Waitsia-03 – Flowline Corridor

Flora, Vegetation and Fauna Assessment

AWE LIMITED

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Waitsia-03 – Flowline Corridor Flora, Vegetation and Fauna Assessment

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Cover Photograph: VT1 (Quadrat W3-29) within the Waitsia-03 Study Area (Photograph: Woodman Environmental)

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0	Final Report	BL				

DISCLAIMER

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DEFINITIONS

Term	Definition
ß	Beta
°C	Degrees celsius
AWC	Australian Weeds Committee
AWE	AWE Limited
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BCE	Bamford Consulting Ecologists
DAF	Department of Agriculture and Food
DBCA	Department of Biodiversity, Conservation and Attractions
DBH	Diameter at breast height
DoEE	Department of the Environment and Energy
Dr	Doctor
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
e.g.	For example
EP	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESCAVI	Executive Steering Committee for Australian Vegetation Information
FCT	Floristic Community Types
GDA	Geocentric Datum of Australia
GIS	Geographic Information System
GPS	Global Positioning System
ha	Hectares
IBRA	Interim Biogeographic Regionalisation for Australia
km	Kilometres
m	Metres
Maia	Maia Environmental Consultancy
mm	Millimetres
MNES	Matters of National Environmental Significance
P	Priority
PEC	Priority Ecological Community
Pty Ltd	Proprietary Limited
spp.	Species
TEC	Threatened Ecological Community
TP List	Threatened and Priority Flora List
TPFL	Threatened and Priority Flora
Tronox	Tronox Management Pty Ltd
UPGMA	Unweighted Pair Group Method with Arithmetic Mean
VT	Vegetation Type
WA	Western Australia
WAHerb	Western Australian Herbarium
WC Act	*Wildlife Conservation Act 1950*
WoNS	Weed of National Significance
Woodman Environmental	Woodman Environmental Consulting Pty Ltd

EXECUTIVE SUMMARY

AWE Limited (AWE) manages the Waitsia Gas Field located in the Geraldton Sandplains bioregion of Western Australia. AWE has undertaken drilling within the Waitsia-03 Well Area, approximately 19 km south-east of Dongara in the Shire of Irwin, with results indicating a likely commercial resource at Waitsia-03. AWE is seeking approvals to construct a gas flowline to transport the produced gas to a purpose built gas facility. A Flora, Vegetation and Fauna Assessment was undertaken by Woodman Environmental Pty Ltd along the proposed flowline route and wider area (the Study Area; 47.6 ha in total) to support the approvals process for the Project, with the 10 Clearing Principles assessed for the flowline route.

A Targeted Survey and a Detailed Survey (Environmental Protection Authority (EPA) 2016a) was undertaken from 6th – 10th November 2017 to assess the flora and vegetation components of the Study Area. A total of 173 discrete vascular flora taxa were recorded within the Study Area, of which 157 were native taxa and 16 introduced (weed) taxa. No Threatened flora taxa were recorded in the Study Area or any taxa listed under the *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act) that are considered to be Matters of National Environmental Significance. Five significant flora taxa listed as Priority flora by the Department of Biodiversity Conservation and Attractions (DBCA), were recorded within the Study Area:

- *Austrostipa* sp. Cairn Hill (M.E. Trudgen 21176 (P3);
- *Baeckea* sp. Walkaway (A.S. George 11249) (P3);
- *Banksia elegans* (P3);
- *Comesperma griffinii* (P4); and
- *Stawellia dimorphantha* (P4).

Austrostipa sp. Cairn Hill (M.E. Trudgen 21176) (P3) is known from a limited number of records (eight records) however occurs across a large range of approximately 450 km. The record within the Study Area represents a locality hole for this taxon, with the nearest record located approximately 40 km to the north of the Study Area. From a regional perspective the removal of or damage to any plants at this location are negligible, and will not be detrimental to the continued existence to the taxon as a whole.

No Declared weeds or Weeds of National Significance were recorded within the Study Area nor were any taxa as listed as Matters of National Environmental Significance. Three taxa have ratings of High for the Midwest were recorded including **Aira cupaniana* (Silvery Hairgrass), **Centaurea melitensis* (Maltese Cockspur) and **Ursinia anthemoides* (Ursinia).

Four vegetation types (VTs) were defined and mapped in the Study Area, consisting of:

- Vegetation predominantly on yellow to grey sandy soils, on slopes and dunes (VT1 to 3); and
- Vegetation predominantly on grey light clay to brown loamy clay in association with limestone subsoils, on simple slopes or in basins (VT4).

VT2 and VT4 have some affinities with the conservation significant FCT 9b of Woodman Environmental (2009). VT4 also occupies basins (playas) that may experience intermittent inundation or temporal waterlogging, and form part of a wetland chain that is connected to a larger hydrological system incorporating the inundated wetland to the east/northeast of the Study Area. As such this VT may provide an important function required to maintain ecological integrity of a significant ecosystem as per EPA (2016a). Versions of VT2 and VT4 and its sub-types occur in small

areas outside the Study Area (i.e. areas of vegetation with similar taxa but not necessarily the same composition and structure occur to the south of the Study Area).

No occurrences of riparian vegetation, Threatened Ecological Communities listed under the EPBC Act or by DBCA, or Priority Ecological Communities as classified by DBCA, were recorded within the Study Area.

A fauna survey was conducted by Dr Mike Bamford of Bamford Consulting Ecologists on 13th November 2017. Direct and indirect observation of two conservation significant EPBC listed fauna taxa, Carnaby's Black-Cockatoo and Rainbow Bee-eater, were recorded at the time of the fauna survey. Significant species of note that are likely to occur in the Study Area regularly include Carnaby's Black-Cockatoos, Rainbow Bee-eaters (observed in the Study Area), Rufous Fieldwrens and Conservation Significance Level 3 (locally significant) bird species, including the Southern Scrub-robin and the White-breasted Robin. The basins/damplands in the Study Area consisting of VT4 may be particularly important for bird species such as fairy-wrens and scrubwrens, with larger trees likely to be roosting sites for Carnaby's Black-Cockatoo.

The fauna assemblage was considered to be generally intact and relatively diverse, with the Study Area likely to support a sub-set of the fauna assemblage of the general region. Medium-sized mammal fauna and minor components of other fauna groups were considered to be lacking. Two faunal VSAs are present within the Study Area:

- Mixed tall shrubland with emergent Banksia and Allocasuarina spp. on sand (associated with VT1 and 3); and
- Allocasuarina forest with scattered eucalypts, over an open mid- and under-storey of Melaleuca on pale grey clayey-loam soils that may experience waterlogging. Occasional dense thickets of Melaleuca (associated with VT4).

Although impacts are considered to be negligible to minor, and mitigated by implementation of appropriate management actions, key threatening processes to fauna include degradation of habitat due to weed invasion; mortality from operations; increased interactions from feral and native species; and disturbance from dust, light and noise.

Of the 10 Clearing Principles, the proposed flowline was considered to have potential to be at variance to one principle relating to impacts on the environmental values of any adjacent or nearby conservation area. With implementation of management actions under existing management plans and hygiene procedures, the impacts of the installation of the flowline will be minimal. AWE currently manage existing assets within conservation estate.

1 INTRODUCTION

1.1 Project Overview

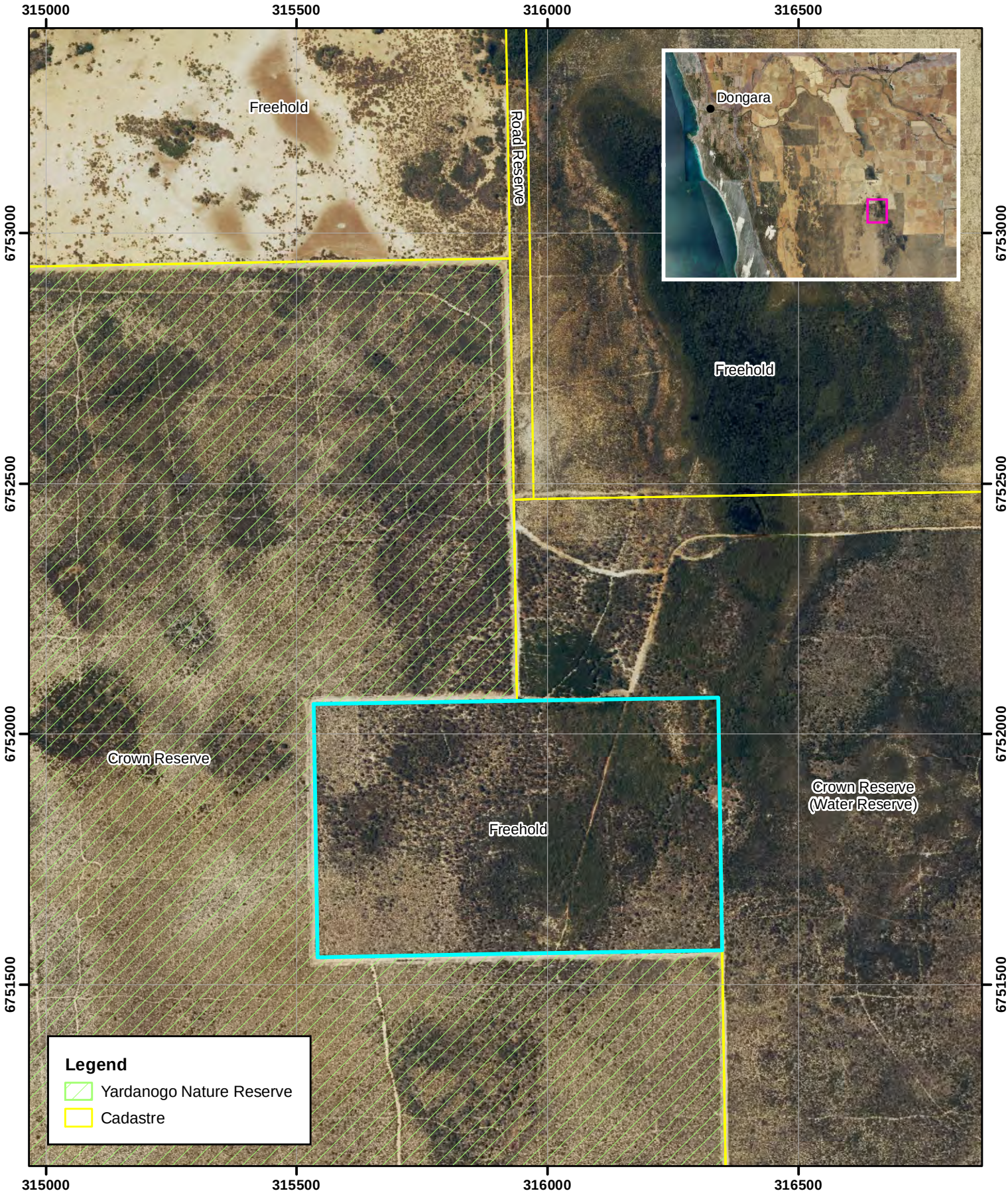
AWE Limited (AWE) manages the Waitsia Gas Field located in the Geraldton Sandplains bioregion of Western Australia (WA). The Waitsia-03 Well Area is located on title L1 R1 south east of Dongara, in the southern extension of the Waitsia Gas Field.

AWE has undertaken drilling within the Waitsia-03 Well Area with results indicating a likely commercial resource at Waitsia-03. AWE is seeking approvals to construct a gas flowline to transport the produced gas to a purpose built gas production facility (the Project).

AWE commissioned Woodman Environmental Consulting Pty Ltd (Woodman Environmental) to undertake a Flora, Vegetation and Fauna Assessment along the proposed flowline route and wider area (the Study Area) to support the approvals process for the flowline.

1.2 Study Area Definition

The Waitsia-03 Study Area (the Study Area) is located within the Shire of Irwin, approximately 19 km south-east of Dongara. The Study Area is located within Yardanogo Class C Nature Reserve (C36203) (crown reserve), road reserve, freehold, and crown reserve (water reserve), and consists largely of remnant vegetation with small areas of previously cleared tracks and firebreaks. The Study Area is approximately 47.6 ha in size and includes a rectangle of remnant vegetation (Hudson Resources Block – freehold) and 30 m either side of the centre of the Waitsia-03 access track in the north (Nature Reserve, crown reserve (water reserve), road reserve and freehold land) (Figure 1).



Study Area Location	Author: Alison Saligari	N
	WEC Ref: AWE17-38-01	
WOODMAN ENVIRONMENTAL	Filename: AWE17-38-01-f01.mxd	**Figure**
	Scale: 1:10,000 (A4)	1
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report AWE17-38-01.	Revision: C - 20 March 2018	

1.3 Level of Assessment

1.3.1 Flora and Vegetation

The flora and vegetation assessment of the Study Area involved a Targeted Survey and a Detailed Survey as defined in Sections 4.2 and 4.3 of the 'Technical Guidance for Flora and Vegetation Surveys for Environmental Impact Assessment' (Environmental Protection Authority (EPA) 2016a). As per the results of the desktop review (Section 3.1 and 3.2 of this report), the Study Area is likely to support a high diversity of flora and vegetation, including significant flora taxa (EPA 2016a).

Under Schedule 5 of the *Environmental Protection Act 1986* (EP Act), any development that has the potential to impact native vegetation within Western Australia, unless declared especially exempt, needs to be assessed against the clearing principles before receiving a clearing permit. The flora and vegetation survey has been undertaken to provide information to determine if the project would be in variance to these relevant principles.

The level of survey has been undertaken to provide relevant information to provide assessment of and an assessment of proposed clearing impacts against the *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act) significance of impact guidelines as and if required.

1.3.2 Fauna

Due to the previous level of surveys undertaken within and adjacent to the project area, a Level 1 fauna survey (site inspection) of the project area was conducted. Additional notes and observations of relevant features which may be assessed under the 10 Clearing Principles and/or under the EPBC Act were also taken.

1.4 Aim and Objectives

The aim of the survey is to provide relevant flora, vegetation and fauna information to support the approvals process for the Project, including:

- Assessment under the *Petroleum Geothermal Energy Resources (Environment) Regulations 2012* and *Petroleum Pipelines (Environment) Regulations 2012*;
- Assessment of the 10 Clearing Principles (pursuant to the *Environmental Protection Clearing of Native Vegetation Regulations 2004*); and
- Assessment of proposed clearing impacts against the EPBC Act significance of impact guidelines if required.

To achieve this aim, the overall objectives of the assessment in terms of flora and vegetation were to:

- Provide concise and relevant information regarding the locations and extent of populations of flora taxa occurring within the Study Area that are one of the following (hereafter referred to as significant flora taxa), to provide context for impact assessment:
  - Listed Threatened Species under the EPBC Act (Commonwealth);
  - Threatened Flora under the *Wildlife Conservation Act 1950* (WA) (WC Act);
  - 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 EPA (2016b);
- Identify and map the location of all Vegetation Types (VTs) and vegetation condition that occur within the Study Area with regards to the methods provided by EPA (2016);
- Identify, map and describe VTs that occur within the Study Area that are one of the following (hereafter referred to as significant vegetation), to provide context for impact assessment:
  - Threatened Ecological Community (TEC) under the EPBC Act;

- TEC as classified by DBCA and endorsed by the WA Minister for the Environment;
- 'Priority Ecological Community' (PEC) as classified by DBCA;
- Areas of wetland or riparian vegetation; and
- Other significant vegetation as defined by EPA (2016b).

The overall objectives of the assessment in terms of fauna were to:

- Provide an assessment of the biodiversity of fauna taxa which may occur in the area;
- Identify the fauna habitats of the project area which may be relevant to the presence of conservation significant fauna taxa;
- Provide an assessment of the likelihood of use of the Project area by conservation significant fauna taxa;
- Provide an assessment of the 10 Clearing Principles as they relate to the fauna values of the Project area.

The survey and reporting works comply with the following documents:

- *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*;
- *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); and
- *Environmental Factor Guideline – Terrestrial Fauna* (EPA 2016d).

1.5 Structure of Report

This report presents the results of both the desktop study and field survey (Section 4) (Detailed and Targeted Survey) of the Study Area. The results of the background research/desktop study, which include a review of known information relevant to the Study Area through all sources of literature available, are presented in Section 3. The results of the detailed field survey of the Study Area, including review of Matters of National Environmental Significance (MNES), are presented in Section 5.

2 BACKGROUND

2.1 Climate

The Study Area is located within the Northern Sandplains region in the South-west Province of WA. The Northern Sandplains region is characterised by a dry, warm Mediterranean climate with winter precipitation. There are seven to eight dry months per year, with the region generally receiving between 300 - 500 mm of precipitation annually (Beard 1990). Figure 2 displays average monthly maximum and minimum temperatures for Mingenew (the nearest meteorological station to the Study Area with temperature data), and average monthly rainfall recorded for Dongara (the nearest long-term meteorological station to the Study Area with rainfall data) (Bureau of Meteorology 2018).

The highest average daily maximum temperature at Mingenew occurs in January (36.4°C) with the lowest average minimum temperature experienced in August (6.9°C). The average annual rainfall for Dongara station is 456.7 mm (data from 1884-2017). Average monthly rainfall peaks from late autumn to winter (May - August), with the highest rainfall on average received in June (108.4 mm). Rainfall received at Dongara prior to survey being conducted over the winter period in 2017 (May - August), was below the long-term average, with 241.4 mm received compared to the average of 371.7 mm (Bureau of Meteorology 2018).

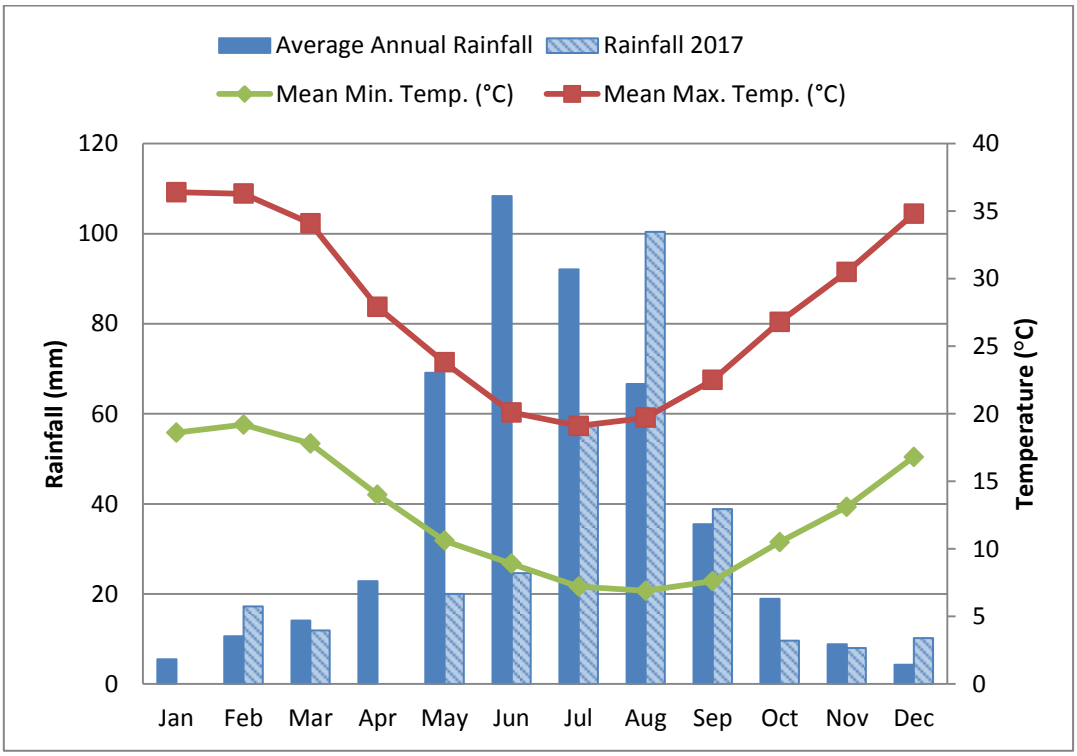


Figure 2: Mean Maximum and Minimum Temperatures (° Celsius) for Mingenew and Mean Rainfall (mm) for Dongara (Bureau of Meteorology 2018)

2.2 Geology and Soils

The Study Area is located in the Northern Sandplains Region (Irwin Botanical District) which is somewhat equivalent to the Geraldton Sandplains IBRA (Interim Biogeographic Regionalisation for Australia) Bioregion (Commonwealth of Australia 2012). Beard (1990) describes the Northern Sandplains Region geology as consisting of mainly sedimentary basins exposing Permian to

Cretaceous sediments with horsts of Proterozoic rocks. The prior land surface forms extensive lateritic sandplain which is locally dissected, particularly near the coast. The sandplain soils consist of leached sandy soils near the coast and yellow sands with an earthy fabric further inland, both overlying laterite (Beard 1990).

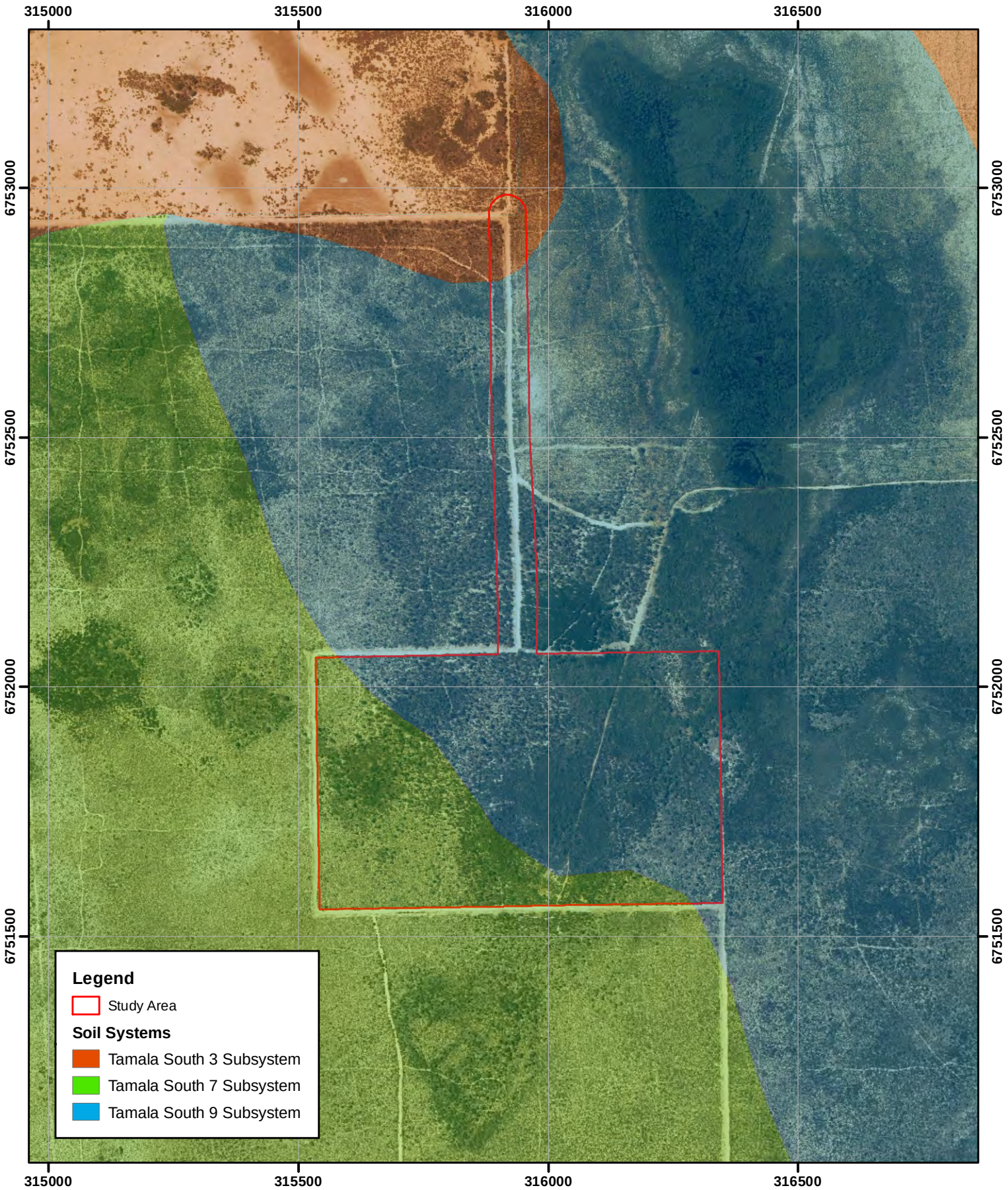
The Study Area occurs specifically within the Geraldton Sandplains 3 (Lesueur Sandplain) subregion. The subregion consists of coastal Aeolian and limestones, Jurassic siltstones and sandstones (often heavily lateritised) of central Perth Basin, as well as alluvials associated with drainage systems. Extensive yellow sandplains occur in south-eastern parts of the subregion, especially where the subregions overlaps the western edge of the Pilbara Craton, and lateritised sandplains occur along the north-eastern margins (Desmond and Chant 2001).

Soil-landscape mapping of WA shows the Study Area consists of the following units, as presented on Figure 3 (sourced from Government of Western Australia 2017):

- Tamala South 3 Subsystem - Low hills with relict dunes and some limestone outcrop, deep and shallow yellow sand over limestone;
- Tamala South 7 Subsystem - Level to gently undulating sandplain, yellow deep sand; and
- Tamala South 9 Subsystem - Swamps and playas similar to those found in Ta8 but significantly larger, shallow loams and sands, commonly wet.

2.3 Land Tenure and Usage

The Study Area is partially located within the Yardanogo Class C Nature Reserve (C36203) (crown reserve) and also includes areas of road reserve, freehold and crown reserve (water reserve) (Figure 1). The nearest other nature reserve managed by the DBCA for the purposes of conservation is the Beekeepers Nature Reserve, located approximately 11 km to the west of the Study Area.



Soil Landscape Mapping	Author: Alison Saligari	N
	WEC Ref: AWE17-38-01	
WOODMAN ENVIRONMENTAL	Filename: AWE17-38-01-f03.mxd	**Figure**
	Scale: 1:10,000 (A4)	3
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report AWE17-38-01.	Revision: A - 19 February 2018	

3 DESKTOP REVIEW

3.1 Vegetation

3.1.1 Regional Vegetation

The Study Area is located in the Northern Sandplains Region (Irwin Botanical District) which is somewhat equivalent to the Geraldton Sandplains IBRA (Interim Biogeographic Regionalisation for Australia) Bioregion (Commonwealth of Australia 2012). The vegetation of this region is described as scrub heath on sandplains near the coast, composed mainly of proteaceous scrub-heaths, rich in endemics, on the sandy earths of an extensive, undulating, lateritic sandplain (Beard 1990; Desmond and Chant 2001).

The Study Area occurs specifically within the Geraldton Sandplains 3 (Lesueur Sandplain) subregion. The subregion contains shrub-heaths rich in endemics occurring on a mosaic of lateritic mesas, sandplains, coastal sands and limestones, with heath on lateritised sandplains occurring along the subregions north-eastern margins (Desmond and Chant 2001).

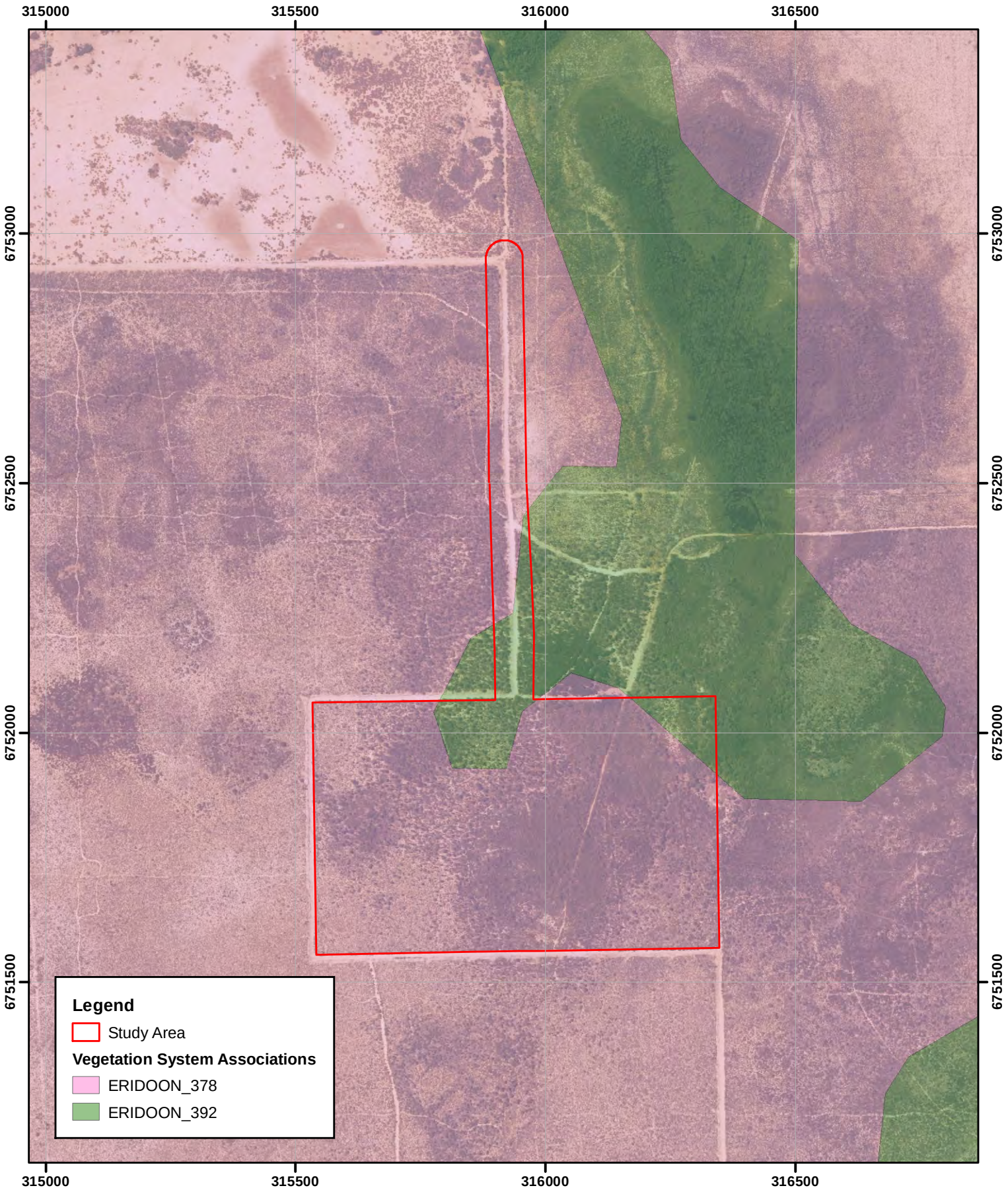
Beard (1976) mapped the vegetation of the Dongara area (including the Study Area) related to physiognomy, at a scale of 1:250,000. The Study Area coincides with one vegetation system, Eridoon, as described by Beard (1976). The vegetation mapping by Beard (1976) was used by Shepherd *et al.* (2002) to describe vegetation system associations. Vegetation system associations were also described at a scale of 1:250,000. Two vegetation system associations occur in the Study Area (Table 1, Figure 4).

Table 1 also presents the current extent of each vegetation system association in relation to its pre-European extent (Government of Western Australia 2016), and the percentage of the current extent of each vegetation system association currently protected for conservation (in DBCA-managed land). Eridoon_378 is relatively well represented, with 65 % of the pre-European extent remaining of which 21.9 % is reserved. Eridoon_392 is also well represented with 97.9 % of the pre-European extent remaining however only 3.3 % is reserved.

Table 1: Extent of the Vegetation System Association of the Survey Area (Government of Western Australia 2016)

Vegetation System Association	Description	Current Extent (ha)	Percentage of Pre-European Extent Remaining	Percentage of Current Extent Reserved for Conservation *
Eridoon_378	Shrublands; scrub-heath with scattered *Banksia* spp., *Eucalyptus todtiana* and *Xylomelum angustifolium* on deep sandy flats in the Geraldton Sandplain Region	60,826.7	65.0	21.9
Eridoon_392	Shrublands; *Melaleuca thyoides* thicket	429.8	97.9	3.3

*Note: proportion of current extent reserved in IUCN classified reserves I - IV



Vegetation System Associations	Author: Alison Saligari	N
	WEC Ref: AWE17-38-01	
WOODMAN ENVIRONMENTAL	Filename: AWE17-38-01-f04.mxd	**Figure**
	Scale: 1:10,000 (A4)	4
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report AWE17-38-01.	Revision: A - 12 February 2018	

3.1.2 Conservation Significant Vegetation

A search of the Commonwealth Department of the Environment and Energy (DoEE) database with regard to MNES listed under the EPBC Act was performed for a central point in the Study Area, with a 5 km buffer (DoEE 2018a). There were no TECs returned from the search. The results of this search are presented in Appendix A.

An interrogation of DBCA's Threatened and Priority Ecological Communities (TEC/PEC) Database was undertaken to determine known locations of TECs and PECs within the vicinity of the Study Area (DBCA 2017a). The search was undertaken an area encompassing the Study Area with a 15 km buffer. Two significant vegetation communities were returned from the search:

- Coastal sands dominated by *Acacia rostellifera*, *Eucalyptus oraria* and *Eucalyptus obtusiflora* - Priority 1; and
- Subtropical and Temperate Coastal Saltmarsh – Priority 3.

These vegetation communities are located over 10 km from the Study Area and it is considered unlikely that either of these vegetation types would have suitable habitat within the Study Area. Appendix B presents definitions, categories and criteria for TECs and PECs (DEC 2013a).

3.1.3 Local Vegetation Surveys

Maia Environmental Consultancy (Maia) undertook a combined Level 1 flora and vegetation reconnaissance survey and targeted flora survey of the Waitsia-03 Well Area and access tracks to the well area (the well area and tracks partially overlap the Study Area), in January 2016 (Maia 2016). A total of seven relevés were undertaken as part of the survey to map vegetation, with field notes used to delineate the boundaries of each type (Maia 2016).

A total of three vegetation types were mapped within the well area polygon including:

- AF: Open Low Forest of *Allocasuarina huegeliana* and / or *Allocasuarina campestris* with an Open Tall Shrubland to Tall Shrubland of *Acacia rostellifera*, *Banksia prionotes* and *Banksia elegans* (P4);
- BSL: Mixed *Banksia* Tall Shrubland (*Banksia attenuata, Banksia menziesii and Banksia elegans* (P4)) with a mixed Open Low Shrubland (*Melaleuca trichophylla*, *Scholtzia laxiflora* and *Verticordia densiflora* var. *cespitosa*) and Isolated Low Trees of *Allocasuarina huegeliana*; and
- MSL: Tall Shrubland of *Melaleuca viminea* subsp. *viminea* and *Melaleuca huegelii* subsp. *huegelii* with Open Mid Shrubland of *Melaleuca viminea* subsp. *viminea* and Isolated Low Trees of *Eucalyptus camaldulensis* subsp. *obtusa*.

These VTs were not representative of listed TECs or PECs (Maia 2016).

Woodman Environmental undertook a flora and vegetation assessment of the Denison 3D survey area for Arc Energy Ltd, including areas adjacent to the west of the Study Area (Woodman Environmental 2004). The survey area was large (39,400 ha), incorporating several nature reserves as well as private property and including 257 detailed recording sites. The Denison 3D survey area included the majority of the Yardanogo Nature Reserve; four plant communities were mapped within the vicinity of the Study Area:

- W3: Open Low Woodland of *Banksia prionotes* over dwarf *Banksia attenuata* and mixed shrubs on yellow sand;
- W7: Open Low Woodland *of Banksia menziesii* over Heath dominated by *Banksia attenuata* and mixed proteaceous shrubs;
- H6: Heath dominated by *Banksia hookeriana* on deep yellow sand; and

- H10: Dense Heath dominated by *Banksia sessilis* var. *flabellifolia*, *Melaleuca* ?*systena* and *Acacia spathulifolia* on shallow soils with limestone outcropping.

None of the plant communities listed above were representative of TECs, or were specifically regionally or locally significant. However, each of the communities above were noted as being significant as they provided habitat for significant flora taxa (Threatened (T), Priority (P) 1 or P2) (Woodman Environmental 2004).

Woodman Environmental undertook a flora and vegetation assessment of the Tiwest Joint Venture (Tiwest – now Tronox Management Pty Ltd (Tronox)) Dongara tenements to determine Floristic Community Types of the Dongara project area (Woodman Environmental 2009). These tenements partially overlap the Study Area. A total of 150 permanent 10 x 10 m quadrats were assessed in October and November 2007. Of the 21 Floristic Community Types (FCTs) mapped in the Dongara study area, three FCTs were mapped within the Study Area (3b, 9b and 21a,) and two FCTs were mapped within close vicinity of the Study Area (4b and 20):

- 3b: Low Woodland to Thicket of *Banksia attenuata* and *Banksia menziesii* over mixed shrubs dominated by myrtaceous species on brown or yellow sand on lower to mid slopes and plains;
- 4b: Thicket dominated by *Banksia hookeriana* and/or *Banksia attenuata*, with emergent *Banksia prionotes* on yellow sand on upper slopes and dune crests;
- 9b: Low Woodland to Low Forest of *Eucalyptus camaldulensis* over Open Scrub of *Acacia rostellifera*, *Chamelaucium uncinatum* and *Melaleuca* spp. on grey or brown sandy clay in drainage lines and depressions;
- 20: Thicket dominated by *Actinostrobus pyramidalis* on grey diatomaceous earth on lower slopes and depressions; and
- 21a: Low Woodland of *Banksia prionotes* and/or *Casuarina obesa* over Low Scrub of *Banksia* spp. and *Calothamnus* spp. on yellow or brown sand.

Of these FCTs, FCT 20 was ranked as having high conservation significance (ranking '4'), due to the small extent within the Dongara study area, restricted nature of the applicable landform and the lack of known mapped presence in conservation reserves. FCT 9b was also ranked as having high conservation significance (ranking '4') due to the small extent within the Dongara study area (Woodman Environmental 2009).

Woodman Environmental undertook a combined Level 1 flora and vegetation reconnaissance survey and targeted flora survey of the Proposed Xyris Lateral flowline easement for AWE in December 2015 (Woodman Environmental 2018a) (located approximately 3 km north of the Study Area). A total of five non-permanent relevés and grid searching was undertaken during the survey. A total of three vegetation types were mapped during the survey:

- VT 1: Low Woodland of *Banksia menziesii* over Low open Shrubland dominated by *Banksia attenuata* over Low Open Shrubland dominated by *Melaleuca leuropoma*, *Petrophile macrostachya* and *Pileanthus filifolius* over Mid Sedgeland dominated by *Mesomelaena pseudostygia* and *Chordifex sinuosus* on lower slopes on yellow sand.
- VT 2: Low Woodland of *Banksia menziesii*, *Banksia prionotes* and *Eucalyptus todtiana* over Tall Sparse Shrubland dominated by *Acacia scirpifolia* and *Banksia attenuata* over Mid Open Shrubland dominated by *Eremaea beaufortioides* and *Baeckea* sp. Walkaway (A.S. George 11249) (P3) over Mid Sedgeland dominated by *Desmocladus asper* and *Mesomelaena pseudostygia* on mid to upper slopes on yellow sand.
- VT 3: Tall Closed Shrubland of *Acacia rostellifera* over Mid Closed Grassland dominated by **Bromus diandrus* and **Ehrharta longiflora* on lower slopes and open depressions on yellow sand.

None of the VTs mapped in the Study Area were considered to represent any listed TECs or PECs (Woodman Environmental 2018a).

3.1.4 Summary of Significant Vegetation

The results of searches of DBCA's Threatened Flora Databases, DoEE database search, and the results of local vegetation surveys (outlined in Sections 3.1.2 and 3.1.3) indicate that no significant vegetation communities are known to occur within or in close proximity to the Study Area.

3.2 Flora

3.2.1 Regional Flora

DBCA's flora databases, including the Western Australian Herbarium (WAHerb) Specimen Database, Threatened and Priority Flora (TPFL) Database, and Threatened and Priority Flora List (TP List), were interrogated for information regarding listed significant taxa known from within and in the vicinity of the Study Area (DBCA 2017b). This search was conducted prior to the field surveys and was requested for the Study Area with a 15 km buffer (Database Search Area).

A total of 62 taxa were returned from the database search including 56 Priority taxa and six Threatened flora taxa. These taxa are presented in Appendix C.

Of the 62 taxa returned from the DBCA search, nine taxa have locations within 5 km of the Study Area. These are presented on Figure 5, and in Section 3.2.3.1 (Table 3). Appendix D presents conservation codes for Western Australian flora (DBCA 2017c).

The search of the DoEE Species Profile and Threats Database (DoEE 2018a) with regard to MNES listed under the EPBC Act (Appendix A) returned 10 Threatened flora taxa which may occur, or habitat may occur within the area (Table 2). Of these, three taxa (*Conostylis dielsii* subsp. *teres*, *Conostylis micrantha* and *Paracaleana dixonii*) are considered to have a possible likelihood of occurrence within the Study Area, with the remaining seven taxa considered unlikely based on location of nearest record and/or habitat preference.

The search of the DoEE Species Profile and Threats Database (DoEE 2018a) (Appendix A) also identified four significant invasive flora taxa or habitat for such taxa, that may occur within the Study Area and surrounds; **Asparagus asparagoides* (Bridal Creeper), **Cenchrus ciliaris* (Buffel Grass), **Lycium ferocissimum* (African Boxthorn) and **Tamarix aphylla* (Athel Pine). Of these taxa, it is considered possible that **Cenchrus ciliaris* and **Lycium ferocissimum* may possibly occur in the Study Area, as they are known from within the vicinity (<20 km) of the Study Area (DBCA 2007-). **Asparagus asparagoides* and **Tamarix aphylla* do not have records within 70 km of the Study Area, and are considered unlikely to occur in the Study Area.

A search of the WAHerb Specimen Database was undertaken for records of introduced taxa within the Study Area and surrounds. This search was performed using the online tool *NatureMap* (DBCA 2007-) using a central point in the Study Area to which a buffer of 15 km was applied. A total of 18 introduced taxa were returned as presented in Section 3.2.3.2. Of these taxa, **Echium plantagineum* (Paterson's Curse) is a Declared Pest in WA under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) (Department of Agriculture and Food (DAF) 2018), and **Lycium ferocissimum* (African Boxthorn) is Weed of National Significance (WoNS) (Australian Weeds Committee (AWC) 2018).

312500 315000 317500 320000

6757500 6755000 6752500 6750000 6747500 6745000

Legend

Study Area

Significant Flora

- Bel *Banksia elegans* (P4)
- Bga *Beyeria gardneri* (P3)
- BspW *Baeckea* sp. Walkaway (A.S. George 11249) (P3)
- Cgr *Comesperma griffinii* (P2)
- Eac *Eremaea acutifolia* (P3)
- Ezo *Eucalyptus zopherophloia* (P4)
- H?ga *Hypocalymma ?gardneri* (P3)
- Hga *Hypocalymma gardneri* (P3)
- Hsa *Hemigenia saligna* (P3)
- HspE *Hemiandra* sp. Eneabba (H. Demarz 3687) (P3)
- Mstd *Mesomelaena stygia* subsp. *deflexa* (P3)
- Pru *Persoonia rudis* (P3)
- ScaN *Stylidium carnosum* subsp. Narrow leaves (J.A. Wege 490) (P1)
- Sdi *Stawellia dimorphantha* (P4)
- Sgr *Schoenus griffinianus* (P4)
- SspE *Schoenus* sp. Eneabba (F. Obbens & C. Godden I154) (P2)
- Tgl *Thysanotus glaucus* (P4)
- Vlul *Verticordia luteola* var. *luteola* (P3)

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This map should only be used in conjunction with WEC report AWE17-38-01.

Significant Flora Known from the Vicinity of the Study Area

Revision: A - 12 Feb 2018 Scale: 1:40,000 (A3)

Author: Alison Saligari

WEC Ref: AWE17-38-01

Filename: AWE17-38-01-f05.mxd

Projection: GDA 1994 MGA Zone 50

Figure

5

Table 2: Significant Flora Taxa Returned from the DoEE Database Search (DoEE 2018a)

Taxon	Status	Closest Record to the Study Area (DBCA 2007-)	Flowering Period (WAHerb 1998-)	Habitat (WAHerb 1998-)	Likelihood of Occurrence with the Study Area
Conostylis dielsii subsp. *teres*	Threatened – Endangered	Approximately 13 km to the north	Jul to Aug	White, grey or yellow sand, gravel. Low open woodland	Possible although no records within 10 km of the Study Area
Conostylis micrantha	Threatened – Endangered	Approximately 14 km to the north	Jul to Aug	White or grey sand. Sandplains	Possible although no records within 10 km of the Study Area
Eucalyptus crispata	Threatened – Vulnerable	Approximately 12 km to the east	Mar to Jun	Sand, loam with lateritic gravel. Lateritic breakaways	Unlikely given distribution of this taxon is to the south-east in a different land/soil system and preferred habitat
Eucalyptus impensa	Threatened – Endangered	Approximately 63 km to the south	Jun to Jul	Yellow sand. Lateritic hills	Unlikely given the distance of nearest record and preferred habitat
Eucalyptus leprophloia	Threatened – Endangered	Approximately 10 km to the east	Aug to Oct	White or grey sand over laterite. Valley slopes. On or near laterite breakaways	Unlikely given the preferred habitat
Eucalyptus x *balanites*	Threatened – Endangered	Over 110 km to the SSE	Oct to Dec or Jan to Feb	Sandy soils with lateritic gravel	Unlikely given the distance of nearest record and preferred habitat
Hemiandra gardneri	Threatened – Endangered	Approximately 83 km to the south and SE	Aug to Oct	Grey or yellow sand, clayey sand. Sandplains	Unlikely given the distance of nearest record
Paracaleana dixonii	Threatened – Endangered	Approximately 5 km to the east and south	Oct to Dec or Jan	Sand over laterite, heath to Banksia woodland (on eastern margin of Geraldton Sandplain and (northern) Swan Coastal Plain)	Possible
Thelymitra stellata	Threatened – Endangered	Approximately 15 km to the SE	Oct to Nov	Sand, gravel, lateritic loam	Unlikely given the distance of nearest record and preferred habitat
Wurmbea tubulosa	Threatened – Endangered	Approximately 17 km to the NW	Jun to Aug	Clay, loam. River banks, seasonally-wet places	Unlikely given the distance of nearest record and preferred habitat

3.2.2 Local Flora Surveys

The flora and vegetation reconnaissance survey and targeted flora survey undertaken by Maia (2016) recorded a total of 95 taxa from 67 genera and 28 families, with most common families being Myrtaceae (20 taxa), Proteaceae (15 taxa) and Fabaceae (eight taxa). Three Priority species were recorded in the Survey Area including (note – these locations are not presented in Figure 5 or Figure 7):

- *Baeckea* sp. Walkaway (A.S. George 11249) (P3);
- *Banksia elegans* (P4); and
- *Stawellia dimorphantha* (P4).

No Threatened flora taxa were recorded during the survey. A total of eight weed species were recorded in the survey area including **Avena barbata, *Chenopodium murale, *Pentameris airoides, *Polypogon maritimus, *Solanum nigrum, *Sonchus oleraceus, *Centaurium tenuifolium* and **Ehrharta longiflora*. No Declared Pests or WoNS were recorded during the survey.

The flora and vegetation assessment of the Denison 3D survey area by Woodman Environmental (2004) recorded a total of 515 vascular plant taxa, belonging to 81 plant families, with the most common families being Myrtaceae and Proteaceae. One Threatened Flora taxon was recorded during the survey (*Stawellia dimorphantha*), which has since been downgraded to P4 status (WAHerb 1998-). A total of eight Priority flora taxa were also recorded within the Denison 3D study area, one of which has since been removed from the Priority list (*Hakea polyanthema*). Of the significant flora taxa recorded by the survey, six taxa have records in close proximity (within 5 km) to the Study Area as listed below and are presented in Figure 5:

- *Baeckea* sp. Walkaway (A.S. George 11249) (P3);
- *Banksia elegans* (P4);
- *Eucalyptus zopherophloia* (P4);
- *Hemigenia saligna* (P3);
- *Schoenus* sp. Eneabba (F.Obbens & C.Godden I154) (P2); and
- *Stawellia dimorphantha* (P4).

A total of 68 weed species were recorded within the broader survey area by Denison 3D survey (Woodman Environmental 2004). Of these, one taxon (**Echium plantagineum*) is a Declared Pest under the BAM Act (DAF 2018).

The flora and vegetation assessment of the Tronox Dongara tenements by Woodman Environmental recorded a total of 543 native vascular plant taxa belonging to 72 plant families with the most common families being Myrtaceae (75 taxa), Proteaceae (64 taxa) and Cyperaceae (30 taxa) (Woodman Environmental 2009). A total of 22 significant flora taxa were recorded during the survey including one Threatened flora taxon (*Paracaleana dixonii*) and 21 Priority Flora taxa. Of these, four taxa were have records in close proximity (within 5 km) to the Study Area as listed below and are presented in Figure 5:

- *Baeckea* sp. Walkaway (A.S. George 11249) (P3);
- *Banksia elegans* (P4);
- *Schoenus griffinianus* (P4); and
- *Stawellia dimorphantha* (P4).

Woodman Environmental have previously undertaken a number of annual flora and vegetation assessments for Tronox within the Tronox Dongara tenements. The following taxa recorded as part

of these surveys have records in close proximity (within 5 km) to the Study Area and are presented in Figure 5:

- *Banksia elegans* (P4) (Woodman Environmental 2012);
- *Beyeria gardneri* (P3) (Woodman Environmental 2016, 2018b);
- *Comesperma griffinii* (P2) (Woodman Environmental 2012);
- *Hemiandra* sp. Eneabba (H. Demarz 3687) (P3) (Woodman Environmental 2012);
- *Hypocalymma* ?*gardneri* (P3) (Woodman Environmental 2012);
- *Mesomelaena stygia* subsp. *deflexa* (P3) (Woodman Environmental 2012);
- *Persoonia rudis* (P3) (Woodman Environmental 2018b);
- *Schoenus griffinianus* (P4) (Woodman Environmental 2012); and
- *Stawellia dimorphantha* (P4) (Woodman Environmental 2012).

The Xyris Lateral flowline easement flora and vegetation survey by Woodman Environmental recorded a total of 97 discrete native vascular flora taxa, belonging to 35 families and 80 genera (Woodman Environmental 2018a). The most well-represented families were Myrtaceae, Poaceae and Proteaceae. A total of two significant flora taxa were recorded within the Study Area as listed below (Figure 5):

- *Banksia elegans* (P4); and
- *Baeckea* sp. Walkaway (A.S. George 11249) (P3).

A total of 21 introduced flora taxa were recorded during the survey of the Study Area. Of these, one taxon currently listed as a Declared Pest (BAM Act) was recorded during the survey (**Echium plantagineum*).

Woodman Environmental undertook a weed survey for AWE at Waitsia-03 and along the access track alignment (this survey area partially overlaps the Study Area) in August 2017 (Woodman Environmental 2018c). A total of 36 confirmed weed taxa were recorded. These are presented in Section 3.2.3, Table 4. There were no taxa listed as a Declared Pests under the BAM Act (DAF 2018) or as WoNS (AWC 2018) were recorded during the survey.

3.2.3 Summary of Significant Flora and Introduced Flora

3.2.3.1 Significant Flora

A list of significant flora taxa that are known from within or in the vicinity of the Study Area is presented in Table 3. This list has been compiled from the results of searches of DBCA's Threatened Flora Databases, DoEE database search, and the results of local flora surveys as outlined in Sections 3.2.1 and 3.2.2.

A total of 15 significant taxa are known from within or in the vicinity of the Study Area, including listed Threatened and Priority taxa. The locations of these taxa are presented in Figure 5. Of these, three taxa are known to occur in the Study Area as indicated in Table 3 (shaded yellow).

Table 3: Significant Flora Taxa Known from Within or in the Vicinity of the Study Area

Taxon	Status	Source*	Flowering Period (WAHerb 1998-)	Habitat (WAHerb 1998-)
Baeckea sp. Walkaway (A.S. George 11249)	P3	DBCA (2017b) **Maia (2016)** WEC (2004, 2009, 2018a)	Dec or Jan	Yellow/brown or white sand. Undulating plains, hillslope
Banksia elegans	P4	**DBCA (2017b)** **Maia (2016)** WEC (2004, 2009, 2012, 2018a)	Oct to Nov	Yellow, white or red sand. Sandplains, low consolidated dunes
Beyeria gardneri	P3	WEC (2016, 2018b)	Aug to Sep	Yellow sand
Comesperma griffinii	P2	DBCA (2017b) WEC (2012)	Oct	Yellow or grey sand Plains.
Eucalyptus zopherophloia	P4	WEC (2004)	Oct to Dec or Jan	Grey/white sand with limestone rubble. Coastal areas
Hemiandra sp. Eneabba (H. Demarz 3687)	P3	DBCA (2017b) WEC (2012)	Feb	Sand. Disturbed sites
Hemigenia saligna	P3	WEC (2004)	Jul to Oct	Lateritic and sandy soils
Hypocalymma ?gardneri	P3	WEC (2012)	Aug to Sep	Grey-brown sand, laterite. Sandplains, upper slopes, heathland
Mesomelaena stygia subsp. *deflexa*	P3	DBCA (2017b) WEC (2012)	Mar to Oct	White, grey or lateritic sand, clay, gravel
Paracaleana dixonii	T	DBCA)2017b) DoEE (2018a)	Oct to Dec or Jan	Sand over laterite, heath to Banksia woodland (on eastern margin of Geraldton Sandplain and (northern) Swan Coastal Plain)
Persoonia rudis	P3	DBCA (2017b) WEC (2018b)	Sep to Dec or Jan	White, grey or yellow sand, often over laterite
Schoenus griffinianus	P4	WEC (2009, 2012)	Sep to Oct	White sand
Schoenus sp. Eneabba (F. Obbens & C. Godden I154)	P2	DBCA (2017b) WEC (2004)	Dec	Grey, yellow or white sand. Undulating sandplains, mid slopes, tops of rises
Stawellia dimorphantha	P4	DBCA (2017b) **Maia (2016)** WEC (2004, 2009, 2012)	Jun to Nov	White, grey, yellow sand
Verticordia luteola var. *luteola*	P3	DBCA (2017b)	Dec or Jan	White sand. Flats

* Bold text indicates source from which the taxa was recorded/extracted in the Study Area

3.2.3.2 Introduced Flora

A list of introduced flora taxa known from within or in the vicinity of the Study Area is presented in Table 4. This has been compiled from WAHerb specimen data (DBCA 2007-) and from local flora surveys (Section 3.2.2). A total of 54 introduced taxa are known to occur within or in the vicinity of the Study Area including the Declared Pest **Echium plantagineum* (DAF 2018) and the WoNS **Lycium ferocissimum* (AWC 2018).

DBCA prioritises weeds in each region, based on their invasiveness, ecological impact, potential and current distribution and feasibility of control based on the Weed Prioritisation Process (DEC 2013b). Table 4 presents the ecological impact ratings for each introduced taxon under the Weed Prioritisation Process for DBCA based on the species-led ecological impact and invasiveness ranking

summary results for the Midwest Region (DPaW 2014). A total of 16 weeds known from within or in the vicinity of the Study Area have ratings of High for the Midwest (shaded pink). Of these, nine taxa are known to occur in the Study Area as indicated in Table 4 (shaded yellow).

Table 4: Introduced Flora Taxa Known from Within or in the Vicinity of the Study Area

Taxon	Common Name	Source^	Comments
**Arctotheca calendula*	Cape Weed	WEC (2018)	Ecological impact rating High (DPaW 2014)
**Asphodelus fistulosus*	Onion Weed	DBCA (2007-)	Ecological impact rating Medium (DPaW 2014)
**Avena barbata*	Bearded Oat	Maia (2016)	Ecological impact rating High (DPaW 2014)
**Avena fatua*	Wild Oat	WEC (2018)	Ecological impact rating High (DPaW 2014)
**Avena sativa*	Common Oat	WEC (2018)	Ecological impact rating Low (DPaW 2014)
**Brassica tournefortii*	Mediterranean Turnip	WEC (2018)	Ecological impact rating High (DPaW 2014)
**Briza maxima*	Blowfly Grass	WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Bromus diandrus*	Great Brome	WEC (2018)	Ecological impact rating High (DPaW 2014)
**Bromus madritensis*	Madrid Brome	WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Cenchrus ciliaris*	Buffel Grass	DBCA (2007-)	Ecological impact rating High (DPaW 2014)
**Cenchrus echinatus*	Burr Grass	DBCA (2007-)	Not rated by DPaW (2014)
**Centaurea melitensis*	Maltese Cockspur	DBCA (2007-)	Ecological impact rating High (DPaW 2014)
**Centaurium tenuiflorum*	-	Maia (2016)	Ecological impact rating Low (DPaW 2014)
?**Cerastium glomeratum*	Mouse Ear Chickweed	WEC (2018)	Ecological impact rating Medium (DPaW 2014)
**Chenopodium murale*	Nettle-leaf Goosefoot	Maia (2016)	Ecological impact rating Unknown (DPaW 2014)
**Cicer arietinum*	Chickpea	DBCA (2007-)	Not rated by DPaW (2014)
**Corrigiola litoralis*	Strapwort	DBCA (2007-)	Ecological impact rating Unknown (DPaW 2014)
Dischisma capitatum	Woolly-headed Dischisma	WEC (2018)	Ecological impact rating Low (DPaW 2014)
**Echium plantagineum*	Paterson's Curse	DBCA (2007-), WEC (2018)	Declared Pest (DAF 2018), Ecological impact rating High (DPaW 2014)
**Ehrharta brevifolia*	Annual Veldt Grass	WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Ehrharta longiflora*	Annual Veldgrass	Maia (2016), WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Erodium botrys*	Long Storksbill	WEC (2018)	Ecological impact rating Low (DPaW 2014)
**Galium murale*	Small Goosegrass	DBCA (2007-), WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Hordeum leporinum*	Barley Grass	WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Hypochaeris glabra*	Smooth Catsear	WEC (2018)	Ecological impact rating Low (DPaW 2014)
**Leontodon rhagadioloides*	Cretan Weed	DBCA (2007-)	Ecological impact rating High (DPaW 2014)
**Lolium multiflorum*	Italian Ryegrass	WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Lupinus cosentinii*	Lupin	DBCA (2007-), WEC (2018)	Ecological impact rating Medium (DPaW 2014)
**Lycium ferocissimum*	African Boxthorn	DBCA (2007-)	WoNS (AWC 2018), Ecological impact rating High (DPaW 2014)
**Lysimachia arvensis*	Pimpernel	WEC (2018)	Ecological impact rating Low (DPaW 2014)
**Minuartia mediterranea*	-	WEC (2018)	Not rated by DPaW (2014)
**Monoculus monstrosus*	Stinking Roger	WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Ornithopus compressus*	Yellow Serradella	WEC (2018)	Ecological impact rating Low (DPaW 2014)
**Pentameris airoides*	False Hairgrass	Maia (2016)	Ecological impact rating Unknown (DPaW 2014)
Polycarpon tetraphyllum	Fourleaf Allseed	WEC (2018)	Ecological impact rating Low (DPaW 2014)
**Polypogon maritimus*	Coast Beardgrass	Maia (2016)	Ecological impact rating Medium (DPaW 2014)
**Raphanus raphanistrum*	Wild Radish	WEC (2018)	Ecological impact rating High (DPaW 2014)

Taxon	Common Name	Source^	Comments
**Reichardia tingitana*	False Sowthistle	DBCA (2007-)	Ecological impact rating Unknown (DPaW 2014)
**Rumex crispus*	Curled Dock	WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Sinapis arvensis*	Charlock	DBCA (2007-)	Ecological impact rating Unknown (DPaW 2014)
**Solanum lycopersicum*	Tomato	WEC (2018)	Not rated by DPaW (2014)
**Solanum nigrum*	Black Berry Nightshade	Maia (2016), WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Sonchus oleraceus*	Common Sowthistle	DBCA (2007-), Maia (2016), WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Stellaria media*	Chickweed	WEC (2018)	Ecological impact rating Low (DPaW 2014)
**Trifolium arvense*	Hare's Foot Clover	WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Trifolium ?campestre*	Hop Clover	WEC (2018)	Ecological impact rating High (DPaW 2014)
Trifolium glomeratum	Cluster Clover	WEC (2018)	Ecological impact rating High (DPaW 2014)
**Trifolium subterraneum*	Subterranean Clover	WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Urospermum picroides*	False Hawkbit	DBCA (2007-)	Ecological impact rating High (DPaW 2014)
**Ursinia anthemoides*	Ursinia	WEC (2018)	Ecological impact rating High (DPaW 2014)
**Verbesina encelioides*		DBCA (2007-)	Ecological impact rating High (DPaW 2014)
Vulpia sp. (*myuros* or *muralis*)	Rat's Tail Fescue	WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**?Wahlenbergia capensis*	Cape Bluebell	WEC (2018)	Ecological impact rating Unknown (DPaW 2014)
**Zaluzianskya divaricata*	Spreading Night Phlox	DBCA (2007-)	Ecological impact rating Unknown (DPaW 2014)

^WEC – Woodman Environmental

3.3 Fauna

Bamford Consulting Ecologists (BCE) undertook a desktop review of the fauna values of the Waitsia-03 Study Area (BCE 2018). A number of fauna studies have previously been conducted in the region including:

- A Level 2 fauna survey conducted by BCE in the Mt Adams Road area on behalf of Tronox (Metcalf and Bamford 2008). This study area is just south of the Waitsia Study Area, with work carried out included searching for significant species, spotlighting, trapping, bat surveys and bird surveys;
- More recent work carried out in the Tronox study area that targeted the Western Ground Parrot (Bamford 2012);
- A Level 1 fauna assessment of the Waitsia Wells study area (Bamford *et al.* 2015), part of the broader area within which the Waitsia-03 Project is located; and
- An assessment of the Waitsia-03 Project area and its significance for Black Cockatoo spp. (Bamford 2016). This included a detailed site inspection of the Waitsia-03 well site, quantification of Banksia density and flowering, and a comparison of the extent of similar vegetation across Yardanogo Nature Reserve.

Previous studies have identified 251 vertebrate fauna species as potentially occurring in the broader Waitsia area:

- Two fish;
- 10 frogs;
- 47 reptiles;
- 173 birds; and
- 15 native and 11 introduced mammals.

The vertebrate assemblage listed above includes 30 species of conservation significance, the most likely to regularly use the site being Carnaby's Black-Cockatoo. In addition, two invertebrates of conservation significance may be present in the region. Appendix E presents a list of these conservation significant fauna taxa.

Key Vegetation and Substrate Associations (VSAs) of the Waitsia area (Bamford *et al.* 2015) were:

- VSA 1. Agricultural land. Extensively cleared pale sand (high in the landscape) to red sandy loam (alluvial flats low in the landscape). Scattered paddock trees; mostly York Gum on alluvial flats. Some rows of planted eucalypts along tracks and fencelines appear to be River Gums;
- VSA 2. Kwongan to open Banksia woodland on sand. This occurs on higher ground in the west, south and in the central strip of native vegetation. In some areas there are emergent Banksias and Eucalypts;
- VSA 3. Riparian shrub-thicket on dark peaty-sand. This occurs around and across seasonal wetlands low in the landscape in the south of the Study Area;
- VSA 4. Eucalypt/Banksia/Acacia low forest on sand. This lies on the transition between sandy rises that support Kwongan in the east and the alluvial flats that lie in the central valley of the Project area. The low forest is probably a response to water availability low in the landscape and where the soil changes. It forms a prominent belt of vegetation along farmland in the north but also occurs in the south where it merges with the riparian shrub-thicket;
- VSA 5. York Gum Woodland on red sandy loam. This probably occurred across the alluvial red sandy loams low in the landscape, but is now extensively cleared. Apart from scattered paddock trees, there is a small remnant of this VSA about a kilometre north of Waitsia-02; and
- VSA 6. Irwin River Red Gum Woodland. This lines the Irwin River and consists of very large trees forming a gallery woodland or forest along the watercourse. The understorey is substantially degraded.

4 METHODS

4.1 Flora and Vegetation Survey

4.1.1 Personnel and Licencing

Table 5 lists the personnel involved in both fieldwork and plant identifications for the assessment of the Study Area. The field team leader has had 18 years previous field experience in similar areas to the Study Area, with personnel involved in plant identifications having several years of taxonomic experience with the flora of the Geraldton Sandplains. All plant material was collected under the scientific licences pursuant to the WC Act Section 23C and Section 23F as listed in Table 5.

Table 5: Personnel and Licensing Information

Personnel	Role	Qualifications	Flora Collecting Permit (WC Act (WA))
Beth Loudon	Project Management; Team Leader; field survey	BSc (Biology)	SL012068 (Section 23C) 121-1617 (Section 23F)
Emalyn Loudon	Field survey	BAgrib (Agriculture) (Hons)	-
David Coultas	Plant identifications	BSc (Environmental Biology) (Hons)	NA

4.1.2 Field Survey

The field survey was conducted from the 6th – 10th November 2017. It is considered that the survey was conducted during the appropriate season (Spring), with the majority of taxa in this region (Geraldton Sandplains bioregion) flowering at this time.

A total of 29 non-permanent flora survey quadrats measuring 10 m x 10 m were established during survey. This quadrat size is the indicative size used in flora and vegetation surveys in the Geraldton Sandplains Bioregion, as outlined in Table 1 of EPA (2016a).

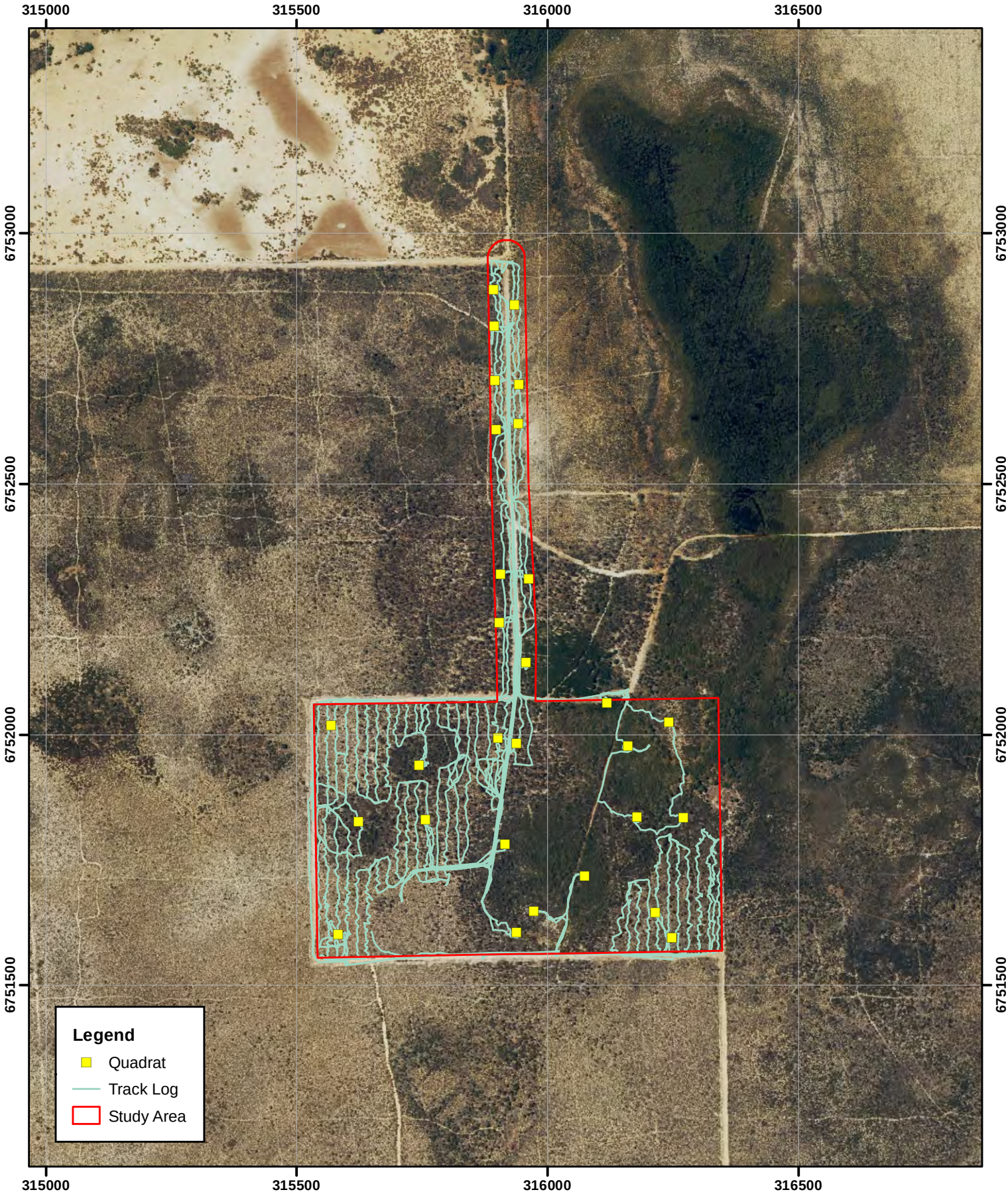
All vascular flora taxa present within each quadrat were recorded. At least one reference specimen of most taxa (excluding common, distinctive taxa) encountered was collected for verification and identification purposes.

The following information was recorded at each quadrat:

- Personnel;
- Unique quadrat number;
- Date of survey;
- GPS (Global Positioning System) coordinates (GDA (Geocentric Datum of Australia) 94);
- Site photograph;
- Topography (including landform type and aspect);
- Soil colour and type (including the presence of any rock outcropping and surface stones);
- Vegetation condition (EPA 2016a; adapted from Keighery 1994: scale presented in Appendix F);
- Approximate time since fire;
- Presence of disturbance (if any);
- Percentage foliage cover (for each taxon); and
- Height (m) (for each taxon, excluding climbers/aerial shrubs).

Access to the Study Area was achieved via vehicle and on foot. Additional flora taxa were recorded opportunistically in the survey areas via a search around the general vicinity of each quadrat, during traverses on foot between quadrats and during targeted searching of the Study Area. Mapping notes of vegetation type boundaries and distribution were also taken while traversing on foot and by vehicle.

Targeted searching for significant flora taxa known from the vicinity of the Study Area was undertaken as part of the survey. Areas of appropriate habitat within the Study Area that were considered suitable for the presence of significant taxa as identified in the desktop review, were traversed with transects undertaken at a spacing of approximately 20 m (Figure 6).



Study Area Track Logs and Quadrats Flora and Vegetation Survey	Author: Alison Saligari	
	WEC Ref: AWE17-38-01	
WOODMAN ENVIRONMENTAL	Filename: AWE17-38-01-f06.mxd	**Figure**
	Scale: 1:10,000 (A4)	6
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report AWE17-38-01.	Revision: A - 12 February 2018	

4.1.3 Plant Collection and Identification

Specimens of any unknown taxa were collected and pressed for later identification at the WA Herbarium. Identifications were undertaken by experienced botanist David Coultas. 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* (WAHerb 1998-) with all names checked against the current DBCA Max database to ensure their validity. 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 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).

4.1.4 Floristic Analysis

PATN (V3.12) (Belbin and Collins 2009) was utilised to perform a classification and ordination analysis on a data matrix compiled of the 29 quadrats established by this study and an additional 65 quadrats established within or in close proximity to the Study Area for the Dongara Tenements Flora and Vegetation Studies Regional FCT Analysis (Woodman Environmental 2009).

The analysis used 404 taxa, with taxa belonging to several categories were removed prior to analysis as listed below:

- Ephemeral or annual taxa – the presence of ephemeral or annual taxa is strongly influenced by seasonal conditions, with fewer taxa and individuals usually present following below-average rainfall;
- Perennial taxa that produce annual flowering/fruiting parts that are essential for identification – such taxa include geophytic taxa (e.g. Droseraceae, Orchidaceae) that can only be identified from flowering or fruiting material, however only produce such material during their flowering periods. Removal of such taxa from the analysis removes temporal variation in the presence of such taxa between surveys conducted in differing seasons and years;
- Introduced taxa – introduced taxa were removed as their distributions are generally defined by the presence of disturbance (e.g. clearing, animal movement) rather than particular natural habitat types;
- Hybrids – hybrids are usually the result of random reproductive events that produce small numbers (often only one) of sterile offspring, and are not usually associated with particular habitat types;
- Singletons – taxa that are only recorded once are removed from the analysis as their statistical significance may be overstated and obscure vegetation patterning where they do not dominate a vegetation unit;
- Opportunistic taxa – taxa that are recorded from outside a quadrat within the same vegetation unit are not included for the same reason as singletons; and
- Taxa where identification was unclear – such taxa were removed from the analysis where identification was unclear due to poor available material in the field.

Certain taxa were amalgamated (through the allocation of the same analysis code) and treated as the same species where their analysis as separate entities could not be justified e.g. *Acacia pulchella* and *Acacia pulchella* var. *pulchella*.

A single-layer data matrix (i.e. presence/absence data only) was used in the classification analysis. The Bray-Curtis coefficient was used to generate an association matrix and consisted of pairwise coefficients of similarities between quadrats based on floristic data. Agglomerative hierarchical clustering, using flexible UPGMA (ß=-0.1), was used to generate a quadrat classification dendrogram (Sneath and Sokal 1973).

4.1.5 Vegetation Type Mapping and Description

The classification analysis of Study Area floristic data aggregated quadrats into a cluster classification that may be appropriate for the data analysed. The resultant dendrogram and two-way table were examined to determine the plausibility of clusters with regard to taxon groups, taxa/cluster relationships and field observations. This process determined a final number of clusters, which were considered to represent VTs.

Manual reassignment of one quadrat (W3-28) to a more appropriate VT based on quadrat data and field observations was undertaken. Examination of the two-way table identified particular taxa that influenced the quadrats' placement within the cluster, in addition to the presence or absence of certain taxa (namely *Conostylis candicans* and *Banksia prionotes*) that justified its manual reassignment.

VT descriptions have been adapted from the 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 is produced nation-wide. It should be noted that the NVIS system utilises vegetation descriptions derived from structural characteristics of the individual community units, while the VTs presented in this report have been derived from analysis of quadrat floristics, excluding any structural data. VTs therefore may include multiple structural types. Considering the effect of disturbance factors such as fire on vegetation structure, this approach is designed to provide a map of VTs that reflect taxon composition and the influences of the physical and chemical environment rather than disturbance history.

It should also be noted that this report describes VTs at the NVIS Sub-Association level, rather than the Association level as stipulated by EPA (2016a). This level is considered more appropriate for the vegetation of the Study Area, as generally the vegetation possessed one or more additional strata to the traditional three-stratum classification system used at the Association level.

The locations of quadrats within each VT were used in conjunction with aerial photography interpretation and field notes taken during the survey to develop VT mapping polygon boundaries. These VT mapping polygon boundaries were then digitised using Geographic Information System (GIS) software.

4.1.6 Vegetation Condition Mapping

Vegetation condition was recorded at all quadrats, and also opportunistically within the Study Area where areas of disturbance to vegetation were noted (e.g. weed infestations, areas of historical clearing). Vegetation condition was described using the vegetation condition scale presented in EPA (2016a) (as adapted from Keighery (1994)), and is presented in Appendix F. Vegetation condition polygon boundaries for the Study Area were developed using this information in conjunction with aerial photography interpretation, and were digitised as for VT polygon boundaries.

4.1.7 Assessment of Significant Flora and Vegetation

4.1.7.1 Significant Flora

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

- Being identified as a Threatened or Priority species (listed significant taxa);
- Locally endemic or associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems);
- New species or 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 Study Area are discussed in Section 5.1.2, with reference to the above categories. Review of MNES-listed flora taxa is also provided in Section 5.1.2.

No classification of the potential local significance of recorded significant flora taxa has been undertaken as part of this assessment. It is considered that such a classification is best undertaken as part of any overall impact assessment that may need to be undertaken for the Project, as significant flora information may change prior to such an impact assessment being conducted.

4.1.7.2 Significant Vegetation

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

- Being identified as a Threatened or Priority Ecological Community (listed significant vegetation);
- 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.

These criteria are generally applicable to VTs mapped in the Study Area, and are therefore used to determine whether a VT is locally significant (with 'local' referring to the Study Area). It is more difficult to apply these criteria in a regional context, as there is no publicly-available Geraldton Sandplains-wide dataset of VTs. Regional significance of vegetation is discussed in Section 5.2.2 in relation to existing publicly available literature, with vegetation manually assessed against the current listings of:

- TECs listed under the EPBC Act;
- TECs as classified by DBCA and endorsed by the WA Minister for the Environment (DBCA 2016);
- PECs as classified by DBCA (DBCA 2017d);
- Areas of wetland or riparian vegetation; and
- Other significant vegetation as defined by EPA (2016a; b).

4.1.7.3 Limitations of the Survey

Table 6 presents the limitations of the flora and vegetation survey of the Study Area in accordance with EPA (2016a).

Table 6: Limitations of the Flora and Vegetation Survey of the Study Area

Limitation	Limitation of Survey	Comment
Level of survey	No	Targeted Survey and Detailed Survey conducted over one field trip in late November 2017, within but on the outer limits of the usual peak flowering season in the Geraldton Sandplains Bioregion. Replicated quadrats were established in each vegetation pattern identified in the Study Area. EPA (2016a) indicates that survey may be required to be undertaken in other seasons. It is considered that survey in the peak flowering season only is adequate in this case, as it considered likely that most taxa that flower outside the peak flowering season could be identified during the survey period
Competency /experience of the consultant(s) carrying out the survey	No	Senior personnel undertaking the survey have had extensive experience in conducting similar assessments in the Geraldton Sandplains Bioregion, and all personnel undertaking the field survey have had previous experience undertaking similar surveys
Scope (floral groups that were sampled; some sampling methods not able to be employed because of constraints?)	No	All vascular groups that were present during the detailed and targeted survey were sampled. No constraints prevented appropriate sampling techniques (quadrat establishment, relevés, targeted searching and opportunistic recording) being employed
Proportion of flora identified, recorded and/or collected	No	A high proportion of perennial vascular taxa were recorded based on the intensity and method of survey. A lower proportion of ephemeral and annual vascular taxa were recorded based on the below-average rainfall prior to and the later timing of the survey. Unknown vascular taxa were collected within quadrats, relevés and opportunistically, with specimens identified at the WA Herbarium
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	No	Sources of information used included government databases (DBCA, DoEE) and previous reports and unpublished data from the vicinity of the Study Area (Maia 2016; Woodman Environmental 2004, 2009, 2012, 2016, 2018a-c). Good contextual information for the Study Area was available prior to the survey
The proportion of the task achieved and further work which might be needed	No	Targeted and Detailed Survey was completed, with the targeted survey including grid searching for significant flora taxa throughout the entire Study Area. No further survey within the Study Area is considered necessary
Timing/weather/season/ cycle	No	The field survey was conducted in Spring, corresponding with the optimum flowering period for the Geraldton Sandplains Bioregion. The flowering period was considered by Woodman Environmental to be good. The below-average rainfall in the months prior to the survey and later timing of the survey limited the number of ephemeral and annual taxa recorded/identified however this did not impact the outcomes of the survey or prevent identification of any potential significant taxa that may potentially occur in the Study Area. The timing coincided with the peak flowering period for *Paracaleana dixonii* (Threatened)
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey	No	Although some disturbances such as historical clearing and weeds were apparent, these did not appear to have significantly impacted the flora taxa present and are therefore not considered to have affected the results of the survey
Intensity of survey	No	The survey intensity was considered adequate, with replication of quadrats in VTs and detailed foot searching (particularly for significant flora) undertaken throughout the Study Area

Limitation	Limitation of Survey	Comment
Completeness and mapping reliability	No	The survey of the Study Area is considered complete in terms of mapping of VTs. Specific grid searching for significant flora taxa was undertaken for throughout the entire Study Area. Mapping reliability was considered good as high resolution aerial photography was used, with 29 quadrats established in the Study Area and detailed field notes recorded. Foot and vehicle transects were employed to aid in mapping which increased the reliability
Resources and experience of personnel	No	Adequate resources including experienced field personnel and taxonomists with appropriate expertise in Swan Coastal Plain Bioregion flora were utilised
Remoteness and/or access problems	No	Access to the Study Area was considered good, given the entire Study Area was accessible via tracks and firebreaks

4.2 Fauna Survey

As reported by BCE (2018), a site visit of the proposed flowline route was conducted by Dr Mike Bamford on 13th November 2017. The focus of the inspection was the Waitsia-03 flowline route and access track; the Hudson Resources Block (rectangular area) was also reviewed in the field. In addition, the area of open water located to the north-east of the project area (via a track) was also inspected, to provide additional context in terms of the local environment. The site visit was conducted from midday until sunset.

During this visit the road and flowline alignments were walked and observations made on fauna and fauna habitats. This included assessing large trees for their potential as nesting habitat for black-cockatoos. The assessment of trees with the potential to provide nesting habitat was based on the basic criterion of the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2012) guidelines, being trees with a diameter at breast height (DBH) greater than 500 mm, combined with a classing system developed by BCE (Table 7). Therefore, the following information was recorded for every tree with a DBH greater than 500 mm:

- Tree location (UTM, datum WGS 84);
- Species and life status (dead/alive);
- DBH; and
- Potential as a nest tree (Classes 1 to 5) based upon Table 1.

Table 7: Grading System for the Assessment of Potential Nest Trees for Black Cockatoos

Class	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

Previous surveys for the Waitsia-03 Project area were also used in the assessment of fauna values. The Waitsia-03 Study Area is discussed with regard to each of the ten Clearing Principles as listed in Schedule 5 of the *Environmental Protection Act* (WA) 1986 (EP Act). For each of the Clearing Principles a general statement is made on how the fauna values of the Waitsia-03 Study Area relates to that Clearing Principle, with further discussion providing the basis for this general statement.

5 RESULTS

5.1 Flora

5.1.1 Vascular Flora Census

A total of 173 discrete vascular flora taxa representing 50 families and 124 genera were recorded in the Study Area by this survey. A total of 157 of these taxa were native taxa. The most well-represented families were Myrtaceae (26 taxa), Poaceae (29 taxa), Fabaceae (16 taxa) and Proteaceae (15 taxa).

Average native taxon richness per quadrat was 15.8, with the greatest number of taxa recorded in a single quadrat being 37 (W3-24 in VT1), and the lowest number being four (W3-19 in VT4). A full list of taxa is presented in Appendix G, with raw quadrat data and parameters presented in Appendix H.

A small number of orchid species that were observed during the *Waitsia-03 Weed Assessment* in August 2017 (Woodman Environmental 2018c), that were not present at the time of the flora and vegetation survey have been included in the species list.

5.1.2 Significant Flora Taxa

Table 8 presents a list of significant flora taxa recorded in the Study Area, together with location information. A total of five significant flora taxa were recorded within the Study Area. No Threatened flora taxa were recorded within the Study Area. Locations of significant flora taxa are presented in Appendix I and Figure 7.

Table 8: Summary of Significant Flora Taxa Recorded within the Study Area

Taxon	Status	Number of Point Locations Recorded in Study Area	Number of Individuals Recorded in Study Area	VTs
Austrostipa sp. Cairn Hill (M.E. Trudgen 21176)	P3	1	1	3
Baeckea sp. Walkaway (A.S. George 11249)	P3	1	5	1
Banksia elegans	P4	204	2868	1, 2, 3, 4
Comesperma griffinii	P2	3	14	1
Stawellia dimorphantha	P4	70	141	1, 3

Austrostipa sp. Cairn Hill (M.E. Trudgen 21176) (P3) is a tufted perennial grass growing to 0.6 m high (Plate 1) which occurs on slopes and flats on yellow or brown sands in a range of vegetation types (e.g. *Corymbia calophylla* forest over sandplain shrubs and heath; Banksia woodland/heath) (WAHerb 1998-). It has a range of approximately 450 km in Western Australia (where it is endemic), from north of Dongara in the north-west, to near Bruce Rock in the south-east. This taxon is known from eight records representing approximately eight broad localities, two of which occur within conservation reserves including Burma Road Nature Reserve and Cairn Hill Westrail Reserve (DPaW 2007-).

Austrostipa sp. Cairn Hill (M.E. Trudgen 21176) (P3) was recorded at one point location within the Study Area, with one individual recorded (Appendix I). Targeted searching for this taxon was not undertaken as it is not known from the vicinity of the Study Area and was consequently not identified in the Desktop Review. It is considered that this taxon is uncommon in the Study Area, occurring at one quadrat within VT3 (Figures 7 and 8). The occurrence within the Study Area

represents a locality hole for this taxon, with the nearest record located approximately 40 km to the north of the Study Area.

Plate 1: *Austrostipa* sp. Cairn Hill (M.E. Trudgen 21176) (P3) (Photo: Woodman Environmental – scanned specimen)

Baeckea sp. Walkaway (A.S. George 11249) (P3) is a dense, multi-stemmed shrub growing up to 2 m high (Plate 2) which occurs on undulating plains and hillslopes on yellow/brown or white sand in Kwongan or Banksia woodland/heath (WAHerb 1998-). It has a range of approximately 120 km in Western Australia (where it is endemic), from near Geraldton in the north-west, to south-east of Mullewa in the east and south-east of Dongara in the south. This taxon is known from 39 records representing approximately 32 broad localities, five of which occur within conservation reserves including Burma Road Nature Reserve Indarra Spring Nature Reserve, Yardanogo Nature Reserve (DPaW 2007-).

Baeckea sp. Walkaway (A.S. George 11249) (P3) was recorded at one point location within the Study Area, with five individuals recorded (Appendix I). This taxon occurs on upper slopes on grey sand within VT 1 (Figure 7, 8). There are a number of known locations of this taxon within 5 km of the Study Area (DPaW 2007-, Maia 2016, Woodman Environmental 2004, 2009, 2018a).

The location of *Baeckea* sp. Walkaway (A.S. George 11249) (P3) recorded by Maia (2016) near the southern boundary of the Study Area was revisited during this survey however no plants were relocated. It is possible that these plants were cleared during the approved construction of the well pad.

Plate 2: *Baeckea* sp. Walkaway (A.S. George 11249) (P3) (Photos: Woodman Environmental)

Banksia elegans (P4) is a shrub growing up to 4 m high (Plate 3) which occurs on sandplains and low consolidated dunes on yellow, white or red sand (WAHerb 1998-). It has a range of approximately 175 km in Western Australia (where it is endemic), from north-west of Dongara in the north-west, to near Hill River in the south-east. This taxon is known from 36 records representing approximately 19 broad localities, seven of which occur within conservation reserves including Beekeepers Nature Reserve, Lake Logue Nature Reserve, Lesueur National Park and Yardanogo Nature Reserve (DPaW 2007-).

Banksia elegans (P4) was common within the Study Area, with a total of 204 point locations recorded within the Study Area and 2868 individuals recorded across these point locations (Appendix I). This taxon was recorded on dunes and plains on sand, most commonly within VTs 1 and 3 filtering into the edges of VTs 2 and 4 (Figure 7, 8). There are a number of known locations of this taxon within 5 km of the Study Area (DPaW 2007-, Maia 2016, Woodman Environmental 2004, 2009, 2012, 2018a).

Plate 3: *Banksia elegans* (P4) (Photos: Woodman Environmental)

Comesperma griffinii (P2) is an annual or perennial herb growing to 0.15 m high (Plate 4) which occurs on plains on yellow or grey sand (WAHerb 1998-). It has a large range of approximately 830 km in Western Australia (where it is endemic), from east of Geraldton in the north-west, to near Esperance in the south-east. However, this taxon is known from just 11 records representing approximately 10 broad localities, four of which occur within conservation reserves including Indarra Nature Reserve, Helms Forestry Reserve, Kenwick Wetland and South Eneabba Nature Reserve (DPaW 2007-).

Comesperma griffinii (P2) was recorded at three point locations within the Study Area, with 14 individuals recorded across these point locations (Appendix I). This taxon generally occurred on clayey sand or light clay in open depressions within the sub-vegetation type of VT 1 (Figure 7, 8). There is one known location of this taxon approximately 15 km south-east of the Study Area, however; the next closest record is over 60 km south of the Study Area (DPaW 2007-).

Plate 4: *Comesperma griffinii* (P2) (Photos: Woodman Environmental – scanned specimen)

Stawellia dimorphantha (P4) is a stilt-rooted perennial herb growing up to 0.2 m high (Plate 5) which occurs on white, grey and yellow sand. (WAHerb 1998-). It has a range of approximately 89 km in Western Australia (where it is endemic), from north of Dongara in the north, to near Eneabba in the south. This taxon is known from 65 records representing approximately 20 broad localities, 6 of which occur within conservation reserves including Beekeepers Nature Reserve and Yardanogo Nature Reserve (DPaW 2007-).

Stawellia dimorphantha (P4) was recorded at 70 point locations within the Study Area, with 141 individuals recorded across these point locations (Appendix I). This taxon was relatively common within the Study Area, occurring on dunes and plains on sand within VTs 1 and 3 (Figure 7, 8). There are a number of known locations of this taxon within 5 km of the Study Area (DPaW 2007-, Maia (2016), Woodman Environmental 2004, 2009, 2012).

Plate 5: *Stawellia dimorphantha* (P4) (Photo: Woodman Environmental)

315250 315500 315750 316000 316250 316500

6753000 6752750 6752500 6752250 6752000 6751750 6751500

Legend

Study Area

Significant Flora

- AspCH *Austrostipa* sp. Cairn Hill (M.E. Trudgen 21176) (P3)
- Bel *Banksia elegans* (P4)
- BspW *Baeckea* sp. Walkaway (A.S. George 11249) (P3)
- Cgr *Comesperma griffinii* (P2)
- Sdi *Stawellia dimorphantha* (P4)

315250 315500 315750 316000 316250 316500

WOODMAN ENVIRONMENTAL

This map should only be used in conjunction with WEC report AWE17-38-01.

N

Significant Flora Taxa of the Study Area

Revision: A - 12 Feb 2018 Scale: 1:5,000 (A3)

Author: Bethea Loudon

WEC Ref: AWE17-38-01

Filename: AWE17-38-01-f07.mxd

Projection: GDA 1994 MGA Zone 50

Figure

7

5.1.3 Introduced Taxa

Table 9 presents a list of the introduced flora taxa recorded in the Study Area, location information and ecological impact ratings for each introduced taxon under the Weed Prioritisation Process for the Midwest Region (DPaW 2014). A total of 16 introduced flora taxa were recorded in the Study Area as presented in Table 8, with the locations recorded presented in Appendix I. No Declared weeds or WoNS were recorded within the Study Area. A total of three taxa have ratings of High for the Midwest including **Aira cupaniana,* **Centaurea melitensis* and **Ursinia anthemoides.* Introduced taxa were scattered throughout the Study Area but were predominantly associated with VT4 (more damp habitats).

Table 9: Summary of Introduced Taxa Recorded within the Study Area

Taxon	Common Name	Number of Locations Recorded in Study Area	VTs	Comments
**Aira cupaniana*	Silvery Hairgrass	2	4	Ecological impact rating High (DPaW 2014)
**Avena sativa*	Common Oat	1	4	Ecological impact rating Low (DPaW 2014)
**Briza minor*	Shivery Grass	1	4	Ecological impact rating Unknown (DPaW 2014)
**Centaurea melitensis*	Maltese Cockspur	1	4	Ecological impact rating High (DPaW 2014)
**Centaurium tenuiflorum*	-	1	4	Ecological impact rating Low (DPaW 2014)
**Ehrharta longiflora*	Annual Veldt grass	10	2,3,4	Ecological impact rating Unknown (DPaW 2014)
**Galium murale*	Small Goosegrass	2	4	Ecological impact rating Unknown (DPaW 2014)
**Hypochaeris glabra*	Smooth Catsear	19	1,2, 3,4	Ecological impact rating Low (DPaW 2014)
**Lysimachia arvensis*	Pimpernel	9	3,4	Ecological impact rating Low (DPaW 2014)
**Pentameris airoides* subsp. *airoides*	False Hairgrass	2	2,3	Ecological impact rating Unknown (DPaW 2014)
**Rostraria cristata*	-	1	4	Ecological impact rating Unknown (DPaW 2014)
**Solanum nigrum*	Black Berry Nightshade	1	4	Ecological impact rating Unknown (DPaW 2014)
**Sonchus oleraceus*	Common Sowthistle	3	4	Ecological impact rating Unknown (DPaW 2014)
**Ursinia anthemoides*	Ursinia	12	1,2, 3	Ecological impact rating High (DPaW 2014)
**Vulpia myuros* forma *myuros*	Rat's Tail Fescue	9	1,3, 4	Ecological impact rating Unknown (DPaW 2014)
**Wahlenbergia capensis*	Cape Bluebell	7	1,2, 3	Ecological impact rating Unknown (DPaW 2014)

**Aira cupaniana* (Silvery Hairgrass) is an annual grass growing up to 0.4 m high occurring on sandy clay, sand and loam (WAHerb 1998-). This taxon is a common (often abundant) widespread weed of pastures and poor soils as well as many types of bushland throughout South-West Province of WA (Hussey *et al.* 2007). This taxon was rated as High by the Weed Prioritisation Process for the Midwest Region, with an invasiveness rating of Rapid (DPaW 2014).

**Centaurea melitensis* (Maltese Cockspur) is an erect annual or biennial herb growing up to 1 m high occurring along roadsides, in cultivated areas and in other disturbed areas. (WAHerb 1998-). This taxon is a common throughout the southern Eremaean Province and throughout the South-West Province (WAHerb 1998-). This taxon was rated as High by the Weed Prioritisation Process for the Midwest Region, with an invasiveness rating of Rapid (DPaW 2014).

**Ursinia anthemoides* (Ursinia) is a slender, erect annual herb growing to 0 .5 m high and occurring within roadsides and waste places. The fruits of this taxon have both pappus and hairs, and are therefore easily dispersed by wind. Ursinia also has generally faster, less variable and higher germination rates compared with native annual species, giving it a competitive advantage (WAHerb

1998-). It is a common and widespread weed in various habitats throughout the south-west (Hussey *et al.* 2007). **Ursinia anthemoides* was rated as High by the Weed Prioritisation Process for the Midwest Region, with an invasiveness rating of Rapid (DPaW 2014).

**Aira cupaniana* and **Centaurea melitensis* were recorded in low covers at the time of the survey. **Ursinia anthemoides* was more widespread and generally at low covers however was present at slightly higher covers (2-3 %) in VT2 (W3-16) and VT3 (W3-09, W3-10) at the time of the survey.

5.2 Vegetation

5.2.1 Vegetation Types

A total of four VTs were described and mapped within the Study Area. These VTs represent two broad groups of vegetation relating to soils and topography, as depicted by the two main branches in the dendrogram (Appendix J):

- Vegetation predominantly on yellow to grey sandy soils, on slopes and dunes (VT1 to 3); and
- Vegetation predominantly on grey light clay to brown loamy clay in association with limestone subsoils, on simple slopes or in basins (VT4).

The VTs described in the Study Area are summarised in Table 10. Table 10 includes the description of each VT (as per Section 4.2.4), total area mapped in the Study Area, quadrats established in the VT, taxon richness of the VT, and significant flora taxa recorded in the VT. VT mapping within the Study Area is presented on Figure 8. Appendix K presents a taxon-VT matrix compiled from quadrat.

VTs 1, 2 and 3 are floristically similar to each other, grouping under the same sub-branch (Appendix I). VT2 and 3 are floristically more similar, grouping together at the same sub-level separate to VT1 quadrats. This is likely an artefact of low taxon richness and vegetation condition rather than taxa in common. VTs 1 to 3 are associated with the Tamala South 3 and 7 soil subsystems (although the soil mapping in Figure 3 does not quite correlate being mapped at a broader scale), being recorded and mapped on areas of yellow to grey sand. VTs 1 to 3 occupy 55 % of the Study Area, occurring in the north, west and south-east sections (Figure 8).

VT1 consists of Banksia shrubland dominated by *Banksia attenuata* on undulating slopes and low dunes of yellow to grey sand, with small occurrences of *Allocasuarina campestris* shrublands on grey clayey soils in open depressions generally associated with swales. The incorporation of these areas in VT1 is possibly the result of their small size, low native taxon richness and integration of some species across boundaries. The vegetation of VT1 occupies 28.1 % of the Study Area, with four significant taxa were recorded (*Baeckea* sp. Walkaway (A.S. George 11249) (P3), *Banksia elegans* (P4), *Comesperma griffinii* (P2) and *Stawellia dimorphantha* (P4)) (Figures 7 and 8; Table 10).

VT2 consists of shrublands dominated by *Acacia rostellifera* and *Chamelaucium uncinatum* on low mounds of white sand. Two areas of this VT occur on the eastern side of the Study Area interspersed amongst vegetation predominantly consisting of VT4, occupying 4.8 % of the Study Area. The vegetation has very low native taxon richness with an understorey dominated by introduced forbs and grasses. *Banksia elegans* (P4) was recorded in the interzone between VT2 and VT3 in the southeast of the Study Area hence it's occurrence in VT2 (Figures 7 and 8; Table 10).

VT3 consists of shrublands of *Chamelaucium uncinatum*, *Acacia rostellifera* and/or *A. scirpifolia* with occasional trees of *Allocasuarina huegeliana* and *Banksia prionotes* or *B. attenuata* over *Conostylis candicans* subsp. *candicans* on undulating slopes and plains of yellowish sand. This VT is scattered throughout the lower portion of the Study Area, occupying 22 %. The vegetation has relatively low native taxon richness particularly in comparison to VT1, and is reminiscent of vegetation associated

with yellow sand over limestone. Three significant taxa were recorded in VT3, *Austrostipa* sp. Cairn Hill (M.E. Trudgen 21176) (P3), *Banksia elegans* (P4) and *Stawellia dimorphantha* (P4) (Figures 7 and 8; Table 10).

VT4 is floristically distinct from VTs 1 to 3, occurring in a separate super-group (second major branch) of the dendrogram (Appendix I), reflecting the difference in vegetation and soils to the other three VTs. VT4 is associated with the Tamala South 9 soil subsystem, with the vegetation occupying basins (playas) that may experience intermittent inundation or temporal waterlogging rather than seasonal inundation. The vegetation is reflective of a limestone influence (e.g. *Melaleuca lanceolata*, *M. huegelii* subsp. *huegelii*) and clay soils, low-lying conditions or subsoil moisture (e.g. *Allocasuarina lehmanniana* subsp. *lehmanniana*, *Eucalyptus camaldulensis subsp. obtusa*, *Thomasia rulingioides*). VT4 consists of four sub-vegetation types as described in Table 10 and occupies 35.3 % of the Study Area. *Banksia elegans* (P4) was recorded in the interzone between VT3 and VT4 in the southeast of the Study Area hence it's occurrence in VT4 (Figures 7 and 8; Table 10).

Of the Dongara Tiwest quadrats (Woodman Environmental 2009), five quadrats grouped with VT1 (07-008, 07-013, 07-131), VT2 (08-161) and VT4 (07-133). The remaining 60 quadrats grouped separately, reflecting their distance from the Study Area and alternate soil/vegetation composition.

5.2.2 Other Areas Described

Areas discernible at 1:10,000 scale where no vegetation occurred because of human disturbance were mapped as 'Cleared Land' (C). This included the Waitsia-03 access road, the well pad and associated clearing for fire control measures around the flare pit, and maintained firebreaks (Figure 8). A total of 4.6 ha of 'Cleared Land' has been mapped, representing 9.7 % of the Study Area.

5.2.3 Vegetation Condition

The condition of the vegetation of the Study Area ranged from Completely Degraded (0.2 %) to Excellent (30 %), with Degraded, Good and Very Good representing 0.8 %, 14.9 % and 44.3 % respectively. No areas of Pristine vegetation were present. VT1 ranged in condition from Very Good to Excellent; VT2, Good to Very Good; VT3, Good to Very Good; and VT4, Good to Excellent.

Lower condition scores reflected the level of introduced taxa present, the presence of historical human disturbance (soil movement, tracks) and the quality (density, composition) of the understorey. The latter factor was taken into account when assessing the condition of sand-based areas in the rectangular portion of the Study Area. Comparison to adjacent surrounding vegetation found these areas to possess a more open understorey with apparent lower diversity, perhaps as a result of some historical disturbance such as grazing (remnants of an old fence were evident) or repeated fire.

Historical firebreaks or tracks that had regrowth were mapped as being vegetated however were assigned a vegetation condition to reflect their current state.

5.2.4 Significant Vegetation

The VTs mapped within the Study Area do not represent any of the listed State or Commonwealth TECs (DBCA 2016; DoEE 2018b) or PECs (DBCA 2017d). No riparian vegetation was recorded within the Study Area.

Elements of VT4 have affinities with FCT 9b (Low Woodland to Low Forest of *Eucalyptus camaldulensis* over Open Scrub of *Acacia rostellifera*, *Chamelaucium uncinatum* and *Melaleuca* spp. on grey or brown sandy clay in drainage lines and depressions) of Tronox's Dongara project area (Woodman Environmental 2009) which was mapped as occurring in the current Study Area. This FCT

was considered to have high conservation significance (ranking '4'), due to the small extent within the Dongara study area, restricted nature of the applicable landform and the lack of known mapped presence in conservation reserves.

VT4, particularly the basin east of the well pad and access track, forms part of a wetland chain and is connected to the inundated wetland to the northeast. As such this VT may provide an important function required to maintain ecological integrity of a significant ecosystem as per EPA (2016a).

Table 10: Summary of Vegetation Types Mapped in the Study Area

VT	Summary	Photograph
1	**Description:** Low isolated clumps of trees to low woodland of *Allocasuarina huegeliana* and *Banksia prionotes* over tall sparse to closed shrubland dominated by *B. attenuata, B. elegans*, *B. hookeriana* or *B. menziesii* over mid shrubland dominated by *B. attenuata, Melaleuca leuropoma* and *Verticordia densiflora* var. *densiflora* occasionally with low sparse to shrubland dominated by *Conostylis candicans* subsp. *candicans* or *Hibbertia hypericoides* on lower to upper slopes and crests of dunes on yellow to grey sand, with occurrences of mid open shrubland to tall closed shrubland of *A. campestris* over mid isolated clumps of shrubs to low open shrubland containing by *Kunzea micrantha* subsp. *petiolata* and/or *M. leuropoma* in open depressions of grey clayey sand or light clay **Area mapped:** 13.4 ha (28.1 %) **Sampling:** 10 quadrats (W3-01, W3-02, W3-03, W3-12, W3-13, W3-14, W3-15, W3-21, W3-24, W3-29) **Significant Taxa:** *Baeckea* sp. Walkaway (A.S. George 11249) (P3), *Banksia elegans* (P4), *Comesperma griffinii* (P2), *Stawellia dimorphantha* (P4) (Figure 7) **Average Perennial Taxon Richness per Quadrat:** 22.8 ± 8.0 **Indicator Taxa:** *Alexgeorgea nitens*, *Allocasuarina campestris*, *Banksia elegans* (P4), *Banksia menziesii*, *Callitris arenaria, Eremaea beaufortioides* var. *beaufortioides, Gompholobium tomentosum, Hibbertia hypericoides, Melaleuca leuropoma, Mesomelaena pseudostygia, Neurachne alopecuroidea, Stawellia dimorphantha* (P4), *Stenanthemum notiale* subsp. *notiale, Verticordia densiflora* var. *densiflora, Xanthorrhoea drummondii*	   **Plate 2:** Variants of VT1 (Quadrat W3-02 top left, W3-29 top right, W3-03 bottom)

VT	Summary	Photograph
2	**Description:** Mid shrubland to tall closed shrubland dominated by *Acacia rostellifera* and *Chamelaucium uncinatum* on low mounds of white sand **Area mapped:** 2.3 ha (4.8 %) **Sampling:** 2 quadrats (W3-16, W3-17) **Significant Taxa:** *Banksia elegans* (P4) (in peripheral vegetation) (Figure 7) **Average Perennial Taxon Richness per Quadrat:** 3 ± 0 **Indicator Taxa:** *Acacia rostellifera, Chamelaucium uncinatum*	 **Plate 3:** Variants of VT2 (Quadrat W3-16 left, W3-17 right)
3	**Description:** Low isolated clumps of trees to low woodland of *Allocasuarina huegeliana* and *Banksia prionotes* over tall open to tall shrubland of *Chamelaucium uncinatum* or tall closed shrubland of *Acacia rostellifera* over low isolated clumps of shrubs to low open shrubland of *Conostylis candicans* subsp. *candicans*; or Tall isolated clumps of shrubs to tall open shrubland of *Acacia scirpifolia* or *A. rostellifera* over mid open shrubland of *Banksia attenuata* over mid isolated clumps to mid open sedgeland of *Ecdeiocolea monostachya* over low open to low shrubland of *Conostylis candicans* subsp. *candicans* on plains and simple slopes of yellow to grey sand **Area mapped:** 10.5 ha (22 %) **Sampling:** 6 quadrats (W3-09, W3-10, W3-11, W3-23, W3-27, W3-28) **Significant Taxa:** *Austrostipa* sp. Cairn Hill (M.E. Trudgen 21176) (P3), *Banksia elegans* (P4), *Stawellia dimorphantha* (P4) (Figure 7) **Average Perennial Taxon Richness per Quadrat:** 9.7 ± 3.6 **Indicator Taxa:** *Austrostipa elegantissima, Conostylis candicans* subsp. *candicans, Dianella revoluta* var. *divaricata*	  **Plate 4:** Variants of VT3 (Quadrat W3-10 top left, W3-27 top right, W3-23 bottom)

VT	Summary	Photograph
4	**Description:** Low open to low closed forest of *Eucalyptus camaldulensis* subsp. *obtusa* and *Melaleuca lanceolata* over tall isolated clumps of shrubs to tall shrubland of *M. concreta* and *M. huegelii* subsp. *huegelii* in basins on grey light clay to brown loamy clay occasionally with limestone surface pebbles; or Low woodland of *Allocasuarina huegeliana* and *Eucalyptus camaldulensis* subsp. *obtusa* over tall isolated clumps of shrubs of *Melaleuca huegelii* subsp. *huegelii*, occasionally with *A. lehmanniana* subsp. *lehmanniana* and mid isolated clumps of shrubs *Calothamnus quadrifidus* subsp. *angustifolius* on simple slopes or in basins on grey light clay with limestone surface pebbles; or Low isolated clumps of trees to low woodland of *Eucalyptus camaldulensis* subsp. *obtusa* (occasionally with *Allocasuarina huegeliana*) over tall sparse to tall shrubland *A. lehmanniana* subsp. *lehmanniana* and *Melaleuca huegelii* subsp. *huegelii* over mid isolated clumps of shrubs to mid shrubland of *M. viminea* subsp. *viminea*, occasionally over low isolated clumps of shrubs of *Thomasia rulingioides* in basins on grey light clay with limestone surface pebbles; or Mid open forest of *Eucalyptus camaldulensis* subsp. *obtusa* over tall isolated clumps of shrubs to tall closed shrubland of *Melaleuca huegelii* subsp. *huegelii* in basins on grey light clay to brown clay loam **Area mapped:** 16.8 ha (35.3 %) **Sampling:** 11 quadrats (W3-04, W3-05, W3-06, W3-07, W3-08, W3-18, W3-19, W3-20, W3-22, W3-25, W3-26) **Significant Taxa:** *Banksia elegans* (P4) (in peripheral vegetation) (Figure 7) **Average Perennial Taxon Richness per Quadrat:** 6.2 ± 2.0 **Indicator Taxa:** *Eucalyptus camaldulensis* subsp. *obtusa, Melaleuca huegelii* subsp. *huegelii*	 **Plate 5:** Variants of VT4 (Quadrat W3-06 top left, W3-18 top right, W3-07 bottom left, W3-19 bottom right) Note: Trees of *Eucalyptus camaldunlensis* subsp. *obtusa* ranged in height from 5 to 11m in height and girths of approximately 10 to 40 cm in diameter, with most trees having a girth at the lower end of the range

315250 315500 315750 316000 316250 316500

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Legend

Study Area

Vegetation Condition

- E Excellent
- VG Very Good
- G Good
- D Degraded
- CD Completely Degraded
- C Cleared Land

315250 315500 315750 316000 316250 316500

WOODMAN ENVIRONMENTAL

This map should only be used in conjunction with WEC report AWE17-38-01.

N

Study Area
Vegetation Condition Mapping

Revision: A - 12 Feb 2018 Scale: 1:5,000 (A3)

Author: Bethea Loudon

WEC Ref: AWE17-38-01

Filename: AWE17-38-01-f09.mxd

Projection: GDA 1994 MGA Zone 50

Figure

9

Legend

- Quadrat
- Study Area

Vegetation Types

1 Low isolated clumps of trees to low woodland of *Allocasuarina huegeliana* and *Banksia prionotes* over tall sparse to closed shrubland dominated by *B. attenuata, B. elegans*, *B. hookeriana* or *B. menziesii* over mid shrubland dominated by *B. attenuata, Melaleuca leuropoma* and *Verticordia densiflora* var. *densiflora* occasionally with low sparse to shrubland dominated by *Conostylis candicans* subsp. *candicans* or *Hibbertia hypericoides* on lower to upper slopes and crests of dunes on yellow to grey sand, with occurrences of mid open shrubland to tall closed shrubland of *A. campestris* over mid isolated clumps of shrubs to low open shrubland containing by *Kunzea micrantha* subsp. *petiolata* and/or *M. leuropoma* in open depressions of grey clayey sand or light clay

2 Mid shrubland to tall closed shrubland dominated by *Acacia rostellifera* and *Chamelaucium uncinatum* on low mounds of white sand

3 Low isolated clumps of trees to low woodland of *Allocasuarina huegeliana* and *Banksia prionotes* over tall open to tall shrubland of *Chamelaucium uncinatum* or tall closed shrubland of *Acacia rostellifera* over low isolated clumps of shrubs to low open shrubland of *Conostylis candicans* subsp. *candicans*; or Tall isolated clumps of shrubs to tall open shrubland of *Acacia scirpifolia* or *A. rostellifera* over mid open shrubland of *Banksia attenuata* over mid isolated clumps to mid open sedgeland of *Ecdeiocolea monostachya* over low open to low shrubland of *Conostylis candicans* subsp. *candicans* on plains and simple slopes of yellow to grey sand

4 Low open to low closed forest of *Eucalyptus camaldulensis* subsp. *obtusa* and *Melaleuca lanceolata* over tall isolated clumps of shrubs to tall shrubland of *M. concreta* and *M. huegelii* subsp. *huegelii* in wetlands on grey light clay to brown loamy clay occasionally with limestone surface pebbles; or
Low woodland of *Allocasuarina huegeliana* and *Eucalyptus camaldulensis* subsp. *obtusa* over tall isolated clumps of shrubs of *Melaleuca huegelii* subsp. *huegelii*, occasionally with *A. lehmanniana* subsp. *lehmanniana* and mid isolated clumps of shrubs *Calothamnus quadrifidus* subsp. *angustifolius* on simple slopes or in wetlands on grey light clay with limestone surface pebbles; or
Low isolated clumps of trees to low woodland of *Eucalyptus camaldulensis* subsp. *obtusa* (occasionally with *Allocasuarina huegeliana*) over tall sparse to tall shrubland *A. lehmanniana* subsp. *lehmanniana* and *Melaleuca huegelii* subsp. *huegelii* over mid isolated clumps of shrubs to mid shrubland of *M. viminea* subsp. *viminea*, occasionally over low isolated clumps of shrubs of *Thomasia rulingioides* in wetlands or depressions on grey light clay with limestone surface pebbles; or
Mid open forest of *Eucalyptus camaldulensis* subsp. *obtusa* over tall isolated clumps of shrubs to tall closed shrubland of *Melaleuca huegelii* subsp. *huegelii* in wetlands on grey light clay to brown clay loam

C Cleared Land

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W3-01 W3-02 W3-03 W3-04 W3-05 W3-06 W3-07 W3-08 W3-09 W3-10 W3-11 W3-12 W3-13 W3-14 W3-15 W3-16 W3-17 W3-18 W3-19 W3-20 W3-21 W3-22 W3-23 W3-24 W3-25 W3-26 W3-27 W3-28 W3-29

N

This map should only be used in conjunction with WEC report AWE17-38-01.

Study Area Vegetation Type Mapping	Author: Bethea Loudon	**Figure** 8
	WEC Ref: AWE17-38-01	
	Filename: AWE17-38-01-f08.mxd	
Revision: A - 12 Feb 2018 Scale: 1:5,000 (A3)	Projection: GDA 1994 MGA Zone 50	

5.3 Fauna

5.3.1 Fauna Taxa of the Study Area

Table 11 presents the fauna taxa which were observed either within the Waitsia-03 Study Area or in the vicinity of the open water wetland habitat located to the east/northeast of the Study Area during the field visit. Two of these taxa are of conservation significance, and two are introduced fauna. Although Carnaby's Black-Cockatoo was not observed during this field visit, evidence of use of the area was seen through recent foraging debris below *Banksia prionotes* trees along the flowline route and within the Hudson Resources Block.

Table 11: Fauna Taxa Observed in the Study Area and Surrounds

Common Name	Scientific Name	Conservation Status	Notes
Tadpoles	Species uncertain		In nearby wetland (not in Study Area)
Bobtail	*Tiliqua rugosa*		Several along track
Burton's Legless Lizard	*Lialis burtonis*		Juvenile crossing track near well pad
Emu	*Dromaius novaehollandiae*		Tracks
Pacific Black Duck	*Anas superciliosus*		Two in wetland (not observed in Study Area)
Galah	*Eolophus roseicapilla*		Several seen
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	E S1; CS 1	None observed, but recent forging debris (few weeks old?) on *Banksia prionotes*
Rainbow Bee-eater	*Merops ornatus*	M S3; CS 1	Few around
Splendid Fairy-wren	*Malurus splendens*		In dampland thickets
White-browed Scrubwren	*Sericornis frontalis*		In dampland thickets
Weebill	*Smicrornis brevirostris*		Small party in eucalypts
Brown Honeyeater	*Lichmera indistincta*		Heard in Banksia woodland
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		Two flew over well pad
Rufous Whistler	*Pachycephala rufiventris*		In Banksia woodland
Golden Whistler	*Pachycephala pectoralis*		In dampland thickets
Grey Fantail	*Rhipidura albiscapa*		One near wetland (not observed in Study Area)
Tree Martin	*Petrochelidon nigricans*		Few overhead
Silvereye	*Zosterops lateralis*		In dampland thickets
Echidna	*Tachyglossus aculeatus*		Diggings in several areas
Western Grey Kangaroo	*Macropus fuliginosus*		Tracks and scats
Pig	*Sus scrofa*	Introduced	Diggings and tracks around wetland (not observed in Study Area)
Fox	*Vulpes vulpes*	Introduced	Tracks throughout

5.3.2 Fauna Values of the Project Area

Fauna values within the project area can be summarised as follows (BCE 2018):

Fauna Assemblage

Generally intact and relatively diverse, but missing a large portion of the medium-sized mammal fauna and minor components of other fauna groups. The Waitsia-03 Study Area can be expected to

support a sub-set of the fauna assemblage of the general region but the majority of the regional assemblage would be present, at least occasionally. The fauna assemblage is widely represented in the general region due to the presence of Yardanogo Nature Reserve that provides similar habitat.

Vegetation and Substrate Associations (VSAs)

The broader Waitsia Project area has a range of VSAs including farmland and extensive shrublands, however two VSAs were recognised within the Waitsia-03 Study Area:

1) Mixed tall shrubland with emergent Banksia and Allocasuarina spp. on sand (Plate 6 and 7);

   This VSA covers the northern part of the corridor along the access track and the northwest, southwest and southeast corners of the Hudson Resources Block portion of the Study Area, and extends in to the adjacent Yardanogo Nature Reserves to the west and south. A portion of the Study Area, on the east side of the access track in the north, has been burnt within the last two years. This VSA encompasses VTs 1 to 3 (Figure 10); and

2) Allocasuarina forest with scattered Eucalypts, over an open mid- and under-storey of Melaleuca on pale grey clayey-loam soils that may experience waterlogging. Occasional dense thickets of Melaleuca (Plate 8).

   This VSA is on the edge of an extensive dampland/sumpland system; areas of open water with Paperbark woodland were observed to the east/northeast of the Study Area (Plate 9) and were investigated for local context. This VSA is equivalent to VT4 (Figure 10).

Plate 6: Banksia woodland east of the entrance track (burnt~2 years ago) (Photo: BCE).

Plate 7: Allocasuarina woodland with Banksia – to the north of the well pad (Photo: BCE).

Plate 8: Melaleuca thicket to the east of the well pad (Photo: BCE).

Plate 9: Wetland east/northeast of the Study Area (Photo: BCE).

The current Waitsia-03 Study Area is located on areas originally mapped as VSAs 2 (Kwongan to open Banksia woodland on sand) and 4 (Eucalypt/Banksia/Acacia low forest on sand) (BCE 2015) (Section 3.3), which were noted to be, along with VSAs 5 and 6, of greater value by Carnaby's Black-Cockatoo, a conservation significant species.

It was noted during the field visit that vegetation immediately east of the well pad and along the existing diagonal track through the Hudson Resources Block was a she-oak forest (*Allocasuarina* with scattered *Eucalyptus*) with a fairly open, shrubby mid and understorey of *Melaleuca* on pale grey clayey-loam soils that may experience waterlogging. Occasional dense thickets of *Melaleuca* were present, especially immediately east of the well pad. This dampland/playa system within the Study Area was noted to be at the southern end of a long wetland system, with open water and paperbark swamp to the northeast.
The Carnaby's Black-Cockatoo roost found previously (BCE 2015) was in large trees along this drainage system (Figure 10) however individuals could also roost in large trees including within the Hudson Resources Block portion of the Study Area, and within the Waitsia-03 clearing proposal area (flowline route). However, the field visit was not undertaken at the ideal time of year for roosting activity and this was not observed during the site visit.

Species of Conservation Significance

A large number of significant species may be present in the region, but many of these are migratory waterbirds for which there is little if any suitable habitat directly within the Waitsia-03 Study Area; they may periodically utilise the wetlands to the east/northeast of the Study Area. Significant species of note that are likely to occur in the Study Area regularly include Carnaby's Black-Cockatoos, Rainbow Bee-eaters (observed in the Study Area), Rufous Fieldwrens and Conservation Significance Level 3 (locally significant) bird species, including the Southern Scrub-robin and the White-breasted Robin (Appendix E). The basins/damplands in the Study Area may be particularly important for bird species such as fairy-wrens and scrubwrens. There is a known roosting site for Carnaby's Black-Cockatoo in tall trees around the wetland to the east/northeast of Waitsia-03 Study Area (316325mE 6752399mN) (Figure 10).

Conservation significant reptiles which may occur in the area include the Carpet Python, Tiger Snake and the Black-striped Snake, with the Brush Wallaby also possibly occurring.

Patterns of Biodiversity

Detailed patterns of biodiversity could not be examined, but it can be predicted that the dampland/playa areas in the Study Area may provide seasonal refugia and breeding habitat for a range of fauna species e.g. frogs and waterbirds. The Mixed tall shrubland (VSA 1) areas in the Study Area may provide a seasonal food resource for a large number of birds. These shrublands were assessed for their foraging value for Carnaby's Black-Cockatoo (Bamford 2016) and it was concluded that: 3 ha of such vegetation in the Waitsia-03 footprint represented 0.31 % of similar vegetation across Yardanogo Nature Reserve; and that 3 ha had a carrying capacity of <0.2 birds/year (based on regional habitat assessments conducted by Williams *et al.* 2016).

Key Ecological Processes

Main processes currently affecting the fauna assemblage in the survey area include local hydrology, fire, feral species and connectivity. Connectivity is important as the broader Waitsia area lies in a position to provide linkage between other areas of bushland (via Irwin River in the north and native vegetation in the south), which means it may have more species (especially birds) using the site regularly than might otherwise be the case, and it has a role in supporting biodiversity in nearby areas. Hydrology is especially important at the Waitsia-03 Study Area with a nearby dampland and wetland system that forms part of a chain of groundwater dependent ecosystems.

5.3.3 Carnaby's Black-Cockatoo Foraging and Nesting Habitat Value

Carnaby's Black-Cockatoo may visit the Study Area. Carnaby's Black-Cockatoo forages in proteaceous heath, Banksia woodlands and Eucalyptus woodlands. As noted above, Carnaby's Black-Cockatoo may use VSA 1 (Mixed tall shrubland) as a seasonal food source. As noted by BCE (2016), the mixed Banksia shrubland of the Waitsia-03 Study Area would have a broadly similar carrying capacity for Carnaby's Black-Cockatoos, which was estimated at one bird per 21.7 ha in the Yardanogo Nature Reserve by Williams *et al.* (2016). This may apply to VSA 1, which is broadly equivalent to VTs 1, 2 and 3 (Figure 10).

A total of four trees, including the tree near the well pad, were identified in the Study Area along the flowline route (Figure 10) that are close to meeting the Black-Cockatoo nesting-tree criterion for DBH. As none of these trees measured over 500 mm DBH they will not be considered further. Pertinent details of these trees are given in Table 12.

Table 12: Details of Large Eucalyptus Trees Noted in the Project Area with Regards to Potential for Carnaby's Black-Cockatoo Nesting Trees

Tree	DBH (mm)	Comment	Easting	Northing
Large Eucalypt	350	Raven nest; no large hollows	315940	6752302
Large *E.* ?*camaldulensis*	400	No large hollows	315944	6752070
Large *E.* ?*camaldulensis*	400	No large hollows	315854	6751650
Large *E.* ?*camaldulensis*	400	No large hollows	315904	6751875

315250 315500 315750 316000 316250 316500

6753000 6752750 6752500 6752250 6752000 6751750 6751500

Legend

Study Area

Tree Type

Potential Nest (Based on DBH)

Known Roost Site

Fauna Vegetation & Substrate Associations

VSA

1 Mixed tall shrubland with emergent Banksia and Allocasuarina spp. on sand

4 Allocasuarina forest with scattered Eucalypts, over an open mid- and under-storey of Melaleuca on pale grey clayey-loam soils that may experience waterlogging. Occasional dense thickets of Melaleuca

C Cleared

WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC report AWE17-38-01.

Study Area Key Fauna Vegetation and Substrate Associations and Potential Carnaby's Black-Cockatoo Trees

Revision: A - 8 Mar 2018 Scale: 1:5,000 (A3)

Author: Bethea Loudon

WEC Ref: AWE17-38-01

Filename: AWE17-38-01-f10.mxd

Projection: GDA 1994 MGA Zone 50

Figure

10

6 DISCUSSION

6.1 Flora

A total of 173 discrete vascular flora taxa were recorded within the Study Area, of which 157 were native taxa. This is comparable to nearby surveys covering somewhat similar areas including the Maia (2016) flora and vegetation survey of the Waitsia-03 Well Area and access tracks (95 taxa recorded), and the Woodman Environmental (2018a) flora and vegetation survey of the Proposed Xyris Lateral flowline easement (97 taxa recorded). Overall it is considered that the Study Area has been well sampled.

The rainfall received by the Study Area was below average prior to the survey in 2017. Although some ephemeral taxa may not have been sighted (e.g. Drosera) or were not present (e.g. orchids) at the time of the survey, the conditions are unlikely to have impacted the outcomes of the survey or prevent identification of any potential significant taxa that may have potentially occurred in the Study Area.

A total of five significant flora taxa were recorded within the Study Area consisting of DBCA listed Priority flora taxa. No Threatened flora taxa were recorded in the Study Area or taxa listed under the EPBC Act as returned in the MNES search results.

Paracaleana dixonii (Threatened) which is known from within approximately 5 km of the Study Area, would have been identifiable if present as the survey coincided with the peak flowering period for this taxon, and targeted survey for significant taxa was undertaken. In addition, based on observations recorded by experienced Woodman Environmental personnel during other surveys of nearby areas, this taxon does not typically occur within Banksia woodland on yellow sand in the area. It is found to the south of the Study Area in Banksia woodlands on deep white sand and heath areas overlying laterite near the base of the plateau.

Two other Threatened taxa, *Conostylis dielsii* subsp. *teres* and *Conostylis micrantha*, identified as having potential to occur within the Study Area based on habitat preference, were not observed. Although these two taxa have an earlier flowering period, they would have been identifiable at the time of the survey by their perennial nature, foliage and remnant flowers. Their preferred habitat is proteaceous/myrtaceous shrubland/woodland on sand to the north of the Study Area however it typically overlies laterite, unlike VTs 1 to 3 in the Study Area. Only two taxa of Conostylis were recorded (*C. candicans* subsp. *candicans* and *C. neocymosa*).

Of the significant taxa recorded in the Study Area, *Baeckea* sp. Walkaway (A.S. George 11249) (P3), *Banksia elegans* (P4) and *Stawellia dimorphantha* (P4) are known from relatively large distributions (175 km, 120 km and 89 km respectively) and consist of a large number of records (greater than 30 records). In addition, there are number of known locations of these taxa within 5 km of the Study Area (DPaW 2007-, Maia 2016, Woodman Environmental 2004, 2009, 2012, 2018a) as well as records for each taxon within conservation reserves including Yardanogo Nature Reserve (DPaW 2007-). Survey for these taxa within the Study Area is considered to have been adequate.

Austrostipa sp. Cairn Hill (M.E. Trudgen 21176) (P3) is known from a limited number of records (eight records), although the range for this taxon is substantial (approximately 450 km). As mentioned previously, targeted searching was not undertaken for this taxon as it is not known from the vicinity of the Study Area and therefore it is possible that there are additional locations of this taxon within the Study Area. The occurrence of this taxon within the Study Area is of interest as it represents a locality hole for this taxon, with the nearest record located approximately 40 km to the north of the

Study Area. From a regional perspective the removal of or damage to any plants at this location are negligible to the taxon as a whole.

Comesperma griffinii (P2) is also known from a limited number of records (11 records), although it also has a very large range of approximately 830 km. This taxon was found within the sub-vegetation type of VT 1 consisting of open depressions on clayey sand or light clay, with the preferred habitat for the taxon being somewhat limited in the Study Area. However, survey for this taxon within the Study Area is considered to have been adequate with the habitat extending beyond the extent of the Study Area.

No Declared weeds or WoNS were recorded within the Study Area nor were any taxa as listed in the MNES search results. Three taxa have ratings of High for the Midwest were recorded including **Aira cupaniana, *Centaurea melitensis* and **Ursinia anthemoides.* Control of weed taxa is recommended, particularly within proposed impact areas; it is likely that these taxa may invade new disturbance areas, including rehabilitation areas.

6.2 Vegetation

Four VTs were defined and mapped in the Study Area. This number was expected and typical given the geologies and topographies present in the Study Area, coupled with the flora of these units. VTs 1 to 3 consist of Banksia shrublands on yellow to grey sandy soils on slopes and dunes (Tamala South 3 and 7 soil subsystems) and VT4 on clay/loamy clay in association with limestone subsoils and wetland features, on simple slopes or in basins (Tamala South 9 soil subsystem).

The vegetation of the Study Area is consistent with the broader vegetation units of the Geraldton Sandplains 3 (Lesueur Sandplain) subregion (shrub-heaths rich in endemics occurring on a mosaic of lateritic mesas, sandplains, coastal sands and limestones), and vaguely consistent with Beard's vegetation system association, Eridoon_378 (Shrublands; scrub-heath with scattered Banksia spp., *Eucalyptus todtiana* and *Xylomelum angustifolium* on deep sandy flats). Although the Eridoon_392 vegetation system association (Shrublands; *Melaleuca thyoides* thicket) is mapped as occurring in the Study Area, the wetland thickets present are not comprised of *Melaleuca thyoides*.

Low native taxon richness or small areas with overlapping taxa resulted in a number of sub-vegetation types being incorporated into one VT (e.g. VT1 and 4). Taxon richness of the Study Area quadrats was generally lower than that of quadrats of the Tronox tenement study in the adjacent Yardanogo Nature Reserve (Woodman Environmental 2009). This may reflect historical disturbance of the Study Area such as grazing or repeated fire. The condition of the vegetation of the Study Area ranged from Completely Degraded to Excellent, with signs of historical human disturbance such as soil movement and rubbish, in some areas.

Of the VTs mapped within the Study Area, VT1 (generally occurring on the western portion of the Hudson Resources Block and along the northern section of the access track/proposed flowline route) has affinities with Maia's VT BSL (Section 3.1.3; (Maia 2016)) which is somewhat reflective of the mapping undertaken by Maia. Likewise VT3 and VT4 (generally occurring in the central to eastern portions of the Hudson Resources Block and extending into the south of the access track/proposed flowline route) have affinities with Maia's VTs AF and MSL respectively (Maia 2016), which is also somewhat reflective of the mapping undertaken by Maia. However, as the survey by Maia was a vegetation reconnaissance survey and targeted flora survey with vegetation mapped structurally using relevés (and not including the entire current Study Area) there are differences in mapping and vegetation descriptions.

The VTs of the Study Area do not have any similarities to the VTs recorded by Woodman Environmental (2004) during the Denison 3D survey. The Denison 3D vegetation communities are less comparable to the VTs mapped by this survey as they were was undertaken at a much larger scale and were based on detailed recording sites rather than quadrats. There are however similarities between VT1 and VT3 and FCT 3b and FCT 4b of Woodman Environmental (2009) (Tronox tenements study), while VT2 and VT4 have some affinities with the conservation significant FCT 9b of Woodman Environmental (2009) of Tronox's tenements. FCTs 3b and 9b were broadly mapped by Woodman Environmental (2009) over the Study Area and within the adjacent Yardanogo Nature Reserve. Overall, in the absence of a regional dataset for statistical comparison, it is considered that VT1 and VT3 occur commonly outside the Study Area, and versions of VT2 and VT4 and its sub-types occur in small areas outside the Study Area (i.e. areas of vegetation with similar taxa but not necessarily the same composition and structure occur to the south of the Study Area in part represented by FCT 20 and 21a), based on comparison with local vegetation surveys and presence of similar adjacent vegetation within Yardanogo Nature Reserve.

In addition to VT4 having similarities to the conservation significant FCT 9b, this vegetation type occupies basins (playas) that may experience intermittent inundation or temporal waterlogging, and form part of a wetland chain that is connected to a larger hydrological system incorporating the inundated wetland to the east/northeast. As such this VT may provide an important function required to maintain ecological integrity of a significant ecosystem as per EPA (2016a).

No occurrences of riparian vegetation, TECs listed under the EPBC Act, TECs as classified by DBCA, or PECs as classified by DBCA, were recorded within the Study Area.

6.3 Fauna

Direct and indirect observation of two conservation significant EPBC listed fauna taxa, Carnaby's Black-Cockatoo and Rainbow Bee-eater, were recorded at the time of the fauna survey. It was noted that the fauna survey was not undertaken at the ideal time of year for roosting activity of Carnaby's Black-Cockatoo (usually Autumn), however large trees within the Study Area are considered to be suitable for roosting and as such no further survey for potential roost trees is required. Roosting birds will be scattered over several hectares where there are large trees and do not always utilise the same roost or part of a roost site on every occasion. The Study Area also supports Rufous Fieldwrens (P4) and CS3 (locally significant) bird species, including the Southern Scrub-robin and the White-breasted Robin.

Several small bird and reptile species were also observed in the Study Area, along with evidence of Echidna, Western Grey Kangaroo and the introduced Red Fox, in both the Banksia shrubland (VT1 and 3) and wetland/basin habitats (VT4).

The fauna assemblage was considered to be generally intact and relatively diverse, with the Study Area likely to support a sub-set of the fauna assemblage of the general region. Medium-sized mammal fauna and minor components of other fauna groups were considered to be lacking. Two faunal VSAs are present within the Study Area:

- Mixed tall shrubland with emergent Banksia and Allocasuarina spp. on sand (associated with VT1 and 3); and
- Allocasuarina forest with scattered eucalypts, over an open mid- and under-storey of Melaleuca on pale grey clayey-loam soils that may experience waterlogging. Occasional dense thickets of Melaleuca (associated with VT4).

The dampland/playa areas of VT4/VSA 2 in the Study Area may provide seasonal refugia and breeding habitat for a range of fauna species e.g. frogs and waterbirds, with the Mixed tall shrubland (VT1-3/VSA 1) areas in the Study Area may provide a seasonal food resource for a large number of birds including Carnaby's Black-Cockatoo.

The Clearing Principles do not entirely capture some recognised impacting processes associated with development projects; these are discussed by Gleeson and Gleeson (2012). The following notes therefore consider key threatening processes with respect to the Waitsia-03 proposed flowline route along the access track:

- Mortality during construction while trench is open. Moderate impact; limiting the duration that the trench remains open, back-filling immediately after pipe is laid and undertaking work during day-time if practicable will minimise impacts to transient fauna;
- Degradation of habitat due to weed invasion leading to population decline. Negligible with management;
- Ongoing mortality from operations. Negligible assuming low traffic volumes;
- Species interactions including feral and overabundant native species. Negligible to Minor. Some risk if workers at the site leave or provide food for feral species. There are already feral pigs in the area as well as foxes, cats and rabbits;
- Hydrological change. Negligible if little or no change occurs to surface flows or subsurface hydrology, but the adjacent wetland system is likely to be very sensitive to any hydrological impacts;
- Altered fire regimes. Negligible with management and awareness-training; and
- Disturbance during construction (dust, light, noise). Probably Negligible but impact uncertain. Consideration of day-time pipe-lay if practicable and shielding of light will reduce mortality of insects and reduce possible effects on the nearby Carnaby's Black-Cockatoo roost.

Risks in relation to the clearing principles and threatening processes in general are mostly considered to be low due largely to the small impact area and the large extent of the adjacent Yardanogo Nature Reserve.

Some management can reduce these risks, and management can also reduce other possible risks. For example, clearing footprint can be tightly controlled, and hydrological impacts to surface flows during construction can be minimised. There should also be management and training in place to reduce changes in the abundance of feral species, to minimise the risk of unplanned bushfires and to minimise impacts of lighting on fauna in adjacent areas.

6.4 Assessment against the 10 Clearing Principles

The 10 Clearing Principles as listed in Schedule 5 of the EP Act are discussed in relation to the proposed flowline route only of the Waitsia-03 Study Area. For each of the Clearing Principles a general statement is made on how the fauna values of the proposed flowline relates to that Clearing Principle, with further discussion providing the basis for this general statement.

Principle (a): Native vegetation should not be cleared if it comprises a high level of biological diversity.

The project is not considered to be at variance to this Principle.

The study area lies near the northern edge of the Leseuer Sandplains subregion (GES02), adjacent to the Geraldton Hills subregion (GES01), both of which are in the Geraldton Sandplains Biogeographical Region (Commonwealth of Australia 2012). This subregion is described as a being

"...composed mainly of proteaceous scrub-heaths, rich in endemics, on the sandy earths of an extensive, undulating, lateritic sandplain..." and "exhibits extremely high floristic endemism, with over 250 species of sandplain flora endemic to the subregion. The area is known Australia-wide and internationally as having particularly high floristic diversity and levels of endemism" (Desmond and Chant 2001).

The floral composition of the entire Study Area itself can be considered moderately diverse, with a total of 157 native taxa representing 47 families and 121 genera recorded during the survey. Of the four vegetation types (VTs) recorded in the Study Area, VTs 1, 3 and 4 occur along the proposed flowline route (VT3 consisting of low species richness). With respect to other similar floral surveys undertaken in the local area; 76 native flora taxa were recorded within the proposed Xyris lateral area survey (Woodman Environmental 2016) however the levels of historical disturbance of both these survey areas are quite different. The Xyris lateral area had been largely historically cleared in comparison to the current survey area. The floral diversity of the Waitsia-03 Study Area may also be higher due to the presence of two distinct vegetation types, being those associated with differences in soil types and underlying geology; yellow to grey sandy soils on slopes and dunes (*Allocasuarina* – *Banksia* – *Acacia* Low woodlands and shrublands) and vegetation on grey light clay to brown loamy clay in association with limestone on simple slopes to depressions (*Eucalyptus camaldulensis* subsp. *obtusa* – *Allocasuarina huegeliana* – *Melaleuca huegelii* subsp. *huegelii* Low forest to low woodlands).

Although the region is known for its high endemism, few of the flora taxa recorded within the Study Area and proposed flowline route are known from limited ranges. Those with more limited ranges, *Baeckea* sp. Walkaway (A.S. George 11249) (P3) (175 km), *Banksia elegans* (P4) (120 km) and *Stawellia dimorphantha* (P4) (89 km) are not restricted to the immediate area.

Fauna species richness in the region is not as exceptional as regional flora species richness, although invertebrate richness is virtually unknown. Maryan (2005) has noted that the general region is extremely high in reptile species richness. The fauna assemblage of the Study Area likely supports a sub-set of the general region, with medium-sized mammal fauna and minor components of other fauna groups considered to be lacking.

As the area of vegetation and faunal vegetation and substrate associations (VSAs) to be directly impacted by the proposed flowline is likely to be small (fringing vegetation along an existing track and well pad) and the vegetation types extend beyond the Study Area, the proposed flowline is not considered to be at variance to this Principle.

Principle (b): Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

The project is not considered to be at variance to this Principle.

Several significant fauna species have been recorded from the broader Waitsia area, including Eastern Great Egret and Carnaby's Black-Cockatoo. Evidence of Carnaby's Black-Cockatoo and Rainbow Bee-eater were observed during this survey of the Study Area. There is also potential for approximately 18 conservation significant fauna taxa to occur in the Waitsia-03 Study Area or nearby (Bamford *et al*., 2015). A Carnaby's roost site was recorded from approximately 200m east of the Waitsia-03 Study Area and the shrublands with Banksia along the flowline route are foraging habitat for this taxon. However, given the small area of impact associated with the proposed flowline and the widespread nature of the two VSAs present within the area, the proposed flowline is considered unlikely to compromise significant habitat for Carnaby's Black-Cockatoo or any other conservation

significant fauna species. The roost site is not likely to be directly impacted and there should be no direct impacts on nearby wetlands. The small scale of the proposed flowline mitigates impacts on fauna in general.

Principle (c): Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.

The project is considered not to be at variance to this Principle.

No Threatened flora species listed under the WC Act or EPBC Act have been recorded within the Study Area or proposed flowline route.

Five flora taxa listed as Priority flora by the DBCA (as per DBCA 2017e) are known to occur within the Study Area, of which all five occur along the proposed flowline route:

- *Austrostipa* sp. Cairn Hill (M.E. Trudgen 21176 (P3);
- *Baeckea* sp. Walkaway (A.S. George 11249) (P3);
- *Banksia elegans* (P3);
- *Comesperma griffinii* (P4); and
- *Stawellia dimorphantha* (P4).

All five taxa are known to occur outside the Study Area across relatively large ranges, and within nearby/adjacent conservation estate. Although the record of *Austrostipa* sp. Cairn Hill (M.E. Trudgen 21176 (P3) forms a locality hole for the area, this taxon occurs over a range of approximately 450 km. In addition, the habitat in which this taxon was recorded extends outside the Study Area and may possibly support additional plants/locations. Any disturbance to the location of *Austrostipa* sp. Cairn Hill (M.E. Trudgen 21176 (P3) within the Study Area will not be detrimental to the continued existence of this taxon as a whole.

Principle (d): Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.

The project is not considered to be at variance to this Principle.

None of the vegetation types mapped within the Study Area or the proposed flowline route are representative of Threatened Ecological Communities (TECs) under the WC Act or EPBC Act (DBCA 2016; DoEE 2018a), or any listed Priority Ecological Communities (PECs) under DBCA (2017d).

The Study Area is approximately 14km east of the nearest recognised TEC, as recognised within the Protected Matters Search Tool. This TEC "Subtropical and Temperate Coastal Saltmarsh", is not expected to be impacted, directly or indirectly, by the proposed development. The nearby wetland is not listed as a TEC and while it is a notable community in the local context, it should not be impacted directly or indirectly assuming suitable hydrological management.

Principle (e): Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

The project is not considered to be at variance to this Principle.

Although the Geraldton Sandplains region is recognised as having been heavily cleared for agriculture, the western portion of the Lesueur Sandplains subregion is well represented in the reserve system (Desmond and Chant, 2001). The Study Area and proposed flowline route is located in an area of remnant vegetation adjacent to the eastern boundary of the Yardanogo Class C Nature Reserve (C36203) (crown reserve), with remnant vegetation of road reserve, freehold tenure, and

crown reserve (water reserve) on the eastern boundaries of the Study Area (Figure 1). Areas to the north and east have been heavily cleared for agriculture.

Impacts to the Eridoon_378 and Eridoon_392 vegetation system associations for which 65 % and 97.9 % remain respectively, is negligible from both a local and regional context. The small scale and low impact of the proposed flowline and the extent of remnant vegetation in the immediate vicinity mitigates the impact.

Although VT4 has similarities to local vegetation that is considered significant, the area to be impacted by the proposed flowline route is small.

Principle (f): Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

The project considered not to be at variance to this Principle.

An extensive north-south dampland/wetland system lies to the east, extending into the southern end of the Study Area, associated with VT4 and VSA 2 in basins (playas). As VT4 comprises a wetland habitat linked to a larger hydrological system and wetland chain, any significant interference (particularly sub-surface) to these areas may present some risk to the local (within the Study Area) and broader wetland system (wetland to the east/northeast). However the small area to be impacted by the proposed flowline route, in addition to impacts only occurring to the edges of this vegetation/landform is minimal and therefore not considered to be a variance to this Principle.

Principle (g): Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

The project is not considered to be at variance to this Principle.

The proposed flowline route follows an existing access track and associated vegetation clearing, with any vegetation clearing as part of the flowline installation not likely to involve extensive clearing or further appreciable degradation of the existing environment. Rehabilitation of cleared areas and management of weeds and feral animals during the construction and operation of the Project should ensure the project causes minimal land degradation.

Principle (h): Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area

The project may be at variance to this Principle.

Clearing of small amounts of vegetation may occur within or adjacent to conservation area, with the proposed flowline route occurring along/adjacent to a small section of the eastern boundary of Yardanogo Nature Reserve. Introduction of 'dieback' (*Phytophthora cinnamomi*) and new weed taxa in to the Nature Reserve may potentially occur if hygiene management procedures are not adhered to. Existing weed levels may be exacerbated through soil disturbance and soil movement associated with the construction of the flowline.

These processes will be managed and threats minimised under existing management plans and hygiene practices for the site however as there would still be potential for Yardanogo Nature Reserve to be impacted, the works is considered to have potential to be at variance to this Clearing Principle.

Principle (i): **Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water**

The project is considered not to be at variance to this Principle.

The installation of the proposed flowline is unlikely to cause deterioration in the quality of surface or underground water.

The small amount of vegetation that may be cleared by the installation of the flowline is unlikely to significantly increase runoff in to nearby wetland basins, with infrastructure such as drainage controls to be installed where surface runoff is likely to accumulate to catch sediment.

No watercourses will be crossed or interfered with during the installation of the proposed flowline through the Study Area. The inundated wetland to the east/northeast of the proposed route will not be impacted.

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

The project is not considered to be at variance to this Principle.

The nearest Bureau of Meteorology station to Study Area that captures rainfall, Dongara, recorded an average annual rainfall of 456 mm between 1884 and 2017 (Bureau of Meteorology 2018). With the close proximity of the wetland system to the east/northeast, major and/or sustained rainfall events would likely cause flooding within the Study Area however this would not be caused or exacerbated by clearing associated with the proposed flowline.

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