, adequate data has been collected to define and assess the presence, extent and significance of species and communities within the survey area. Based on the values identified, it is unlikely that proposed works would appreciably reduce the representativeness of individual taxa or vegetation associations within the local area or indeed across the broader landscape. It is recognised that the survey area far exceeds what would be impacted by any site works.

# 1. Introduction

## 1.1 Project background

Eco Logical Australia (ELA) was engaged by Australian Gas Infrastructure Group (AGIG) to undertake a Detailed and Targeted flora survey and vegetation condition assessment, a Basic fauna survey, Targeted Black Cockatoo habitat assessment and Targeted Malleefowl survey of the West Erregulla Pipeline Project.




A proposed pipeline and gas processing plant (the project) includes a survey area of 212.2 hectares (ha), approximately 230 kilometres (km) north-east of Perth, and 50 km south-east of Dongara, Western Australia (WA; **Figure 1**). The objectives of this survey were as follows:

- Undertake a desktop assessment to identify the potential occurrence of any Federal or State conservation listed flora, fauna or communities;
- Undertake a Detailed and Targeted flora and vegetation survey in accordance with the Environmental Protection Authority (EPA) *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016), including:
  - Identification and mapping of vegetation communities, including identification of Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs);
  - Completion of a full species inventory (including weeds), and mapping of any Federal or State listed Threatened, Priority or other significant flora; and
- Assessment and mapping of vegetation structure cover and condition.
- Undertake a Basic fauna survey in accordance with the EPA *Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020), including:
  - Broad level fauna habitat mapping;
  - Targeted fauna searches and mapping of any Federal or State listed Threatened, Priority and other conservation listed fauna species present and their habitat; and
  - Opportunistic observations of fauna species.
- Undertake a Targeted Black Cockatoo habitat assessment in accordance with the *Environmental Protection and Biodiversity Conservation (EPBC) Act referral guidelines for three threatened black cockatoo species* (DSEWPac 2012).
- Undertake a Targeted Malleefowl survey in accordance with the National Heritage Trust *National Manual for The Malleefowl Monitoring System* (National Heritage Trust 2007).
- Preparation of a standalone summary report detailing the findings of the desktop assessment and field survey; and
- Provision of data including relevant mapping at an appropriate scale and associated data files.



**Figure 1: Survey area location**



- Legend**
-  Survey Footprint
  -  Town
  -  Major Road

0 5 10  
Kilometers  
Scale: 1:350,000 (A4)  
Datum/Projection:  
GDA 1994 MGA Zone 50



## 2. Methodology

### 2.1 Desktop review

#### 2.1.1 Database searches and literature review

The following Commonwealth and State databases were searched for information relating to conservation listed flora, fauna and ecological communities in order to compile and summarise existing data to inform the field survey. Searches of the Commonwealth EPBC Act Protected Matters Search Tool (PMST) and the State NatureMap (DBCA 2007-2021) online databases were undertaken using a polygon presented in **Table 1**. Applied buffers below are considered suitable based on flora and fauna assemblages expected to occur within the survey area. It should be noted that the buffers for the DBCA database searches are selected by DBCA on a case-by-case basis and are therefore not always consistent with other searches undertaken in the area.

**Table 1: Database searches undertaken for the survey area**

Database	Reference	Buffer (km)
<b>Search area polygon coordinates:</b>		
50J 319124 mE 6746717 mS (north-west corner);		
50J 336944 mE 6746281 mS (north-east corner);		
50J 336783 mE 6743316 mS (south-east corner); and		
50J 319659 mE 6744175 mS (south-west corner).		
EPBC Act Protected Matters Search Tool (PMST) for Threatened species and communities listed under the EPBC Act	DAWE 2020	10
DBCA and Western Australian Museum (WAM) NatureMap online database.	DBCA 2007-2020	0
Atlas of Living Australia database	ALA 2021	0
Birddata database	Birddata 2021	0
Birdlife Australia Black Cockatoo roosting database	Birdlife 2021	12
Index of Biodiversity Surveys for Assessments (IBSA)	DWER 2021	0
<b>Search area: survey area shapefile</b>		
DBCA Threatened and Priority flora database searches for Declared Rare Flora (DRF) listed under the latest WA Wildlife Conservation (Rare Flora) Notice and Priority Flora.	DBCA 2020a	10
DBCA Threatened and Priority fauna database searches for Scheduled fauna listed under the EPBC Act or latest WA Wildlife Conservation (Specially Protected Fauna) Notice and Priority Fauna.	DBCA 2020b	50
DBCA Threatened and Priority Ecological Communities' database search	DBCA 2020c	15

In addition, the following documents, provided by AGIG, were also reviewed:

- Review of key potential flora, vegetation and fauna values on the proposed pipeline for Strike Energy near Dongara - Mattiske Consulting Pty Ltd (2020);
- West Erregulla targeted threatened flora survey - Ecologia Environment (2018); and
- West Erregulla Project Flora and Vegetation Assessment – Woodman Environmental Consulting (2013).

### 2.1.2 Likelihood of occurrence assessment

A likelihood of occurrence assessment was undertaken to identify conservation listed flora and fauna species that possibly occur within the survey area, identified from a review of key datasets and literature, as specified above. Conservation codes, categories and criteria for flora and fauna protected under the EPBC Act and the State *Biodiversity Conservation Act 2016* (BC Act) are provided in **Appendix A** (DBCA 2019a). Criteria used for this assessment are presented in **Appendix B**.

## 2.2 Field survey

### 2.2.1 Survey team and timing

The initial field survey was conducted by Dr Jeffry Cargill (Senior Botanist), Daniel Brassington (Botanist), Briana Wingfield (Ecologist) and Jeni Morris (Ecologist) from 7<sup>th</sup> to 10<sup>th</sup> September 2020. In order to capture threatened and priority flora known to commence flowering from October onwards, a follow up targeted survey was conducted in areas of suitable habitat identified during the first survey. The second survey was conducted by Dr Jeffry Cargill (Senior Botanist) and Daniel Brassington (Botanist) from 8<sup>th</sup> to 9<sup>th</sup> October 2020. The survey team's relevant qualifications, experience and licences are provided in **Table 2**. There was no rainfall recorded during the field survey (BoM 2020).

**Table 2: Survey team**

Name	Qualification	Relevant experience	Licences
Dr. Jeffry Cargill	BSc. Hons. PhD Environmental Sciences	Jeff has more than 12 years' experience in botanical and ecological studies throughout Western Australia including baseline vegetation studies (Reconnaissance and Detailed surveys), Targeted threatened and priority flora surveys, fauna and black cockatoo surveys, MNES surveys, environmental risk assessments and rehabilitation and vegetation monitoring programs.	Flora scientific collection licence: FB62000138 Declared Rare Flora (DRF) permit: TFL 48-1920
Daniel Brassington	BSc. Hons. Environmental Science	Daniel has over 8 years' experience in botanical surveys and environmental services throughout Western Australia. This includes baseline vegetation studies (Reconnaissance and Detailed surveys), Threatened and Priority flora surveys, rehabilitation and vegetation monitoring, targeted species surveys, weed control, seed collection and processing, nursery operations and revegetation operations. Daniel has an extensive background in both mining and consulting, particularly in remote areas.	Flora scientific collection licence: SL012503 DRF permit: TFL 15-1920
Briana Wingfield	BSc. Conservation and Wildlife Biology and Environmental Science (Hons)	Briana has seven years' experience conducting fauna surveys across Western Australia, including Basic fauna surveys and Targeted black cockatoo habitat assessments.	N/A

Name	Qualification	Relevant experience	Licences
Jeni Morris	BSc. Conservation and Wildlife Biology	Jeni has over five years' experience conducting flora, vegetation and fauna surveys across a range of Western Australian bioregions, including the Mid West, Carnarvon and Gascoyne bioregions.	Flora scientific collection licence: FB62000070 DRF permit: TFL 13-1920

### 2.2.2 Flora and vegetation survey

A Detailed flora and vegetation survey was conducted in accordance with the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016). The survey included:

- Mapping of vegetation types and completion of a species list; and
- Vegetation condition mapping using the scale outlined in EPA (2016), which is adapted from Keighery (1994).

Stainless steel fence droppers were used to permanently mark the north-west corner of each quadrat. Dominant vegetation communities were described, with respect to dominant species, structure and overall condition. The survey involved the use of 10 x 10 m quadrats as recommended for the Geraldton sandplain bioregion (EPA 2016). Photos were taken from the north-western corner of each quadrat. Where relevant, opportunistic sampling of species not recorded within the quadrats was undertaken to supplement the existing list of species recorded from within the survey area.

A total of 26 quadrats were established across the survey area (**Figure 2**). The following data was recorded within each quadrat:

- Vegetation structure and classes, cover of all species, dominant species list for each vegetation type (in accordance with the National Vegetation Information System (NVIS) Level V structure and floristics);
- Vegetation condition, in accordance with the scale outlined in EPA (2016) adapted from Keighery (1994);
- Full species list of both native and introduced species; and
- Relevant site data including coordinates, site photograph, soil, geology, drainage, slope etc. and any other relevant observational data.

### 2.2.3 Targeted searches

A targeted survey was undertaken within the survey area to identify and record and conservation significant flora or communities potentially occurring, including:

- Threatened flora or TECs listed under the EPBC Act;
- Threatened (Declared Rare) Flora listed under the latest WA Wildlife Conservation (Rare Flora) Notice under the BC Act;
- PECs endorsed by the Western Australian Minister for the Environment; or
- Priority (P) flora recognised by DBCA.

The survey methodology involved personnel walking meandering transects across the survey area, with transect spacing being determined by suitability of habitat for target species. Locations of survey transects is shown in **Figure 2**. Flora species able to be identified in the field were recorded, and voucher specimens of unfamiliar species were collected for later identification. All collections were assigned a

unique collecting number. For conservation significant identified in the field, the following was recorded:

- A colour photograph;
- GPS location;
- Population size estimate;
- Location of population boundaries;
- Associated habitat/landscape element;
- Time and date observed;
- Observer details; and
- A voucher specimen suitable for use as a reference specimen (if appropriate to do so for conservation significant flora).

Flora specimen identification was undertaken by ELA botanist Daniel Brassington, with assistance from Dr Jeffrey Cargill where required. The Western Australian Herbarium (WAH) was also utilised to confirm additional specimens. Species identification utilised taxonomic literature and keys and where required specimens were confirmed using the WAH reference collection. Suitable material that meets WAH specimen lodgement requirements, such as flowering material and range extensions, will be submitted along with Threatened and Priority Report forms to DBCA, as required by conditions of collection licences issued under the BC Act. Nomenclature used for the flora species within this report follows the WA Plant Census as available on FloraBase (DBCA and WAH 2020).

## 2.2.4 Data analysis

### 2.2.4.1 Flora species accumulation curve

A flora species accumulation curve was undertaken to indicate adequacy of the survey effort (Clarke and Gorley 2006). As the number of survey sites increases, and correspondingly the size of the area surveyed increases, there should be a diminishing number of new species recorded. At some point, the number of new species recorded becomes essentially asymptotic. The asymptotic value was determined using Michaelis-Menten modelling and provided an incidence-based coverage estimator of species richness. When the number of new species being recorded for survey effort expended approaches this asymptotic value, the survey effort can be considered adequate.

### 2.2.4.2 Vegetation communities

Plymouth Routines in Multivariate Ecological Research v6 (PRIMER) statistical analysis software was used to analyse species-by-site data and discriminate survey sites based on their species composition (Clarke and Gorley 2006). To down weight the relative contributions of quantitatively dominant species a 4th root transformation was applied to the species percentage cover dataset. Introduced species (weeds), specimens not identified to species level and singletons (species recorded at a single quadrat and not forming a dominant structural component) were excluded from the data set prior to analysis. In addition, annuals were also removed from the dataset prior to analysis due to the likelihood of substantial differences between years based on seasonality of local rainfall events. Computation of similarity matrices was based on the Bray-Curtis similarity measure. Data were analysed using a series of multivariate analysis routines including Similarity Profile (SIMPROF), Hierarchical Clustering (CLUSTER) and Similarity Percentages (SIMPER). Results were used to inform and support interpretation of aerial photography and delineation of individual plant communities.

## 2.2.5 Fauna survey

### 2.2.5.1 Basic fauna survey

The Basic fauna survey was conducted in accordance the EPA *Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020). An assessment of fauna habitat in terms of its ability to support and sustain populations of fauna, along with an assessment of the likelihood of occurrence of conservation significant fauna species, was undertaken during the survey. The habitat characteristics and fauna database records used in assessing likelihood of occurrence for fauna included:

- Vegetation community, structure and condition;
- Soil and landform type;
- Extent and connectivity of bushland;
- Fauna species habitat preferences;
- Proximity of conservation significant fauna records; and
- Signs of species presence.

Opportunistic recordings of fauna species were made at all times during the field survey. These included visual sightings of active fauna such as reptiles and birds; records of bird calls; and signs of species presence such as tracks, diggings, burrows, scats and any other signs of fauna activity.

Nomenclature used for the vertebrate fauna species within this report follows the WAM Checklist of the Vertebrates of Western Australia (WAM 2020). Where common names were not stated for certain species, the following references were consulted:

- Amphibians and reptiles: Bush et al. (2010);
- Reptiles: Wilson and Swan (2013);
- Birds: Morcombe (2007); and
- Mammals: Menkhorst and Knight (2011).

### 2.2.5.2 Targeted Black Cockatoo habitat assessment

A black cockatoo habitat assessment was undertaken in accordance with the Department of Sustainability, Environment, Population and Communities (SEWPaC) *EPBC Act referral guidelines for three threatened black cockatoo species* (SEWPaC 2012). This involved assessing all significant tree species known to support potential suitable breeding, roosting and foraging habitat. Significant breeding trees are defined as trees of suitable species with a Diameter at Breast Height (DBH) greater than 500 millimetres (mm; > 300 mm for salmon gum and wandoo; SEWPaC 2012). Trees with a DBH greater than 500 mm (or >300 mm for Salmon Gum and Wandoo) are large enough to potentially contain hollows suitable for nesting black cockatoos or have the potential to develop suitable hollows over the next 50 years. Trees of this size may also be large enough to provide roosting habitat (i.e. trees which provide a roost or rest area for the birds). All potential breeding trees with a DBH of 500 mm or greater encountered within the Project Area were recorded.

Hollows were considered 'suitable' if the entrance was >100 mm in diameter, >300 mm deep and aligned near vertical. If it was not possible to determine if a hollow was suitable or not it was categorised as 'potentially suitable'. Hollows that did not meet any of the requirements were categorised as 'unsuitable'. Trees that met the required measurements were inspected with a camera-pole for

suitability of hollows for nesting and/or roosting and evidences of current or previous occupancy, including wear and chew marks around the entrance.

Vegetation present within the Project Area was assessed for its potential to provide foraging and roosting habitat for black cockatoos as per the SEWPaC guidelines (SEWPaC 2012), and the extent of potential suitable habitat within the Survey Area was mapped. Observations were also made of any black cockatoo foraging activity or feeding residue such as chewed Banksia, Jarrah and Marri nuts, and any black cockatoo individuals observed within the Survey Area.

The foraging value of vegetation to black cockatoos depends upon a number of factors including the foraging plant species present, the extent and density of those foraging species and the overall structure and condition of foraging species present. In addition, presence of weeds and/or disease or drought (i.e. plant deaths) was also considered as these can influence native vegetation recruitment and regrowth which may influence the viability of foraging species present in the short, medium or long term (Bamford 2020b, c). Foraging habitat quality can also be influenced by additional contextual information such as the availability, or lack of, foraging habitat nearby and presence/extent of breeding habitat.

Foraging habitat was assigned a quality rating based on three components (**Table 3**):

- Vegetation composition, condition and structure;
- Extent of weeds and/or tree deaths which has the potential to suppress regrowth or successful recruitment and therefore affect foraging habitat viability in the short, medium or long term; and
- Presence of black cockatoos.

As with vegetation condition, foraging quality is usually not uniform throughout an entire vegetation association and, as such, these variations have been accounted for within the assessment by using a habitat quality range (**Table 3**; i.e. low to moderate or moderate to high).

**Table 3: Definition of black cockatoo foraging habitat quality\***

Foraging habitat quality	Justification
High	<ul style="list-style-type: none"> <li>• Presence of suitable foraging plant species<sup>#</sup>, including non-native food sources, for black cockatoos at a high density (i.e. foliage cover of suitable species &gt;60%) and presence of preferred food sources at several strata;</li> <li>• Low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium or long term) or</li> <li>• Lower quality foraging habitat based on vegetation characteristics, but with evidence of use (i.e. chewed nuts, cones, seeds or flowers).</li> </ul>
Moderate to high	<ul style="list-style-type: none"> <li>• Presence of suitable foraging plant species*, including non-native food sources, for black cockatoos at a high density (i.e. foliage cover of suitable species 40-60%) and presence of preferred food sources at several strata;</li> <li>• Foraging species with greater than 60% projected foliage cover but foraging habitat viability reduced due to high weed invasion and/or tree deaths indicating that the vegetation could potentially decline in the medium term due to suppressed regrowth or disease, or</li> <li>• Lower quality foraging habitat but with evidence of use (i.e. chewed nuts, cones, seeds or flowers).</li> </ul>
Moderate	<ul style="list-style-type: none"> <li>• Presence of suitable foraging plant species, including non-native food sources, for black cockatoos at a low to moderate density (i.e. projected foliage cover of suitable species 20-40%); and/or</li> </ul>

Foraging habitat quality	Justification
	<ul style="list-style-type: none"> <li>Foraging species with 40-60% projected foliage cover but foraging habitat viability reduced due to high weed invasion and/or tree deaths indicating that the vegetation could potentially decline in the medium term due to suppressed regrowth or disease; and/or</li> <li>Lower quality foraging habitat but with evidence of use (i.e. chewed nuts, cones, seeds or flowers).</li> </ul>
Low to moderate	<ul style="list-style-type: none"> <li>Suitable foraging species present but at a lower density (i.e. foliage cover of preferred species 10-20%);</li> <li>Foraging species with 20-40% projected foliage cover but foraging habitat viability reduced due to high weed invasion and/or some tree deaths indicating that the vegetation could potentially decline in the medium term due to suppressed regrowth or disease; and/or</li> <li>Lack of preferred foraging plant species but other suitable foraging species present at a low density.</li> </ul>
Low	<ul style="list-style-type: none"> <li>Suitable foraging species present at a low density (i.e. projected foliage cover of preferred foraging species less than 10%); and/or</li> <li>Scattered foraging species or paddocks with known food sources such as melons or weeds that represent a short-term food source.</li> </ul>
Negligible	<ul style="list-style-type: none"> <li>Presence of some scattered foraging species but with projected foliage cover of less than 2%.</li> </ul>
Nil	<ul style="list-style-type: none"> <li>No suitable foraging species present;</li> <li>Cleared areas.</li> </ul>

\*Methods for assigning quality to black cockatoo foraging habitat are based on ELAs internal scoring system and have been refined to include additional methodology developed by Bamford Consulting Ecologists (Bamford) in Bamford (2020a, 2020b).

# Based on the list of suitable foraging plants collated from the following sources: Groom (2011), Johnstone et al. (2011), SEWPaC (2012), Heydenrych (2012) and Lee *et al.* (2013).

### 2.2.5.3 Targeted Malleefowl survey

A Targeted Malleefowl survey was conducted in accordance with the National Malleefowl Monitoring Manual (National Malleefowl Recovery Team 2020). A targeted survey for Malleefowl, including:

- Transect searches (i.e., spacing of approximately 20 m apart with four personnel) in suitable habitat for mound nests;
- Location and photograph of each nest mound, including the placement of two or three sticks in an 'X' formation in the centre of the mound to indicate mounds that have been inspected;
- Assessment of the activity status, being: active (containing eggs); recently active (showing signs of disturbance); or inactive (not showing any signs of disturbance).
- Nest mound profile, being: typical crater with raised rims (1); mound fully dug out (2); mound with litter (3); mound mounded up (no crater) (4); mound that has a sandy crater with peak in centre (5); and mound low and flat without peak or crater (6);
- Dimensions (total height and width) of each nest mound, where the nest mound has been excavated and the diameter across the rim/depth of excavation from the rim;
- Vegetation type in which each nest mound is identified;
- Any signs of physical disturbance, including whether or not the surface of the mound has recently been disturbed (scraped);
- If any eggshell is visible on the mound and how much (none, some or lots); and
- If animal prints or scats are present (including which species if possible).



### 2.3 Limitations

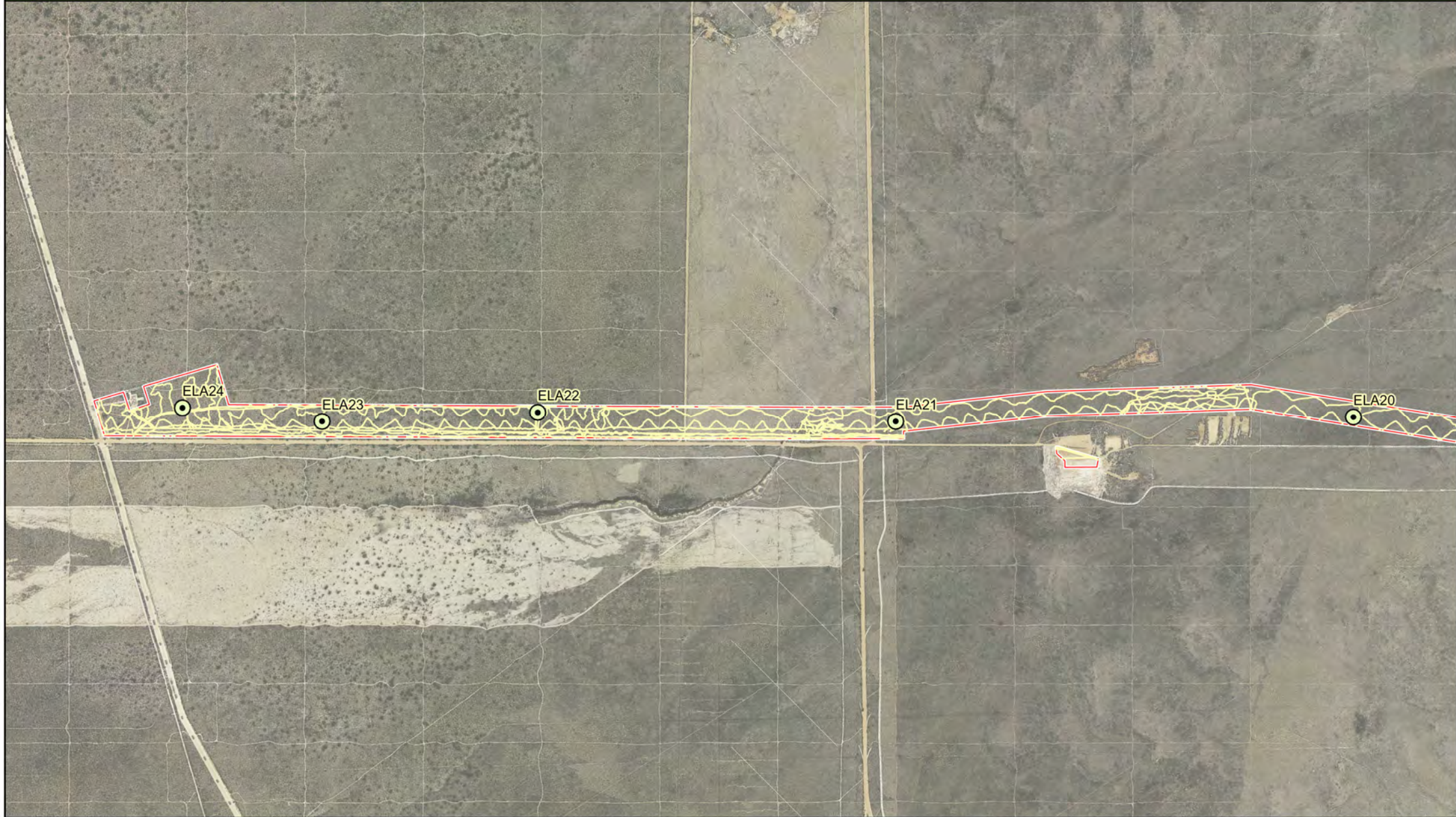
The EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) and *Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020) recommends including discussion of the limitations of the survey methods used. These limitations are summarised in **Table 4**.

**Table 4: Survey limitations**

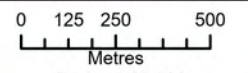
Potential survey limitation	Impact on survey
Sources of information and availability of contextual information (i.e. pre-existing background versus new material).	<b>Not a constraint.</b> Previous reports for the region were provided where applicable. Broad-scale vegetation mapping at a scale of 1:1,000,000 was available. Land system mapping at a scale of 1:2,000,000 and soil and landform mapping was also available. Available information was sufficient to provide context at varying scales and therefore were not considered a limitation.
Scope (i.e. what life forms, etc., were sampled).	<b>Not a constraint.</b> The survey requirement of a Detailed and Targeted flora and vegetation survey and a Basic and Targeted fauna survey in accordance with relevant State and Federal legislation and EPA guidance documents was adequately met.
Proportion of flora collected and identified (based on sampling, timing and intensity).	<b>Not a constraint.</b> Adequacy of sampling effort was tested via a species accumulation curve; approximately 88.93% of the flora potentially present within the survey area were recorded, which is considered to be an acceptable level of sample effort to compile a comprehensive flora inventory and subsequently accurately delineate vegetation communities present within the survey area.
Completeness and further work which might be needed (i.e. was the relevant survey area fully surveyed).	<b>Not a constraint.</b> The survey area was fully covered to meet requirements outlined in the scope of works. Quadrat locations were pre-selected using high resolution aerial photography, and confirmed in the field, to ensure all apparent vegetation communities identified were sampled, with multiple replications where possible. Site selection and replication was considered adequate to accurately analyse and discriminate sites based on species composition and subsequently delineate vegetation community boundaries.
Mapping reliability.	<b>Not a constraint.</b> Coverage of the survey area was considered to be good. High quality aerial maps were used for both the survey and subsequent vegetation mapping. Due to the nature of vegetation in the survey area, mapping boundaries of individual communities were discrete, and thus are considered accurate.
Timing, weather, season, cycle.	<b>Not a constraint.</b> The survey was undertaken in the appropriate season as specified by the EPA <i>Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment</i> (2016), with rainfall in the three months prior to the survey matching the long-term average and allowing for the presence of some annual species.
Disturbances (fire, flood, accidental human intervention, etc.).	<b>Potential constraint:</b> A fire in April 2019 resulted in disturbance of majority of the survey area and is considered a potential constraint as it has the potential to prevent flora species being detected or identified. Post fire regeneration was very good, with majority of species that were expected to occur being recorded. It is noted however, that structural elements of defined vegetation communities may slightly change over time as plant growth and development continue.  Minor disturbances included minimal presence of weeds and feral fauna (rabbit diggings, scats).
Intensity (in retrospect, was the intensity adequate).	<b>Not a constraint.</b> The survey effort was adequately met. The area was searched for conservation significant species by field staff undertaking transects across the survey area spaced adequately apart. This method provides an accurate assessment of habitat characteristics and likelihood of conservation significant species. The number of

Potential survey limitation	Impact on survey
Resources (i.e. were there adequate resources to complete the survey to the required standard).	<p>quadrats established was sufficient to determine the vegetation communities present and to identify any vegetation of conservation significance.</p> <p><b>Not a constraint.</b> The number of personnel conducting this field survey in the given time was adequate to undertake the required level of survey. Additional resources, including equipment available, additional support and personnel were adequate.</p>
Access problems (i.e. ability to access survey area).	<p><b>Not a constraint.</b> All relevant areas within the survey area were able to be accessed and surveyed.</p>
Experience levels (e.g. degree of expertise in plant identification to taxon level).	<p><b>Not a constraint.</b> The personnel conducting this field survey were both suitably qualified to identify specimens, having previously undertaken flora and fauna surveys in the Geraldton sandplain bioregion of Western Australia.</p>

Figure 2: Survey effort (Page 1 of 3)

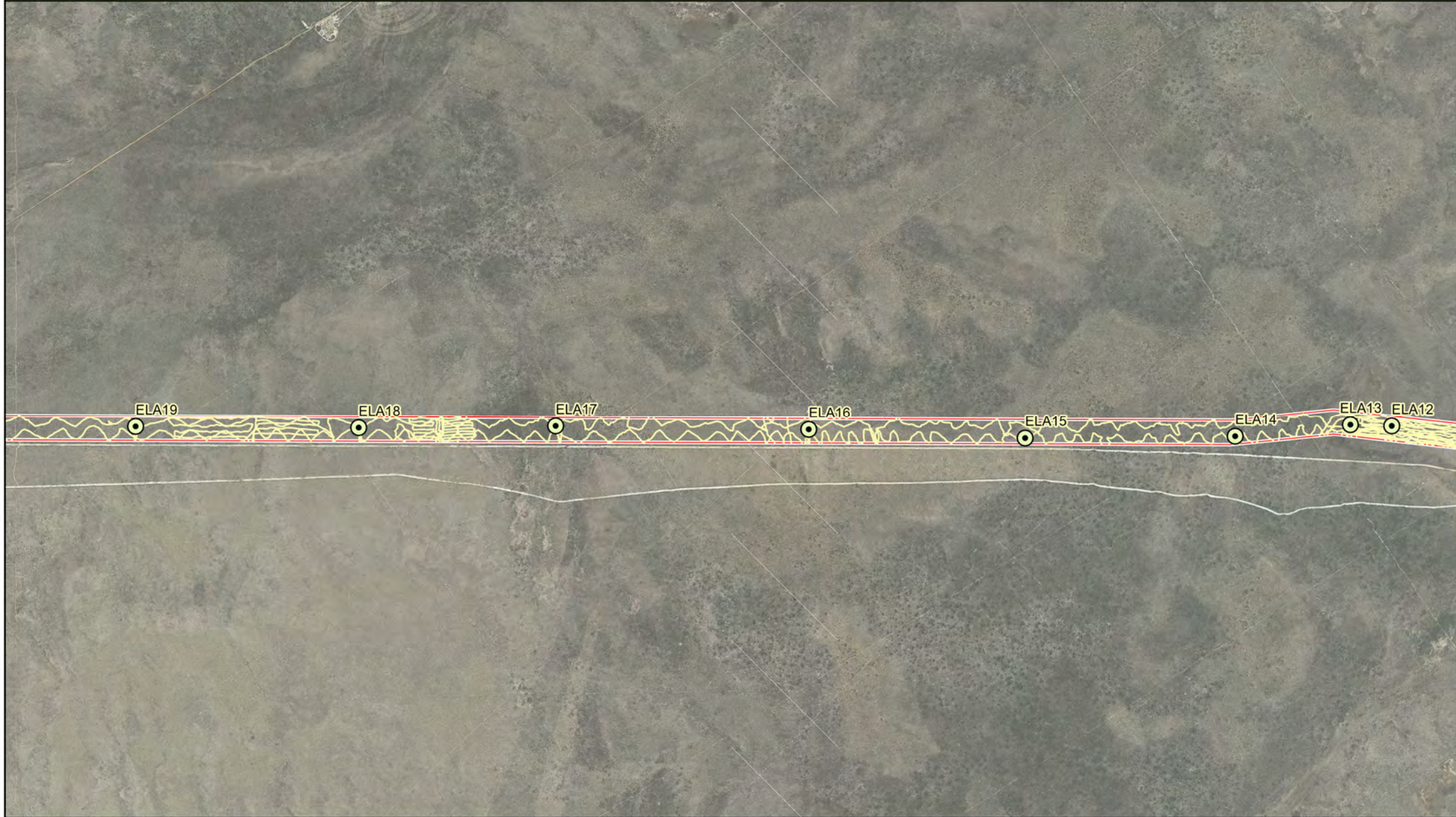


- Legend**
- Survey Footprint
  - Quadrat
  - Transect

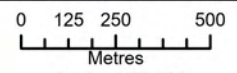


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Datum/Projection:  
GDA 1994 MGA Zone 50



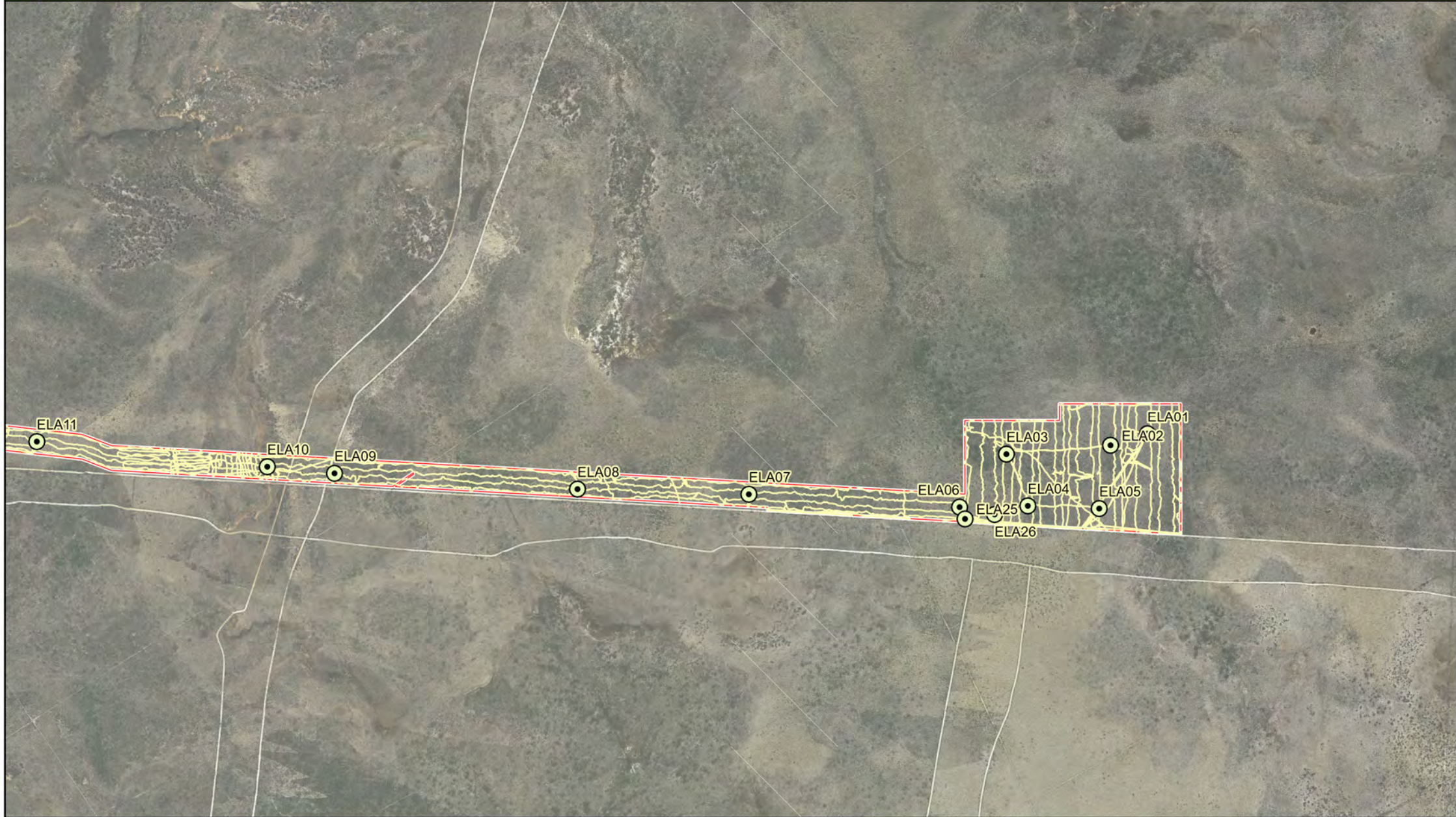


- Legend**
- Survey Footprint
  - Quadrat
  - Transect

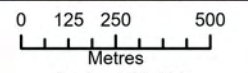
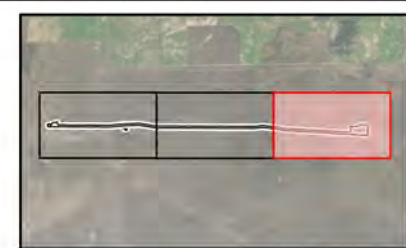


Scale: 1:20,000  
Datum/Projection:  
GDA 1994 MGA Zone 50





- Legend**
- Survey Footprint
  - Quadrat
  - Transect



Scale: 1:20,000  
Datum/Projection:  
GDA 1994 MGA Zone 50



## 3. Results

### 3.1 Desktop review

#### 3.1.1 Climate

The Swan Coastal Plain experiences a warm, Mediterranean climate with hot dry summers and mild wet winters (Mitchell et al. 2002). Based on climate data from the nearby Bureau of Meteorology (BoM) Dongara weather station (station number 8044; climate data 1844 – current; located approximately 50 km north-west of the survey area), the area receives an annual average rainfall of 454.4 mm, with most rainfall occurring during the winter months of June, July and August (BoM 2020; **Table 5**).

In the 12 months preceding the field survey, the area received a total of 164.3 mm which is below the long-term average of 454.4 mm (BoM 2020). The area received 75.5 mm of rainfall in August 2020, which is above the long-term average for the same period (66.3 mm; BOM 2020). As a result, survey conditions at this time were considered to be good, with the majority of individuals being recorded in various reproductive stages (e.g. flowering, seeding), allowing for the positive identification of individual species.

**Table 5: Rainfall data recorded at the Dongara weather station (8044) 12 months prior to the field survey compared to the long-term average**

Month	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Total monthly rainfall 2019-20 (mm)	13.2	7.2	0.0	0.0	0.0	34	5.6	6.0	22.8	-	-	75.5	164.3
Average monthly rainfall 1896 - current	35.2	18.7	8.7	4.3	5.4	10.6	13.8	22.3	68.1	108.3	91.8	66.3	454.4

Source: BoM 2020. Note: June and July 2020 rainfall data is missing from Dongara weather station

#### 3.1.2 Geology, landforms and soils

The survey area is situated within the Northern Sandplains Region (Irwin Botanical District) as described by Beard (1976; 1990). This region is characterised by extensive lateritic sandplains, locally dissected especially near the coast, and almost entirely underlain by sedimentary rocks of a mostly siliceous nature. The sedimentary rocks form a series of plateaux, including the Dandaragan Plateau, on which the survey area is located. While dissected by rivers and eroded by sea on the west, stretches of the plateau surface is still preserved, and forms extensive monotonous sandplains, with lateritic outcrops on ridges and breakaways also common. Four broad geology soil units have been mapped across the survey area, as described in **Table 6**.

**Table 6: Broad geology soil units of the survey area**

Unit	Type	Description	Extent (ha) within the survey area
Czl	Lateritic duricrust	Pisolitic, nodular or vuggy ferruginous laterite; some lateritic soils; ferricrete; magnesite; ferruginous and siliceous duricrusts and reworked products, calcrete, kaolinised rock, gossan; residual ferruginous saprolite	22.6
Czs	Sand - residual	Sand or gravel plains; quartz sand sheets commonly with ferruginous pisoliths or pebbles, minor clay; local calcrete, laterite, silcrete, silt, clay, alluvium, colluvium, aeolian sand	142.9
Jsya	Sandstone, siltstone, shale, conglomerate, coal	Variegated sandstone, feldspathic sandstone, siltstone, shale, conglomerate, coal	4.5
Qd	Sand - aeolian, sand - residual	Dunes, sandplain with dunes and swales; may include numerous interdune claypans; residual and aeolian sand with minor silt and clay; aeolian red quartz sand, clay and silt, in places gypsiferous; yellow hummocky sand	42.2

Sandy soils are found throughout the survey area. Two soil units have been mapped across the survey area, as described in **Table 7**.

**Table 7: Soil units of the survey area**

Unit	Description	Extent (ha) within the survey area	Proportion of extent within the survey area (%)
Wd9	Broad valleys and undulating interfluvial areas with some discontinuous breakaways and occasional mesas; lateritic materials mantle the area: chief soils are sandy acidic yellow mottled soils, (Dy5.81) containing much ironstone gravel in the A horizons, and (Dy5.84), both forming a complex pattern with each other and with lateritic sandy gravels (KS-Uc2.12). Associated are leached sands (Uc2.21) underlain by lateritic gravels and mottled clays that occur at a progressively greater depth down slope	191.0	90
Ca27	Sandy plains with occasional pockets of sand dunes, a few small swamps, and stream courses: chief soils are leached sands (Uc2.21), often with a sandy clay substrate between 3 and 6 ft in depth. Associated are (Dy5.61) and gravelly (Dy5.81) soils with (Uc1.22) soils on the dunes	21.2	10

### 3.1.3 Interim Biogeographic Regionalisation of Australia

The Interim Biogeographic Regionalisation for Australia (IBRA7) currently classifies 89 bioregions across Australia, based on a range of biotic and abiotic factors such as climate, vegetation, fauna, geology and landform (Thackway and Cresswell 1995; DAWE 2020b). These bioregions are currently further refined into 419 sub-regions representing more localised and homogenous geomorphological units in each bioregion (DAWE 2020b). IBRA divides Western Australia into 26 biogeographic regions and 53

subregions based on dominant landscape characteristics of climate, lithology, geology, landform and vegetation (DAWE 2020b).

The survey area is situated in the Geraldton sandplain bioregion (Lesueur sandplain subregion, GS3). The Geraldton sandplain bioregion comprises mainly proteaceous shrub-heaths on extensive, undulating and lateritic sandplain (Desmond and Chant 2001). More specifically, the Lesueur sandplain subregion comprises coastal Aeolian and limestones, Jurassic siltstones and sandstones of central Perth Basin. Alluvials are associated with drainage systems and there are extensive yellow sandplains in south-eastern parts. Shrub-heaths rich in endemics occur on a mosaic of lateritic mesas, sandplains, coastal sands and limestones, and heath on lateritised sandplains along the subregions north-eastern margins (Desmond and Chant 2001).

### 3.1.4 Land system mapping

Soil Landscape Mapping - Systems mapping prepared by the Department of Primary Industries and Regional Development (DPIRD), provides an inventory and condition survey of lands at a 1: 250 000 scale (version April 2018; DPIRD 2020). Two land systems are present within the survey area, as outlined in **Table 8** and **Figure 3**.

**Table 8: Land systems of the survey area**

Land system	Land system description	Total current extent mapped in Western Australia	Extent (ha) mapped within the survey area	Proportion of total current extent (%) within the survey area
Mount Adams System (224Ma)	Gently undulating sandplain with low gravel ridges and occasional laterite breakaways.	86,963	187.2	0.1
Correy System (221Cy)	Broad sandy alluvial fan of the lower Arrowsmith River. Pale deep sands predominate, with grey shallow sandy duplexes, moderately deep sandy gravels and yellow deep sands less common. Banksia woodlands and heathlands.	27,252	25.0	0.2

### 3.1.5 Broad-scale vegetation mapping

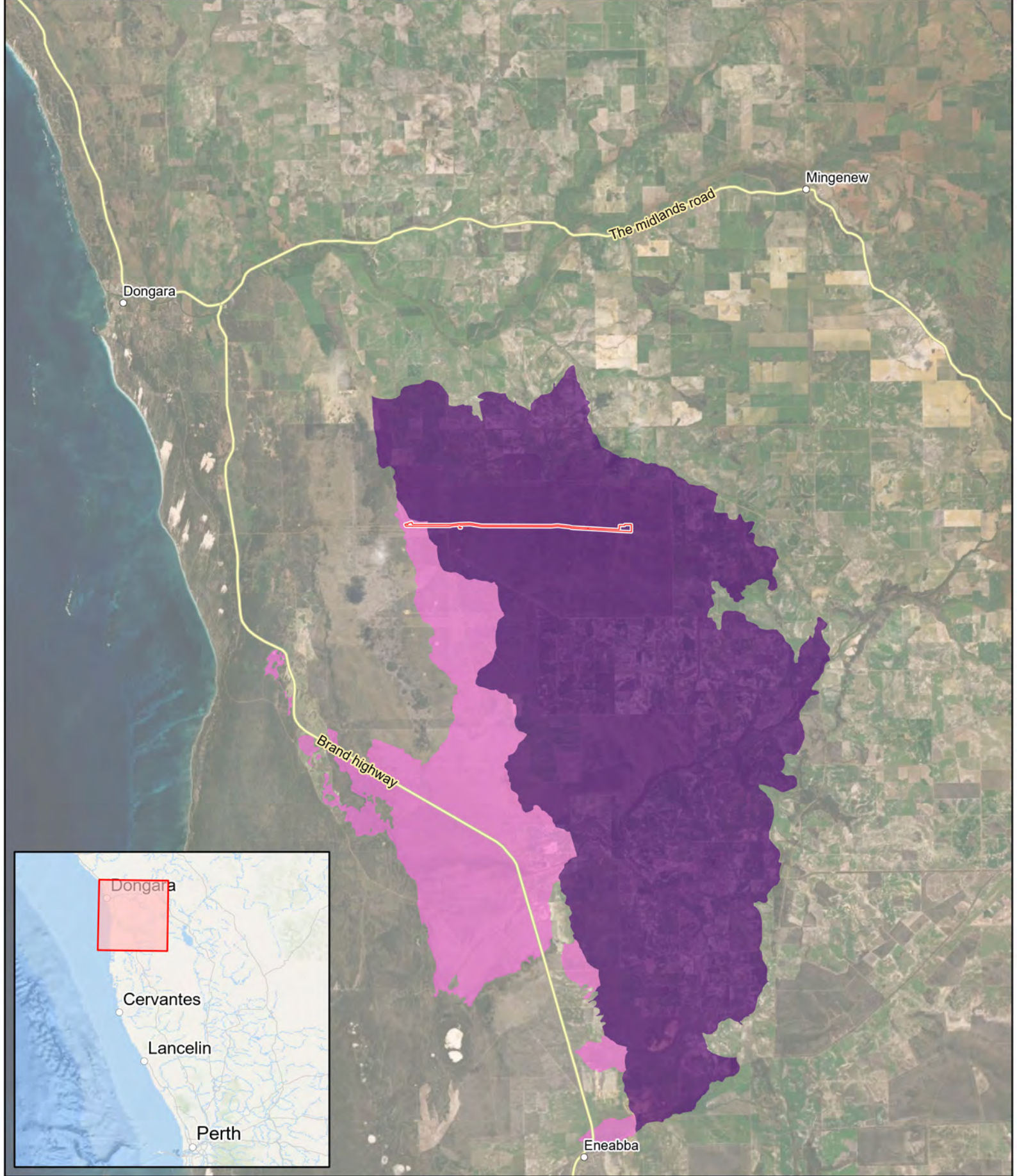
The vegetation of the survey area was defined and mapped by Beard (1976) and within the broader region by Beard (1990) in the Irwin Botanical District as coastal scrub heath on sandplains, with *Acacia* and *Allocasuarina* thickets further inland, and hard-setting loams with *Acacia* scrub and scattered *Eucalyptus loxophleba*. Three vegetation associations are present within the survey area, as outlined in **Table 9** and **Figure 4**.



Table 9: Beard (1976) vegetation associations of the survey area

Vegetation association	Description	Pre-European extent (ha) within the Lesueur sandplain subregion	Current extent (ha) within the Lesueur sandplain subregion	Proportion of pre-European extent remaining (%)	Extent (ha) mapped within the survey area	Proportion of current extent within the survey area (%)
49	Shrublands; mixed heath	33,139.33	13,618.88	41.10	12.1	0.1
378	Shrublands; scrub-heath with scattered <i>Banksia</i> spp., <i>Eucalyptus todtiana</i> and <i>Xylomelum angustifolium</i> on deep sandy flats in the Geraldton sandplains bioregion	90,922.87	60,668.26	66.72	46.2	0.1
379	Shrublands; scrub-heath on lateritic sandplain in the central Geraldton sandplains bioregion	370,029.76	111,632.48	30.17	153.9	0.1

**Figure 3: Land system mapping of the survey area**

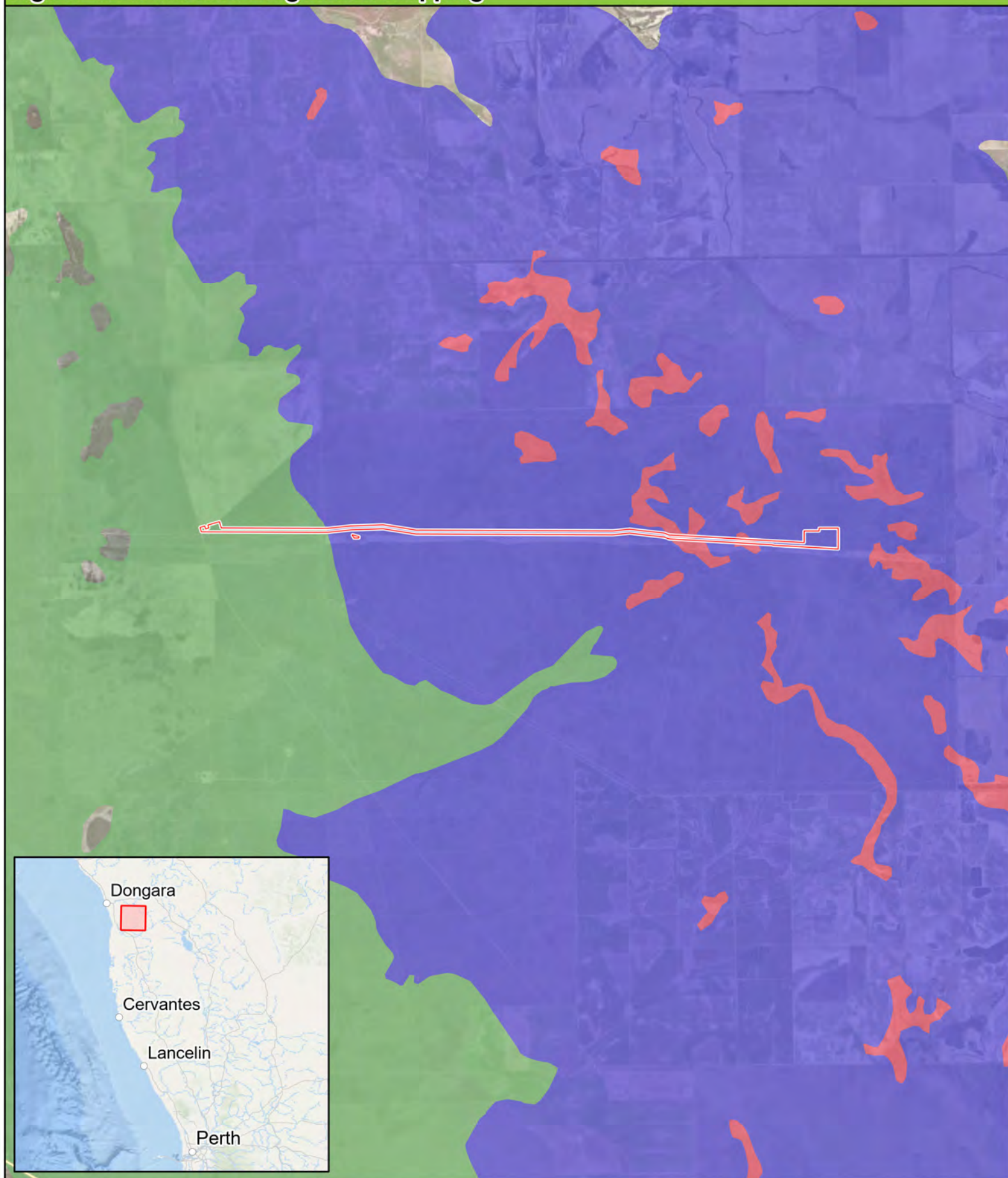


- Legend**
- Land system**
- Correy System (221Cy)
  - Mount Adams System (224Ma)

0 5 10  
Kilometers  
Scale: 1:350,000 (A4)  
Datum/Projection:  
GDA 1994 MGA Zone 50



**Figure 4: Broad scale vegetation mapping**



- Legend**
- Survey Footprint
  - Major Road

- Beard's (1975) vegetation associations**
- ERIDOON\_378
  - TATHRA\_379
  - TATHRA\_49

0 5  
Kilometers  
Scale: 1:350,000 (A4)  
Datum/Projection:  
GDA 1994 MGA Zone 50

### 3.1.6 Previous surveys undertaken in the vicinity of the survey area

An overview of the prior studies in the vicinity of the survey area is provided in **Table 10**.

**Table 10: Overview of previous studies undertaken in proximity to the survey area**

Reference	Survey type and location	Conservation significant species of communities
Review of key potential flora, vegetation and fauna values on the proposed pipeline for Strike Energy near Dongara (Mattiske 2020)	Desktop assessment of the potential flora, vegetation and fauna values present (within the current survey area)	12 threatened and 18 priority flora species have the potential to occur. 4 threatened ecological communities (TECs) and 6 Priority ecological communities (PECs) have the potential to occur. 10 threatened fauna species have the potential to occur.
West Erregulla targeted threatened flora survey (ecologia 2018)	Targeted threatened flora survey (within the current survey area)	No individuals of the targeted threatened taxa <i>Thelymitra stellata</i> , <i>Paracaleana dixonii</i> and <i>Eucalyptus crispata</i> . No TECs and PECs were recorded.  <b>Threatened (Declared Rare Flora) flora:</b> <i>Thelymitra stellata</i> , <i>Paracaleana dixonii</i> , <i>Eucalyptus crispata</i> . <i>T. stellata</i> records were associated with vegetation types 7a, 7b, 8, 11, 13a. <i>P. dixonii</i> records were associated with vegetation types 7a, 7b, 8, 10, 11, 12, 13a. <i>E. crispata</i> records were associated with vegetation type 8 and 10.  <b>Priority flora:</b> 23 confirmed taxa No TECs and PECs were recorded.
West Erregulla Project Flora and Vegetation Assessment (Woodman 2013)	Detailed flora and vegetation survey (within the current survey area)	

No previous studies were found within a 100 km radius of the survey area (DWER 2021).

### 3.1.7 Areas of conservation significance

Environmentally Sensitive Areas (ESAs) are defined in the Environmental Protection (Environmentally Sensitive Areas) Notice 2005 under section 51B of the State *Environmental Protection Act 1986* (EP Act). ESAs include areas declared as World Heritage, included on the Register of the National Estate, defined wetlands, and vegetation containing rare (Threatened) flora and TECs.

PECs are biological flora or fauna communities that are recognised to be of significance, but do not meet the criteria for a TEC. There are five categories of PECs, none of which are currently protected under legislation.

There are no TECs listed at Commonwealth level. There are two TECs listed at State level that occur 10 km to the east of the survey area (DBCA 2020c) (see Appendix A for conservation codes):

- Mound Springs (Three Springs area) (EN); and
- Ferricrete floristic community (Rocky Springs Type) (VU).

There are no PECs listed with the potential to occur within or near the survey area. No World Heritage Areas, National Heritage or Ramsar wetlands are located within or in close proximity to the survey area. The Yardanogo Nature Reserve (R36203) and Beekeepers Nature Reserve (R24496) are located to the west of the survey area.

### 3.1.8 Flora and fauna species of conservation significance

An initial 61 conservation listed flora species and 46 conservation listed fauna species were identified as possibly occurring within the survey area, based on the database searches (Section 2.1.1) and using criteria outlined in **Appendix B (Figure 5 to Figure 7)**.

Conservation significant flora species identified from database searches undertaken included 14 Threatened species and 47 Priority species. The flora likelihood of occurrence assessment is presented in **Appendix C**.

Database searches identified one Threatened flora species, *Paracaleana dixonii* (Endangered under the EPBC Act and Vulnerable under the BC Act) recorded within the survey area in 2011. This record included 24 plants recorded approximately 5 km west from the eastern end of the survey area.

Conservation significant fauna species identified from database searches undertaken included five species listed as Endangered under the EPBC Act, four species listed as Vulnerable under the EPBC Act, 23 species listed as Migratory under the EPBC Act/BC Act, one species listed as Vulnerable under the BC Act, one species listed as Migratory under the BC Act, one species listed as 'other specially protected fauna' under the BC Act, one species listed as 'species of special conservation interest (conservation dependent fauna)', two species listed as P1 by DBCA, one species listed as P2 by DBCA, four species listed as P3 by DBCA and three species listed as P4 by DBCA.

Aquatic and marine species were not considered in the likelihood of occurrence assessment as the survey area does not contain core habitat that these species solely rely on for survival. The fauna likelihood of occurrence assessment is presented in **Appendix D**.

One confirmed white-tailed Black Cockatoo record occurs within 12 km of the survey area; 10 km north (IRWMILR001; Birdlife 2021).