A REVIEW OF FLORA AND VEGETATION AND TARGETED SEARCH FOR PITYRODIA SP. MARBLE BAR - SULPHUR SPRINGS ZINC COPPER PROJECT

Prepared By

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Prepared For

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TABLE OF CONTENTS

Page

TABLES

FIGURES

PLATES

APPENDICES

LIST OF ABBREVIATIONS

BAM Act:	*Biosecurity and Agriculture Management Act 2007* (WA)
BC Act:	*Biodiversity Conservation Act 2016* (WA)
BOM:	Bureau of Meteorology
DAFWA:	Department of Agriculture and Food, Western Australia
DBCA	Department of Biodiversity, Conservations and Attractions
DotEE:	Department of the Environment and Energy
En:	Endangered
EP Act:	*Environmental Protection Act 1986* (WA)
EPA:	Environmental Protection Authority
EPBC Act:	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
IBRA:	Interim Biogeographical Regionalisation for Australia
Mattiske	Mattiske Consulting Pty Ltd
PEC:	Priority ecological community
T:	Threatened
TEC:	Threatened ecological community
WAH:	Western Australian Herbarium (PERTH)
WAOL:	Western Australian Organism List
WC Act:	*Wildlife Conservation Act 1950* (WA)

EXECUTIVE SUMMARY

Mattiske Consulting Pty Ltd was commissioned in September 2017 by Venturex Resources Ltd to undertake a reconnaissance level flora and vegetation survey on the Sulphur Springs Project. Sulphur Springs is located approximately 144 km southeast of Port Headland and 57 km west of Marble Bar in the Pilbara Region of Western Australia. The total Sulphur Springs Project development area was 845.72 ha. The area has been the subject of a number of previous flora and vegetation surveys (Trudgen *et al.* 2002, Trudgen 2006, 2007a, 2007b, Mattiske Consulting Pty Ltd 2007 and Outback Ecology 2013). The scope of the current survey is the validation of previous vegetation mapping by Trudgen (2002) and Mattiske (2007), threatened and priority search within the project footprint area (including a targeted search for *Pityrodia* sp. Marble Bar Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)) and to provide an assessment of groundwater dependent ecosystems. This report provides a consolidation of botanical values recorded from 2001 to 2017.

A total of 360 vascular plant taxa, representative of 139 genera and 48 families, were recorded within the wider Sulphur Springs Project area. The majority of taxa recorded were representative of the Fabaceae (77 taxa), Poaceae (60 taxa) and Malvaceae (37 taxa) families. Within the development area a total of 185 vascular plant taxa, representative of 84 genera and 35 families were recorded. The majority of the taxa recorded were widespread both locally and more broadly within the associated biogeographical subregion.

Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) has been recorded within the Sulphur Springs Project area. It is listed as a Threatened flora taxon pursuant to Schedule 1 of the *Wildlife Conservation Act 1950* and as listed by the WAH (1998-). *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) is also listed at the Federal level as Endangered pursuant to section 179 of the EPBC Act as listed by the DotEE (2018c). A total of 257 individuals of *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) were recorded within or close to the Sulphur Springs Project area (Mattiske 2007). One priority flora taxa, *Euphorbia clementii* (P2), as listed by WAH (1998-), was recorded within the Sulphur Springs Project area. A further two priority flora recorded in close proximity to the Sulphur Springs Project area were *Gymnanthera cunninghamii* (P3) and *Ptilotus mollis* (P4, Mattiske 2007).

A total of three introduced (weed) species were recorded within the Sulphur Springs Project area. One of these, **Calotropis procera*, is a declared pest organisms pursuant to section 22 of the BAM Act (the remaining two are permitted under section 11 of the BAM Act). **Calotropis procera* is categorised as "exempt", requiring no permit of conditions for keeping. It should however be proactively controlled at this early stage with only one mature flowering plant found in the current survey. **Cenchrus ciliaris* and **Setaria verticillata* were the other two weed species encountered in the Sulphur Springs Project area. All weed species were restricted to the main access road creekline. Given the extent of disturbance, in terms of drill tracks, old camps and laydown areas, it is notable that more introduced species were not recorded.

No threatened ecological communities, pursuant to Schedule 1 of the *Wildlife Conservation Act 1950* and as listed by the DBCA (2016), or priority ecological communities as listed by the DBCA (2018c), were recorded within the Sulphur Springs Project area.

Fifteen vegetation communities were delineated and mapped across the Sulphur Springs Project area. The majority of the Sulphur Springs Project area consist of vegetation communities 5a and 6a, which are dominated by *Eucalyptus leucophloia* and *Corymbia hamersleyana* low trees over *Acacia* spp. and *Triodia* spp. hummock grasslands on ridge slopes, creek banks, flood banks and distributing fans. These two vegetation communities account for 71.8 % of the total mapped area within the development envelope. Overall, the vegetation communities mapped and species recorded in the Sulphur Springs Project area were consistent with the historical mapping of Beard (1975; 1990). The dominant woodlands and grasslands present in the Sulphur Springs Survey area are well represented both at the local and regional scale (Beard 1975; Beard 1990). Consequently, mine development would result in a minimal impact on the vegetation values of the area.

Ground-water Dependent Ecosystems (GDE's) are ecosystems that rely wholly or partially on access to groundwater to meet their water requirements (Sinclair, Knight and Merz 2001). The vegetation of the Sulphur Springs Project area was assessed for the presence of GDE's. Vegetation communities 1a and 2a were inferred to have a moderate likelihood of being a GDE. Site investigation found *Eucalyptus victrix* as the dominant tree species within these sites, while the understorey consisted largely of *Melaleuca lasiandra*, *Petalostylis labicheoides*, *Stemodia grossa* and *Cyperus vaginatus*. *Eucalyptus victrix* is regarded as being a facultative phreatophyte that most likely draws the majority of its water requirement from the unsaturated zone, but can use groundwater opportunistically as required (Astron 2015). It is noted that although vegetation communities 1a and 2a were inferred to have a moderate likelihood of being a GDE, the vegetation is consistent with the typical creekline vegetation of the Pilbara bioregion (Beard 1975). The total mapped area of vegetation communities 1a and 2a in the Sulphur Springs Project totals 32.8 ha or 3.9 % which represents a small portion of the development envelope area.

1. INTRODUCTION

Mattiske Consulting Pty Ltd was commissioned in September 2017 by Venturex Resources Ltd to undertake a targeted flora and vegetation survey of the footprint areas on the Sulphur Springs Project. The Sulphur Springs Project area has been the subject of a number of previous flora and vegetation surveys. In 2001, Trudgen et al. (2002) completed a flora and vegetation survey of the proposed mine areas and access road. In addition, Trudgen (2006, 2007a, 2007b) completed rare flora searches, assessment of vegetation and identification of Groundwater Dependent Ecosystems. Mattiske Consulting Pty Ltd (2007) further reviewed the flora and vegetation and Groundwater Dependent Ecosystems and Outback Ecology (2013) completed a Level 1 flora and vegetation survey of the area.

1.1. Location and Scope of Project

Sulphur Springs is located approximately 144 km southeast of Port Headland and 57 km west of Marble Bar in the Pilbara Region of Western Australia (Figure 1). The Sulphur Springs Project is a prospective Zinc-Copper deposit in development by Venturex Resources Ltd.

The scope of the current survey is the validation of previous vegetation mapping, undertake a threatened and priority search within the current project footprint and provide an assessment of groundwater dependent vegetation.

1.2. Environmental Legislation and Guidelines

The following key Commonwealth (federal) legislation relevant to this survey is the:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

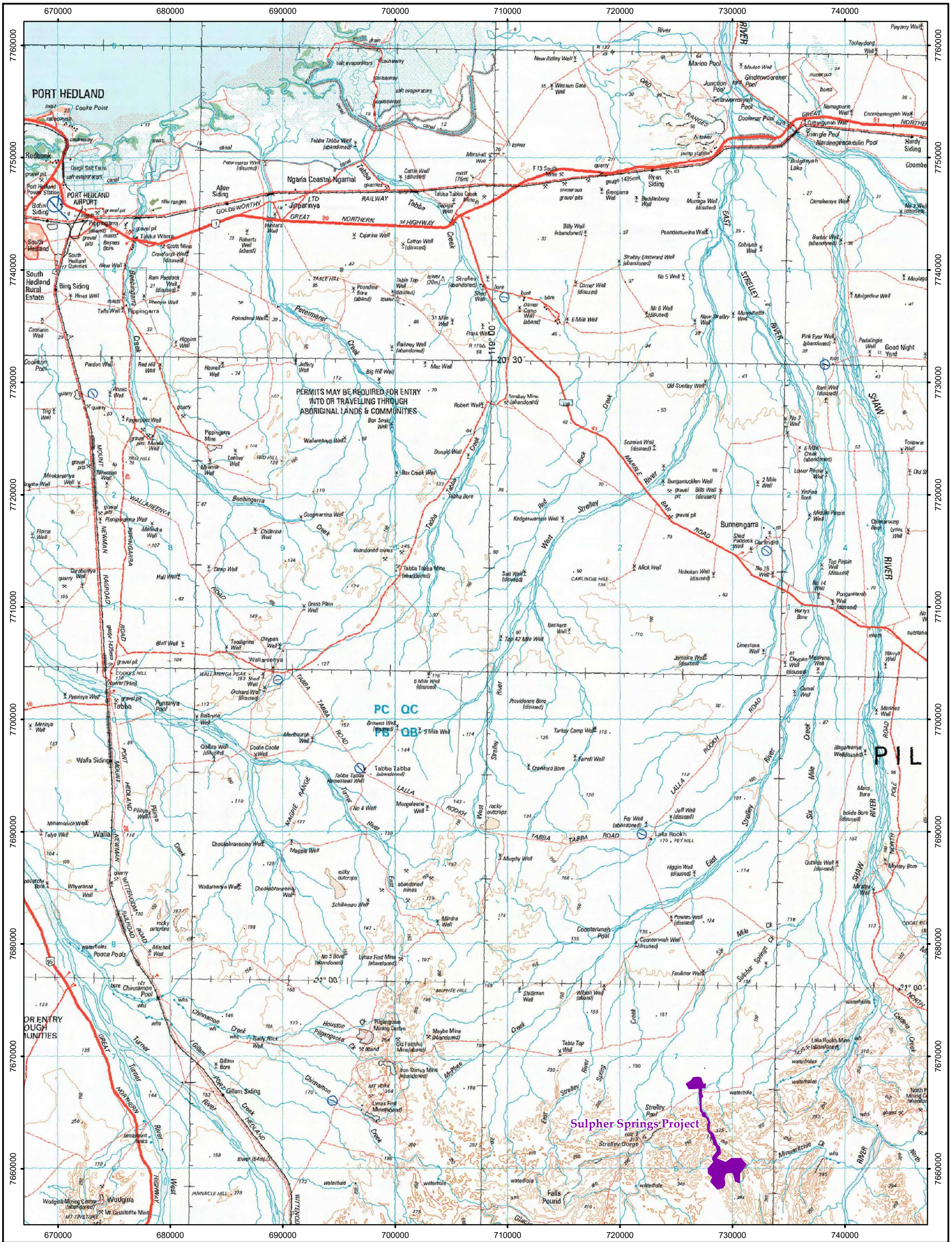
The following key Western Australian (state) legislation relevant to this survey include the:

- *Biodiversity Conservation Act 2016* (BC Act);
- *Environmental Protection Act 1986* (EP Act); and
- *Wildlife Conservation Act 1999* (WC Act).

Furthermore, key Western Australian guidelines relevant to this survey are the:

- *Environmental Factor Guideline: Flora and Vegetation* (Environmental Protection Authority [EPA] 2016a);
- *Technical Guidance – Flora and vegetation surveys for environmental impact assessment* (EPA 2016b).

Definitions of flora and vegetation terminology commonly used throughout this report are provided in Appendix A.



Notes:
Topography: Landgate

Client:
VENTUREX RESOURCES LIMITED

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Date: Mar 2018 | Rev: A | A3

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Sulphur Springs Project
Locality

Figure: 1

2. BACKGROUND

2.1. Regional Context

The Sulphur Springs Project lies within the Fortescue Botanical District, which is situated in the Pilbara Region (Beard 1990). More recently, the vegetation of Western Australia has been assigned to bioregions and subregions under the Interim Biogeographical Regionalisation for Australia (IBRA), with the survey area being within the Chichester (PIL1) subregion of the Pilbara 1 bioregion (Department of the Environment and Energy [DotEE] 2018a).

2.2. Climate

The Pilbara bioregion experiences a semi-desert to tropical climate characterised by hot summers and relatively warm dry winters. Tropical cyclones can occur between the months of January to April, bringing sporadic drenching rainfall events (Kendrick and McKenzie 2001).

The nearest Bureau of Meteorology weather station to the project is located at Marble Bar, approximately 57 km to the east of the Sulphur Springs Project area. Weather data collected from the Marble Bar Meteorological Station indicates rainfall occurs mainly in the first half of the year with a mean average rainfall of approximately 380 mm (Figure 2). Rainfall for the 12 months prior to the survey (total of 527 mm) was over the long term average for the same period (total of 381.6 mm). The three months prior to the survey, however, experienced below-average rainfall with 0.8 mm received compared to the long term average of 8.1 mm (Figure 2).

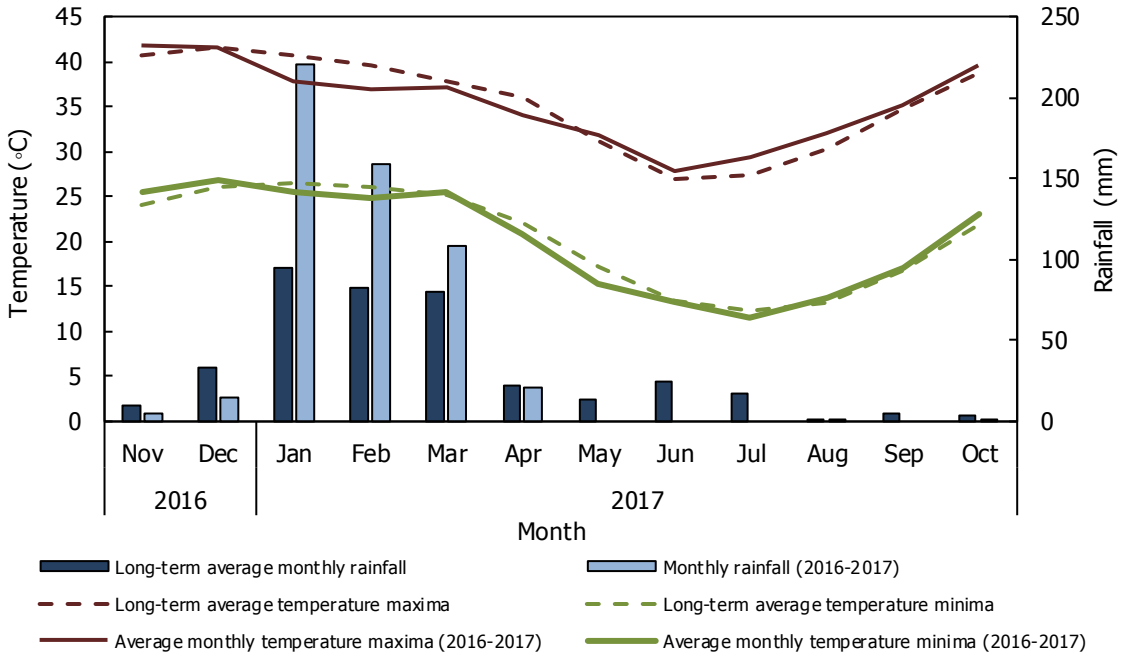

Figure 2: Rainfall and temperature data for Sulphur Springs Project

Note: Rainfall and Temperature data from Marble Bar (Bureau of Meteorology 2018a).

2.3. Geology, Soils and Topography

Beard (1990) described the underlying geology of the Fortescue Botanical District as a basement of Archaean granite and volcanics, overlain by massive deposits of Proterozoic sediments (including jaspilite and dolomite) and volcanics. Topographically, a mountainous region rising to 1250 m and soils mainly hard alkaline red soils on plains and pediments, shallow and skeletal soils on the ranges (Beard 1990).

2.4. Regional Vegetation

2.4.1. Botanical District

The Sulphur Springs Project is situated within the Fortescue Botanical District of the Pilbara Region. The vegetation of this district is predominantly tree and shrub steppe communities with *Eucalyptus* trees, *Acacia* shrubs, *Triodia pungens* and *T. wiseana*. Some mulga occurs in valleys and there are short grass plains on alluvia (Beard 1990).

2.4.2. Vegetation Systems

A regional survey was undertaken in the Pilbara between 1995 and 1999 by the Department of Agriculture (now the Department of Primary Industries and Regional Development) and the Department of Land Administration (now Landgate) to develop a comprehensive description of the biophysical resources and the vegetation composition and soil condition within the region. The information was used by van Vreeswyk *et al.* 2004 to classify and map the land systems of the Pilbara region based on landform, soil, vegetation, geology and geomorphology. An assessment of the land systems provides an indication of the occurrence and distribution of vegetation types within and surrounding the project area. The Sulphur Springs Project lies on three land systems listed below (Table 1; Figure 3).

Boolgeeda System: Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands

Capricorn System: Rugged sandstone hills, ridges, stony footslopes and interfluves supporting low acacia shrublands or hard spinifex grasslands with scattered shrubs

Rocklea System: Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex and occasionally soft spinifex grasslands with scattered shrubs

Table 1: Extent of Land Systems intersecting the Sulphur Springs Project

LAND SYSTEM	STATE-WIDE	DEVELOPMENT ENVELOPE	
	CURRENT EXTENT (ha)	AREA OF INTERSECTION (ha)	PROPORTION OF CURRENT EXTENT (%)
Boolgeeda System	52232.7872	122.0914	0.234
Capricorn System	285605.5855	555.2105	0.194
Rocklea System	791445.6356	168.4166	0.021

725000 730000 735000

7670000 7665000 7660000 7655000

283Mc
Macroy System

283Mc
Macroy System

280Bg
Boolgeeda System

280Rk
Rocklea System

280Rk
Rocklea System

280Cp
Capricorn System

280Bg
Boolgeeda System

280Rk
Rocklea System

280Bg
Boolgeeda System

280Gr
Granitic System

280Bk
Black System

280Mc
Macroy System

280Gr
Granitic System

Legend
Proposed Development Envelope
MAPPING_UN
280Bg
280Bk
280Cp
280Gr
280Mc
280Rk
283Mc
283St

725000 730000 735000

Notes:
Land Systems: DPIRD Agriculture and Food

Client:
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N

0 1,000 m
Scale: 1:50,000
MGA94 (Zone 50)

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Date: Feb 2018 | Rev: A | A3

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Sulpher Springs Project

Land Systems

Figure: 3

2.4.3. IBRA7 Biogeographical Sub-regions

More recently, the Interim Biogeographic Regionalisation for Australia (IBRA) delineated 85 bioregions across Australia, based on a range of biotic and abiotic factors, including climate, vegetation, fauna, geology and landform (Thackway and Cresswell 1995; DotEE 2018a). IBRA Version 7 refined the original 85 bioregions and 403 subregions described in IBRA 6.1, by expanding the number of regions to 89 and the number of subregions to 419. The subregions represent more localised and homogenous geomorphological units in each bioregion. IBRA7 includes four new oceanic bioregions, and seven new subregions in the oceanic bioregions and six new subregions in South Australia (DotEE 2018a).

The Sulphur Springs Project is situated within the Chichester sub-region of the Pilbara 1 region (Figure 4). A summary of the sub-regions is set out below. Table 2 sets out the extent of intersection of the Sulphur Springs Project with the Chichester IBRA7 sub-region.

Table 2: Extent of IBRA sub-region intersecting the Sulphur Springs Project

IBRA SUB-REGION	STATE-WIDE	DEVELOPMENT ENVELOPE	
	CURRENT EXTENT (ha)	AREA OF INTERSECTION (ha)	PROPORTION OF CURRENT EXTENT (%)
Chichester (PIL1)	8374727.8663	845.7185	0.010

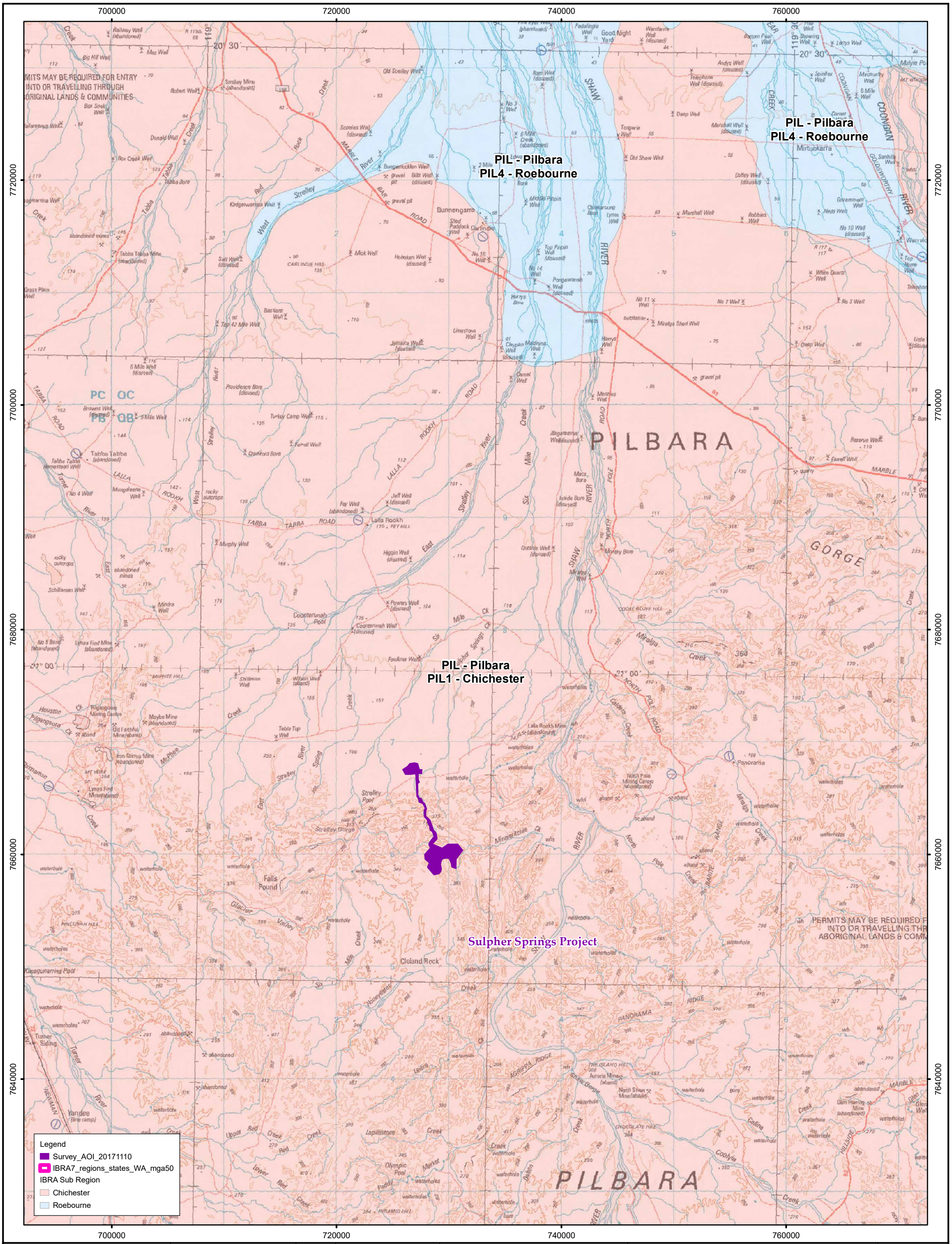
PIL1 – Chichester Sub Region

The Chichester subregion (PIL1) comprises the northern section of the Pilbara Craton. Kendrick and McKenzie (2001) describe it as undulating archaean granite and basalt plains including significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges.

2.4.4. Pre-European Vegetation

The pre-European vegetation dataset, prepared through the National Land and Water Resources Audit, describes vegetation in relation to natural resource boundaries commonly used for environmental reporting (Shepherd *et al.* 2002). The pre-European vegetation dataset builds on the vegetation map database developed by G R Beeston and A J M Hopkins, based on 1: 250,000 scale mapping. A total of 819 vegetation types were recognised in Western Australia, ranging from tall forests, through to a wide variety of forests and woodlands, shrublands and grasslands, mostly with an overstorey of trees. The identification of the original pre-European and current extent of each of the vegetation types assist in providing baselines for managing issues such as land clearing. Although the extent of native vegetation remains largely intact within the inland areas of Western Australia, the structure and floristic composition have been altered since European settlement through grazing by introduced animals such as sheep, cattle, goats and rabbits, mining activities and by altered fire regimes (Shepherd *et al.* 2002).

In more recent years Hopkins, Beeston and Shepherd (2001) delineated a series of vegetation maps based primarily on the work of John Beard carried out from 1964 to 1981. The area of pre-European vegetation associations intersecting the Sulphur Springs Project are set out in Table 3 and Figure 5, and are based on the 2016 Statewide Vegetation Statistics (Government of Western Australia 2016).



Notes:
IBRA Regions: Environment Australia

Client:
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N

0 6km
Scale: 1:300,000
MGA94 (Zone 50)
CAD Ref: a1527_f17_03
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Sulphur Springs Project
Interim Biogeographic Regionalisation for Australia

Figure: **4**

725000 730000 735000

7670000 7665000 7660000 7655000

93.4
ABYDOS PLAIN - CHICHESTER

82.1
GEORGE RANGES

93.3
ABYDOS PLAIN

Legend
Proposed Development Envelope
sa_code
82.1
93.3
93.4

Notes:
PE Veg: DPIRD Agriculture and Food

Client:
VENTUREX RESOURCES LIMITED

N

0 1,000 m
Scale: 1:50,000
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Sulphur Springs Project
Pre European Vegetation

Figure: 5

Table 3: Extent of pre-European vegetation associations intersecting the Sulphur Springs Project

VEGETATION ASSOCIATION	STATE-WIDE	DEVELOPMENT ENVELOPE	
	PRE-EUROPEAN EXTENT (ha)	AREA OF INTERSECTION (ha)	PROPORTION OF CURRENT EXTENT (%)
George Ranges (82)	317396.6637	729.7924	0.230
Abydos Plain – Chichester (93)	2483168.1861	115.9261	0.005

2.5. Groundwater Dependant Ecosystems

Ground-water Dependent Ecosystems (GDE's) are ecosystems that rely wholly or partially on access to groundwater to meet their water requirements (Sinclair, Knight and Merz 2001). Many ecosystems rely purely on rainfall for their water requirements, but GDEs rely on additional input from groundwater. Changes in the timing, quantity, quality or distribution of groundwater may result in negative impacts on growth and health of vegetation of a GDE and ultimately lead to plant deaths and changes in ecosystem composition (Eamus 2009).

The Groundwater Dependent Ecosystem Atlas displays the name, location, ecosystem type and potential of a GDE occurring within the survey area (Bureau of Meteorology [BOM] 2018b). GDE's are assigned to either; aquatic, terrestrial or subterranean categories of ecosystems. Aquatic ecosystems rely on the surface expression of ground-water, including ecosystems that have a ground-water component, such as rivers, wetlands and springs. Terrestrial ecosystems rely on subsurface ground-water. Subterranean ecosystems occur in caves, aquifers and underflow of rivers (BOM 2018b). The potential of a GDE occurring in a given area can be determined by combining the following attributes; depth to water table, vegetation type, summer growth and persistence of water (Table 4; Sinclair Knight Merz 2012).

2.6. Previous Surveys

The Sulphur Springs Project has been the subject of a number of previous flora and vegetation surveys. In 2001, Trudgen *et al.* (2002) completed a flora and vegetation survey of the proposed mine areas and access road. In addition, Trudgen (2006, 2007a, 2007b) completed rare flora searches, assessment of vegetation and identification of Groundwater Dependent Ecosystems. Mattiske Consulting Pty Ltd (2007) further reviewed the flora and vegetation and Groundwater Dependent Ecosystems and Outback Ecology (2013) completed a Level 1 (reconnaissance level to current guidelines) flora and vegetation survey of the area. Ecologia (2012) also completed a regional targeted search for *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) in close proximity to the Sulphur Springs Project area.

3. OBJECTIVES

The objective of this survey was to provide an overview of the flora and vegetation in the Sulphur Springs Project area. Specifically, the objectives include:

- Undertake a desktop assessment to evaluate the values of the Sulphur Springs Project area to identify any matters of botanical or conservation significance;
- Review previous literature and current databases associated with the Sulphur Springs Project area;
- Search for additional threatened and priority flora species in the Sulphur Springs Project area and provide location and population information on those recorded (including a targeted search for *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En));
- Validate previous vegetation mapping in the Sulphur Springs Project area;
- Conduct an assessment of groundwater dependant vegetation in the Sulphur Springs Project area; and
- Prepare a report summarising the findings.

4. METHODS

4.1. Desktop Assessment

The desktop assessments were undertaken using the resources of the Department of Biodiversity, Conservation and Attractions (DBCA 2016, 2018a, 2018c), Department of the Environment and Energy (DotEE 2018b, 2018c, 2018d), NatureMap (Department of Parks and Wildlife 2007-), Western Australian Herbarium's FloraBase (Western Australian Herbarium 1998-) and Western Australian Organisms List (Department of Primary Industries and Regional Development 2018).

The search parameters used for each database were a 40 km radius at 21° 08' 49"S, 119° 12' 19"E. These database searches were utilised to identify the possible occurrence of threatened and priority flora, threatened and priority ecological communities and any other matters protected under the *Environment Protection and Biodiversity Conservation Act 1999* within the vicinity of the Sulphur Springs Project area.

4.2. Field Survey

The validation of previous vegetation mapping, threatened and priority flora search and assessment of groundwater dependent vegetation in the current footprint was undertaken by two experienced botanists from Mattiske Consulting Pty Ltd between the 21st and 24th of November 2017. The field survey was conducted in accordance with methods outlined in *Technical Guidance – Flora and vegetation surveys for environmental impact assessment* (EPA 2016b). All botanists held valid collection licences to collect flora for scientific purposes, issued under the Wildlife Conservation Act 1950. The geographic coordinates of the survey areas were provided by Venturex Resources Ltd. Field maps were prepared by CAD Resources (Carine, Western Australia).

The threatened and priority flora search was undertaken by means of comprehensive foot traverses in locations that hadn't previously been searched by Trudgen *et al.* 2002, Trudgen 2006, Trudgen 2007a and Trudgen 2007b within the development envelope. All previous localities of threatened and priority flora found by Trudgen were accessible in the field on Garmin GPS devices. Along narrow areas, linear foot traverses were completed between 10 and 25 m apart depending on size of area (mostly hilly or steep terrain) or in larger areas (mostly on flats) grids were walked at approximately 50 m intervals. Flora that was unknown to the botanists or resembled threatened or priority flora were collected, the location, habitat and condition noted and the number of plants counted.

Vegetation mapping validation was undertaken on previous Mattiske mapping (Mattiske Consulting Pty Ltd 2007) in the Sulphur Springs Project area. All previous Mattiske mapping was undertaken utilising field data from Trudgen (Trudgen *et al.* 2002, 2007a). Maps incorporating Mattiske mapping were produced by CAD Resources to be used in the field. Mapped vegetation was visited in the field, to confirm the main contributing attributes remained. No additional sampling in these vegetation communities were carried out. All species contributing to vegetation communities were crosschecked and updated to reflect current taxonomy and nomenclature.

The groundwater dependent ecosystem (GDE) assessment was undertaken on creekline vegetation in the Sulphur Springs Project area. Seven sites (100 m in length) running along the creekline were assessed for GDE indicator species, GDE tree size, GDE tree health, surface water attributes and co-occurring vegetation from all strata levels (Table 4, Figure 6). Sites were chosen based on previous finding from the Mattiske Consulting Pty Ltd 2007 report in which Vegetation Alliance 1a and 2a were classed as having a very high and high probability respectively of being a GDE. All these attributes were used in combination to construct a likelihood matrix to confirm or reject the presence of GDE at these sites (Table 4).

Table 4. Criteria used to identify Groundwater Dependent Ecosystems (Table modified from Sinclair Knight Merz 2012).

Note: Low likelihood of GDE: 0-4
Moderate likelihood of GDE: 5-9
High likelihood of GDE: 10+

Criteria – Rational		Contribution Score to Likelihood Matrix
1	Vegetation type and Key Species Specific vegetation types and species are known to use groundwater, therefore they can be used as indicators of GDE's	Contains *Melaleuca argentea* – 5 Contains *Eucalyptus camaldulensis* – 2 Contains *Eucalyptus victrix* – 2
2	Persistent water bodies Vegetation communities fringing persistent water sources are likely to access groundwater (a GDE)	Surface water present – 2 Surface water absent – 1
3	Indicator Tree Species Size Increased size of tree species are likely to infer access to groundwater, therefore can be used as indicators of GDE's	Large – 3 Medium – 2 Small – 1
4	Indicator Tree Species Health Increased health of tree species are likely to infer access to groundwater, therefore can be used as indicators of GDE's	Healthy – 3 Moderate – 2 Poor – 1

All plant specimens collected during the field surveys were dried and processed in accordance with the requirements of the Western Australian Herbarium. The plant species were identified through comparisons with pressed specimens housed at the Western Australian Herbarium. Where appropriate, plant taxonomists with specialist skills were consulted. Nomenclature of the species recorded is in accordance with the Western Australian Herbarium (Western Australian Herbarium 1998-).

4.3. Survey Timing

According to Table 3 in the *Technical guidance – Flora and vegetation surveys for environmental impact assessment* (EPA 2016b), the primary survey timing for the Eremaean Botanical Province is 6 to 8 weeks post wet season (March – June). As the current survey was conducted in late November survey timing is not ideal. As a result of the survey being done so late in the season many plants were no longer flowering, though many still retained fruit. Although this may have contributed to many species being unable to be confidently identified to species level and an underrepresentation of annual species, of the 10 threatened and priority species with the potential to occur in the Sulphur Springs Project only one is considered an annual species. It is also worth noting that annual species are not generally included in vegetation mapping so their absence from survey quadrats would not have detrimental effects on the accuracy of vegetation community delineation. The majority of previous surveys by Trudgen have been conducted within the primary timing period, with surveys conducted in April 2001, April 2006, May 2006, May 2007 and June 2007.

4.4. Survey Limitations

A general assessment was made of the current survey against a range of factors that may have limited the outcomes and conclusions of this report (Table 5). Based on this assessment, the present survey has not been subject to constraints which would affect the thoroughness of the survey, and the conclusions which have been formed.

Table 5: Potential limitations affecting the conclusions made in this report

POTENTIAL SURVEY LIMITATION	IMPACT ON CURRENT SURVEY
Availability of contextual information at a regional and local scale	**Not a limitation:** Reference resources such as Beard's mapping and historical survey data in the vicinity of the survey area (Consultant's reports), together with online flora and vegetation information, has provided an appropriate level of information for the current survey.
Competency/experience of team carrying out survey; experience in the bioregion surveyed	**Not a limitation:** All botanists had extensive experience working in a range of botanical districts across the state. Majority of the plants observed in the field were collected for formal identification and were compared with specimens at the Western Australian State Herbarium where required.
Proportion of flora collected and identification issues	**Potential limitation:** The field survey was conducted after the peak flowering period for the Pilbara area. Whilst the late November period was not ideal, identification of threatened and priority flora species was not impacted due to some species still retaining fruit or identifications being able to be made on sterile material collected.
Effort and extent of survey (Was the appropriate area surveyed for the type of survey (reconnaissance/targeted/detailed)	**Not a limitation:** The intensity of the survey effort of the Sulphur Springs Project was considered to be sufficient for a reconnaissance level survey. Resources, in terms of equipment, support and personnel were adequate.
Access restrictions within survey area	**Not a limitation:** Vehicle access to gorge and rocky slopes in the Sulphur Springs Project was at time difficult, however foot traverses were sufficient to allow access to the entirety of the survey area.
Survey timing, rainfall, season of survey	**Potential limitation:** The EPA (2016b) recommends that flora and vegetation surveys in the Eremaean Botanical Province be conducted 6 – 8 weeks post wet season (March – June). The current survey was conducted in late November which falls outside of this period. Rainfall in the six months preceding the survey was slightly below average (Figure 2), however the wet season (Jan – Mar) was massively above average rainfall with 487.2 mm compared to 255.9 mm. Although these factors may affect the completeness of the species list, it is not expected to have a significant effect on mapping reliability, nor on the identification of threatened and priority species in the area as majority were perennial species.
Disturbances (fire/flood/clearing)	**Not a limitation:** The Sulphur Springs Project exhibits negligible levels of disturbance from agricultural and mining activities.
Data and statistical analysis	**Not a limitation:** Introduced species, annual species and singletons were excluded from the data set prior to analysis. Data collected was sufficient for delineation of vegetation communities based on statistical analysis.

5. DESKTOP ASSESSMENT RESULTS

5.1. Potential Flora

A total of 118 vascular plant taxa, representative of 62 genera and 33 families, have the potential to occur within the Sulphur Springs Project (DPaW 2007-). The most commonly represented families were the Fabaceae (33 taxa), Poaceae (13 taxa) and Malvaceae (10 taxa). The most commonly represented genera were *Acacia* (15 taxa) and *Tephrosia* (10 taxa).

A total of 74 vascular plant taxa, representative of 40 genera and 15 families, were recorded by Outback Ecology (2013) and a total of 514 vascular plant taxa, representative of 161 genera and 58 families, were recorded by Trudgen *et al.* 2002, Trudgen 2006, 2007a, 2007b and cited in Mattiske Consulting Pty Ltd (2007), in previous surveys of the Sulphur Springs Project and adjacent areas.

5.1.1. Potential Threatened and Priority Flora

One threatened flora species, *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) pursuant to subsection (2) of section 23F of the WC Act and as listed by the DBCA (2018a) has been recorded in the Sulphur Springs Project. At a Federal level, *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) is also listed as Endangered pursuant to section 179 of the EPBC Act or listed by the DotEE (2018c).

A total of 9 priority flora species as listed by WAH have the potential to occur within the Sulphur Springs Project, comprising of one Priority 2, 6 Priority 3 and 2 Priority 4 species (WAH 1998-).

Mattiske Consulting Pty Ltd (2007) lists 7 species priority flora species previously recoded within the greater Sulphur Springs Project area. These species include: *Euphorbia clementii* (P2), *Gonocarpus ephemerus* (P2), *Olearia fluvialis* (P2), *Abutilon trudgenii* (P3), *Acacia glaucocaesia* (P3), *Gymnanthera cunninghamii* (P3) and *Ptilotus mollis* (P4). *Gonocarpus ephemerus, Olearia fluvialis*, *Abutilon trudgenii* (now known as *Abutilon* sp. Pilbara (W.R. Barker 2025)) and *Acacia glaucocaesia* have been downgraded since 2007 and are now no longer priority flora species.

Trudgen *et al.* (2002) and Trudgen (2006, 2007a, 2007b) identified *Pityrodia* sp. Panorama as potentially a new flora species within the Sulphur Springs Project area. Ecologia (2012) confirmed that *Pityrodia* sp. Panorama is *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En), now listed as Threatened pursuant to subsection (2) of section 23F of the WC Act and is listed by the DBCA (2018a). *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) is a many branched shrub to 2 m tall with grey, densely hairy leaves and pink flowers that that appear from July to September. It is a member of the Lamiaceae family, however is yet to be formally described. It has previously been recorded from hill slopes with skeletal brown sandy loam soils.

An assessment of the likelihood of recording all of the listed threatened and priority taxa within the Sulphur Springs Project, based on factors including known soil type, topography and distribution, is set out in Appendix C. Based on this assessment, three taxa – *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En), *Euphorbia clementii* (P2) and *Ptilotus mollis* (P4) – were ranked as being highly likely to be recorded as they had been recorded within the vicinity of the Sulphur Springs Project in previous surveys. Four taxa were ranked with a medium likelihood of being recorded in the survey area and the remaining three taxa were ranked with a low likelihood of being recorded in the survey area (Appendix C).

5.1.2. Potential Introduced (Weed) Species and Declared Pest (Plant) Organisms

A total of three introduced species have the potential to occur within the Sulphur Springs Project (DPaW 2007-). These species are: **Aerva javanica*, **Cenchrus ciliaris* and **Portulaca pilosa*. None of these are listed as declared pest organisms pursuant to section 22 of the BAM Act (Department of Primary Industries and Regional Development [DPIRD] 2018) or listed as a Weed of National Significance (WONS; DotEE 2018e).

In previous surveys by Trudgen cited in Mattiske Consulting Pty Ltd (Mattiske 2007), 10 weed species were recorded within the greater Sulphur Springs area. These species were: **Cenchrus ciliaris* (Buffel Grass), **Cynodon dactylon* (Couch Grass), **Setaria verticillata* (Whorled Pigeon Grass), **Aerva javanica* (Kapok Bush), **Portulaca oleracea* (Purslane), **Argemone ochroleuca* (Mexican Poppy), **Vachellia farnesiana* (Mimosa Bush), **Ricinus communis* (Caster Oil Plant), **Solanum nigrum* (Black berry nightshade) and **Cucumis melo* subsp. *agrestis* (now *Cucumis melo*, Ulcardo Melon). Two of these species (*Portulaca oleracea* and *Cucumis melo*) are now no long considered weed species. Trudgen (2007a) also states that **Malvastrum americanum* (Spiked Malvastrum) may be present in the area if further surveys are conducted after sufficient rain.

5.2. Potential Threatened and Priority Ecological Communities

No Threatened Ecological Communities (TEC) were identified as occurring in the vicinity of the Sulphur Springs Project pursuant to Schedule 1 of the WC Act and as listed by the DBCA (2016).

No Priority Ecological Communities (PEC) as listed by the DBCA (2018c) currently intersect the Sulphur Springs Project.

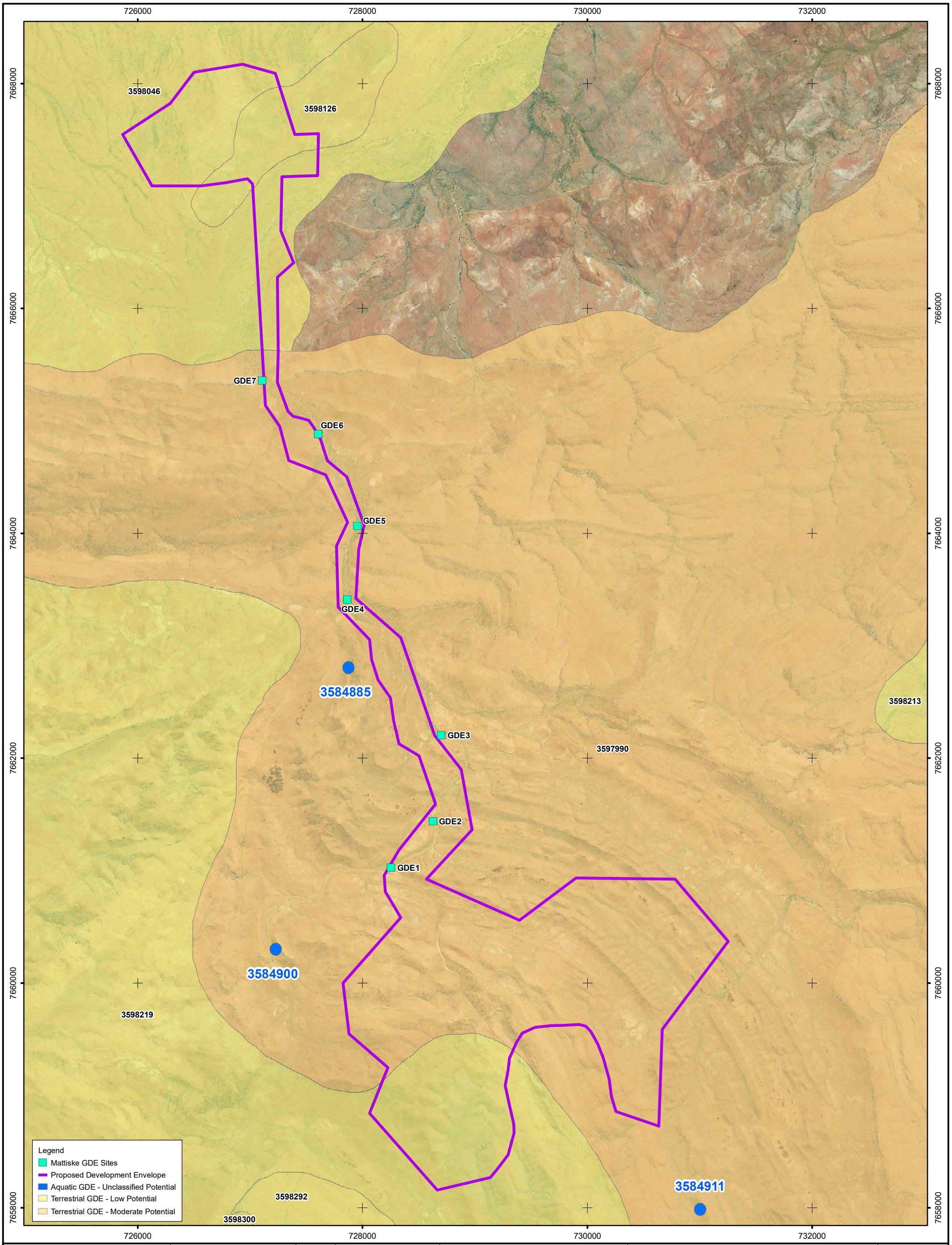
5.3. Groundwater Dependant Ecosystems

No known groundwater dependant ecosystems are present within the Sulphur Springs Project area as inferred from the national Groundwater Dependant Ecosystem Atlas (BOM 2018b). The Sulphur Springs Survey area is however on the Groundwater Dependant Ecosystem Atlas, showing both a low potential and moderate potential of occurrence of terrestrial GDE's (Figure 6). There are three unclassified aquatic GDE's in close proximity to the survey area (Figure 6). These GDE's are pools identified by regional studies of the Western Australia's Department of Water associated with the De Grey river system. The GDE's are approximately 200, 600 and 800 m respectively from the boundary of the Sulphur Springs Survey area.

Mattiske Consulting Pty Ltd (2007) suggests there are two Vegetation Alliances that have a very high (1a) and high (2a) probability of being a GDE. These Vegetation Alliances are described as:

1a – Open forest to open woodland of *Eucalyptus camaldulensis*, *Melaleuca argentea* and *Eucalyptus victrix* with scattered tall shrubs of *Indigofera monophylla* over *Schoenus falcatus*, *Cyperus vaginatus* and *Triodia longiceps* sedgeland/grassland in river beds.

2a – *Eucalyptus victrix* scattered trees to open woodland which may include *Melaleuca glomerata* and *Melaleuca linophylla* over open to closed scrub in creek beds and low slopes.



Notes:
Aerial photography: Landgate (Oct 2005)
GDE: BOM (28/01/2018)

Client:
VENTUREX RESOURCES LIMITED

N

0 600m
Scale: 1:30,000
MGA94 (Zone 50)

CAD Ref: a1527_f17_07
Date: Mar 2018 | Rev: B | A3

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Sulphur Springs Project
National Groundwater Dependent Ecosystems & Mattiske GDE Sites

Figure: 6

6. FIELD SURVEY RESULTS

6.1. Flora

A total of 360 vascular plant taxa, representative of 139 genera and 48 families, were recorded within the wider Sulphur Springs Project area. The majority of taxa recorded were representative of the Fabaceae (77 taxa), Poaceae (60 taxa) and Malvaceae (37 taxa) families. Within the development area a total of 185 vascular plant taxa, representative of 84 genera and 35 families were recorded. The taxa recorded during the survey are set out in Appendix D. Ninety-three annual plant species were recorded during the survey of the Sulphur Springs Project area, representing 25.8 % of all taxa recorded. A number of plant species could not be identified accurately to species level due to the absence of sufficient taxonomic characters to enable accurate identification.

6.1.1. Threatened and Priority Flora

One threatened flora species, *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En), pursuant to subsection (2) of section 23F of the WC Act and as listed by the DBCA (2018a), and Endangered pursuant to section 179 of the EPBC Act or listed by the DotEE (2018c), has been recorded within the Sulphur Springs Project area since 2001. The geographic locations and number of plants recorded are presented in Figure 7 and Appendix E.

Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) is a is a many branched shrub to 2 m tall with grey, densely hairy leaves and pink flowers that that appear from July to September (Plate 1). It is a member of the Lamiaceae family, however is yet to be formally described. It has been recorded from hill slopes with skeletal brown sandy loam soils.

Plate 1: In situ photograph of *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, E) and habitat (Photographs: L. Cockram)

One priority flora species, *Euphorbia clementii* (P2), as listed by the DBCA (2018a), was recorded within the Sulphur Springs Project area. Two further priority species have are recorded in surveys since 2001 however are outside the current project boundary, being *Gymnanthera cunninghamii* (P3) and *Ptilotus mollis* (P4). *Olearia fluvialis, Gonocarpus ephemerus*, *Abutilon trudgenii* (now *Abutilon* sp. Pilbara (W.R. Barker 2025)) and *Acacia glaucocaesia* have since been downgraded from priority status. The geographic locations and number of plants recorded are presented in Appendix E. The locations of priority species recorded during the survey of the Sulphur Springs Project area are also presented in Figure 7. A brief description of these species is provided below:

- **PRIORITY 2:**

  Euphorbia clementii – EUPHORBIACEAE – Erect herb, growing to 60 cm high. White flowers from April to May. Occurring on gravelly hillsides or stony ground. WAH houses 23 specimens of

Euphorbia clementii from areas around the Shire of East Pilbara and the Shire of Port Hedland (WAH 1998-).

- **PRIORITY 3** (Outside of current development boundary)**:**

  Gymnanthera cunninghamii – APOCYNACEAE – Erect shrub 1 to 2 m high. Cream-yellow-green flowers from January to December. Occurring on sandy soils. WAH houses 32 specimens of *Gymnanthera cunninghamii* from areas around the Shires of Ashburton, Broome, Carnarvon, East Pilbara, Exmouth, Karratha and Port Hedland (WAH 1998-).

- **PRIORITY 4** (Outside of current development boundary)**:**

  Ptilotus mollis – AMMARANTHACEAE – Compact perennial shrub to 50 cm high with soft grey foliage. White/pink flowers from May or September. Occurring on stony hills and scree slopes. WAH houses 34 specimens of *Ptilotus mollis* from areas around the Shires of Ashburton, East Pilbara and Port Hedland (WAH 1998-).

No additional threatened or priority flora species were recorded during the November 2017 Sulphur Springs Survey in areas that had had not previously been covered by either Mattiske Consulting Pty Ltd (2007), Trudgen *et al.* (2002) or Trudgen (2006, 2007a, 2007b).

6.1.2. Introduced (Weed) Species and Declared Pest (Plant) Organisms

Due to the highly transient nature of weed species, only weeds recorded in the 2017 survey are presented. A total of three introduced (weed) species were recorded within the Sulphur Springs Project in November 2017 - **Calotropis procera,* **Cenchrus ciliaris* and **Setaria verticillata* (Figure 8, Appendix F). One of these, **Calotropis procera*, is a declared pest organism pursuant to section 22 of the BAM Act, while **Cenchrus ciliaris* and **Setaria verticillata* are permitted under section 11 of the BAM Act (DPIRD 2018). **Calotropis procera* has a declared pest organism category of exempt, requiring no permit or conditions for keeping. **Calotropis procera* is a shrub to 4 m in height with white and purple flowers (Plate 2). A total of 1 mature flowering plant was recorded in the Sulphur Springs Project area along the access road creekline, 3 km south of the Abydos road (Table 6).

Table 6. Significant Weed Species Recorded within the Sulphur Springs Project
WAOL (Western Australian Organism List; DPIRD 2018)

Species	WOAL	GDA 94_Zone 50		Population no.
		Easting	Northing	
**Calotropis procera* (Calotrope)	Declared Pest (s22)	727862	7663410	1 plant

Plate 2: In situ photograph of *Calotropis procera (Photographs: L. Cockram)

Abbrev	Species	SCC
Ec	*Euphorbia clementii*	P2
Pmb	*Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4)	T

Legend

MCPL Flora Conservation Code

- T
- P2
- Atlas Iron - Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4)
- Proposed Development Envelope

Notes:
Aerial photography: Landgate (Oct 2005)
Flora, Quadrats: MCPL (Aug 2007 - URS0706) undated May 2018

Client: VENTUREX RESOURCES LIMITED

N

0 600m

Scale: 1:30,000
MGA94 (Zone 50)

CAD Ref: a1527_f17_05

Date: May 2018 | Rev: D | A3

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Sulphur Springs Project

Threatened and Priority Flora

Figure: 7

726000 728000 730000 732000

7668000 7666000 7664000 7662000 7660000 7658000

Cc Cc Cc Cp Cc Cc Sv Cc Cc Cc Cc Cc Cc Cc Sv Cc

Legend

Proposed Development Envelope

No. of Plants

1
6-10
26-50
51-100
100-200
200-500
500+

Species

Cc - *Cenchrus ciliaris
Cp - *Calotropis procera
Sv - *Setaria verticillata

Notes:
Aerial photography: Landgate (Oct 2005)

Client: VENTUREX RESOURCES LIMITED

N

0 600m
Scale: 1:30,000
MGA94 (Zone 50)

CAD Ref: a1527_f17_08
Date: Mar 2018 | Rev: C | A3

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Sulphur Springs Project
Introduced Flora

Figure: **8**

6.2. Vegetation

6.2.1. Vegetation Communities

A total of 15 vegetation communities were defined and mapped across the Sulphur Springs Project area, with 13 of these occurring in the Development Envelope. The vegetation communities mapped is presented in Figure 9 and the area of each vegetation community shown in Table 7. A summary of the vegetation communities descriptions is presented below.

Open Forest to Open Woodland: Flowlines

1a - Open forest to open woodland of *Eucalyptus camaldulensis, Melaleuca argentea* and *Eucalyptus victrix* with scattered tall shrubs of *Indigofera monophylla* over *Schoenus falcatus, Cyperus vaginatus* and *Triodia longiceps* sedgeland/grasslands in river beds.

Open Forest to Open Woodland: Other

2a - *Eucalyptus victrix* scattered trees to open woodland of *Melaleuca glomerata* and *Melaleuca linophylla* over open to closed scrubs in creek beds and low slopes.

5a - *Eucalyptus leucophloia* scattered low trees over patches of *Acacia* spp. shrubs over hummock grasslands of *Triodia* spp. including *T. brizoides*, *T. wiseana* and *T. epactia* on ridge slopes.

6a - *Corymbia hamersleyana* scattered low trees to low open woodland over tall shrubs to open shrubland of *Acacia* spp. and *Grevillea wickhamii* over hummock grasslands on creek banks, flood banks and distributing fans.

8a - *Terminalia canescens* scattered low trees to low woodland on creek banks.

9a - *Atalaya hemiglauca*, *Acacia pruinocarpa*, *Ehretia saligna* var. *saligna*, *Acacia tumida*, *Corymbia ferriticola* and *Ficus platypoda* scattered low trees over high open shrubland on steep rocky gorge walls.

High Shrublands to Open Scrublands

10a- Shrubland to open scrubland of *Acacia* species including *A. tumida*, *A. acradenia* and *A. orthocarpa* over hummock grassland on upper and steep slopes.

11a - Shrubland to closed scrubland of *Acacia* spp. including *A. acradenia*, *A. pyrifolia* and *A. tumida* along small creeklines and adjacent parts of valley floors and distributing fans.

12a - *Acacia inaequilatera* scattered tall shrubs to high open shrubland over *Triodia brizoides* hummock grasslands on ridge slopes and low hills.

13a - *Acacia inaequilatera* scattered tall shrubs to high shrubland over *Triodia wiseana* hummock grasslands occurring on gentle lower slopes.

14a - *Acacia ancistrocarpa* high open shrubland to open scrub.

15a - *Acacia trachycarpa* high open shrubland to high shrublands.

Low Shrublands to Low Open Heaths

16a - Low shrublands to low open heath on gentle slopes and undulating plains.

Hummock Grasslands

17a - Hummock grasslands on slopes and ridges.

Other Grasslands and Herblands

18a - Cracking clays on gentle sloping plains and seasonal damplands.

Table 7. Area of each vegetation community within the Sulphur Springs Project

Vegetation Community	Total Area Mapped (ha)	Area Within Development Envelope (ha)	Percentage in Total Mapped Area	Percentage in Development Envelope area
1a	458.02	5.05	3.66	0.60
2a	177.68	27.72	1.42	3.28
5a	2253.42	306.98	18.00	36.30
6a	7285.81	300.12	58.19	35.49
8a	26.15	0	0.21	0
9a	258.63	51.04	2.07	6.04
10a	43.15	0	0.34	0
11a	818.37	39.63	6.54	4.69
12a	36.68	0.95	0.29	0.11
13a	569.40	72.13	4.55	8.53
14a	222.39	2.88	1.78	0.34
15a	44.81	5.11	0.36	0.60
16a	101.17	2.74	0.81	0.32
17a	55.05	23.31	0.44	2.76
18a	39.56	8.05	0.32	0.95
Totals	**12520.35**	**845.72**	**100**	**100**

6.2.2. Threatened and Priority Ecological Communities

No TECs, pursuant to Schedule 1 of the WC Act and as listed by the DBCA (2016) were recorded within the Sulphur Springs Project. No PECs as listed by the DBCA (2018c) were recorded within the Sulphur Springs Project.

726000 728000 730000 732000

7668000 7666000 7664000 7662000 7660000 7658000

Legend

- 10a
- 11a
- 12a
- 13a
- 14a
- 15a
- 16a
- 17a
- 18a
- 1a
- 2a
- 5a
- 6a
- 8a
- 9a
- Proposed Development Envelope

Notes:
Aerial photography: Landgate (Oct 2005)

Client:
VENTUREX RESOURCES LIMITED

N

0 600m

Scale: 1:30,000
MGA94 (Zone 50)

CAD Ref: a1527_f17_06

Date: Mar 2018 | Rev: D | A3

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Sulphur Springs Project

Vegetation

Figure: 9

6.3. Groundwater Dependent Ecosystems

A total of 7 sites were investigated for the likelihood of being Groundwater Dependant Ecosystems within the Sulphur Springs Survey area (Figure 6, Table 8 and Table 9). These sites were focused on the 1a and 2a vegetation communities which had previously been classified as potentially being a very high and high probability respectively of being a GDE by Mattiske (Mattiske Consulting Pty Ltd 2007).

All 7 field sites investigated had *Eucalyptus victrix* as the dominant indicator tree species, while the midstorey and understorey was largely similar between sites. The dominant midstorey taxa included *Melaleuca lasiandra* and *Atalaya hemiglauca*, and the dominant understorey taxa included *Cyperus vaginatus* and *Stemodia grossa.* Six of the 7 sites had no surface water present, while site GDE4 was observed to have a low level of flowing water and some minor pooling. Tree health was observed as healthy in 5 sites and moderate in in the remaining sites GDE1 and GDE5. Tree size was observed as medium across sites GDE1, GDE2, GDE3 and GDE5, large at site GDE7, while sites GDE4 had medium to large and site GDE6 had small to medium sized trees.

The above characteristics were scored in a matrix to produce a GDE likelihood score (Table 9). Scores produced for sites GDE1 to GDE7 ranged from a total of 7 to 9. This included 3 sites totalling 7 (GDE1, GDE5, GDE6), 2 sites totalling 8 (GDE2, GDE3) and 2 sites totalling 9 (GDE4, GDE7). All sites with scores between 5 and 9 were deemed to have a moderate likelihood of GDE presence in the Sulphur Springs Survey area.

It is appropriate to infer that from these results, vegetation communities 1a and 2a that occur in combination with GDE survey sites GDE1 to GDE7 also have a moderate likelihood of GDE presence across the Sulphur Springs Project area. The total mapped area of vegetation communities 1a and 2a in the current Sulphur Springs Project development envelope totals 32.8 ha or 3.9 %.

Table 8. Investigation of Groundwater Dependent Ecosystem sites in the Sulphur Springs Project

Site	GDA 94_Zone 50		Indicator Tree Species	Tree Size	Tree Health	Vegetation Strata			Surface water
	Easting	Northing				Overstorey	Midstorey	Understorey	
GDE1	728253	7661024	*Eucalyptus victrix*	Medium	Moderate	*Eucalyptus victrix, Acacia coriacea* subsp. *pendens*	*Acacia pyrifolia, Melaleuca lasiandra, Atalaya hemiglauca, Petalostylis labicheoides*	*Cyperus vaginatus, Stemodia grossa, Cymbopogon ambiguus*	Dry
GDE2	728625	7661438	*Eucalyptus victrix*	Medium	Healthy	*Eucalyptus victrix*	*Melaleuca lasiandra, Acacia pyrifolia, Atalaya hemiglauca, Acacia tumida, Gossypium robinsonii*	*Stemodia grossa, Cymbopogon ambiguus*	Dry
GDE3	728701	7662202	*Eucalyptus victrix*	Medium	Healthy	*Eucalyptus victrix, Atalaya hemiglauca, Acacia coriacea* subsp. *pendens*	*Melaleuca lasiandra, Petalostylis labicheoides, Acacia pyrifolia*	*Cyperus vaginatus, Sesbania cannabina, Cymbopogon ambiguus, Cleome viscosa, Stemodia grossa, *Cenchrus ciliaris*	Dry
GDE4	727864	7663410	*Eucalyptus victrix*	Large/ Medium	Healthy	*Eucalyptus victrix, Acacia coriacea* subsp. *pendens*	*Atalaya hemiglauca, Melaleuca lasiandra, Petalostylis labicheoides*	*Cyperus vaginatus, Stemodia grossa*	Flowing, low level, pooling
GDE5	727954	7664065	*Eucalyptus victrix*	Medium	Moderate	*Eucalyptus victrix, Atalaya hemiglauca, Acacia coriacea* subsp. *pendens*	*Melaleuca lasiandra, Melaleuca bracteata, Acacia pyrifolia*	*Cyperus vaginatus, Stemodia grossa*	Dry
GDE6	727606	7664882	*Eucalyptus victrix*	Medium/Small	Healthy	*Eucalyptus victrix, Atalaya hemiglauca*	*Melaleuca lasiandra, Melaleuca bracteata, Acacia pyrifolia*	**Cenchrus ciliaris, Eriachne benthamii, Cymbopogon ambiguus*	Dry
GDE7	727108	7665358	*Eucalyptus victrix*	Large	Healthy	*Eucalyptus victrix*	*Melaleuca lasiandra, Atalaya hemiglauca*	*Eriachne benthamii, Acacia pyrifolia, *Cenchrus ciliaris*	Dry

Table 9. Likelihood matrix scores to identify Groundwater Dependent Ecosystems

(See Table 4 for criteria and contribution scores)

Site	Matrix Criteria Score				Total Score	GDE Likelihood
	Vegetation Type and Key Species	Persistent water bodies	Indicator Tree Size	Indicator Tree Health		
GDE1	2	1	2	2	7	Moderate
GDE2	2	1	2	3	8	Moderate
GDE3	2	1	2	3	8	Moderate
GDE4	2	2	3	2	9	Moderate
GDE5	2	1	2	2	7	Moderate
GDE6	2	1	3	1	7	Moderate
GDE7	2	1	3	3	9	Moderate

7. DISCUSSION

Mattiske Consulting Pty Ltd was commissioned in September 2017 by Venturex Resources Ltd to undertake a reconnaissance level flora and vegetation survey on the Sulphur Springs Project area. Sulphur Springs is located approximately 144 km southeast of Port Headland and 57 km west of Marble Bar in the Pilbara Region of Western Australia. The total Sulphur Springs Project development area was 845.72 ha. The area has been the subject of a number of previous flora and vegetation surveys. In 2001, Trudgen *et al.* (2002) completed a flora and vegetation survey of the proposed mine areas and access road. In addition, Trudgen (2006, 2007a, 2007b) completed rare flora searches, assessment of vegetation and identification of groundwater dependent ecosystems. Mattiske Consulting Pty Ltd (2007) further reviewed the flora and vegetation and Groundwater Dependent Ecosystems and Outback Ecology (2013) completed a Level 1 flora and vegetation survey of the area. Ecologia (2012) completed a regional survey for *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) which was in close proximity. The scope of the current survey was the validation of previous vegetation mapping by Trudgen *et al.* (2002) and Mattiske (2007), threatened and priority flora search within the current project footprint and to provide an assessment of groundwater dependent ecosystems.

A total of 360 vascular plant taxa, representative of 139 genera and 48 families, were recorded within the wider Sulphur Springs Project area. The majority of taxa recorded were representative of the Fabaceae (77 taxa), Poaceae (60 taxa) and Malvaceae (37 taxa) families. Within the development area a total of 185 vascular plant taxa, representative of 84 genera and 35 families were recorded. The majority of the taxa recorded were widespread both locally and more broadly within the associated biogeographical subregion.

Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) has been recorded within the Sulphur Springs Project area. It is listed as a Threatened flora taxon pursuant to Schedule 1 of the *Wildlife Conservation Act 1950* and as listed by the WAH (1998-). *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) is also listed at the Federal level as Endangered pursuant to section 179 of the EPBC Act as listed by the DotEE (2018c). A total of 257 individuals of *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) were recorded within or close to the Sulphur Springs Project area. One priority flora taxa, *Euphorbia clementii* (P2), as listed by WAH (1998-), was recorded within the Sulphur Springs Project area. A further two priority flora recorded in close proximity to the Sulphur Springs Project area were: *Gymnanthera cunninghamii* (P3) and *Ptilotus mollis* (P4). A total of four species; *Olearia fluvialis, Gonocarpus ephemerus*, *Abutilon trudgenii* (now *Abutilon* sp. Pilbara (W.R. Barker 2025)) and *Acacia glaucocaesia* have been downgraded from priority status since surveys in the period since 2001.

A total of three introduced (weed) species were recorded within the Sulphur Springs Project area. One of these, **Calotropis procera*, is a declared pest organisms pursuant to section 22 of the BAM Act (the remaining two are permitted under section 11 of the BAM Act). No species recorded are listed as Weeds of National Significance (WONS). **Cenchrus ciliaris* and **Setaria verticillata* were the other two weed species encountered in the Sulphur Springs Project area. All weed species were mapped and found to be restricted to the main access road creekline. **Cenchrus ciliaris* (Buffel Grass) is a widespread species across the Pilbara region and is described as being resistance to fire, drought, and grazing making it extremely persistent, and its rapid growth and flowering allow for dominance within native vegetation. They are also aggressive colonisers of native habitats, especially moist environments, where they form dense monocultures and have the ability to change native ecosystems (Humphries *et al.* 1991). **Calotropis procera* is listed as a declared pest organism, however it is categorised as exempt, requiring no permit of conditions for keeping. It should however be proactively controlled at this early stage with only one mature flowering plant found in the current survey. Given the extent of disturbance, in terms of drill tracks, old camps and laydown areas, it is notable that more introduces species were not recorded. Weeds present a management issue associated with possible spread during disturbance to the Sulphur Springs Project area. It is recommended that a weed management plan is developed and adhered to in order to minimise the spread of weeds throughout the Sulphur Springs Project area.

Fifteen vegetation communities were delineated and mapped across the Sulphur Springs Project area, 13 of which are represented in the development envelope. The majority of the Sulphur Springs Project area consist of vegetation communities 5a and 6a, which are dominated by *Eucalyptus leucophloia* and *Corymbia hamersleyana* low trees over *Acacia* spp. and *Triodia* spp. hummock grasslands on ridge slopes, creek banks, flood banks and distributing fans. These two vegetation communities account for 71.8 % of the total mapped area with the development envelope. The other 11 vegetation communities occurring within the development envelope comprises coverage of less than 10 %, with 6 of these less than 1 %. Overall, the vegetation communities mapped and species recorded in the Sulphur Springs Project area were consistent with the historical mapping of Beard (1975; 1990). The dominant woodlands and grasslands present in the Sulphur Springs Survey area are well represented both at the local and regional scale (Beard 1975; Beard 1990). Consequently, mine development would result in a minimal impact on the vegetation values of the area.

No threatened ecological communities, pursuant to Schedule 1 of the Wildlife Conservation Act 1950 and as listed by the DBCA (2016), or priority ecological communities as listed by the DBCA (2018c), were recorded within the Sulphur Springs Project area.

Ground-water Dependent Ecosystems are ecosystems that rely wholly or partially on access to groundwater to meet their water requirements (Sinclair Knight Merz 2001). Many ecosystems rely purely on rainfall for their water requirements, but GDEs rely on additional input from groundwater (Eamus 2009). The vegetation of the Sulphur Springs Project area was assessed for the presence of GDE's through the investigating of seven field sites. These seven sites were investigated for vegetation type and key species presence, presence of persistent water bodies, indicator tree size and indicator tree health. Matrix scores were developed from field results, with all seven sites recording a moderate likelihood of being a GDE. Site investigation found *Eucalyptus victrix* as the dominant tree species within these sites, while the understorey consisted largely of *Melaleuca lasiandra*, *Petalostylis labicheoides*, *Stemodia grossa* and *Cyperus vaginatus*. *Eucalyptus victrix* is regarded as being a facultative phreatophyte that most likely draws the majority of its water requirement from the unsaturated zone, but can use groundwater opportunistically as required (Astron 2015). In general, the water use strategy of *E. victrix* appears to be highly opportunistic, enabling survival in a wide range of ecohydrological settings. From an assessment of water level ranges of Pilbara riparian species, it was found that the mean minimum water level depth of *E. victrix* was greater than that for *E. camaldulensis*, providing some support for the view that *E. victrix* is found in slightly drier areas than *E. camaldulensis* and may not be as responsive to water table fluctuations (Loomes 2010). It is noted that although a moderate likelihood of sites representing a GDE, the vegetation is consistent with the typical creekline vegetation of the Pilbara bioregion (Beard 1975). The total mapped area of vegetation communities 1a and 2a in the Sulphur Springs Project totals 32.8 ha or 3.9 % which represents a small portion of the development envelope area. In the event of mine development, it is recommend to monitor vegetation condition within communities 1a and 2a to enable any change in vegetation health along creeklines to be identified.

The principal issue with respect to the flora and vegetation surveyed is in relation to the presence of *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En) both within and external to the Sulphur Springs Project area. It would be appropriate, in the event of mine development, to put in place a management plan to minimise impacts to this species and the associated vegetation.

8. ACKNOWLEDGEMENTS

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9. PERSONNEL

The following Mattiske Consulting Pty Ltd personnel were involved in this project:

NAME	POSITION	PROJECT INVOLVEMENT	FLORA COLLECTION PERMITS
Dr EM Mattiske	Managing Director & Principal Ecologist	Planning, managing, reporting	N/A
Dr S Ruoss	Experienced Botanist, Project Leader	Planning, fieldwork, data analysis, reporting	SL012018
Ms L Cockram	Experienced Botanist	Fieldwork	SL012083
Mr B Ellery	Taxonomist	Plant identification	SL012024

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APPENDIX A1: THREATENED AND PRIORITY FLORA DEFINITIONS

Under section 179 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), **threatened flora** are categorised as extinct, extinct in the wild, critically endangered, endangered, vulnerable and conservation dependent (Table A1.1).

Table A1.1 Federal definition of threatened flora species

Note: Adapted from section 179 of the EPBC Act.

CODE	CATEGORY	DEFINITION
Ex	**Extinct**	Species which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	**Extinct in the Wild**	Species which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	**Critically Endangered**	Species which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	**Endangered**	Species which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	**Vulnerable**	Species which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent**	Species which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

The *Wildlife Conservation Act 1950* (WC Act) provides for (amongst other things) the protection of flora likely to become extinct or rare or otherwise in need of special protection in Western Australia under section 23F. **Threatened** (or **rare**) **flora** are listed in the *Wildlife Conservation (Rare Flora) Notice 2016* (under section 23F(2) of the WC Act; Department of Biodiversity, Conservation and Attractions 2018b) and are categorised under Schedules 1-4 as critically endangered, endangered, vulnerable or extinct, respectively. Threatened flora are defined as "likely to become extinct or is rare, or otherwise in need of special protection", pursuant to section 23F(2) of the WC Act. Threatened species are categorised as critically endangered, endangered, vulnerable and presumed extinct (Table A1.2).

Table A1.2 State definition of threatened flora species

Note: Adapted from Department of Biodiversity, Conservation and Attractions (2018b).

CODE	CATEGORY	DEFINITION
CR	**Critically endangered**	Species considered to be facing an extremely high risk of becoming extinct in the wild (listed under Schedule 1 of the *Wildlife Conservation (Rare Flora) Notice 2017*).
EN	**Endangered**	Species considered to be facing a very high risk of becoming extinct in the wild (listed under Schedule 2 of the *Wildlife Conservation (Rare Flora) Notice 2017*).
VU	**Vulnerable**	Species considered to be facing a high risk of becoming extinct in the wild (listed under Schedule 3 of the *Wildlife Conservation (Rare Flora) Notice 2017*).
EX	**Presumed extinct species**	Species that have been adequately searched for and there is no reasonable doubt that the last individual has died (listed under Schedule 4 of the *Wildlife Conservation (Rare Flora) Notice 2017*).

Priority flora species are defined as "possibly threatened species that do not meet the survey criteria, or are otherwise data deficient; or are adequately known, are rare but not threatened, meet criteria for near threatened or have recently been removed from the threatened species list for other than taxonomic reasons" (Department of Biodiversity, Conservation and Attractions 2018b). **Priority species are not afforded any protection under state or federal legislation**, however are considered significant under the Environmental Protection Authority's *Environmental Factor Guideline: Flora and Vegetation*. The Department of Biodiversity, Conservation and Attractions categorises priority flora into four categories: Priority 1; Priority 2, Priority 3 and Priority 4 (Table A1.3).

Table A1.3: State definition of priority flora species

Note: Adapted from Department of Biodiversity, Conservation and Attractions (2018b).

CODE	CATEGORY	DEFINITION
P1	**Priority 1:** Poorly-known species	Known from one or a few locations (< 5) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation; or are otherwise under threat of habitat destruction or degradation. In urgent need of further survey.
P2	**Priority 2:** Poorly-known species	Known from one or a few locations (< 5). Some occurrences are on lands managed primarily for nature conservation. In urgent need of further survey.
P3	**Priority 3:** Poorly-known species	Known from several locations and the species does not appear to be under imminent threat; or from few but widespread locations with either a large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. In need of further survey.
P4	**Priority 4:** Rare, Near Threatened, and other species in need of monitoring	**a) Rare -** Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. **b) Near Threatened -** Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. **c) Other -** Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

APPENDIX A2: THREATENED AND PRIORITY ECOLOGICAL COMMUNITY DEFINITIONS

Under section 181 of the EPBC Act, **threatened ecological communities** are categorised as critically endangered, endangered and vulnerable (Table A2.1).

Table A2.1 Federal definition of threatened ecological communities

Note: Adapted from section 181 and section 182 of the EPBC Act.

CATEGORY	DEFINITION
Critically Endangered	If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
Vulnerable	If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

Currently there is no Western Australian legislation covering the conservation of state listed **threatened ecological communities** (TECs), however, a non-statutory process is in place, whereby the Department of Biodiversity, Conservation and Attractions have been identifying and informally listing TECs since 1994. Some of these TECs are endorsed by the Federal Minister as threatened, and some of these are also listed under the EPBC Act and therefore afforded legislative protection at the Commonwealth level.

Table A2.2 State definition of threatened ecological communities

Note: Adapted from Department of Environment and Conservation (2013).

CODE	CATEGORY	DEFINITION
PD	**Presumed Totally Destroyed**	An ecological community will be listed as PD if there are no recent records of the community being extant **and either** of the following applies: **1.** Records within the last 50 years have not been confirmed despite thorough searches or known likely habitats; or **2.** All occurrences recorded within the last 50 years have since been destroyed.
CR	**Critically Endangered**	An ecological community will be listed as CR when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future, meeting **any one or more of** the following criteria: **1.** The estimated geographic range and distribution has been reduced by at least 90% and is either continuing to decline with total destruction imminent, or is unlikely to be substantially rehabilitated in the immediate future due to modification; **2.** The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area; or **3.** The ecological community is highly modified with potential of being rehabilitated in the immediate future.
EN	**Endangered**	An ecological community will be listed as EN when it has been adequately surveyed and is not CR, but is facing a very high risk of total destruction in the near future. The ecological community must meet **any one or more of** the following criteria: **1.** The estimated geographic range and distribution has been reduced by at least 70% and is either continuing to decline with total destruction imminent in the short term future, or is unlikely to be substantially rehabilitated in the short term future due to modification; **2.** The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area; or **3.** The ecological community is highly modified with potential of being rehabilitated in the short term future.
VU	**Vulnerable**	An ecological community will be listed as VU when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing high risk of total destruction in the medium to long term future. The ecological community must meet **any one or more of** the following criteria: **1.** The ecological community exists largely as modified occurrences that are likely to be able to be substantially restored or rehabilitated; **2.** The ecological community may already be modified and would be vulnerable to threatening process, and restricted in range or distribution; or **3.** The ecological community may be widespread but has potential to move to a higher threat category due to existing or impending threatening processes.

Priority ecological communities (PECs) are defined as possible threatened ecological communities that do not meet the stringent survey criteria for the assessment of threatened ecological communities, and are listed by the Department of Biodiversity, Conservation and Attractions. Similarly to priority flora, PECs are not afforded legislative protection, however are considered significant under the Environmental Protection Authority's (2016a) *Environmental Factor Guideline: Flora and Vegetation*. The Department of Biodiversity, Conservation and Attractions categorises priority ecological communities into five categories: Priority 1; Priority 2, Priority 3, Priority 4 and Priority 5 (Table A2.3).

Table A2.3 State definition of priority ecological communities

Note: Adapted from Department of Environment and Conservation (2013).

CODE	CATEGORY	DEFINITION
P1	**Priority 1** (Poorly known ecological communities)	Ecological communities that are known from very few, restricted occurrences (generally ≤ 5 occurrences or a total area of ≤ 100 ha). Most of these occurrences are not actively managed for conservation (e.g. located within agricultural or pastoral lands, urban areas, or active mineral leases) and for which immediate threats exist.
P2	**Priority 2** (Poorly known ecological communities)	Communities that are known from few small occurrences (generally ≤ 10 occurrences or a total area of ≤ 200 ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation.
P3	**Priority 3** (Poorly known ecological communities)	**1.** Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation; **2.** Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat; or **3.** Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing and inappropriate fire regimes.
P4	**Priority 4** (Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring)	**1.** Rare – Communities known from few occurrences that are considered to have been adequately surveyed, sufficient knowledge is available, and are considered not to be currently threatened. **2.** Near Threatened – Communities considered to have been adequately surveyed and do not qualify for Conservation Dependent, but are close to qualifying for Vulnerable. **3.** Communities that have been removed from the list of threatened communities during the past five years.
P5	**Priority 5** (Conservation Dependent ecological communities)	Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

APPENDIX A3: CATEGORIES AND CONTROL MEASURES OF DECLARED PEST (PLANT) ORGANISMS IN WESTERN AUSTRALIA

Section 22 of Western Australia's *Biosecurity and Agriculture Management Act 2007* (BAM Act) makes provision for a plant taxon to be listed as a declared pest organism in respect to parts of, or the entire State. According to the BAM Act, a declared pest is defined as a prohibited organism (section 12), or an organism for which a declaration under section 22 (2) of the Act is in force.

Under the *Biosecurity and Agriculture Management Regulations 2013* (WA), declared pest plants are placed in one of three control categories, C1 (exclusion), C2 (eradication) or C3 (management), which determines the measures of control which apply to the declared pest (Table A4.1). The current listing of declared pest organisms and their control category is through the Western Australian Organism List (Department of Primary Industries and Regional Development 2018).

Table A3.1 Categories and control measures of declared pest (plant) organisms

Note: Adapted from *Biosecurity and Agriculture Management Regulations 2013*.

CONTROL CATEGORY	CONTROL MEASURES
C1 (Exclusion) '(a) Category 1 (C1) — Exclusion: if in the opinion of the Minister introduction of the declared pest into an area or part of an area for which it is declared should be prevented.' Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.	In relation to a category 1 declared pest, the owner or occupier of land in an area for which an organism is a declared pest or a person who is conducting an activity on the land must take such of the control measures specified in subregulation (1) as are reasonable and necessary to destroy, prevent or eradicate the declared pest.
C2 (Eradication) '(b) Category 2 (C2) — Eradication: if in the opinion of the Minister eradication of the declared pest from an area or part of an area for which it is declared is feasible.' Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.	In relation to a category 2 declared pest, the owner or occupier of land in an area for which an organism is a declared pest or a person who is conducting an activity on the land must take such of the control measures specified in subregulation (1) as are reasonable and necessary to destroy, prevent or eradicate the declared pest.
C3 (Management) '(c) Category 3 (C3) — Management: if in the opinion of the Minister eradication of the declared pest from an area or part of an area for which it is declared is not feasible but that it is necessary to: **(i)** alleviate the harmful impact of the declared pest in the area; or **(ii)** reduce the number or distribution of the declared pest in the area; or **(iii)** prevent or contain the spread of the declared pest in the area.' Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.	In relation to a category 3 declared pest, the owner or occupier of land in an area for which an organism is a declared pest or a person who is conducting an activity on the land must take such of the control measures specified in subregulation (1) as are reasonable and necessary to: **(a)** alleviate the harmful impact of the declared pest in the area for which it is declared; or **(b)** reduce the number or distribution of the declared pest in the area for which it is declared; or **(c)** prevent or contain the spread of the declared pest in the area for which it is declared.

APPENDIX B: GEOGRAPHIC LOCATIONS OF SURVEY QUADRATS IN THE SULPHUR SPRINGS PROJECT

Note: - indicates coordinates not available

QUADRAT	LOCATION (MGA_Z50)		MAPPED AREA	DEVELOPMENT AREA
	EASTING (mE)	NORTHING (mN)		
B001	728534	7660620	X	X
B002	728538	7660482	X	X
B003	728503	7660418	X	X
B004	728291	7660465	X	X
B005	728378	7660307	X	X
B006	728483	7660208	X	X
B007	728474	7660393	X	X
B008	-	-	X	
B009	-	-	X	
B010	728468	7660971	X	X
B011	728768	7660829	X	X
B012	728925	7660834	X	
B013	729055	7660749	X	
B014	728268	7661114	X	
B015	729702	7659972	X	X
B016	729696	7659828	X	X
B017	729697	7659636	X	X
B018	729848	7659635	X	X
B019	730357	7659644	X	X
B020	730067	7659671	X	X
B021	728852	7660408	X	X
B022	-	-	X	
B023	729723	7660606	X	X
B024	729524	7660660	X	
B025	730190	7660080	X	X
B026	730768	7659512	X	
B027	730985	7659565	X	
B029	730632	7659714	X	X
B030	729579	7660954	X	
B031	731082	7660315	X	X
B032	731099	7660330	X	X
B033	731055	7660387	X	X
B034	730733	7660238	X	X
B035	730435	7660582	X	X
B036	730631	7660748	X	X
B037	729444	7659577	X	X
B038	730189	7658776	X	
B039	-	-	X	
B040	-	-	X	
B041	730003	7658257	X	

APPENDIX B: GEOGRAPHIC LOCATIONS OF SURVEY QUADRATS IN THE SULPHUR SPRINGS PROJECT

Note: - indicates coordinates not available

QUADRAT	LOCATION (MGA_Z50)		MAPPED AREA	DEVELOPMENT AREA
	EASTING (mE)	NORTHING (mN)		
B042	729872	7658219	X	
B043	729127	7659669	X	X
B044	729144	7659437	X	X
B045	729163	7659209	X	X
B046	729328	7659120	X	
B047	-	-	X	
B048	729715	7658265	X	
B049	729612	7658033	X	
B050	728943	7659983	X	X
B051	728461	7660077	X	X
B052	728108	7660214	X	X
B053	727844	7658762	X	
B054	728041	7659615	X	X
B055	-	-	X	
B056	-	-	X	
B057	-	-	X	
B058	728218	7659248	X	
B059	-	-	X	
B060	728531	7658326	X	X
B061	729115	7658679	X	X
B062	-	-	X	
B063	729388	7657510	X	
B064	-	-	X	
B065	-	-	X	
B066	731530	7660669	X	
B067	731814	7660971	X	
B068	730751	7661410	X	
B069	731593	7661125	X	
B070	729279	7661400	X	
B071	728911	7661269	X	
B072	728865	7660909	X	
B073	730375	7657939	X	
B074	-	-	X	
B075	732516	7654639	X	
B076	732751	7654262	X	
B077	732610	7653547	X	
B078	733782	7654017	X	
B079	733340	7653890	X	
B080	733477	7652975	X	
B081	733427	7653002	X	

APPENDIX B: GEOGRAPHIC LOCATIONS OF SURVEY QUADRATS IN THE SULPHUR SPRINGS PROJECT

Note: - indicates coordinates not available

QUADRAT	LOCATION (MGA_Z50)		MAPPED AREA	DEVELOPMENT AREA
	EASTING (mE)	NORTHING (mN)		
B082	733117	7652770	X	
B083	732486	7653683	X	
B084	732307	7653807	X	
B085	732261	7653836	X	
B086	732025	7654127	X	
B087	732422	7653396	X	
B088	732336	7653532	X	
B089	732125	7653619	X	
B090	732097	7653670	X	
B091	732021	7653239	X	
B092	-	-	X	
B093	735148	7651307	X	
B094	735955	7650527	X	
B095	736156	7650381	X	
B096	736006	7650239	X	
B097	736500	7650424	X	
B098	736750	7650598	X	
B099	736552	7650738	X	
B100	-	-	X	
B101	736788	7651450	X	
B102	736278	7651163	X	
B103	737105	7650558	X	
B104	-	-	X	
B105	737223	7650699	X	
B106	-	-	X	
B107	737311	7650337	X	
B108	735800	7650829	X	
B109	731642	7659839	X	
B110	731578	7659787	X	
B111	732541	7656061	X	
B112	732817	7655209	X	
B113	732928	7655138	X	
B114	-	-	X	
B115	730578	7659013	X	X
B116	730665	7658730	X	
B117	730759	7658646	X	
B118	730795	7658644	X	
B119	730839	7658653	X	
B120	-	-	X	
B121	730751	7658879	X	

APPENDIX B: GEOGRAPHIC LOCATIONS OF SURVEY QUADRATS IN THE SULPHUR SPRINGS PROJECT

Note: - indicates coordinates not available

QUADRAT	LOCATION (MGA_Z50)		MAPPED AREA	DEVELOPMENT AREA
	EASTING (mE)	NORTHING (mN)		
B122	730719	7659089	X	
B123	730612	7659401	X	X
B124	730750	7659443	X	
B125	731172	7658933	X	
B126	731019	7658344	X	
B127	730896	7658775	X	
B128	732636	7654443	X	
B129	730920	7659801	X	
B130	-	-	X	
B131	-	-	X	
B132	-	-	X	
B133	729499	7657970	X	
B134	-	-	X	
B135	-	-	X	
B136	-	-	X	
B137	731642	7659839	X	
B138	728993	7657995	X	
B139	729152	7659575	X	X
B140	731174	7660914	X	
B141	731941	7660708	X	
B142	-	-	X	
B143	-	-	X	
M091	727140	7666458	X	X
M094	727172	7665616	X	X
M096	727211	7665146	X	X
M097	727332	7664968	X	X
M099	727523	7664685	X	X
M100	727845	7664296	X	X
M103	727434	7660741	X	
M104	727369	7660730	X	
M105	727414	7660783	X	
M106	727387	7660816	X	
M107	727480	7660680	X	
M108	727438	7660690	X	
M109	727401	7660674	X	
M110	727387	7660664	X	
M111	727345	7660651	X	
M112	727315	7660701	X	
M113	727565	7660665	X	
M114	727611	7660657	X	

APPENDIX B: GEOGRAPHIC LOCATIONS OF SURVEY QUADRATS IN THE SULPHUR SPRINGS PROJECT

Note: - indicates coordinates not available

QUADRAT	LOCATION (MGA_Z50)		MAPPED AREA	DEVELOPMENT AREA
	EASTING (mE)	NORTHING (mN)		
M115	727643	7660646	X	
M116	727584	7660784	X	
M117	727591	7660879	X	
M118	727807	7660877	X	
M119	727757	7660955	X	
M120	727766	7660976	X	
M121	727723	7660978	X	
M122	727346	7661128	X	
M123	727299	7661083	X	
M124	727255	7661138	X	
M125	727311	7661160	X	
M126	-	-	X	
M127	727278	7661310	X	
M128	727301	7661542	X	
M129	727237	7661537	X	
M130	727113	7661634	X	
M131	727015	7661584	X	
M132	727054	7661249	X	
M133	727059	7661181	X	
M134	727231	7661010	X	
M135	727614	7660894	X	
M136	727609	7660939	X	
M137	726674	7667928	X	X
M138	726687	7667949	X	X
M139	726714	7668001	X	X
M140	726846	7668000	X	X
M141	726990	7668065	X	X
M142	727418	7668241	X	
M143	726672	7667830	X	X
M144	726665	7667795	X	X
M145	726613	7667713	X	X
M146	726400	7667777	X	X
M147	725420	7667404	X	
M148	725207	7667451	X	
M149	-	-	X	
M150	727065	7666683	X	X
M151	727029	7666797	X	
M152	726979	7666916	X	
M153	726880	7667070	X	
M154	726799	7667182	X	X

APPENDIX B: GEOGRAPHIC LOCATIONS OF SURVEY QUADRATS IN THE SULPHUR SPRINGS PROJECT

Note: - indicates coordinates not available

QUADRAT	LOCATION (MGA_Z50)		MAPPED AREA	DEVELOPMENT AREA
	EASTING (mE)	NORTHING (mN)		
PAN001	739541	7691388	X	
PAN002	739725	7692388	X	
PAN003	740153	7694411	X	
PAN004	740634	7696065	X	
PAN005	742149	7708015	X	
PAN006	741988	7707401	X	
PAN007	742045	7706457	X	
PAN008	741727	7704912	X	
PAN009	741792	7703413	X	
PAN010	741600	7701600	X	
PAN011	739406	7690324	X	
PAN012	739418	7689222	X	
PAN013	739144	7687391	X	
PAN014	738960	7683361	X	
PAN015	738744	7682416	X	
PAN016	738763	7680345	X	
PAN017	739138	7679424	X	
PAN018	739734	7677324	X	
PAN019	740199	7676900	X	
PAN020	740268	7676508	X	
PAN021	741069	7675759	X	
PAN022	740904	7675164	X	
PAN023	740190	7674898	X	
PAN024	739629	7674430	X	
PAN025	739620	7674407	X	
PAN026	738634	7673626	X	
PAN027	738180	7673374	X	
PAN028	737531	7672496	X	
PAN029	736982	7671741	X	
PAN030	736616	7671274	X	
PAN031	736514	7671338	X	
PAN032	735797	7670662	X	
PAN033	733451	7668049	X	
PAN034	732775	7667761	X	
PAN035	-	-	X	
PAN036	732628	7667595	X	
PAN037	732458	7667227	X	
PAN038	728600	7660644	X	X
PAN039	728694	7660691	X	X
PAN040	728571	7660633	X	X

APPENDIX B: GEOGRAPHIC LOCATIONS OF SURVEY QUADRATS IN THE SULPHUR SPRINGS PROJECT

Note: - indicates coordinates not available

QUADRAT	LOCATION (MGA_Z50)		MAPPED AREA	DEVELOPMENT AREA
	EASTING (mE)	NORTHING (mN)		
PAN041	728695	7660784	X	X
PAN042	728655	7660453	X	X
PAN043	729663	7660135	X	X
PAN044	728662	7660837	X	X
PAN045	729592	7660055	X	X
PAN046	729741	7659911	X	X
PAN047	730650	7659947	X	X
PAN048	730587	7659938	X	X
PAN049	730640	7660145	X	X
PAN050	730608	7660140	X	X
PAN051	730014	7660554	X	X
PAN052	729798	7660533	X	X
PAN053	730008	7660526	X	X
PAN054	733048	7654434	X	
PAN055	733256	7654538	X	
PAN056	733118	7654115	X	
PAN057	733235	7654500	X	
PAN058	736587	7650058	X	
PAN059	736462	7650954	X	
PAN060	736384	7650836	X	
PAN061	736551	7650071	X	
PAN062	736592	7650036	X	
PAN063	727692	7664879	X	
PAN064	727692	7665005	X	
PAN065	727703	7664762	X	
PAN066	727686	7664563	X	X
PAN067	727882	7664180	X	X
PAN068	727977	7664078	X	X
PAN069	727837	7663885	X	X
PAN070	727941	7663887	X	X
PAN071	727891	7663899	X	X
PAN073	728024	7663327	X	X
PAN074	728051	7663161	X	X
PAN075	728049	7663217	X	X
PAN076	732524	7656342	X	
PAN077	731195	7659863	X	
PAN078	733189	7653514	X	
PAN079	733279	7653262	X	
PAN080	732352	7653465	X	
PAN081	731232	7659976	X	

APPENDIX B: GEOGRAPHIC LOCATIONS OF SURVEY QUADRATS IN THE SULPHUR SPRINGS PROJECT

Note: - indicates coordinates not available

QUADRAT	LOCATION (MGA_Z50)		MAPPED AREA	DEVELOPMENT AREA
	EASTING (mE)	NORTHING (mN)		
PAN082	731248	7659889	X	
PAN16B	-	-	X	
PAN20B	-	-	X	
PAN22B	-	-	X	
PAN23B	-	-	X	
PAN26B	-	-	X	
PAN27B	-	-	X	
PAN29B	-	-	X	
PAN30B	-	-	X	
PAN63F	-	-	X	

APPENDIX C: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE SULPHUR SPRINGS PROJECT

Refer to Appendix A for State (SCC) and Federal (FCC; EPBC Act) conservation code definitions. IBRA Distribution: CAR – Carnarvon, CK – Central Kimberly, DAMP – Dampierland, GAS – Gascoyne, GSD – Great Sandy Desert, LSD – Little Sandy Desert, OVP – Ord Victoria Plain, PIL – Pilbara, TAN – Tanami, VB – Victoria Bonaparte

TAXON	FAMILY	SCC	FCC	DESCRIPTION AND HABITAT	POTENTIAL TO OCCUR IN SURVEY AREA
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4	Lamiaceae	T	-	Habit: shrub to 2 m high Flowers: pink Flowering period: July to September Soils: hill slopes, skeletal brown sandy loam IBRA Distribution: PIL Florabase records: 12	High Preferred soils and associated vegetation present within survey area, recorded previously
Euphorbia clementii	Euphorbiaceae	P2	-	Habit: erect herb to 0.3 m high Flowers: white Flowering period: Insufficient information Soils: gravelly hillsides, stony ground IBRA Distribution: PIL Florabase records: 23	High Preferred soils and associated vegetation present within survey area, recorded previously
Acacia levata	Fabaceae	P3	-	Habit: spreading, multi-stemmed shrub 1-3 m high Flowers: yellow Flowering period: May Soils: sand or sandy loam over granite, hillslopes IBRA Distribution: PIL Florabase records: 17	Low Preferred soils not expected to be present within survey area
Eragrostis crateriformis	Poaceae	P3	-	Habit: grass to 0.4 m high Flowers: Insufficient information Flowering period: Jan to May or July Soils: clay loam or clay, creek banks, depressions IBRA Distribution: CAR, GSD, PIL, TAN Florabase records: 40	Medium Preferred soils and associated vegetation potentially present within survey area

APPENDIX C: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE SULPHUR SPRINGS PROJECT

Refer to Appendix A for State (SCC) and Federal (FCC; EPBC Act) conservation code definitions. IBRA Distribution: CAR – Carnarvon, CK – Central Kimberly, DAMP – Dampierland, GAS – Gascoyne, GSD – Great Sandy Desert, LSD – Little Sandy Desert, OVP – Ord Victoria Plain, PIL – Pilbara, TAN – Tanami, VB – Victoria Bonaparte

TAXON	FAMILY	SCC	FCC	DESCRIPTION AND HABITAT	POTENTIAL TO OCCUR IN SURVEY AREA
Fimbristylis sieberiana	Cyperaceae	P3	-	Habit: rhizomatous, perennial herb to 0.6 m Flowers: brown Flowering period: May to June Soils: mud, skeletal soil pockets, pool edges, sandstone cliffs IBRA Distribution: CK, DAMP, GSD, OVP, PIL, VB Florabase records: 23	Low Preferred vegetation not expected to occur within survey area
Heliotropium murinum	Boraginaceae	P3	-	Habit: perennial herb to 0.4 m Flowers: Insufficient information Flowering period: May or September Soils: red sand, plains IBRA Distribution: PIL Florabase records: 12	Medium Preferred soils and associated vegetation potentially present within survey area
Heliotropium muticum	Boraginaceae	P3	-	Habit: perennial herb to 0.3 m high Flowers: Insufficient information Flowering period: Insufficient information Soils: Insufficient information IBRA Distribution: PIL Florabase records: 67	Medium Preferred soils and associated vegetation potentially present within survey area
Triodia basitricha	Poaceae	P3	-	Habit: grass to 0.8 m high Flowers: brown Flowering period: Insufficient information Soils: Insufficient information IBRA Distribution: GAS, PIL Florabase records: 21	Medium Preferred soils and associated vegetation potentially present within survey area

APPENDIX C: ASSESSMENT OF THREATENED AND PRIORITY FLORA POTENTIALLY PRESENT IN THE SULPHUR SPRINGS PROJECT

Refer to Appendix A for State (SCC) and Federal (FCC; EPBC Act) conservation code definitions. IBRA Distribution: CAR – Carnarvon, CK – Central Kimberly, DAMP – Dampierland, GAS – Gascoyne, GSD – Great Sandy Desert, LSD – Little Sandy Desert, OVP – Ord Victoria Plain, PIL – Pilbara, TAN – Tanami, VB – Victoria Bonaparte

TAXON	FAMILY	SCC	FCC	DESCRIPTION AND HABITAT	POTENTIAL TO OCCUR IN SURVEY AREA
Bulbostylis burbidgeae	Cyperaceae	P4	-	Habit: annual sedge to 0.25 m high Flowers: brown Flowering period: March or June to August Soils: granitic soils, granite outcrops, cliff bases IBRA Distribution: PIL Florabase records: 31	Low Preferred vegetation not expected to occur within survey area
Ptilotus mollis	Amaranthaceae	P4	-	Habit: fibrous rooted, perennial herb to 0.03 m high Flowers: white/pink Flowering period: May or September Soils: stony hills and screes IBRA Distribution: LSD, PIL Florabase records: 34	High Preferred soils and associated vegetation present within survey area, recorded previously

APPENDIX D: VASCULAR PLANT SPECIES RECORDED IN THE SULPHUR SPRINGS PROJECT

Note: * denotes introduced species; T & P1 - P4 denotes threatened and priority taxon (DBCA 2018b, WAH 1998-); En - denotes Endangered under EPBC Act 1999 (DotEE 2018c)

FAMILY	SPECIES	MAPPED AREA	DEVELOPMENT AREA
Aizoaceae	*Trianthema pilosum*	X	
	Trianthema sp.	X	
Amaranthaceae	* *Aerva javanica*	X	
	Alternanthera nana	X	
	Alternanthera nodiflora	X	
	Amaranthus undulatus	X	
	Amaranthus sp.	X	
	Gomphrena cunninghamii	X	
	Ptilotus astrolasius	X	X
	Ptilotus auriculifolius	X	
	Ptilotus axillaris	X	X
	Ptilotus calostachyus	X	X
	Ptilotus clementii	X	
	Ptilotus fusiformis	X	
	Ptilotus gaudichaudii	X	
	Ptilotus incanus	X	
	Ptilotus mollis (P4)	X	X
	Ptilotus nobilis subsp. *nobilis*	X	
Apocynaceae	* *Calotropis procera*	X	X
	Carissa lanceolata	X	
	Gymnanthera cunninghamii (P3)	X	
	Marsdenia angustata	X	
Araliaceae	*Trachymene didiscoides*	X	
	Trachymene oleracea	X	
Asteraceae	*Centipeda minima*	X	
	* *Flaveria trinervia*	X	X
	Pentalepis trichodesmoides	X	
	Pluchea dentex	X	
	Pluchea dunlopii	X	
	Pluchea ferdinandi-muelleri	X	
	Pluchea rubelliflora	X	
	Pluchea tetranthera	X	
	Pterocaulon serrulatum	X	
	Pterocaulon sphacelatum	X	X
	Pterocaulon sphaeranthoides	X	X
	Pterocaulon sp.	X	
	Streptoglossa bubakii	X	X
	Streptoglossa decurrens	X	X
	Streptoglossa odora	X	
Boraginaceae	*Ehretia saligna* var. *saligna*	X	X
	Heliotropium chrysocarpum	X	
	Heliotropium cunninghamii	X	
	Heliotropium heteranthum	X	X
	Heliotropium ovalifolium	X	
	Heliotropium paniculatum	X	X
	Heliotropium skeleton	X	X
	Heliotropium tenuifolium	X	X
	Heliotropium sp.	X	X
	Trichodesma zeylanicum var. *zeylanicum*	X	X

APPENDIX D: VASCULAR PLANT SPECIES RECORDED IN THE SULPHUR SPRINGS PROJECT

Note: * denotes introduced species; T & P1 - P4 denotes threatened and priority taxon (DBCA 2018b, WAH 1998-); En - denotes Endangered under EPBC Act 1999 (DotEE 2018c)

FAMILY	SPECIES	MAPPED AREA	DEVELOPMENT AREA
Campanulaceae	*Lobelia arnhemiaca*	X	
	Wahlenbergia tumidifructa	X	
Caryophyllaceae	*Polycarpaea corymbosa* var. *corymbosa*	X	
	Polycarpaea holtzei	X	X
	Polycarpaea longiflora	X	
	Polycarpaea sp.	X	
Chenopodiaceae	*Dysphania rhadinostachya*	X	
	Dysphania sphaerosperma	X	
	Salsola australis	X	X
Cleomaceae	*Cleome uncifera*	X	X
	Cleome uncifera subsp. *uncifera*	X	
	Cleome viscosa	X	X
Combretaceae	*Terminalia canescens*	X	X
Convolvulaceae	*Bonamia linearis*	X	X
	Bonamia media	X	X
	Bonamia pannosa	X	X
	Bonamia rosea	X	X
	Bonamia sp.	X	X
	Duperreya commixta	X	
	Evolvulus alsinoides var. *villosicalyx*	X	
	Ipomoea muelleri	X	
	Polymeria ambigua	X	X
	Polymeria calycina	X	X
	Polymeria sp.	X	
Cucurbitaceae	*Cucumis melo*	X	
	Cucumis variabilis	X	X
	Cucumis sp.	X	X
	Trichosanthes cucumerina	X	X
Cyperaceae	*Bulbostylis barbata*	X	X
	Cyperus cunninghamii subsp. *cunninghamii*	X	X
	Cyperus hesperius	X	
	Cyperus iria	X	
	Cyperus squarrosus	X	
	Cyperus vaginatus	X	X
	Cyperus viscidulus	X	X
	Eleocharis atropurpurea	X	
	Fimbristylis dichotoma	X	
	Fimbristylis littoralis	X	
	Fimbristylis microcarya	X	X
	Fimbristylis simulans	X	X
	Fimbristylis sp.	X	X
	Fuirena ciliaris	X	
	Lipocarpha microcephala	X	
	Schoenus falcatus	X	X
Elatinaceae	*Bergia pedicellaris*	X	X

APPENDIX D: VASCULAR PLANT SPECIES RECORDED IN THE SULPHUR SPRINGS PROJECT

Note: * denotes introduced species; T & P1 - P4 denotes threatened and priority taxon (DBCA 2018b, WAH 1998-); En - denotes Endangered under EPBC Act 1999 (DotEE 2018c)

FAMILY	SPECIES	MAPPED AREA	DEVELOPMENT AREA
Euphorbiaceae	*Euphorbia australis*	X	X
	Euphorbia biconvexa	X	
	Euphorbia clementii (P2)	X	X
	Euphorbia coghlanii	X	X
	Euphorbia drummondii	X	
	Euphorbia tannensis subsp. *eremophila*	X	X
	Euphorbia sp.	X	X
	Mallotus ?*dispersus*	X	X
	* *Ricinus communis*	X	
Fabaceae	*Acacia acradenia*	X	X
	Acacia adoxa var. *adoxa*	X	X
	Acacia ampliceps	X	X
	Acacia ancistrocarpa	X	X
	Acacia bivenosa	X	X
	Acacia colei	X	X
	Acacia coriacea subsp. *pendens*	X	X
	Acacia dictyophleba	X	
	Acacia hilliana	X	X
	Acacia inaequilatera	X	X
	Acacia maitlandii	X	X
	Acacia orthocarpa	X	X
	Acacia pruinocarpa	X	X
	Acacia ptychophylla	X	X
	Acacia pyrifolia	X	X
	Acacia sericophylla	X	
	Acacia sphaerostachya	X	
	Acacia spondylophylla	X	X
	Acacia stellaticeps	X	
	Acacia synchronicia	X	
	Acacia trachycarpa	X	X
	Acacia tumida	X	X
	Acacia tumida var. *pilbarensis*	X	X
	Acacia victoriae	X	
	Acacia sp.	X	
	Alysicarpus muelleri	X	
	Cajanus cinereus	X	X
	Cajanus marmoratus	X	
	Crotalaria cunninghamii	X	X
	Crotalaria medicaginea	X	
	Crotalaria ramosissima	X	
	Cullen lachnostachys	X	
	Cullen leucanthum	X	X
	Cullen leucochaites	X	X
	Cullen martinii	X	
	Cullen pogonocarpum	X	
	Cullen stipulaceum	X	
	Desmodium filiforme	X	
	Desmodium muelleri	X	X
	Indigastrum parviflorum	X	
	Indigofera colutea	X	
	Indigofera linifolia	X	
	Indigofera linnaei	X	

APPENDIX D: VASCULAR PLANT SPECIES RECORDED IN THE SULPHUR SPRINGS PROJECT

Note: * denotes introduced species; T & P1 - P4 denotes threatened and priority taxon (DBCA 2018b, WAH 1998-); En - denotes Endangered under EPBC Act 1999 (DotEE 2018c)

FAMILY	SPECIES	MAPPED AREA	DEVELOPMENT AREA
Fabaceae (continued)	*Indigofera monophylla*	X	X
	Indigofera rugosa	X	
	Indigofera trita	X	
	Isotropis atropurpurea	X	X
	Neptunia dimorphantha	X	X
	Petalostylis labicheoides	X	X
	Rhynchosia minima	X	X
	Rhynchosia sp.	X	
	Senna artemisioides subsp. *helmsii*	X	
	Senna artemisioides subsp. *oligophylla*	X	X
	Senna charlesiana	X	X
	Senna glutinosa	X	X
	Senna glutinosa subsp. ×*luerssenii*	X	X
	Senna glutinosa subsp. *glutinosa*	X	
	Senna notabilis	X	X
	Senna symonii	X	X
	Senna venusta	X	X
	Senna sp.	X	
	Sesbania cannabina	X	X
	Sesbania formosa	X	
	Swainsona formosa	X	X
	Templetonia hookeri	X	X
	Tephrosia clementii	X	
	Tephrosia rosea	X	X
	Tephrosia rosea var. *clementii*	X	X
	Tephrosia rosea var. *rosea*	X	
	Tephrosia simplicifolia	X	
	Tephrosia spechtii	X	X
	Tephrosia supina	X	X
	Tephrosia sp. B Kimberley Flora (C.A. Gardner 7300)	X	X
	Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	X	X
	Tephrosia sp.	X	
	Vigna lanceolata var. *lanceolata*	X	
	Zornia chaetophora	X	
Goodeniaceae	*Dampiera candicans*	X	X
	Goodenia cusackiana	X	X
	Goodenia lamprosperma	X	
	Goodenia microptera	X	X
	Goodenia muelleriana	X	X
	Goodenia stobbsiana	X	X
	Goodenia sp.	X	
	Scaevola amblyanthera var. *centralis*	X	
	Scaevola parvifolia subsp. *pilbarae*	X	
Haloragaceae	*Gonocarpus ephemerus*	X	
	Haloragis gossei	X	
Lamiaceae	*Clerodendrum floribundum* var. *angustifolium*	X	
	Clerodendrum floribundum var. *floribundum*	X	
	Clerodendrum tomentosum	X	X
	Clerodendrum sp.	X	X
	Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	X	X

APPENDIX D: VASCULAR PLANT SPECIES RECORDED IN THE SULPHUR SPRINGS PROJECT

Note: * denotes introduced species; T & P1 - P4 denotes threatened and priority taxon (DBCA 2018b, WAH 1998-); En - denotes Endangered under EPBC Act 1999 (DotEE 2018c)

FAMILY	SPECIES	MAPPED AREA	DEVELOPMENT AREA
Lauraceae	*Cassytha capillaris*	X	X
Loganiaceae	*Mitrasacme connata*	X	
Lythraceae	*Ammannia auriculata*	X	X
	Ammannia baccifera	X	X
	Rotala diandra	X	
Malvaceae	*Abutilon lepidum*	X	
	Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	X	X
	Abutilon sp. Pilbara (W.R. Barker 2025)	X	
	Abutilon sp.	X	
	Corchorus elachocarpus	X	
	Corchorus laniflorus	X	X
	Corchorus parviflorus	X	X
	Corchorus sp.	X	X
	Gossypium australe	X	X
	Gossypium robinsonii	X	X
	Hibiscus brachychlaenus	X	
	Hibiscus coatesii	X	X
	Hibiscus leptocladus	X	
	Hibiscus panduriformis (P3)	X	
	Hibiscus sturtii	X	
	Hibiscus sturtii var. *campylochlamys*	X	X
	Hibiscus sturtii var. *platychlamys*	X	X
	Hibiscus sp.	X	
	Melhania sp.	X	
	Seringia elliptica	X	
	Seringia nephrosperma	X	
	Sida cardiophylla	X	X
	Sida clementii	X	
	Sida fibulifera	X	X
	Sida rohlenae subsp. *rohlenae*	X	
	Sida spinosa	X	X
	Sida sp. A Kimberley Flora (P.A. Fryxell & L.A. Craven 3900)	X	X
	Sida sp. Articulation below (A.A. Mitchell PRP 1605)	X	
	Sida sp. Pilbara (A.A. Mitchell PRP 1543)	X	X
	Sida sp.	X	
	Triumfetta chaetocarpa	X	X
	Triumfetta clementii	X	X
	Triumfetta maconochieana	X	X
	Triumfetta propinqua	X	X
	Triumfetta sp.	X	
	Waltheria indica	X	
	Waltheria virgata	X	
Marsileaceae	*Marsilea hirsuta*	X	X
Menispermaceae	*Tinospora smilacina*	X	
Molluginaceae	*Trigastrotheca molluginea*	X	X
Moraceae	*Ficus aculeata* var. *indecora*	X	X
	Ficus platypoda	X	X

APPENDIX D: VASCULAR PLANT SPECIES RECORDED IN THE SULPHUR SPRINGS PROJECT

Note: * denotes introduced species; T & P1 - P4 denotes threatened and priority taxon (DBCA 2018b, WAH 1998-); En - denotes Endangered under EPBC Act 1999 (DotEE 2018c)

FAMILY	SPECIES	MAPPED AREA	DEVELOPMENT AREA
Myrtaceae	*Corymbia ferriticola*	X	X
	Corymbia hamersleyana	X	X
	Corymbia zygophylla	X	
	Corymbia sp.	X	X
	Eucalyptus camaldulensis subsp. *obtusa*	X	
	Eucalyptus leucophloia	X	X
	Eucalyptus leucophloia subsp. *leucophloia*	X	
	Eucalyptus victrix	X	X
	Melaleuca argentea	X	
	Melaleuca bracteata	X	X
	Melaleuca glomerata	X	X
	Melaleuca lasiandra	X	X
	Melaleuca linophylla	X	X
Nyctaginaceae	*Boerhavia burbidgeana*	X	
	Boerhavia coccinea	X	X
	Boerhavia gardneri	X	X
	Boerhavia sp.	X	
Onagraceae	*Ludwigia perennis*	X	
	Ludwigia sp.	X	X
Papaveraceae	* *Argemone ochroleuca*	X	
Phyllanthaceae	*Flueggea virosa* subsp. *melanthesoides*	X	X
	Notoleptopus decaisnei var. *decaisnei*	X	
	Phyllanthus maderaspatensis	X	X
Plantaginaceae	*Stemodia grossa*	X	X
	Stemodia viscosa	X	
Poaceae	*Aristida contorta*	X	
	Aristida holathera var. *holathera*	X	X
	Aristida holathera var. *latifolia*	X	
	Aristida hygrometrica	X	
	Aristida latifolia	X	
	Bothriochloa sp.	X	
	* *Cenchrus ciliaris*	X	X
	Chrysopogon fallax	X	X
	Cymbopogon ambiguus	X	X
	Cymbopogon obtectus	X	
	Cymbopogon procerus	X	X
	Cymbopogon sp.	X	
	* *Cynodon dactylon*	X	
	Dichanthium fecundum	X	
	Dichanthium sericeum subsp. *humilius*	X	X
	Digitaria brownii	X	
	Elytrophorus spicatus	X	X
	Enneapogon caerulescens	X	
	Enneapogon lindleyanus	X	X
	Enneapogon sp.	X	
	Eragrostis cumingii	X	
	Eragrostis eriopoda	X	

APPENDIX D: VASCULAR PLANT SPECIES RECORDED IN THE SULPHUR SPRINGS PROJECT

Note: * denotes introduced species; T & P1 - P4 denotes threatened and priority taxon (DBCA 2018b, WAH 1998-); En - denotes Endangered under EPBC Act 1999 (DotEE 2018c)

FAMILY	SPECIES	MAPPED AREA	DEVELOPMENT AREA
Poaceae (continued)	*Eragrostis tenellula*	X	X
	Eriachne aristidea	X	
	Eriachne benthamii	X	X
	Eriachne ciliata	X	X
	Eriachne festucacea	X	
	Eriachne mucronata	X	X
	Eriachne obtusa	X	X
	Eriachne pulchella	X	X
	Eriachne pulchella subsp. *dominii*	X	X
	Eriachne pulchella subsp. *pulchella*	X	X
	Eriachne tenuiculmis	X	X
	Eriachne sp.	X	X
	Heteropogon contortus	X	
	Iseilema dolichotrichum	X	X
	Iseilema eremaeum	X	
	Iseilema macratherum	X	X
	Paraneurachne muelleri	X	
	Paspalidium clementii	X	
	Paspalidium rarum	X	
	Paspalidium tabulatum	X	
	Schizachyrium fragile	X	
	Setaria dielsii	X	
	* *Setaria verticillata*	X	X
	Sporobolus actinocladus	X	
	Sporobolus australasicus	X	X
	Themeda avenacea	X	
	Themeda triandra	X	X
	Themeda sp.	X	
	Triodia angusta	X	X
	Triodia brizoides	X	X
	Triodia epactia	X	X
	Triodia lanigera	X	X
	Triodia longiceps	X	X
	Triodia melvillei	X	X
	Triodia schinzii	X	
	Triodia wiseana	X	X
	Triodia sp.	X	X
	Yakirra australiensis var. *australiensis*	X	
Polygalaceae	*Polygala isingii*	X	X
	Polygala sp.	X	
Portulacaceae	*Portulaca oleracea*	X	
Proteaceae	*Grevillea pyramidalis*	X	X
	Grevillea pyramidalis subsp. *leucadendron*	X	
	Grevillea pyramidalis subsp. *pyramidalis*	X	X
	Grevillea wickhamii	X	
	Grevillea wickhamii subsp. *aprica*	X	X
	Grevillea wickhamii subsp. *hispidula*	X	X
	Hakea chordophylla	X	X
	Hakea lorea subsp. *lorea*	X	X
	Hakea sp.	X	X

APPENDIX D: VASCULAR PLANT SPECIES RECORDED IN THE SULPHUR SPRINGS PROJECT

Note: * denotes introduced species; T & P1 - P4 denotes threatened and priority taxon (DBCA 2018b, WAH 1998-); En - denotes Endangered under EPBC Act 1999 (DotEE 2018c)

FAMILY	SPECIES	MAPPED AREA	DEVELOPMENT AREA
Pteridaceae	*Cheilanthes sieberi*	X	
Rubiaceae	*Oldenlandia crouchiana*	X	X
	Oldenlandia galioides	X	
	Synaptantha tillaeacea var. *tillaeacea*	X	
Santalaceae	*Santalum lanceolatum*	X	X
Sapindaceae	*Atalaya hemiglauca*	X	X
	Dodonaea coriacea	X	X
Scrophulariaceae	*Eremophila* sp.	X	
Solanaceae	*Nicotiana benthamiana*	X	
	Solanum diversiflorum	X	X
	Solanum horridum	X	
	* *Solanum nigrum*	X	
	Solanum phlomoides	X	X
Thymelaeaceae	*Pimelea ammocharis*	X	
Typhaceae	*Typha domingensis*	X	
Violaceae	*Hybanthus aurantiacus*	X	X
Zygophyllaceae	*Tribulopis angustifolia*	X	
	Tribulus hirsutus	X	
	Tribulus platypterus	X	
	Tribulus suberosus	X	

APPENDIX E: GEOGRAPHIC LOCATIONS OF THREATENED AND PRIORITY FLORA IN THE SULPHUR SPRINGS PROJECT DEVELOPMENT ENVELOPE

Note: * localities outside current project area; T denotes threatened taxa; P1 - P4 denotes priority taxon (DBCA 2018b, WAH 1998-); En - Endangered (DotEE 2018a)

Species	LOCATION (WGS84_Z50)		NO. PLANTS
	EASTING (mE)	NORTHING (mN)	
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	728201	7659636	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	728217	7659623	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	728380	7658790	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	729882	7659504	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	730109	7658829	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	729308*	7659084*	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	729357*	7658177*	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	729741*	7659025*	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	730137*	7658690*	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	730735*	7662487*	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	731733*	7662358*	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	732009*	7662565*	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	732282*	7653420*	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	732326*	7653399*	257 total
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T, En)	733023*	7654626*	257 total
Euphorbia clementii (P2)	738634	7673626	26
Euphorbia clementii (P2)	739170	7679939	28
Euphorbia clementii (P2)	726672	7667830	143
Euphorbia clementii (P2)	726714	7668001	139
Euphorbia clementii (P2)	726765	7667989	139
Euphorbia clementii (P2)	728040	7666664	89

APPENDIX F: GEOGRAPHIC LOCATIONS OF INTRODUCED (WEED) SPECIES RECORDED IN THE SULPHUR SPRINGS PROJECT DEVELOPMENT ENVELOPE

Species	Location (GDA94_Z50)		No. Plants	Area (m)	Condition	Reproductive Status	Comment
	Easting (mE)	Northing (mN)					
**Calotropis procera*	727862	7663410	1	-	Healthy	Flower, Fruit	Along creekline
**Cenchrus ciliaris*	728160	7660883	51-100	50x10	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	728118	7660881	100-200	50x20	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	728058	7660949	100-200	50x20	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	728373	7661152	26-50	50x10	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	728390	7661079	26-50	50x10	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	728583	7661626	51-100	100x20	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	728683	7661654	26-50	50x10	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	728909	7662061	51-100	50x10	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	728709	7662192	100-200	50x50	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	728374	7662695	200-500	100x20	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	728368	7662952	100-200	50x10	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	727878	7663899	200-500	100x20	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	727604	7664884	200-500	100x50	Very Stressed	Vegetative	Along creekline
**Cenchrus ciliaris*	727177	7665231	500+	100x50	Very Stressed	Vegetative	Along creekline
**Setaria verticillata*	728118	7660881	6-10	5x5	Very Stressed	Fruit	Along creekline
**Setaria verticillata*	728640	7662410	6-10	20x10	Dead Recent	Fruit	Along creekline

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 13/12/2017

Kingdom Plantae
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 119° 12' 19" E,21° 08' 49" S
Buffer 40km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	4895	*Abutilon lepidum*			
2.	42920	*Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)*			
3.	3198	*Acacia acradenia*			
4.	11215	*Acacia adoxa var. adoxa*			
5.	3209	*Acacia ampliceps*			
6.	13502	*Acacia coriacea subsp. pendens*			
7.	16174	*Acacia elachantha*			
8.	12673	*Acacia glaucocaesia*		P3	
9.	3370	*Acacia hilliana*			
10.	15289	*Acacia levata*		P3	
11.	3471	*Acacia orthocarpa (Needleleaf Wattle)*			
12.	29015	*Acacia pyrifolia var. pyrifolia*			
13.	15215	*Acacia retivenea subsp. clandestina*			
14.	13078	*Acacia sclerosperma subsp. sclerosperma*			
15.	3553	*Acacia spondylophylla*			
16.	13070	*Acacia synchronicia*			
17.	20319	*Acacia tumida var. pilbarensis*			
18.	2646	*Aerva javanica (Kapok Bush)*	Y		
19.	4740	*Atalaya hemiglauca (Whitewood)*			
20.	2770	*Boerhavia coccinea (Tar Vine, Wituka)*			
21.	11167	*Bonamia erecta*			
22.	6605	*Bonamia linearis*			
23.	751	*Bulbostylis burbidgeae*		P4	
24.	2870	*Calandrinia stagnensis*			
25.	258	*Cenchrus ciliaris (Buffel Grass)*	Y		
26.	19762	*Centipeda minima subsp. macrocephala*			
27.	29101	*Cleome uncifera subsp. uncifera*			
28.	4857	*Corchorus elachocarpus*			
29.	4862	*Corchorus parviflorus*			
30.	13467	*Corchorus trilocularis*			
31.	17084	*Corymbia zygophylla*			
32.	20179	*Crotalaria medicaginea var. neglecta*			
33.	7371	*Cucumis melo (Ulcardo Melon)*			
34.	41721	*Cucumis variabilis*			
35.	17118	*Cullen leucanthum*			
36.	48280	*Cynanchum viminale subsp. australe*			
37.	46558	*Cynodon convergens*			
38.	46555	*Cynodon prostratus*			
39.	809	*Cyperus rigidellus*			
40.	33596	*Dysphania melanocarpa forma leucocarpa*			
41.	357	*Enneapogon caerulescens (Limestone Grass)*			
42.	16730	*Eragrostis crateriformis*		P3	
43.	380	*Eragrostis eriopoda (Woollybutt Grass, Wangurnu)*			
44.	400	*Eriachne aristidea*			
45.	407	*Eriachne festucacea (Plains Wandarrie Grass)*			
46.	414	*Eriachne obtusa (Northern Wandarrie Grass)*			
47.	14548	*Eucalyptus victrix*			
48.	4619	*Euphorbia biconvexa*			
49.	9048	*Euphorbia careyi*			
50.	4622	*Euphorbia clementii*		P2	
51.	11200	*Evolvulus alsinoides var. villosicalyx*			
52.	882	*Fimbristylis sieberiana*		P3	

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
53.	12159	*Fimbristylis simulans*			
54.	6151	*Gonocarpus ephemerus*			
55.	7521	*Goodenia lamprosperma*			
56.	2177	*Hakea lorea (Witinti)*			
57.	6706	*Heliotropium cunninghamii*			
58.	17393	*Heliotropium murinum*		P3	
59.	10891	*Heliotropium muticum*		P3	
60.	17313	*Heliotropium skeleton*			
61.	5215	*Hybanthus aurantiacus*			
62.	3985	*Indigofera rugosa*			
63.	31035	*Indigofera trita subsp. trita*			
64.	6631	*Ipomoea lonchophylla (Cowvine)*			
65.	3035	*Lepidium pedicellosum*			
66.	3037	*Lepidium phlebopetalum (Veined Peppercress)*			
67.	3038	*Lepidium pholidogynum*			
68.	37480	*Lobelia arnhemiaca*			
69.	6519	*Mitrasacme connata*			
70.	38422	*Notoleptopus decaisnei var. decaisnei*			
71.	4680	*Phyllanthus maderaspatensis*			
72.	37720	*Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4)*		T	Y
73.	8168	*Pluchea rubelliflora*			
74.	8170	*Pluchea tetranthera*			
75.	2898	*Polycarpaea corymbosa*			
76.	2902	*Polycarpaea involucrata*			
77.	2886	*Portulaca pilosa (Djanggara)*	Y		
78.	2695	*Ptilotus arthrolasius*			
79.	2728	*Ptilotus gomphrenoides*			
80.	2734	*Ptilotus incanus*			
81.	2744	*Ptilotus mollis*		P4	
82.	13150	*Scaevola browniana subsp. browniana*			
83.	48362	*Schoenoplectiella laevis*			
84.	46821	*Seringia nephrosperma (Free carpel fire-bush)*			
85.	31859	*Sida sp. Articulation below (A.A. Mitchell PRP 1605)*			
86.	7014	*Solanum horridum*			
87.	7029	*Solanum phlomoides*			
88.	7098	*Stemodia grossa (Marsh Stemodia, Mindjaara)*			
89.	7711	*Stylidium desertorum*			
90.	4223	*Swainsona decurrens*			
91.	12356	*Swainsona formosa*			
92.	4253	*Templetonia hookeri*			
93.	19531	*Tephrosia rosea var. clementii*			
94.	19529	*Tephrosia rosea var. rosea*			
95.	15947	*Tephrosia sp. B Kimberley Flora (C.A. Gardner 7300)*			
96.	41811	*Tephrosia sp. Fortescue (A.A. Mitchell 606)*			
97.	20380	*Tephrosia sp. Meentheena (S. van Leeuwen 4479)*			
98.	42442	*Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)*			
99.	40060	*Tephrosia sp. clay soils (S. van Leeuwen et al. PBS 0273)*			
100.	4285	*Tephrosia supina*			
101.	4286	*Tephrosia uniovulata*			
102.	4287	*Tephrosia virens*			
103.	44241	*Trianthema glossostigmum*			
104.	44305	*Trianthema pilosum*			
105.		*Trianthema sp.*			
106.	4368	*Tribulopis angustifolia*			
107.	4379	*Tribulus macrocarpus*			
108.	4380	*Tribulus occidentalis (Perennial Caltrop)*			
109.	7381	*Trichosanthes cucumerina*			
110.	48201	*Trigastrotheca molluginea*			
111.	680	*Triodia basedowii (Lobed Spinifex)*			
112.	45769	*Triodia basitricha (Pilbara Curly Spinifex)*		P3	
113.	13131	*Triodia epactia*			
114.	689	*Triodia lanigera*			
115.	4873	*Triumfetta appendiculata*			
116.	4875	*Triumfetta chaetocarpa (Urchins)*			
117.	16306	*Triumfetta deserticola*			
118.		*Vigna sp.*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement

Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area

S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

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

Australian Government
Department of the Environment and Energy

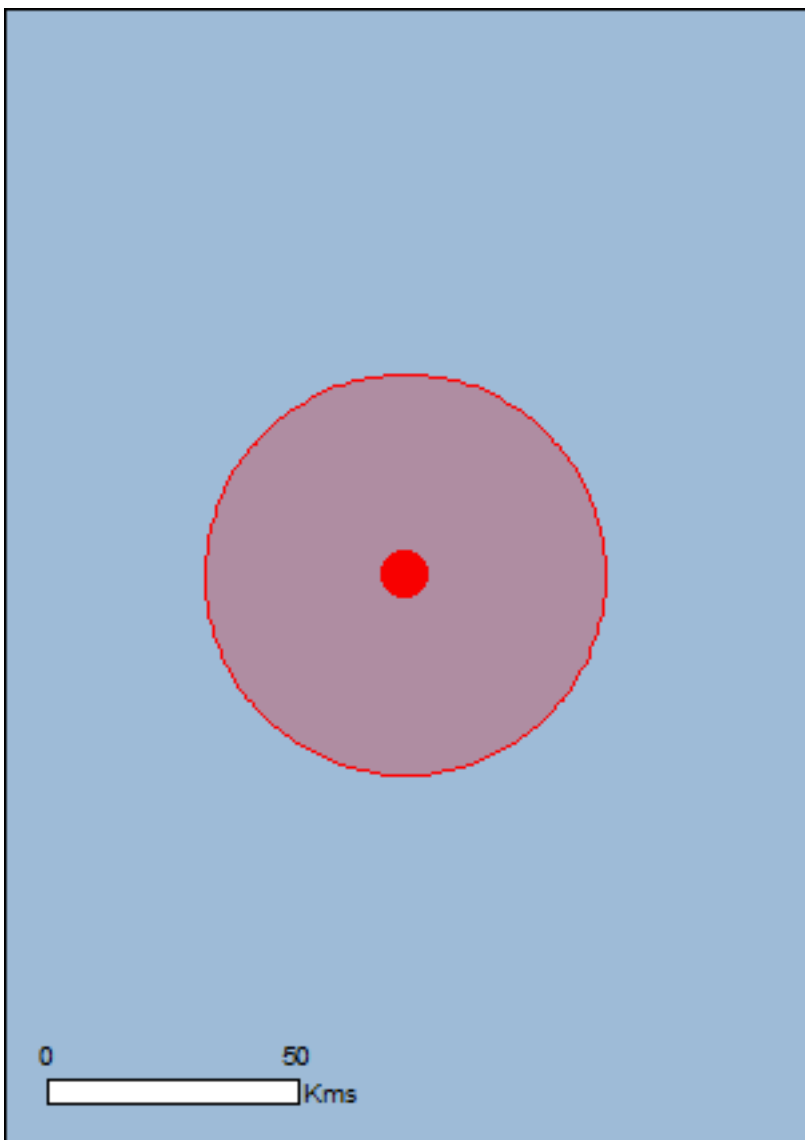
EPBC Act Protected Matters Report

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

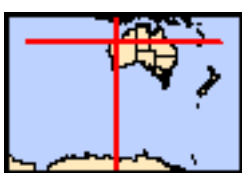
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 28/05/18 15:48:57



Coordinates
Buffer: 40.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	10
Listed Migratory Species:	12

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	17
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	12
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Breeding likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Roosting known to occur within area
Plants		
Pityrodia sp. Marble Bar (G.Woodman & D.Coultas GWDC Opp 4) [88310]	Endangered	Species or species habitat known to occur within area
Reptiles		
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur

Name	Threatened	Type of Presence within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

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

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area
[Charadrius veredus](#) Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
[Glareola maldivarum](#) Oriental Pratincole [840]		Species or species habitat may occur within area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Motacilla cinerea](#) Grey Wagtail [642]		Species or species habitat may occur within area
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat likely to occur within area
[Numenius madagascariensis](#) Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
[Pandion haliaetus](#) Osprey [952]		Species or species habitat likely to occur within area
[Rostratula benghalensis (sensu lato)](#) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-21.14694 119.20528

Acknowledgements

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

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

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

Please feel free to provide feedback via the Contact Us page.

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