



# Reconnaissance Flora and Vegetation Survey Caramulla

Prepared for BHP Western Australia Iron Ore  
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# EXECUTIVE SUMMARY

BHP Western Australia Iron Ore (BHP WAIO) commissioned Onshore Environmental Consultants Pty Ltd (Onshore Environmental) to undertake a reconnaissance (previously referred to as Level 1) flora and vegetation survey of the eastern portion of the Caramulla exploration mining lease (hereafter referred to as the study area). The study area is located approximately 46 km east of Newman and covers approximately 12,500 hectares (ha).

The reconnaissance flora and vegetation survey was completed under *poor* seasonal conditions between the 17<sup>th</sup> and 21<sup>st</sup> of February 2018, with a follow-up targeted flora survey of six bore holes in the western sector of the larger study area completed on the 23<sup>rd</sup> June 2018. There were no plant taxa gazetted as Threatened Flora pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act 1950* (WC Act) or listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) recorded from the study area. Five Priority flora taxa were recorded from the study area; *Eremophila capricornica* (Priority 1), *Ipomoea racemigera* (Priority 2), *Crotalaria smithiana* (Priority 3), *Rhagodia* sp. Hamersley (M. Trudgen 17794) (Priority 3) and *Goodenia nuda* (Priority 4). None of the plant taxa recorded was determined to represent a range extension based on the current known distribution of the species. An additional two species of interest were recorded from the study area; *Indigofera* sp. indet and *Tephrosia* sp. Willowra (G.M. Chippendale 4809).

A total of 30 vegetation associations classified into 12 broad floristic formations were described and mapped within the study area. None of the vegetation associations were determined to be aligned with Federal or State listed Threatened Ecological Communities (TECs) or State listed Priority Ecological Communities (PECs).

Five introduced species were recorded from the study area, none of which were listed as a Declared Pest under the *Biosecurity and Agriculture Management Act 2007* (BAM Act). Vegetation condition within the study area ranged from *excellent* to *good*, with the majority of the vegetation present at higher relief rated as *excellent*. The major disturbances were related to grazing by domestic cattle on drainage lines and floodplains resulting in altered vegetation structure and the introduction of weeds, particularly *\*Cenchrus ciliaris* (Buffel Grass).

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# 1.0 INTRODUCTION

## 1.1 Preamble

BHP WAIO is currently undertaking studies to support the Jimblebar mining operations, located approximately 46 km east of the town of Newman in the Pilbara region of Western Australia. Onshore Environmental was commissioned to undertake a single season reconnaissance flora and vegetation survey of the eastern portion of the Caramulla exploration mining lease. The study area abuts the eastern portion of the Ministerial Statement 857 approval area (Figure 1) and covers approximately 12,500 ha.

## 1.2 Previous Surveys

At least 43 baseline flora and vegetation or biological surveys have been completed at BHP WAIO tenements within a 25 km radius of the study area. These surveys are described in Appendix 1. Five of these previous surveys partially overlap the current survey area:

- Level 2 Riparian and Aquatic Flora and Vegetation survey Jimblebar Creek and Innawally Pool (Onshore Environmental 2016);
- Jimblebar Iron Ore Project Flora and Vegetation Assessment (Outback Ecology 2010);
- Caramulla Exploration Area Flora and Vegetation Survey and Fauna Assessment (GHD 2009);
- Hashimoto Exploration Project Biological Survey: Flora and Vegetation (Ecologia 2007); and
- East Jimblebar Exploration Project Biological Survey (Ecologia 2005).

Additional vegetation mapping was completed across the study area by Onshore Environmental in 2013 as part of a regional consolidation of vegetation mapping:

- Consolidation of Regional Vegetation Mapping (Onshore Environmental 2014a).

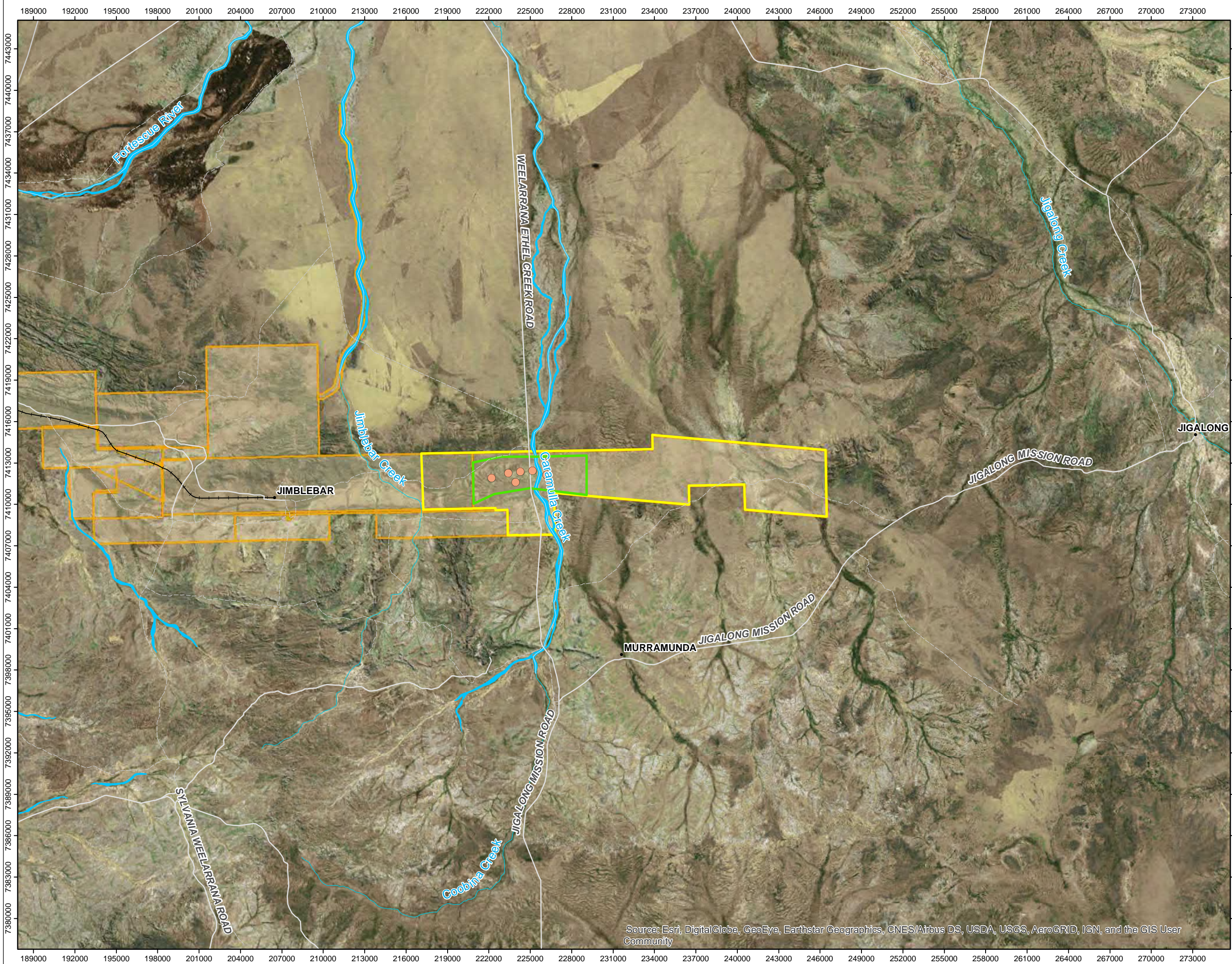
## 1.3 Climate

The Pilbara region has an arid to tropical climate with two distinct seasons; a hot summer from October to April, and a mild winter from May to September. The majority of annual rainfall is received during the hot summer months, typically associated with cyclonic activity and thunderstorms, with falls being of higher intensity and shorter duration contributing to an erratic annual range (Australian Natural Resource Atlas [ANRA] 2013).

Annual rainfall for Newman ranges from 36 mm to over 619 mm, with a long-term average of 332 mm occurring over 30 rain days (BOM 2018). Most of the annual precipitation occurs during the four summer months from December to March. The average maximum summer temperature ranges between 38°C and 40°C, while winter maximum temperatures range from 28°C to 30.5°C (BOM 2018).

The field survey was undertaken in mid-February 2018 and seasonal conditions were rated as *poor*. Rainfall for 2017 was well above average with an annual total of 519 mm. However, the majority of this rainfall fell early in the year with November and December both recording below average falls. Rainfall for January 2018 was slightly higher than average at 84.2 mm but relatively ineffective to plant growth at the time of field survey (Figure 2, BOM 2018).



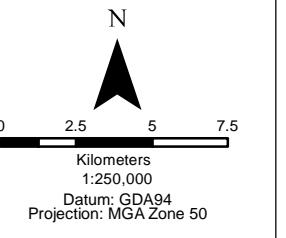
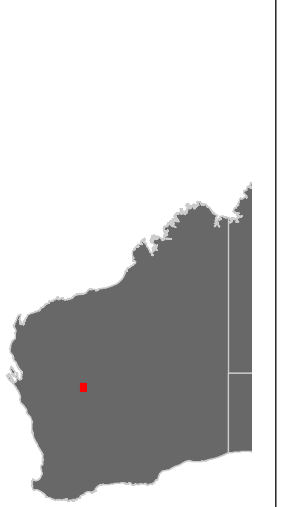


**BHP WAIO  
CARAMULLLA  
2018**

**Study Area  
Location**

**Legend**

- Study Area
- BHP Tenure
- Targeted Survey of Boreholes
- Boreholes locations

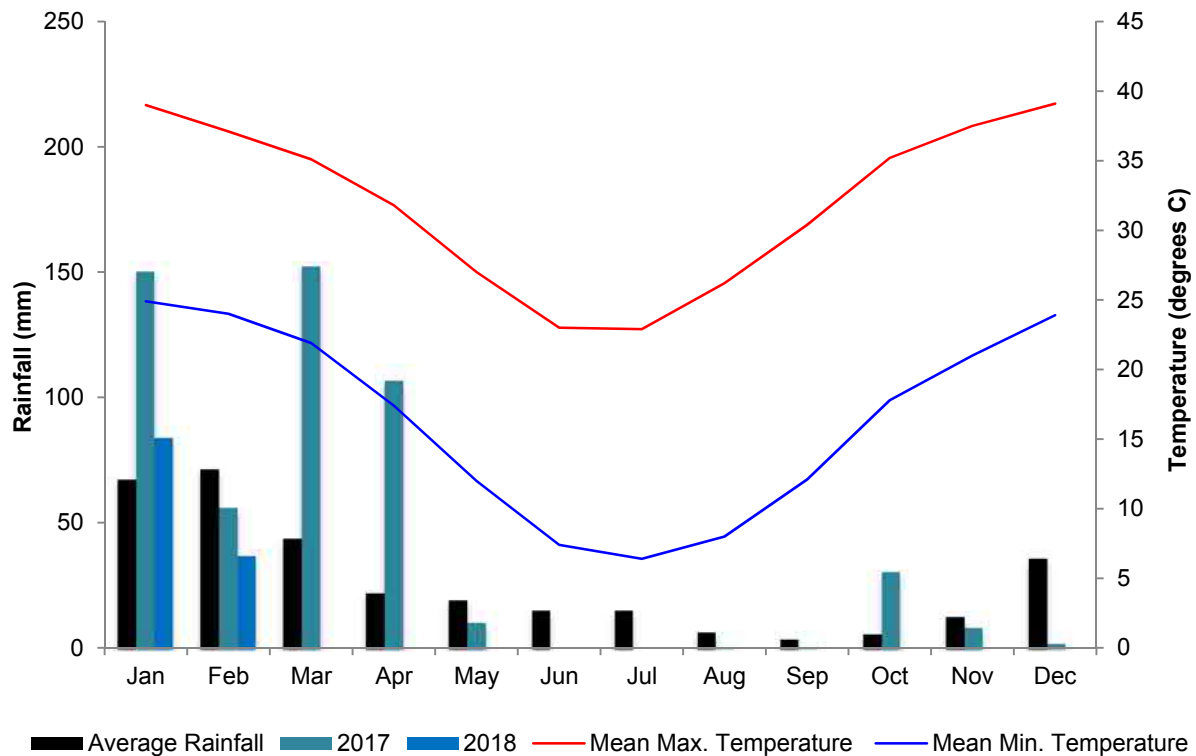


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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





**Figure 2** Climatic data recorded from Newman Airport, with long term monthly rainfall compared against monthly rainfall for 2017 and January-February 2018 (BoM 2018).

## 1.4 Biogeographic Regions

The Interim Biogeographic Regionalisation for Australia (IBRA7) divides Australia into 89 bioregions and 419 sub-regions based on climate, geology, landform, native vegetation and species information (Department of Environment 2013). The study area lies on the boundary between the Pilbara and Gascoyne bioregions. The Pilbara bioregion consists of four sub-regions: Chichester, Fortescue, Hamersley and Roebourne. The study area is located at the southern edge of the Fortescue sub-region (PIL2), adjacent to the boundary of the Hamersley sub-region (PIL3). The Augustus sub-region (GAS3) of the Gascoyne bioregion lies just to the south of the study area.

The Fortescue sub-region is described as alluvial plains and river frontage with extensive salt marsh, mulga-bunch grass, and short grass communities on alluvial plains in the east (Kendrick 2001a). River gum woodlands fringe the drainage lines and it contains the northern limit of Mulga. It also contains a broad calcrete aquifer (originating within a paleo-drainage valley) that feeds many permanent springs in the central Fortescue, supporting large permanent wetlands with extensive stands of River Gum (*Eucalyptus camaldulensis*) and Cadjeput (*Melaleuca argentea*) woodlands (Kendrick 2001a). Caramulla Creek runs through the study area and forms part of the Fortescue River catchment area.

The adjacent Hamersley sub-region is described as a mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite) (Kendrick 2001b). It contains Mulga low woodland over bunch grasses on fine textured soils in valley floors, and *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils of the ranges.

The nearby Augustus sub-region is described as low rugged ranges of Proterozoic sedimentary and granite ranges interspersed by broad flat valleys. The sub-region includes the Narryera Complex and Bryah Basin of the Proterozoic Capricorn Orogen (on northern margin of the Yilgarn Craton), as well as the Archaean Marymia and Sylvania Inliers. The main drainage in the sub-region is to the Gascoyne River, however the area also contains the headwaters of the Ashburton



River and Fortescue River. Extensive areas of alluvial valley-fill deposits occur within this sub-region. The vegetation on rises consists of Mulga woodland and *Triodia* on shallow stony loams. The hardpan plains of the sub-region are dominated by Mulga parkland with shallow earthy loams (Desmond *et al.* 2001).

## 1.5 Existing Land Use

Land tenure in the Pilbara consists of Aboriginal and leasehold reserves, national parks and reserves and Crown land which fall under a range of pastoral and mining leases. The current use of lands surrounding the study area is predominantly for mineral exploration, iron ore mining and dry land agriculture, specifically pastoralism, cattle grazing and rangelands. The study area is located on Sylvania Station within the Shire of East Pilbara, and approximately 8 km east of the existing Jumblebar mining operations (Figure 1).

Conservation lands amount to less than ten percent of the total area of the Pilbara Bioregion, with the major reserves being Karijini and Millstream-Chichester National Parks. These parks are supplemented by lesser conservation estates such as Cane River and Meentheena Conservation Parks. Wetlands of National Significance include the permanent pools of Millstream and Karijini National Parks and the Fortescue Marsh. The study area is not within or adjacent to any gazetted conservation reserves. The Collier Range National Park is the nearest reserve, situated approximately 125 km to the south. Karijini National Park is located approximately 150 km west north-west of the study area.

## 1.6 Landforms

The study area is located at the eastern end of the Ophthalmia Range, which together with the Hamersley Range encompass the Hamersley Plateau. The Hamersley Plateau is characterised by long strike ridges rising 300 m or more above valley floors and flats. Other characteristic landforms of the general area include stony plains and some alluvial plains and sandplains (Tille 2007). The entire region contains mainly rounded ranges and hills in contrast to the characteristic 'mesa form' hills that are located further to the north-east. The source of Caramulla Creek lies at the base of these ranges and flows out into the sloping plains to the north which feed in to the Fortescue Marsh. Specific landforms occurring within the study area include hardpan plains with banded mulga, drainage lines, low hills and sandplains.

## 1.7 Soils

Tille (2007) classified the most recent and detailed mapping of Western Australia's Rangelands and Arid Interior into a hierarchy of soil-landscape mapping units. The study area is located within the following soil unit:

- 285: Hamersley Plateaux Zone, located in the Fortescue Province and described as having stony soils with red shallow loams and some red/brown non-cracking clays and red loamy earths.

The Australian Soil Resource Information System (CSIRO 2006) described five soil types as occurring within the study area and surrounds:

- Mz25: Plains associated with the Fortescue valley; there is a surface cover of stony gravels close to the ranges and hills: chief soils are acid red earths (Gn2.11) with some neutral red earths (Gn2.12); red-brown hardpan is absent. Associated are areas of calcareous earths (Gc) and loams (Um1) on calcrete (kunkar) and some hard red (Dr) soils around creek lines;
- MM16: Alluvial plains dominated by deep cracking clays (Ug5.38), along with some areas of (Uf6.71) soils and minor areas of (Dr2.33) soils;
- BE6: Extensive flat and gently sloping plains, which sometimes have a surface cover of gravels and on which red-brown hardpan frequently outcrops: chief soils are shallow earthy

loams (Um5.3), with associated (Gn) soils of units My5O and Mz23 of Sheet 6. As mapped, there are inclusions of units Oc47 and BB9.

- Fa13: Ranges of banded jaspilite and chert along with shales, dolomites, and iron ore formations; some areas of ferruginous duricrust as well as occasional narrow winding valley plains and steeply dissected pediments. This unit is largely associated with the Hamersley and Ophthalmia Ranges. The soils are frequently stony and shallow and there are extensive areas without soil cover: chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5.11) soils on the steeper slopes. Associated are (Dr2.33, Dr2.32) soils on the limited areas of dissected pediments, while (Um5.52) and (Uf6.71) soils occur on the valley plains; and
- Mz36: Pediments with some steep hills on granites; granitic residuals; bosses and tors: chief soils are acid red earths (Gn2.11) overlying a red-brown hardpan. Other soils include (Uc5.11) and (Dr2.32).

## 1.8 Geology

The ancient continental Western Shield dominates the geology of Western Australia. The Pilbara region makes up a portion of the Western Shield and consists of pre-Cambrian, Proterozoic and Archaean rocks. The area contains some of the earth's oldest rock formations, thought to be around 3.5 billion years old (ANRA 2013). Important mineral reserves, including iron ore, which is prevalent in the Pilbara, are associated with these rock formations. The study area is situated in the southern edge of the Pilbara Craton in close proximity to the sedimentary basins that separate the Yilgarn and Pilbara Cratons. These consist of the sandstone and shales of the Collier and Bresnahan Basins and granites of the Sylvania Inlier (Tille 2007).

The Pilbara Craton lies beneath the Proterozoic rocks of the Hamersley and Bangemall Basins. The Hamersley Basin covers the majority of the southern part of the Pilbara Craton and is separated into three stratigraphic groups; the Fortescue, Hamersley and Turee Creek rock groups.

The Fortescue Group consists mainly of basalt with beds of siltstone, mudstone, shale, dolomite and jaspilite. These rocks form the Chichester Plateau, which lies beneath the Hamersley Plateau. The Turee Creek Group consists of interbedded mudstone, siltstone, sandstone, conglomerate and carbonate. These rocks are the youngest of the three groups and are exposed mainly in the Ashburton Valley. The Hamersley Group is the most relevant to the study area as it contains both the Brockman Iron Formation and the Marra Mamba Iron Formation, which together provide most of the major iron ore deposits in the Pilbara (O'Brien and Associates 1992). This group forms the Hamersley Range and Plateau and consists of jaspilite and dolomite. The jaspilite produces deposits of haematite and limonite, which are mined for iron ore.

The surface geology of the study area is dominated by the following geological formations (Williams and Tyler 1991):

- Fj: Jeerinah Formation: interbedded shale, chert, sandstone, minor felsic tuff;
- Hb: Brockman Iron Formation: banded iron-formation, chert shale;
- Hj: Weeli Wollli Formations: interlayered banded iron-formation, and metadoleritic sills, minor shale;
- Hm: Marra Mamba Iron Formation: chert, ferruginous chert, minor shale;
- Ho: Boolgeeda Iron Formation: fine grained, finely laminated, dark grey brown to black flaggy iron-formation, minor chert, jaspilite shale;
- Hw: Woongarra Volcanics: rhyolite and rhyodacite as cills or flows; commonly porphyritic, phenocrysts of quartz, feldspar, minor tuff and jaspilitic iron-formation;
- MNs(c): Stag Arrow Formation: Interbedded quartz sandstone and conglomerate;
- MNs(s): Stag Arrow Formation: Shale, siltstone;
- Qa: Alluvium: clay, silt, sand, gravel; in drainage channels and adjacent flood plains;
- Qs: Eolian sand: in sheets and longitudinal (seif), chain and net dunes; and
- Qw: Colluvium and alluvium: clay, silt, sand, gravel in broad sheet wash areas; distinctive vegetation striped photo- pattern.



## 1.9 Hydrology

The study area is located within the Fortescue River Catchment. The hydrology of the area is dominated by ephemeral creeks and drainage lines flowing into major drainage lines to the north and east of the study area. Jimblebar Creek, Caramulla Creek and Fortescue River are the major drainage lines of the local area and all three flow north into the Fortescue River catchment area. Caramulla Creek dissects the study area and drains into a broader braided channel to the north.

All rivers in the Pilbara region are seasonal and require heavy rains to flow (Johnson 2004). Due to the hot dry climate and high evaporation rates groundwater is the most available source of water (Johnson 2004). The ground water table generally follows the surface topography. It is recharged via infiltration from rainfall, and stored in large groundwater reserves in the valley fill alluvium of the Fortescue River and Hamersley Range (Johnson 2004).

## 1.10 Flora and Vegetation

The study area is located within the Hamersley Botanical District, which is part of the Eremaean Province (Beard 1990). It is dominated by tree and shrub steppe communities consisting mainly of *Eucalyptus* and *Acacia* species; *Triodia pungens* and *Triodia wiseana* and some Mulga (*Acacia aptaneura*) occur within valley areas and short grass plains occur on alluvia.

Vegetation within the study area (Figure 3) is classified as the following vegetation associations, as mapped by Beard (1975) and later refined by Shepherd *et al.* (2002):

- 18: Low woodland; mulga (*Acacia aneura*);
- 29: Sparse low woodland; mulga, discontinuous in scattered groups;
- 82: Hummock grasslands, low tree steppe; Snappy gum over *Triodia wiseana*;
- 111: Hummock grasslands, shrub steppe; *Eucalyptus gamophylla* over hard spinifex;
- 157: Hummock grasslands, grass steppe; hard spinifex *Triodia wiseana*;
- 199: Hummock grasslands, shrub steppe; mulga over soft spinifex on rises; and
- 216: Low woodland; mulga (with spinifex) on rises.

While the Pre-European extent for each vegetation association is close to 100 percent, less than 18 percent of each association occurs within formal or informal reserves (Table 1).

**Table 1 Pre-European extent of vegetation associations occurring within the study area (Shepherd *et al.* 2002).**

Vegetation Association	Description	Pre-Euro. Extent Remaining (ha)	Remaining area (ha) in IUCN Class I-IV Reserves	% remaining Other Reserves	% remaining DBCA Managed PL
18 Kumarina Hills	Low woodland; mulga ( <i>Acacia aneura</i> )	24,659,110 (99.9%)	2.0	0.3	2.5
29 Fortescue Valley	Sparse low woodland; mulga, discontinuous in scattered groups	7,782,264 (100%)	0.3	0.0	2.4
82 Fortescue Valley	Hummock grasslands, low tree steppe; Snappy gum over <i>Triodia wiseana</i>	2,290,910 (100%)	8.9	0.2	1.0
111 Fortescue Valley and Kumarina Hills	Hummock grasslands, shrub steppe; <i>Eucalyptus gamophylla</i> over hard spinifex	814,103 (100%)	2.9	0.0	0.0

Vegetation Association	Description	Pre-Euro. Extent Remaining (ha)	Remaining area (ha) in IUCN Class I-IV Reserves	% remaining Other Reserves	% remaining DBCA Managed PL
157 Kumarina Hills	Hummock grasslands, grass steppe; hard spinifex <i>Triodia wiseana</i>	542,861 (100%)	17.6	0.0	0.0
199 Fortescue Valley	Hummock grasslands, shrub steppe; mulga over soft spinifex on rises	69,068 (100%)	0.0	0.0	0.0
216 Fortescue Valley	Low woodland; mulga (with spinifex) on rises	298,549 (100%)	0.0	0.0	0.0

## 1.11 Land Systems

The Department of Agriculture (now the Department of Primary Industries and Regional Development) conducted inventory and condition surveys of the Pilbara (van Vreeswyk *et al.* 2004) using an integrated survey method involving the land system approach to rangeland description evaluation. The primary objective of the surveys was to provide comprehensive descriptions and mapping of the biophysical resources of the region, as well as an evaluation on the condition of soils and vegetation.

A total of 102 land systems were defined in the Pilbara at a scale of 1: 250,000 (van Vreeswyk *et al.* 2004), thirteen of which occur within the study area (Table 2, Figure 4). The hills and plains in the western and north-eastern parts of the study area consist of the Newman, Robertson, McKay, Boolgeeda and Sylvania Land Systems. The central part of the study area consists of large areas of mulga which are part of the Washplain, Cadgie, Jamindie and Zebra Land Systems and areas of sandplains of the Divide Land System. Caramulla Creek and a second drainage area in the east of the study area are comprised of the River and Fortescue Land Systems. (Figure 4).

**Table 2 Land systems occurring within the study area (descriptions from van Vreeswyk *et al.* 2004).**

Land System	Representation in the Pilbara	Description
Boolgeeda	7,748 km <sup>2</sup> or 4.3%	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands.
Cadgie	495 km <sup>2</sup> or 0.3%	Hardpan plains with thin sand cover and sandy banks supporting mulga shrublands with soft and hard spinifex.
Divide	5,293 km <sup>2</sup> or 2.9%	Sandplains and occasional dunes supporting shrubby hard spinifex grasslands.
Fortescue	504 km <sup>2</sup> or 0.3%	Alluvial plains and flood plains supporting patchy grassy woodlands and shrublands and tussock grasslands.
Jamindie	2,074 km <sup>2</sup> or 1.1%	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey.
McKay	4,202 km <sup>2</sup> or 2.3%	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands.
Newman	14,580 km <sup>2</sup> or 8.0%	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.
River	4,088 km <sup>2</sup> or 2.3%	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.
Robertson	2,714 km <sup>2</sup> or 1.5%	Hills and ranges of sedimentary rocks supporting hard spinifex grasslands.



Land System	Representation in the Pilbara	Description
Sylvania	1,077 km <sup>2</sup> or 0.6%	Gritty surfaced plains and low rises on granite supporting acacia-eremophila-cassia shrublands.
Talga	2,124 km <sup>2</sup> , 1.2%	Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands.
Washplain	917 km <sup>2</sup> or 0.5%	Hardpan plains supporting groved mulga shrublands.
Zebra	374 km <sup>2</sup> or 0.2%	Hardpan plains with large linear gravelly sand banks supporting acacia shrublands with soft and hard spinifex.



**BHP WAIO  
CARAMULLA  
2018**

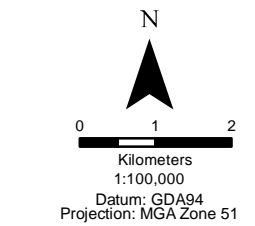
**Beard (1975) vegetation  
complexes within the  
study area**

**Legend**

Study Area

**Pre-European Vegetation  
(Beard 1975)**

- FORTESCUE VALLEY, 111
- FORTESCUE VALLEY, 199
- FORTESCUE VALLEY, 216
- FORTESCUE VALLEY, 29
- FORTESCUE VALLEY, 82
- KUMARINA HILLS, 111
- KUMARINA HILLS, 157
- KUMARINA HILLS, 18
- KUMARINA HILLS, 216
- KUMARINA HILLS, 28
- KUMARINA HILLS, 29



Date: 17/01/2018  
 Status: Final  
 Figure: 3  
 Sheet Size: A3  
 Internal Reference: Carr\_18\_Pre\_euro  
 Drawn by: GSM  
 Requested by: DB







# BHP WAIO CARAMULLA

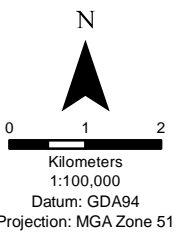
Land systems occurring  
within the study area  
(descriptions from van  
Vreeswyk *et al.* 2004)

## Legend

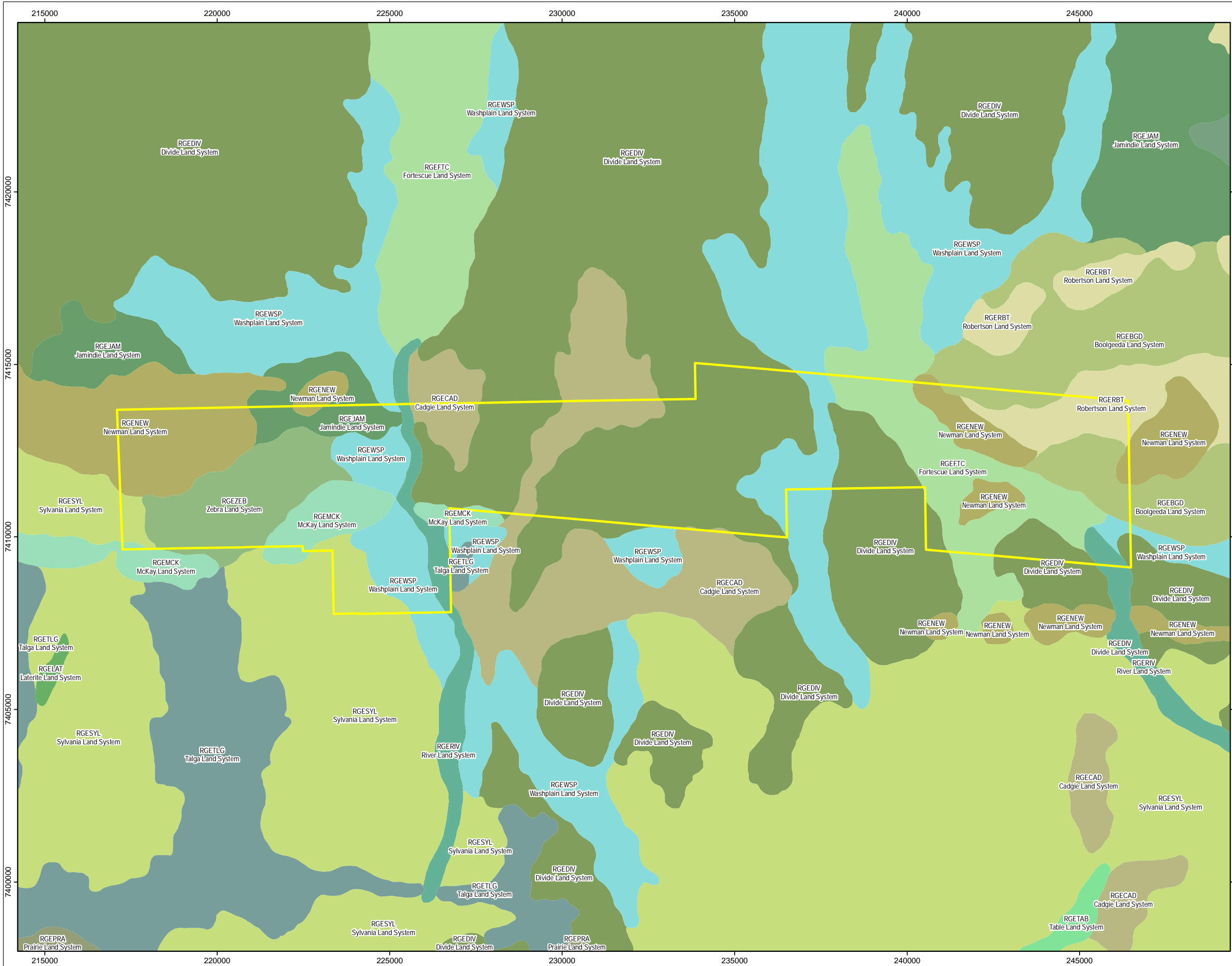
Study Area

Land Systems (within 5km)

- RGEBGD, Boolgeeda Land System
- RGEBLF, Balfour Land System
- RGECAD, Cadgie Land System
- RGEDIV, Divide Land System
- RGEFTC, Fortescue Land System
- RGEJAM, Jamindie Land System
- RGELAT, Laterite Land System
- RGEMCK, McKay Land System
- RGENEW, Newman Land System
- RGEPRP, Prairie Land System
- RGERBT, Robertson Land System
- RGERIV, River Land System
- RGESYL, Sylvania Land System
- RGETAB, Table Land System
- RGETLG, Talga Land System
- RGEWSP, Washplain Land System
- RGEZEB, Zebra Land System



Date: 17/01/2018  
 Status: Final  
 Figure: 4  
 Sheet Size: A3  
 Internal Reference: Carr\_18\_LandSys  
 Drawn by: GSM  
 Requested by: DB



## 2.0 METHODOLOGY

### 2.1 Legislation and Guidance Statements

The flora and vegetation survey was carried out in a manner that was compliant with Environmental Protection Authority (EPA) requirements for the environmental surveying and reporting of flora and vegetation in Western Australia:

- Statement of Environmental Principles, Factors and Objectives (EPA 2016a);
- Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016b); and
- Environmental Factor Guideline Flora and Vegetation (EPA 2016c).

The survey was also conducted in accordance with BHP WAIO's Vegetation and Flora Survey Procedure (BHP WAIO 2018).

### 2.2 Desktop Assessment

#### 2.2.1 Literature Review

A comprehensive literature review of surveys previously completed within or in close proximity to the study area was completed. At least 43 baseline flora and vegetation or biological surveys have been completed at BHP WAIO tenements within a 25 km radius of the study area.

#### 2.2.2 Database Searches

Database searches included databases relating to significant flora, TECs and PECs previously collected or described within, or in close proximity to, the study area. For this report the search was extended beyond the study area to place flora values into a local and regional context. The following databases were searched:

- NatureMap1: This database represents the most comprehensive source of information on the distribution of Western Australia's flora, comprising records from the DBCA Threatened Flora database and the WA Herbarium Specimen Database (40 km radial search, accessed 17<sup>th</sup> January 2018) (DPaW 2007);
- DBCA's Threatened and Priority flora database was searched to confirm the NatureMap results (50 km radial search, accessed 22<sup>nd</sup> January 2018) (DBCA 2018a);
- DBCA's TEC, PEC and Environmentally Sensitive Areas (ESAs) database was searched to identify significant communities (50 km radial search, accessed 2<sup>nd</sup> February 2018) (DBCA 2018b, 2018c);
- BHP Billiton Iron Ore's Threatened and Priority flora database was searched to identify records of significant flora known to be in close proximity of the study area (50 km radial search, accessed 11<sup>th</sup> January 2018);
- EPBC Act Protected Matters database (50 km radial search, accessed 17<sup>th</sup> January 2018) (DoEE 2018); and
- International Union for Conservation of Nature (IUCN) database (accessed 17<sup>th</sup> January 2018) (IUCN 2018).

#### 2.2.3 Assessment of Likelihood of Occurrence in the Study Area

A list of conservation significant species occurring within a 50 km radius of the study area was compiled during the literature review and database searches. The likelihood of each taxon occurring within the study area was assessed using a set of rankings and criteria (as described in Table 3). The criteria are based on presence of suitable landform (inferred from aerial imagery with contours overlaid, and from knowledge of the adjacent areas) and distance to known records.



**Table 3 Ranking system used to assign the likelihood that a species would occur in the study area.**

Rank	Criteria
Recorded	The species has been recorded in the study area.
Likely to occur	The species has previously been recorded from a landform which is present within the study area, and there are previous records within a 20 km radius of the study area.
Possible to occur	The species has previously been recorded from a landform which is present within the study area, and there are previous records within a 50 km radius of the study area.
Unlikely to occur	The landform from which the species has previously been recorded is absent within the study area, and/or there are no previous records within a 50 km radius of the study area.

## 2.3 Baseline Survey Methodology

### 2.3.1 Timing and Personnel

The reconnaissance flora and vegetation survey was completed by Principal Botanist Dr Jerome Bull and Senior Botanist Ms Jessica Waters working over a five-day period between the 17<sup>th</sup> and 21<sup>st</sup> February 2018. A follow-up targeted flora survey of six bore holes in the western sector of the larger study area was undertaken by the same two botanists on the 23<sup>rd</sup> June 2018.

### 2.3.2 Targeted Surveys for Conservation Significant Species

Targeted searches were conducted for conservation significant flora within the study area. Ground-truthing provided an opportunity to record opportunistic locations for Threatened and Priority listed flora, and undertake closer examination of specific landforms where conservation significant flora could be expected to occur.

### 2.3.3 Weed Survey and Mapping

Introduced flora species were recorded from relevé study sites assessed within the study area. Opportunistic collections were also made while moving around the study area, with targeted weed searches completed in high moisture habitats along the main drainage channels.

### 2.3.4 Vegetation Association Mapping

The vegetation mapping utilised high-resolution aerial photography of the entire study area at a scale of 1:20,000, with definition of vegetation polygons based on contrasting shading patterns. Ground-truthing of the study area was completed during the survey with vegetation descriptions made within selected vegetation polygons to confirm dominant structural layers and associated plant taxa.

The location of the relevé plots were overlaid on the aerial photography, and associated flora and vegetation data was used to provide vegetation association descriptions for individual polygons defined. Description of vegetation structure follows the height, life form and density classes of Specht (1970) as modified by Aplin (1979) and Trudgen (2009) (see Appendix 3). This is largely a structural classification suitable for broader scale mapping, but taking all ecologically significant strata into account.

### 2.3.5 Vegetation Association Coding

A vegetation association code was applied to each vegetation association. This code is comprised

of the dominate landform on which the vegetation association occurs and the dominant plant taxa in each vegetation stratum.

### 2.3.6 Vouchering

At least one voucher specimen was taken for each species collected to verify identification. Taxonomy was completed by Dr Jerome Bull, with selected voucher specimens provided to the Western Australian Herbarium (WAH). Use was made of the WAH for confirmation of species identification.

### 2.3.7 Field Survey Constraints

The EPA Technical Guidance (EPA 2016b) list seven potential limitations that field surveys may encounter. These constraints are addressed in Table 4.

**Table 4 Relevance of limitations, as identified by EPA (2016b), to the flora and vegetation survey.**

Constraint	Relevance
Availability of contextual information at a regional and local scale	Five previous flora and vegetation or biological surveys overlap the study area, as well as BHP WAIO consolidated vegetation mapping. There has been additional high intensity sampling from at least 37 other surveys of neighbouring BHP WAIO tenements within a 25 km radius of the study area, providing an extensive local database. This is confirmed by the intensity of records for the local area on FloraBase.
Proportion of flora recorded and/or collected, any identification issues	The reconnaissance flora and vegetation survey was aimed at describing and mapping vegetation associations, and recording flora of conservation significance and introduced flora. Hence, a large proportion of the more common taxa occurring within the study area were not collected. Seasonal conditions at the time of the February 2018 field survey were <i>poor</i> , resulting in an under-estimation of the ephemeral flora component. Additionally, there were peripheral areas of the study area that were inaccessible by foot (due to the distance from existing tracks), and may contain additional flora species that were not recorded in the wider study area.
Survey timing, rainfall, season of survey	The survey was completed in February 2018 under <i>poor</i> seasonal conditions resulting from relatively low summer rainfall during the months preceding field work.
Disturbance that may have affected the results of survey such as fire, flood or clearing	Disturbances within the study area included grazing of vegetation by domestic stock (cattle), presence of introduced flora species, historical mining exploration, and fire (mosaic of burn ages recorded). None of the disturbances were a constraint to completing the survey.
Was the appropriate area fully surveyed (effort and extent)	Two botanists working over a five-day period assessed a total of 115 relevé plots during the February 2018 field survey, representing an adequate survey intensity for a reconnaissance survey.
Access restrictions within the survey area	The study area was accessed by vehicle and on foot. Access constraints were compounded by the large size of the study area and absence of tracks through some sectors of the study area. However, all vegetation types mapped within the study area were assessed.
Competency/experience of the team carrying out the survey, including experience in the bioregion surveyed	The Principal Botanist working on the survey has over 15 years Pilbara experience, and the accompanying Senior Botanist has in excess of seven years Pilbara experience. Together the survey team has completed numerous surveys in close proximity to the study area over recent years.

### 2.3.8 Assessment of Conservation Significance

The conservation significance of flora and ecological communities are classified at a Commonwealth, State and Local level on the basis of various Acts and Agreements, including:

Commonwealth Level:

- EPBC Act: The DoEE lists Threatened flora and ecological communities, which are determined by the Threatened Species Scientific Committee according to criteria set out in the Act. The Act lists flora that are considered to be of conservation significance under one of six categories (Appendix 4).

State Level:

- WC Act: At a State level, native flora species are protected under the *WC Act – Wildlife Conservation Notice*. A number of species are assigned an additional level of conservation significance based on a limited number of known populations and the perceived threats to these locations.
- DBCA Priority list: DBCA produces a list of Priority species and ecological communities that have not been assigned statutory protection under the WC Act. Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added under Priorities 1, 2 or 3. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been removed from the threatened species list for other taxonomic reasons, are placed in Priority 4. These species require regular monitoring (see Appendix 5). The list of PECs identifies those that need further investigation before nomination for TEC status at a State level.

Local Level:

- Species may be considered of local conservation significance because of their patterns of distribution and abundance. Although not formally protected by legislation, such species are acknowledged to be in decline as a result of threatening processes, primarily habitat loss through land clearing.



## 3.0 RESULTS

### 3.1 Desktop Assessment

#### 3.1.1 Previous Flora and Vegetation Surveys

The flora and vegetation of the Pilbara has been assessed at a broad scale by Burbidge (1959) and Beard (1975). More recently, the Department of Agriculture completed an inventory and condition survey of the Pilbara based on land system mapping (van Vreeswyk *et al.* 2004). More specific data has been collected as part of DBCA's Pilbara Region Biological Survey 2002-2013. This dataset has recently been published (DBCA 2016d) and will provide added regional context that will benefit impact assessment for future development proposals within the Pilbara.

In addition to the larger broad scale surveys, an increasing number of smaller intensive flora and vegetation surveys have been completed in recent years associated with resource development projects. These surveys have resulted in the collection of a significant amount of site-specific biological survey data, most of which has been undertaken for formal environmental impact assessment. There are 43 relevant flora and vegetation or biological surveys that have been completed within a 25 km radius of the study area (Appendix 1). Five of these surveys occur within, or partly within, the study area, and the BHP WAIO consolidated vegetation mapping also covers the study area.

#### 3.1.2 Threatened Flora listed under the EPBC Act

A search of the EPBC Act Protected Matters database was undertaken for a 50 km buffer around the study area (DoEE 2018). The database search listed two Threatened Flora or their habitat as likely to occur within the search radius; *Lepidium catapycnon* (Hamersley Lepidium) and *Pityrodia augustensis* (Mt Augustus Foxglove). DBCA has recently downgraded *Lepidium catapycnon* from Threatened Flora to Priority 4 status.

The nearest known records for *Pityrodia augustensis* are over 300 km south of the study area (DoEE 2018). This species has been recorded from rocky hillsides near Mt Augustus and the Mt Fraser Range north of Meekatharra. While suitable habitat may be present surrounding the study area it is considered unlikely to occur due to absence of suitable habitat within the study area and distance to previous records.

#### 3.1.3 Threatened Flora listed under the IUCN Red List

A search of the International Union for Conservation of Nature (IUCN) database (IUCN 2018) determined that no Threatened Flora taxon was likely to occur within the study area.

#### 3.1.4 Threatened Flora listed under the WA Wildlife Conservation (Rare Flora) Notice

The DBCA rare flora database search (DBCA 2018a) did not identify any plant taxon gazetted as Threatened Flora (T) pursuant to subsection (2) of Section 23F of the WC Act from a 50 km radius around the study area.

#### 3.1.5 Priority Flora recognised by the DBCA

The DBCA rare flora database search (DBCA 2018a) identified 14 Priority flora taxa as potentially occurring within a 50 km radius of the study area. These taxa are described in more detail in Table 5. Two of these taxa have previously been recorded from within the study area; *Crotalaria smithiana* (Priority 3) and *Goodenia nuda* (Priority 4).

**Table 5 Significant flora previously recorded from a 50 km search radius of the study area (DBCA 2018a, DBCA 2018c).** SCC - State Conservation Code (WC Act) and DBCA (2018a), FCC - Federal Conservation Code (EPBC Act).

Taxon	Cons. Code	Life Form	Habitat Preference	Suitable Habitat Present	Likelihood in the Study Area
<i>Acacia</i> sp. East Fortescue (J. Bull & D. Roberts ONS A 27.01)	1	Perennial	Eroded BIF ironstone present on low undulating hills	Yes	Possible
<i>Amaranthus centralis</i>	3	Annual	River banks	Yes	Possible
<i>Aristida jerichoensis</i> var. <i>subspinulifera</i>	3	Perennial	Hard pan plains	Yes	Possible
<i>Crotalaria smithiana</i>	3	Annual	Floodplain	Yes	Previously recorded within study area
<i>Eremophila capricornica</i>	1	Perennial	Hardpan plains	Yes	Possible
<i>Eremophila pilosa</i>	1	Perennial	Red brown clay loam, sandplains	Yes	Likely
<i>Eremophila youngii</i> subsp. <i>lepidota</i>	4	Perennial	Stony red sandy loam; flats plains, floodplains, sometimes semi-saline, clay flats	Yes	Possible
<i>Goodenia berringbinensis</i>	4	Annual	Gilgai soaks with light yellow-brown clay soil	Yes	Possible
<i>Goodenia hartiana</i>	2	Perennial	Sand dune swales, sand hills	No	Unlikely
<i>Goodenia nuda</i>	4	Perennial	Plains and floodplains	Yes	Previously recorded within the study area
<i>Ipomoea racemigera</i>	2	Annual	Flats and stream channels	Yes	Possible
<i>Isotropis parviflora</i>	2	Annual	Valley slope of ironstone plateau	Yes	Possible
<i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794)	3	Perennial	Plains	Yes	Likely
<i>Triodia</i> sp. Mt Ella (M.E. Trudgen 12739)	3	Perennial	Amongst rocks and outcrops, gully slopes	Yes	Possible

### 3.1.6 TECs listed under State and Federal Legislation

A search of the EPBC Act Protected Matters database (DoEE 2018) confirmed there were no Federal listed TECs previously recorded within, or adjacent to, the study area. The nearest known TEC is the Endangered '*Ethel Gorge aquifer stygobiont community*' located approximately 33 km west of the study area.

Similarly, a search of the DBCA ecological community database (2018b) confirmed there were no current listed TEC records for the immediate study area.

### 3.1.7 PECs recognised by DBCA

A search of the State database (DBCA 20168b) confirmed there were no PECs within a 50 km radius of the study area.

## 3.2 Significant Flora

### 3.2.1 Threatened Flora listed under the WC Act and EPBC Act

No plant taxon gazetted as Threatened Flora (T) pursuant to subsection (2) of section 23F of the WC Act or listed under the EPBC Act was recorded from the study area.

### 3.2.2 Significant Flora

Five Priority flora taxa were recorded from the study area; *Eremophila capricornica* (Priority 1), *Ipomoea racemigera* (Priority 2), *Crotalaria smithiana* (Priority 3), *Rhagodia* sp. Hamersley (M. Trudgen 17794) (Priority 3) and *Goodenia nuda* (Priority 4) (Figure 5, Appendix 6).

*Eremophila capricornica* (Priority 1) is a newly described species (Nuytsia 2016) growing to 0.75 m tall and producing mauve to lilac flowers between June and August. It was listed as Priority 1 under DBCA Conservation Codes for Western Australian Flora in April 2017. There are two specimens of *Eremophila capricornica* in the WAH and both of these specimens match the recent collection from the study area. One of the WAH specimens was a collection by Onshore Environmental from the OB31 detailed flora and vegetation survey (Onshore Environmental 2014e). At the time this specimen was identified as *Eremophila demissa* by Mr Steven Dillon, the BHP sponsored botanist at the WAH, and noted as being worthy of lodgement due to it being a significant range extension. Buirchell and Brown (2016) have recently conducted an analysis of new and geographically restricted *Eremophila* taxa from Western Australia, resulting in 13 new taxa being described, including *Eremophila capricornica* (Buirchell and Brown 2016). The lodged specimen of *Eremophila demissa* originating from the OB31 survey was analysed by Buirchell and Brown on the 15<sup>th</sup> August 2017 and was subsequently determined to be *Eremophila capricornica*.

*Eremophila capricornica* can be separated from *Eremophila demissa* by its thinner and shorter sepals, lanceolate shaped sepals, less dense covering of glandular hairs on the inner sepal surface (versus densely glandular), shorter pedicel length (2-3 mm versus 3-7 mm), and its oblanceolate leaves (versus obovate to elliptic) (Plate 1).

Currently *Eremophila capricornica* is poorly collected with only two specimens lodged at the WAH. Hence, it is determined to have a restricted geographical range and has been assigned a conservation status of Priority 1. It is likely that this taxon is present across BHP WAIO tenements in the vicinity of the Jimblebar mining operations, including, but not necessarily restricted to, the tenements of OB31, Hashimoto and Caramulla. '*Eremophila demissa*' was also recorded from four study sites within the recent Jimblebar Creek and Innawally Pool survey (Onshore Environmental 2016), and these records are also likely to be *Eremophila capricornica*<sup>1</sup>. It is recommended that analysis of previous reports is undertaken to identify the occurrence of '*Eremophila demissa*' (now *E. capricornica*) and improve the likely distribution of this taxon in the area. Targeted field work is required to confirm identification of this taxon, and expand the distribution both within and outside of BHP WAIO tenements.

*Eremophila capricornica* was recorded from 38 locations within the study area during the current survey (Figure 5). It occurred on hill slopes, undulating low hills, stony plains and hardpan plains where it provided up to five percent ground cover. Vegetation descriptions recorded across the 38 locations were:

- Low Woodland of *Acacia aptaneura*, *Acacia catenulata* subsp. *occidentalis* and *Acacia pruinocarpa* over Open Hummock Grassland of *Triodia basedowii* with Open Shrubland of *Eremophila forrestii* subsp. *forrestii* and *Sida ectogama*;
- Low Woodland of *Acacia pteraneura* over High Open Shrubland of *Acacia wanyu* and *Acacia synchronicia* over Open Shrubland of *Senna glutinosa* subsp. *x luerssenii*;

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<sup>1</sup> These collections were not vouchered as the revision by Buirchell and Brown (2016) had not been completed at that time.



- Low Woodland of *Acacia catenulata* subsp. *occidentalis*, *Grevillea berryana* and *Acacia pteraneura* with Shrubland of *Sida ectogama*, *Dodonaea petiolaris* and *Eremophila forrestii* subsp. *forrestii* with Very Open Hummock Grassland of *Triodia pungens* and *Triodia basedowii*;
- Low Woodland of *Acacia catenulata* subsp. *occidentalis*, *Acacia pteraneura* and *Grevillea berryana* over Shrubland of *Sida ectogama* and *Dodonaea petiolaris* with High Open Shrubland of *Psydrax latifolia*, *Grevillea berryana* and *Eremophila latrobei* subsp. *latrobei*;
- Open Hummock Grassland of *Triodia vanleeuwenii* with Low Open Woodland of *Acacia pteraneura* over High Open Shrubland of *Acacia wanyu*; and
- Hummock Grassland of *Triodia vanleeuwenii* with Low Open Woodland of *Acacia pruinocarpa* and *Grevillea berryana* and High open Shrubland of *Acacia trudgeniana*, *Grevillea berryana* and *Acacia ancistrocarpa*.

*Ipomoea racemigera* (Priority 2) is a creeping annual herb or climber with white flowers (Plate 2). It has previously been recorded from Kununurra, Millstream-Chichester National Park, Newman and BHP WAIO's Dynasty tenement (Onshore Environmental 2015a). It was recorded from three locations along the major drainage line situated in the eastern sector of the study area (Figure 5). A total of 53 plants were recorded with scattered plants found at each location.

*Crotalaria smithiana* (Priority 3) is an annual herb to 0.4 m high with yellow flowers (Plate 3). It is known from several locations to the east of Newman, with a disjunct location to the south east of Halls Creek. This species also occurs in the Northern Territory, Queensland, New South Wales and South Australia. During the current survey, it was recorded from four locations associated with hardpan plains and floodplains in the eastern sector of the study area (Figure 5). A total of nine plants were recorded with scattered individuals present at each location. *Crotalaria smithiana* has previously been recorded as one plant from the south-east sector of the study area (GHD 2009).

*Rhagodia* sp. Hamersley (M. Trudgen 17794) (Priority 3) is a perennial chenopod growing to a height of 2 m and occurring in orange to red loam soils on flood plains (Plate 4). The current known distribution is restricted to the Pilbara Bioregion with increasing numbers of populations recorded in recent years between Tom Price and Newman. *Rhagodia* sp. Hamersley (M. Trudgen 17794) has previously been recorded from numerous BHP WAIO tenements in the south-east Pilbara. During the current survey it was recorded at 118 locations from a variety of habitats across the study area (Figure 5). A total of 218 plants were recorded from footslopes, sandplains, hardpan plains, floodplains, breakaways, stony plains, drainage lines and low undulating hills. Only scattered plants were recorded at each location.

*Goodenia nuda* (Priority 4) occurs on drainage levels, floodplains and sandplains as an erect annual or biennial herb to 0.5 m in height (Plate 5). *Goodenia nuda* is widespread throughout the Pilbara, with additional records from the northern Carnarvon and eastern Gascoyne Bioregions. This species is typically found in relatively mesic habitats, such as floodplains and drainage areas. *Goodenia nuda* has been recorded from approximately 555 locations throughout the Pilbara, including Karijini National Park, 200 km south-east of Newman, Port Hedland and south of Onslow. An isolated record occurs to the east of the Karlamilyi (Rudall River) National Park. It has been recorded from the majority of BHP WAIO tenements in the south-east Pilbara, with a large population known to occur at Davidson Creek (D.Brearley pers. comm.). *Goodenia nuda* was recorded from nine locations on floodplains, hardpan plains and sand plains within the central and eastern parts of the study area (Figure 5). Approximately 100 plants were recorded with scattered plants found at each location.



Plate 1 *Eremophila capricornica*



Plate 2 *Ipomoea racemigera*





Plate 3 *Crotalaria smithiana*



Plate 4 *Rhagodia* sp. Hamersley (M. Trudgen 17794)



Plate 5 *Goodenia nuda*

### 3.2.3 Species of Interest

Two species recorded from the study area were determined to represent species of interest; *Indigofera* sp. indet and *Tephrosia* sp. Willowra (G.M. Chippendale 4809).

Based on the most recent treatment of the *Indigofera* genus by Wilson and Rowe (2015), *Indigofera* sp. indet could not be matched with any other *Indigofera* from the Eremaean Province (including Northern Territory taxa from central Australia). It differed from *Indigofera trita*, *Indigofera boviparda*, *Indigofera chamaeclada* and *Indigofera georgei*.

Based on seven juvenile plants of *Indigofera* sp. indet collected from the one location point within the study area, the closest entity based on broad morphology is a specimen collected by Gibson, van Leeuwen, Langley and Brown on 22<sup>nd</sup> April 2014 from deep red sands on a burnt sand plain near the Carnarvon Range in the Little Sandy Desert (200 km south of the study area). This is similar habitat to the entity collected by Onshore Environmental at Caramulla, which was a red orange sandplain. Like *Indigofera* sp. indet. (Plate 6), the specimen collected by Gibson *et al.* has 3-5 leaflets, sparse to medium hairs which are short, ascending (not appressed) and biramous (medifixed rather than basifixed). More collections of the entity, preferably with good fruiting and flowering material, are required to verify the identification of this species. This material is likely to be available between April and June.

A total of 100 plants were recorded from a single location on a sandplain within the central northern sector of the study area (Figure 5). Vegetation was described as a Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Acacia aptaneura*, *Acacia ayersiana* and *Acacia pruinocarpa* and High Open Shrubland of *Eremophila fraseri*, *Acacia subcontorta* and *Acacia aptaneura*.

*Tephrosia* sp. Willowra (G.M. Chippendale 4809) is also considered to be a species of interest (Plate 7). This species is poorly collected in Western Australia, with one collection made in close proximity to the study area and two additional records from near the Northern Territory border in



the Great Sandy Desert Bioregion. It is recommended that this taxon be recollected when in flower and fruiting. *Tephrosia* sp. Willowra (G.M. Chippendale 4809) was recorded from three locations on hardpan plains within the south-east sector of the study area (Figure 5). A total of 19 plants were recorded. Vegetation was described as:

- Open Tussock Grassland of *Aristida contorta*, *Eulalia aurea* and *Aristida inaequiglumis* with Low Open Woodland of *Acacia aptaneura*, *Corymbia aspera* and *Acacia paraneura* and Open Shrubland of *Senna artemisioides* subsp. *helmsii* and *Solanum lasiophyllum*; and
- Tussock Grassland of *Eulalia aurea*, *Aristida inaequiglumis* and *Chrysopogon fallax* with Low Open Woodland of *Acacia aptaneura*, *Acacia paraneura* and *Hakea lorea* subsp. *lorea* and Low Open Shrubland of *Sida platycalyx*, *Sida fibulifera* and *Senna artemisioides* subsp. *oligophylla*.



Plate 6 *Indigofera* sp. indet



Plate 7     *Tephrosia* sp. Willowra (G.M. Chippendale 4809)



215000 220000 225000 230000 235000 240000 245000



BHP WAIO

Caramulla 2018

Significant Flora & Species of Interest

Legend

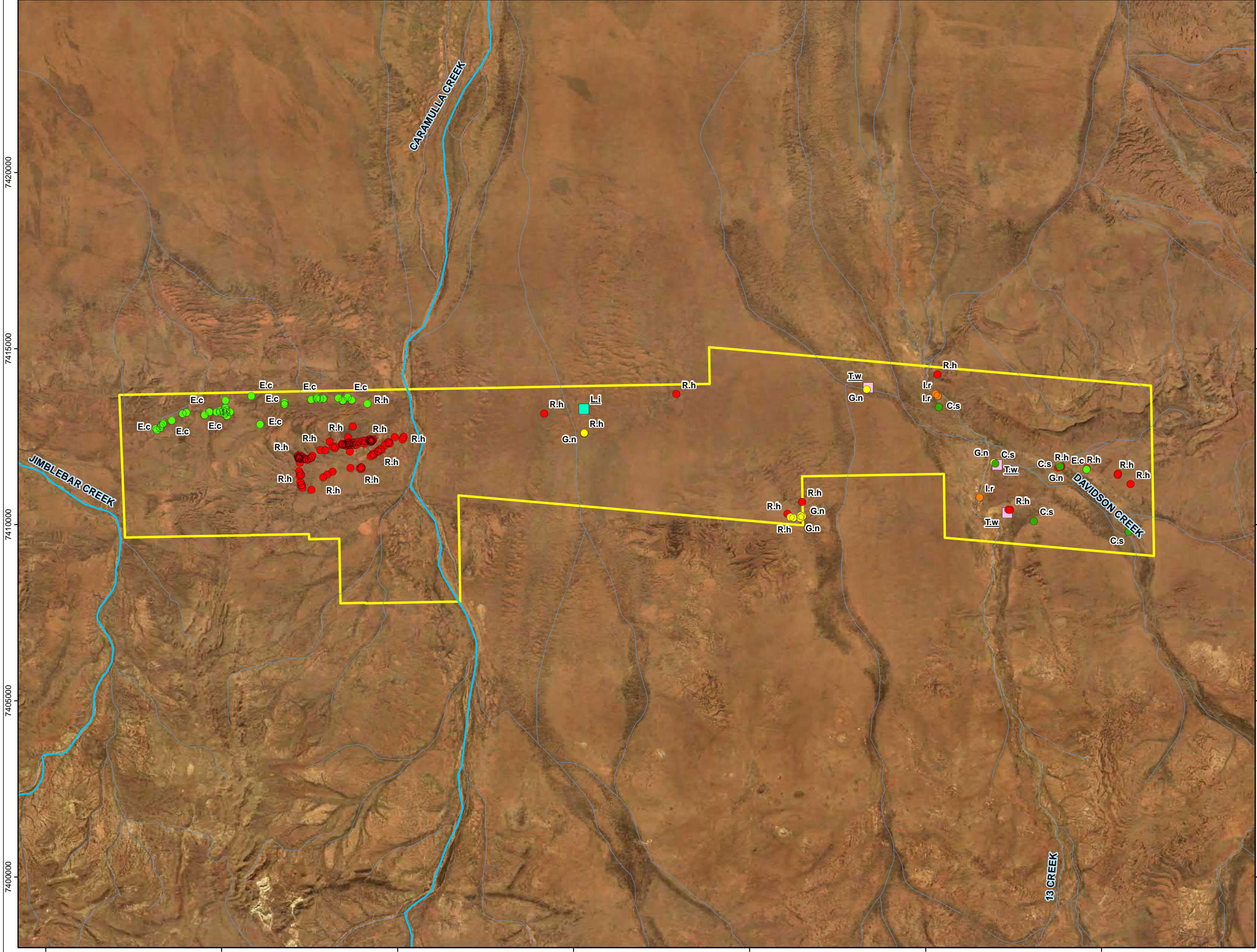
Study

Significant Flora

- *Crotalaria smithiana* (C.s)
- *Eremophila capricornica* (E.c)
- *Goodenia nuda* (G.n)
- *Ipomoea racemigera* (I.r)
- *Rhagodia* sp. Hamersley (M. Trudgen 17794) (R.h)

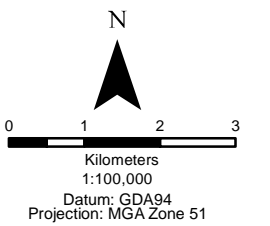
Flora of Interest

- *Indigofera* sp. Indet (L.i)
- *Tephrosia* sp. Willowra (G.M. Chippendale 4809) (T.w)



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### 3.3 Introduced Flora

There were five introduced species recorded from the study area (Table 6, Figure 6, Appendix 7):



- \**Bidens bipinnata* (Bipinnate Beggars Tick);
- \**Cenchrus ciliaris* (Buffel Grass);
- \**Citrullus* sp. indet (Melon);
- \**Malvastrum americanum* (Spiked Malvastrum); and
- \**Vachellia farnesiana* (Mimosa Bush).


None of these taxa are listed as a Declared Pest under the BAM Act.

**Table 6 Introduced species recorded from the study area.**

Taxon (Common Name)	Photograph	Description	Occurrence in study area
<p>*<i>Bidens bipinnata</i> (Bipinnate Beggars Tick)</p>		<p>Erect annual herb that grows up to 1 m in height. This species is widespread in the northern parts of Western Australia from Shark Bay up to the Northern Territory border. It has three pronged barbs on its seeds, so it is easily spread by livestock and other animals. In the Pilbara it is common in moist habitats such as drainage lines, floodplains and gorges, and responds vigorously following rainfall.</p>	<p>Recorded from two locations in the eastern sector of the study area associated with a major drainage line and floodplain. Over 100 plants were estimated at one location with 30 plants estimated at the second location. Ground cover was &lt;2 percent.</p>
<p>*<i>Cenchrus ciliaris</i> (Buffel Grass)</p>		<p>Tufted perennial grass originating from the Middle East as a fodder species by pastoralists. It grows in dense tussocks up to 1 m tall and typically occurs in monospecific stands on loamy plains and creekline levee banks. It is an aggressive colonising species that has become well established throughout the Pilbara, Gascoyne and Murchison regions of Western Australia, and is continuing to spread in the south west (Hussey <i>et al.</i> 1997).</p>	<p>Recorded from ten locations on plains, footslopes and banks associated with major drainage lines in the eastern (Davidson Creek) and western (Caramulla Creek) sectors of the study area. Over 1,500 plants were estimated providing ground coverage up to 10 percent.</p>



Taxon (Common Name)	Photograph	Description	Occurrence in study area
* <i>Citrullus</i> sp. indet		<p>Two species of <i>Citrullus</i> occur in the Pilbara: *<i>Citrullus colocynthis</i> and *<i>Citrullus lanatus</i>. Both species are trailing herbs/climbers that produce yellow flowers. The identification of specimens collected in the field were unable to be confirmed to species level.</p>	<p>Recorded from two locations on a major drainage line and adjacent floodplain in the eastern sector of the study area. A total of six plants were recorded with ground coverage of &lt;1 percent.</p>
* <i>Malvastrum americanum</i> (Spiked Malvastrum)		<p>Erect perennial herb or shrub ranging from 0.5 to 1.3 m in height. Found in a variety of soil types on stony ridges and hill slopes, floodplains and drainage lines.</p>	<p>Recorded from two locations on a major drainage line and floodplain in the eastern sector of the study area. A total of 25 plants were recorded at one location with 100 plants estimated from the second location. Ground coverage was up to a maximum of 3 percent.</p>

Taxon (Common Name)	Photograph	Description	Occurrence in study area
<p>*<i>Vachellia farnesiana</i> (Mimosa Bush)</p>		<p>An erect spreading thicket forming thorny tree or shrub. It grows up to 4 m in height and produces yellow flowers from June to August. Mimosa Bush grows on stony, sandy, clay or loam soils and is common in low lying areas such as creeks and river banks as well as in disturbed areas. It is widespread extending from the Kimberley south to near Perth (Hussey <i>et al.</i> 1997).</p>	<p>Recorded from two locations on a floodplain and major drainage line in the eastern sector of the study area. A single plant was recorded at each location.</p>



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Introduced Flora

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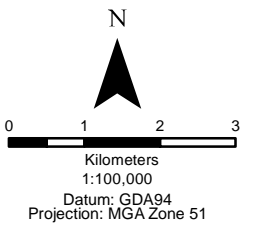
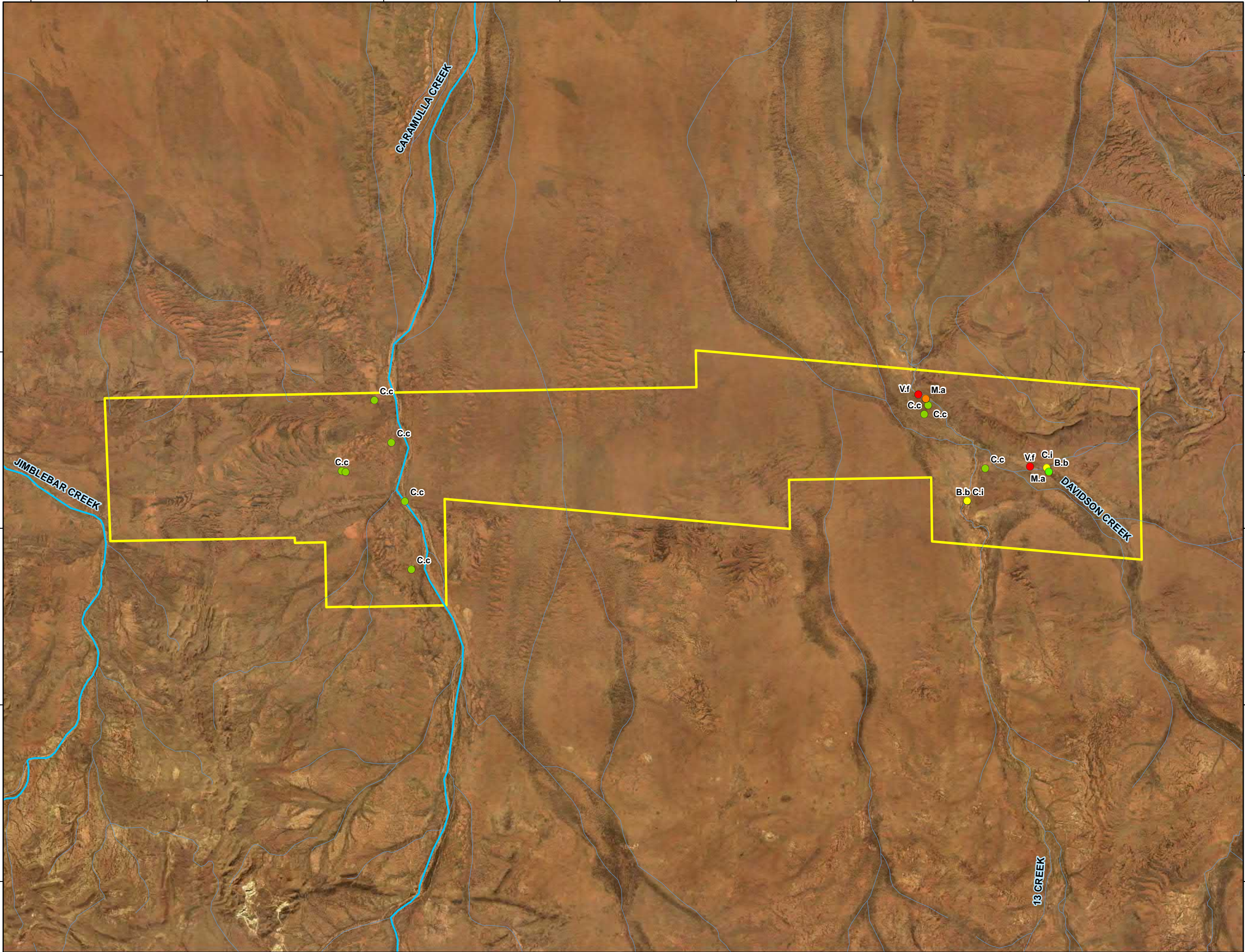
Study

Introduced Flora

- Bidens bipinnata (B.b)
- Cenchrus ciliaris (C.c)
- Citrullus sp. indet (C.i)
- Malvastrum americanum (M.a)
- Vachellia farnesiana (V.f)

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### **3.4 Threatened Ecological Communities**

The field survey confirmed that no TECs occur within the study area.

### **3.5 Priority Ecological Communities**

None of the vegetation associations described and mapped from the study area were aligned with any PECs documented from the Pilbara.

### **3.6 Vegetation**

A total of 30 vegetation associations were described and mapped within the study area (Figure 7). The vegetation associations have been classified into 12 broad floristic formations on the basis of the dominant vegetation stratum (Table 7).

**Table 7** Vegetation descriptions for 30 vegetation associations mapped within the study area.

Broad Floristic Formation	Code	Vegetation Code	Vegetation Description	Condition
<i>Eucalyptus</i> Woodland	1	MA Ec AciAcp CyaEuaCc	Woodland of <i>Eucalyptus camaldulensis</i> over Low Woodland of <i>Acacia citrinoviridis</i> and <i>Acacia coriacea</i> subsp. <i>pendens</i> over Open Tussock Grassland of <i>Cymbopogon ambiguus</i> , <i>Eulalia aurea</i> and * <i>Cenchrus ciliaris</i> on brown sand on major drainage lines	Very Good
<i>Acacia</i> Low Open Forest	2a	SL AcaAay SieErfo ErmuMopAri	Low Open Forest of <i>Acacia catenulata</i> subsp. <i>occidentalis</i> and <i>Acacia ayersiana</i> over Open Shrubland of <i>Sida ectogama</i> and <i>Eremophila forrestii</i> subsp. <i>forrestii</i> over Very Open Tussock Grassland of <i>Eriachne mucronata</i> , <i>Monachather paradoxus</i> and <i>Aristida inaequiglumis</i> on brown sandy clay loam on hardpan plains	Very Good
	2b	FP Aa EuaTtChf PtoErfoMav	Low Open Forest of <i>Acacia aptaneura</i> over Open Tussock Grassland of <i>Eulalia aurea</i> , <i>Themeda triandra</i> and <i>Chrysopogon fallax</i> with Low Open Shrubland of <i>Ptilotus obovatus</i> , <i>Eremophila forrestii</i> subsp. <i>forrestii</i> and <i>Maireana villosa</i> on brown sandy clay loam on drainage areas/floodplains	Very Good
	2c	HC AcaApt ErIIDovSegl Ar	Low Open Forest of <i>Acacia catenulata</i> subsp. <i>occidentalis</i> and <i>Acacia pteraneura</i> over Shrubland of <i>Eremophila latrobei</i> subsp. <i>latrobei</i> , <i>Dodonaea viscosa</i> and <i>Senna glutinosa</i> subsp. <i>x luerssenii</i> with High Open Shrubland of <i>Acacia rhodophloia</i> on orange sandy loam on breakaways	Excellent
<i>Acacia</i> Low Woodland	3a	SL AaAcaApr Tb ErfoSie	Low Woodland of <i>Acacia aptaneura</i> , <i>Acacia catenulata</i> subsp. <i>occidentalis</i> and <i>Acacia pruinocarpa</i> over Open Hummock Grassland of <i>Triodia basedowii</i> with Open Shrubland of <i>Eremophila forrestii</i> subsp. <i>forrestii</i> and <i>Sida ectogama</i> on brown clay loam on hardpan plains	Very Good
	3b	SL Apt Apt Tb	Low Woodland of <i>Acacia pteraneura</i> over High Open Shrubland of <i>Acacia pteraneura</i> and Very Open Hummock Grassland of <i>Triodia basedowii</i> on brown silty loam on hardpan plains	Very Good
	3c	SL Aa ArcAriEua SegfErfrErfo	Low Woodland of <i>Acacia aptaneura</i> over Open Tussock Grassland of <i>Aristida contorta</i> , <i>Aristida inaequiglumis</i> and <i>Eulalia aurea</i> with Open Shrubland of <i>Senna glaucifolia</i> , <i>Eremophila fraseri</i> and <i>Eremophila forrestii</i> subsp. <i>forrestii</i> on brown sandy clay loam on hardpan plains	Excellent
	3d	SP AcaGrbApt SieErfo TpTb	Low Woodland of <i>Acacia catenulata</i> subsp. <i>occidentalis</i> , <i>Grevillea berryana</i> and <i>Acacia pteraneura</i> over Shrubland of <i>Sida ectogama</i> and <i>Eremophila forrestii</i> subsp. <i>forrestii</i> over Very Open Hummock Grassland of <i>Triodia pungens</i> and <i>Triodia basedowii</i> on brown silty loam on stony plains	Very Good
	3f	HS Apt Aw Tv	Low Woodland of <i>Acacia pteraneura</i> over High Shrubland of <i>Acacia wanyu</i> over Open Hummock Grassland of <i>Triodia vanleeuwenii</i> on brown loamy sand on hillslopes	Excellent
<i>Corymbia</i> Low Woodland	4	FP CoasAa TTAriEua	Low Woodland of <i>Corymbia aspera</i> and <i>Acacia aptaneura</i> over Tussock Grassland of <i>Themeda triandra</i> , <i>Aristida inaequiglumis</i> and <i>Eulalia aurea</i> on brown light clay on floodplains	Very Good
<i>Eucalyptus</i> Low Woodland	5	ME EcAptEv TtThaEua BbChsi	Low Woodland of <i>Eucalyptus camaldulensis</i> , <i>Acacia pteraneura</i> and <i>Eucalyptus victrix</i> over Open Tussock Grassland of <i>Themeda triandra</i> , <i>Themeda avenacea</i> and <i>Eulalia aurea</i> over Very Open Herbs of * <i>Bidens bipinnata</i> and <i>Cheilanthes sieberi</i> on orange clayey sand on medium drainage lines	Good
<i>Acacia</i> High Shrubland	6a	MI AerAaancAnl TtEuaErmu Aa	High Shrubland of <i>Acacia eriopoda</i> , <i>Acacia ancistrocarpa</i> and <i>Androcalva luteiflora</i> with Open Tussock Grassland of <i>Themeda triandra</i> , <i>Eulalia aurea</i> and <i>Eriachne mucronata</i> with Low Open Woodland of <i>Acacia aptaneura</i> on brown sand on minor drainage lines	Very Good



Broad Floristic Formation	Code	Vegetation Code	Vegetation Description	Condition
	6b	CP As TrlEncCc RheSeahSeaf	High Shrubland of <i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i> over Open Tussock Grassland of <i>Tripogonella loliiformis</i> , <i>Enneapogon caerulescens</i> and * <i>Cenchrus ciliaris</i> with Open Shrubland of <i>Rhagodia eremaea</i> , <i>Senna artemisioides</i> subsp. <i>helmsii</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> on orange sandy loam on calcrete plains	Good
	6c	FS AptAwAs Tb Apt	High Shrubland of <i>Acacia pteraneura</i> , <i>Acacia wanyu</i> and <i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i> over Open Hummock Grassland of <i>Triodia basedowii</i> with Low Open Woodland of <i>Acacia pteraneura</i> on brown sandy clay loam on footslopes	Very Good
Acacia Shrubland	7	SL AwPsiErf AaApt AaAptAw	Shrubland of <i>Acacia wanyu</i> , <i>Psydrax latifolia</i> and <i>Eremophila forrestii</i> subsp. <i>forrestii</i> with Low Open Woodland of <i>Acacia aptaneura</i> and <i>Acacia pteraneura</i> and High Open Shrubland of <i>Acacia aptaneura</i> , <i>Acacia pteraneura</i> and <i>Acacia wanyu</i> on brown sandy clay loam on hardpan plains	Excellent
Eremophila Low Shrubland	8a	FS ErcuSemaosCct ApApt Aw	Low Shrubland of <i>Eremophila cuneifolia</i> , <i>Senna</i> sp. Meekatharra x? <i>artemisioides</i> subsp. <i>oligophylla</i> and <i>Sclerolaena cuneata</i> with Low Open Woodland of <i>Acacia aptaneura</i> and <i>Acacia pteraneura</i> and High Open Shrubland of <i>Acacia wanyu</i> on brown sandy loam on footslopes	Very Good
	8b	SL ErmaSemaosCcn Apt AptAsAte	Low Shrubland of <i>Eremophila margarethae</i> , <i>Senna</i> sp. Meekatharra x? <i>artemisioides</i> subsp. <i>oligophylla</i> and <i>Sclerolaena cornishiana</i> with Low Open Woodland of <i>Acacia pteraneura</i> and High Open Shrubland of <i>Acacia pteraneura</i> , <i>Acacia sclerosperma</i> subsp. <i>sclerosperma</i> and <i>Acacia tetragonophylla</i> on brown sandy loam on hardpan plains	Very Good
Triodia Hummock Grassland	9a	HS Tv AaApt EreAmaSes	Hummock Grassland of <i>Triodia vanleeuwenii</i> with Low Woodland of <i>Acacia aptaneura</i> and <i>Acacia pteraneura</i> and Shrubland of <i>Eremophila exilifolia</i> , <i>Acacia maitlandii</i> and <i>Senna stricta</i> on brown sandy loam on hillslopes/breakaways	Excellent
	9b	HS Tv AptAprGrb SeglErlErf	Hummock Grassland of <i>Triodia vanleeuwenii</i> with Low Open Woodland of <i>Acacia pteraneura</i> , <i>Acacia pruinocarpa</i> and <i>Grevillea berryana</i> and Open Shrubland of <i>Senna glutinosa</i> subsp. x <i>luerssenii</i> , <i>Eremophila latrobei</i> subsp. <i>latrobei</i> and <i>Eremophila forrestii</i> subsp. <i>forrestii</i> on brown sandy loam on hillslopes	Excellent
	9c	SA TscTb Eg AmeGrjAanc	Hummock Grassland of <i>Triodia schinzii</i> and <i>Triodia basedowii</i> with Very Open Mallee of <i>Eucalyptus gamophylla</i> and High Open Shrubland of <i>Acacia melleodora</i> , <i>Grevillea juncifolia</i> and <i>Acacia ancistrocarpa</i> on brown loamy sand on sandplains	Very Good
	9d	SA Tb ChHIIAa ApacAancAten	Hummock Grassland of <i>Triodia basedowii</i> with Low Open Woodland of <i>Corymbia hamersleyana</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> and <i>Acacia aptaneura</i> and High Open Shrubland of <i>Acacia pachyacra</i> , <i>Acacia ancistrocarpa</i> and <i>Acacia tenuissima</i> on red sand on stony sand plains	Excellent
	9e	SA Tb ChHIIApr Aanc	Hummock Grassland of <i>Triodia basedowii</i> with Low Open Woodland of <i>Corymbia hamersleyana</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> and <i>Acacia pruinocarpa</i> with High Open Shrubland of <i>Acacia ancistrocarpa</i> on orange brown sand on sand plains	Excellent
	9f	Fs Tv Grw AancAbAten	Hummock Grassland of <i>Triodia vanleeuwenii</i> with High Open Shrubland of <i>Grevillea wickhamii</i> subsp. <i>hispidula</i> and Open Shrubland of <i>Acacia ancistrocarpa</i> , <i>Acacia bivenosa</i> and <i>Acacia tenuissima</i> on brown loamy sand on footslopes	Excellent

Broad Floristic Formation	Code	Vegetation Code	Vegetation Description	Condition
	9g	HS Tv AprHll AhiCacaEre	Hummock Grassland of <i>Triodia vanleeuwenii</i> with Low Open Woodland of <i>Acacia pruinocarpa</i> and <i>Hakea lorea</i> subsp. <i>lorea</i> with Low Open Shrubland of <i>Acacia hilliana</i> , <i>Calytrix carinata</i> and <i>Eremophila exilifolia</i> on brown sandy loam on hillslopes	Excellent
	9h	SA Tb AaAancApac AaChHll	Hummock Grassland of <i>Triodia basedowii</i> with High Shrubland of <i>Acacia aptaneura</i> , <i>Acacia ancistrocarpa</i> and <i>Acacia pachyacra</i> with Low Open Woodland of <i>Acacia aptaneura</i> , <i>Corymbia hamersleyana</i> and <i>Hakea lorea</i> subsp. <i>lorea</i> on orange loamy sand on sand plains	Excellent
	9i	FS Tv Ere AprHllAa	Hummock Grassland of <i>Triodia vanleeuwenii</i> with Low Open Shrubland of <i>Eremophila exilifolia</i> and Scattered Low Trees of <i>Acacia pruinocarpa</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> and <i>Acacia aptaneura</i> on orange/brown sandy loam on footslopes	Excellent
<i>Triodia</i> Open Hummock Grassland	10a	SA Tb AaApApt ErfrAsuAa	Open Hummock Grassland of <i>Triodia basedowii</i> with Low Open Woodland of <i>Acacia aptaneura</i> , <i>Acacia paraneura</i> and <i>Acacia pteraneura</i> and High Open Shrubland of <i>Eremophila fraseri</i> , <i>Acacia subcontorta</i> and <i>Acacia aptaneura</i> on brown sandy loam on sand plains	Excellent
	10b	SP Tsc Apt ErfrApt	Open Hummock Grassland of <i>Triodia schinzii</i> with Low Open Woodland of <i>Acacia pteraneura</i> and High Open Shrubland of <i>Eremophila fraseri</i> and <i>Acacia pteraneura</i> on orange sandy loam on sandy/stony plains	Very Good
<i>Eriachne</i> Tussock Grassland	11	GP ErfIEauChf AaHllAmac Ate	Tussock Grassland of <i>Eriachne flaccida</i> , <i>Eulalia aurea</i> and <i>Chrysopogon fallax</i> with Scattered Low Trees of <i>Acacia aptaneura</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> and <i>Acacia macraneura</i> and Scattered Tall Shrubs of <i>Acacia tetragonophylla</i> on brown light medium clay on gilgai plains	Very Good
<i>Aristida</i> Open Tussock Grassland	12	SL ArcEauAri AaAp SeaoSccnSip	Open Tussock Grassland of <i>Aristida contorta</i> , <i>Eulalia aurea</i> and <i>Aristida inaequiglumis</i> with Low Open Woodland of <i>Acacia aptaneura</i> and <i>Acacia parananeura</i> and Low Open Shrubland of <i>Senna artemisioides</i> subsp. <i>helmsii</i> , <i>Sclerolaena cornishiana</i> and <i>Sida platycalyx</i> on orange clay loam on hardpan plains	Very Good



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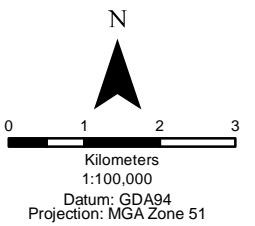
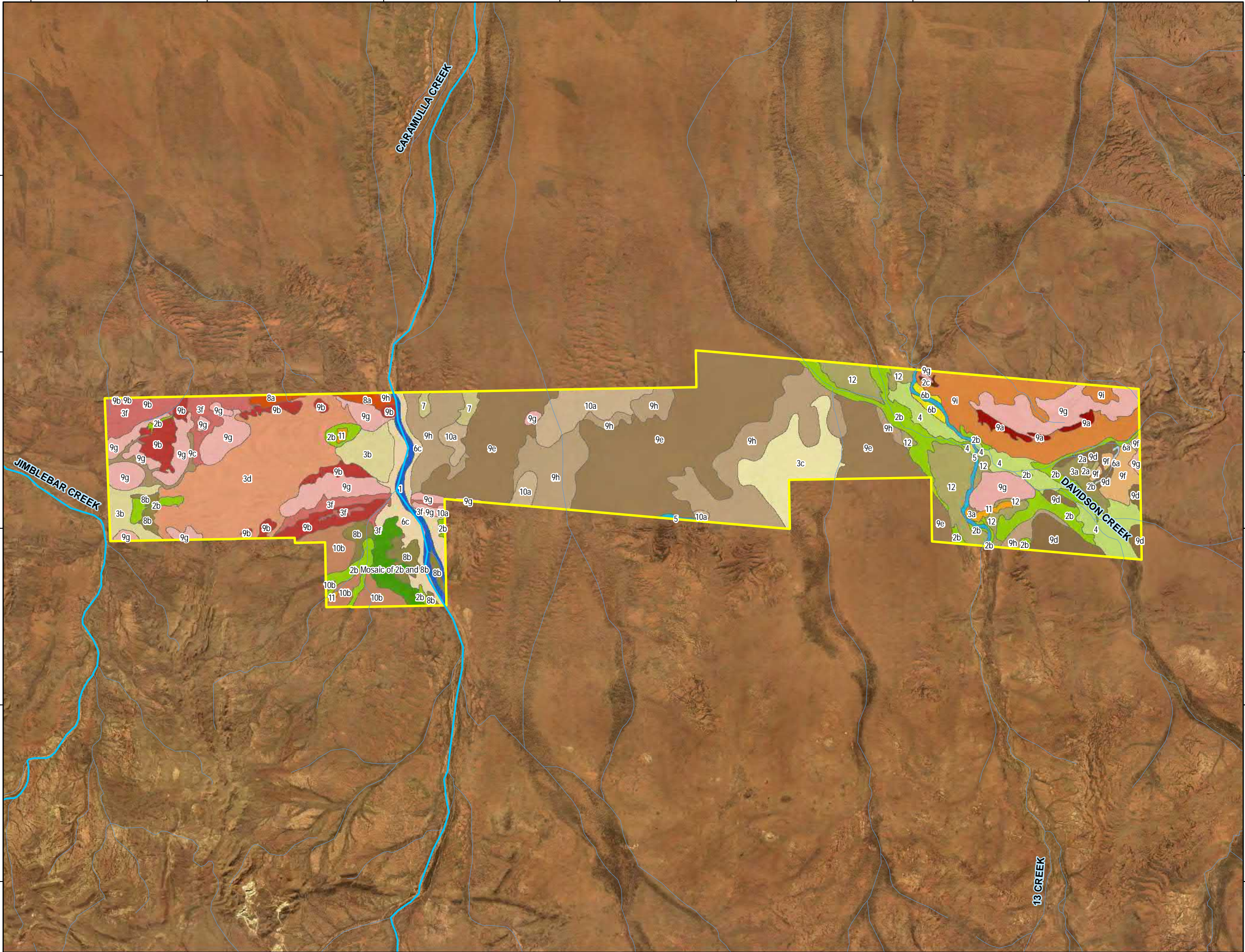
**Vegetation Types**

**Legend**

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### Vegetation Types Legend

### Legend

Study Area

### Vegetation Types

#### Hill Crest

HC AcaApt ErllDovSegl Ar - 2c Low Open Forest of *Acacia catenulata* and *Acacia pteraneura* over Shrubland of *Eremophila latrobei* subsp. *latrobei*, *Dodonea viscosa* and *Senna glutinosa* subsp. *luersenii* with High Open Shrubland of *Acacia rhodophloia* on orange sandy loam on

#### Hill Slopes

HS Tv AaApt EreAmaSes - 9a Hummock Grassland of *Triodia vanleeuwenii* with Low Woodland of *Acacia aptaneura* and *Acacia pteraneura* and Shrubland of *Eremophila exilifolia*, *Acacia maitlandii* and *Senna stricta* on brown sandy loam on hillslopes/breakaways

HS Tv AptAprGrb SeglErllErf - 9b Hummock Grassland of *Triodia vanleeuwenii* with Low Open Woodland of *Acacia pteraneura*, *Acacia pruinocarpa* and *Grevillea berryana* and Open Shrubland of *Senna glutinosa* subsp. *luersenii*, *Eremophila latrobei* subsp. *latrobei* and *Eremophila forrestii* on brown sandy loam on hillslopes

HS Apt Aw Tv - 3f Low Woodland of *Acacia pteraneura* over High Shrubland of *Acacia wanyu* over Open Hummock Grassland of *Triodia vanleeuwenii* on brown loamy sand on hillslopes

HS Tv AprHll AhiCacaEre - 9g Hummock Grassland of *Triodia vanleeuwenii* with Low Open Woodland of *Acacia pruinocarpa* and *Hakea lorea* subsp. *lorea* with Low Open Shrubland of *Acacia hilliana*, *Calytrix carinata* and *Eremophila exilifolia* on brown sandy loam on hillslopes

#### Foot Slopes

FS ErcuSemaScct ApApt Aw - 8a Low Shrubland of *Eremophila cuneifolia*, *Senna* sp. *Meekatharra* x *?artemisioides* subsp. *oligophylla* and *Sclerolaena cuneata* with Low Open Woodland of *Acacia aptaneura* and *Acacia pteraneura* and High Open Shrubland of *Acacia wanyu* on brown sandy loam on footslopes

FS Tv Ere AprHllAa - 9i Hummock Grassland of *Triodia vanleeuwenii* with Low Open Shrubland of *Eremophila exilifolia* and Scattered Low Trees of *Acacia pruinocarpa*, *Hakea lorea* subsp. *lorea* and *Acacia aptaneura* on orange/brown sandy loam on footslopes

FS Tv Grw AancAbAten - 9f Hummock Grassland of *Triodia vanleeuwenii* with High Open Shrubland of *Grevillea wickhamii* and Open Shrubland of *Acacia ancistrocarpa*, *Acacia bivenosa* and *Acacia tenuissima* on brown loamy sand on footslopes

FS AptAwAs Tb Apt -6c High Shrubland of *Acacia pteraneura*, *Acacia wanyu* and *Acacia sclerosperma* over Open Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Acacia pteraneura* on brown sandy clay loam on footslopes

#### Stony Plain

SP Tsc Apt ErfrApt - 10b Open Hummock Grassland of *Triodia schinzii* with Low Open Woodland of *Acacia pteraneura* and High Open Shrubland of *Eremophila fraseri* and *Acacia pteraneura* on orange sandy loam on sandy/stony plains

SP AcaGrbApt SieErf - 3d Low Shrubland of *Eremophila margarethae*, *Senna* sp. *Meekatharra* x *?artemisioides* subsp. *oligophylla* and *Sclerolaena cornishiana* with Low Open Woodland of *Acacia pteraneura* and High Open Shrubland of *Acacia pteraneura*, *Acacia sclerosperma* and *Acacia tetragonophylla* on brown sandy loam on hardpan plains

#### Sandy Clay Loam

SL ErmaSemaScn Apt AptAsAte - 8b Low Shrubland of *Eremophila margarethae*, *Senna* sp. *Meekatharra* x *?artemisioides* subsp. *oligophylla* and *Sclerolaena cornishiana* with Low Open Woodland of *Acacia pteraneura* and High Open Shrubland of *Acacia pteraneura*, *Acacia sclerosperma* and *Acacia tetragonophylla* on brown sandy loam on hardpan plains

SL AaAcaApr Tb ErfoSie - 3a Low Woodland of *Acacia aptaneura*, *Acacia catenulata* and *Acacia pruinocarpa* over Open Hummock Grassland of *Triodia basedowii* with Open Shrubland of *Eremophila forrestii* and *Sida ectogama* on brown clay loam on hardpan plains

SL ArcEauAri AaAp SeoScnSip - 12 Open Tussock Grassland of *Aristida contorta*, *Eulalia aurea* and *Aristida inaequiglumis* with Low Open Woodland of *Acacia aptaneura* and *Acacia paraneura* and Low Open Shrubland of *Senna artemisioides* subsp. *helmsii*, *Sclerolaena cornishiana* and *Sida platycalyx* on orange clay loam on hardpan plains

SL AcaAay SieErf - 2a Low Open Forest of *Acacia catenulata* and *Acacia ayersiana* over Open Shrubland of *Sida ectogama* and *Eremophila forrestii* over Very Open Tussock Grassland of *Eriachne mucronata*, *Monachather paradoxus* and *Aristida inaequiglumis* on brown sandy clay loam on hardpan plains

SL AwPslErf AaApt AaAptAw - 7 Shrubland of *Acacia wanyu*, *Psyrax latifolia* and *Eremophila forrestii* with Low Open Woodland of *Acacia aptaneura* and *Acacia pteraneura* and High Open Shrubland of *Acacia aptaneura*, *Acacia pteraneura* and *Acacia wanyu* on brown sandy clay loam on hardpan plains

SL Apt Apt Tb - 3b Low Woodland of *Acacia pteraneura* over High Open Shrubland of *Acacia pteraneura* and Very Open Hummock Grassland of *Triodia basedowii* on brown silty loam on hardpan plains

SL Aa ArcAriEua SegfErfrErf - 3c Low Woodland of *Acacia aptaneura* over Open Tussock Grassland of *Aristida contorta*, *Aristida inaequiglumis* and *Eulalia aurea* with Open Shrubland of *Senna glaucifolia*, *Eremophila fraseri* and *Eremophila forrestii* on brown sandy clay loam on hardpan plains

#### Sandy Plains

SA Tb ChHllAa ApacAancAten - 9d Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Corymbia hamersleyana*, *Hakea lorea* subsp. *lorea* and *Acacia aptaneura* and High Open Shrubland of *Acacia pachyacra*, *Acacia ancistrocarpa* and *Acacia tenuissima* on red sand on stony sand plains

SA Tb ChHllApr Aanc - 9e Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Corymbia hamersleyana*, *Hakea lorea* subsp. *lorea* and *Acacia pruinocarpa* with High Open Shrubland of *Acacia ancistrocarpa* on orange brown sand on sand plains

SA TscTb Eg AmeGrJAanc - 9c Hummock Grassland of *Triodia schinzii* and *Triodia basedowii* with Very Open Mallee of *Eucalyptus gamophylla* and High Open Shrubland of *Acacia melleodora*, *Grevillea juncifolia* and *Acacia ancistrocarpa* on brown loamy sand on sandplains

SA Tb AaAancApac AaChHll - 9h Hummock Grassland of *Triodia basedowii* with High Shrubland of *Acacia aptaneura*, *Acacia ancistrocarpa* and *Acacia pachyacra* with Low Open Woodland of *Acacia aptaneura*, *Corymbia hamersleyana* and *Hakea lorea* subsp. *lorea* on orange loamy sand on sand plains

SA Tb AaApApt ErfrAsuAa - 10a Open Hummock Grassland of *Triodia basedowii* with Low Open Woodland of *Acacia aptaneura*, *Acacia paraneura* and *Acacia pteraneura* and High Open Shrubland of *Eremophila fraseri*, *Acacia subcontorta* and *Acacia aptaneura* on brown sandy loam on sand plains

#### Calcrete Plains

CP As TrlEncCc RheSeahSeaf - 6b High Shrubland of *Acacia sclerosperma* over Open Tussock Grassland of *Tripogon loliformis*, *Enneapogon caeruleus* and *\*Cenchrus ciliaris* with Open Shrubland of *Rhagodia eremaea*, *Senna artemisioides* subsp. *helmsii* and *Senna artemisioides* subsp. *filifolia* on orange sandy loam on calcrete plains

#### Gilgai Plains

GP ErfIEauChf AaHllAmac Ate - 11 Tussock Grassland of *Eriachne flaccida*, *Eulalia aurea* and *Chrysopogon fallax* with Scattered Low Trees of *Acacia aptaneura*, *Hakea lorea* subsp. *lorea* and *Acacia macraneura* and Scattered Tall Shrubs of *Acacia tetragonophylla* on brown light medium clay on gilgai plains

#### Flood Plain

FP Aa EuaTtChf PtoErfMav - 2b Low Open Forest of *Acacia aptaneura* over Open Tussock Grassland of *Eulalia aurea*, *Themeda triandra* and *Chrysopogon fallax* with Low Open Shrubland of *Ptilotus obovatus*, *Eremophila forrestii* and *Maireana villosa* on brown sandy clay loam on drainage areas/floodplains

FP CoasAa TTAriEua - 4 Low Woodland of *Corymbia aspera* and *Acacia aptaneura* over Tussock Grassland of *Themeda triandra*, *Aristida inaequiglumis* and *Eulalia aurea* on brown light clay on floodplains

#### Major Drainage Line

MA Ec AciAcp CyaEuaCc - 1 Woodland of *Eucalyptus camaldulensis* over Low Woodland of *Acacia citrinoviridis* and *Acacia coriacea* subsp. *pendens* over Open Tussock Grassland of *Cymbopogon ambiguus*, *Eulalia aurea* and *\*Cenchrus ciliaris* on brown sand on major drainage lines

#### Medium Drainage Line

ME EcAptEv TtThaEua BbChsi - 5 Low Woodland of *Eucalyptus camaldulensis*, *Acacia pteraneura* and *Eucalyptus victrix* over Open Tussock Grassland of *Themeda triandra*, *Themeda avenacea* and *Eulalia aurea* over Very Open Herbs of *\*Bidens bipinnata* and *Cheilanthes sieberi* on orange clayey sand on medium drainage lines

#### Minor Drainage Line

MI AerAaancAnl TtEuaErmu Aa - 6a High Shrubland of *Acacia eriopoda*, *Acacia ancistrocarpa* and *Androcalva luteiflora* with Open Tussock Grassland of *Themeda triandra*, *Eulalia aurea* and *Eriachne mucronata* with Low Open Woodland of *Acacia aptaneura* on brown sand on minor drainage lines

#### Mosaic

Mosaic of FP Aa EuaTtChf PtoErfMav and SL ErmaSemaScn Apt AptAsAte - 2b and 8b Mosaic of Low Open Forest of *Acacia aptaneura* over Open Tussock Grassland of *Eulalia aurea*, *Themeda triandra* and *Chrysopogon fallax* with Low Open Shrubland of *Ptilotus obovatus*, *Eremophila forrestii* and *Maireana villosa* on brown sandy clay loam on drainage areas/floodplains and Low Shrubland of *Eremophila margarethae*, *Senna* sp. *Meekatharra* x *?artemisioides* subsp. *oligophylla* and *Sclerolaena cornishiana* with Low Open Woodland of *Acacia pteraneura* and High Open Shrubland of *Acacia pteraneura*, *Acacia sclerosperma* and *Acacia tetragonophylla* on brown sandy loam on hardpan plains

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Figure: 7  
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Internal Reference: Carr\_18\_VTL  
Drawn by: GSM  
Requested by: DB



## 3.7 Vegetation Condition

Vegetation condition within the study area ranged from *excellent* to *good* (Figure 8). The condition of vegetation along the main drainage channel and adjacent levee banks, flood plains and sand plains was generally *very good*. A small area of calcrete plain adjacent to the major drainage line was rated as *good*. This area was invaded by *\*Cenchrus ciliaris* (Buffel Grass) and had been subject to grazing and historical mining disturbance.

The main degrading impacts across the wider study area were related to grazing by cattle, which contributed to altered vegetation composition and structure and introduction of weeds. Buffel Grass was the dominant weed recorded along the main drainage channel where it provided up to 10 percent ground cover.

Vegetation condition improved with increasing elevation onto surrounding hills and ranges where grazing impacts were significantly reduced, and disturbance was generally restricted to historical and more recent exploration activities.



215000 220000 225000 230000 235000 240000 245000



BHP WAIO

Caramulla

Vegetation Condition

Legend

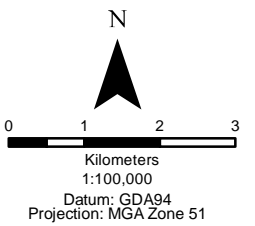
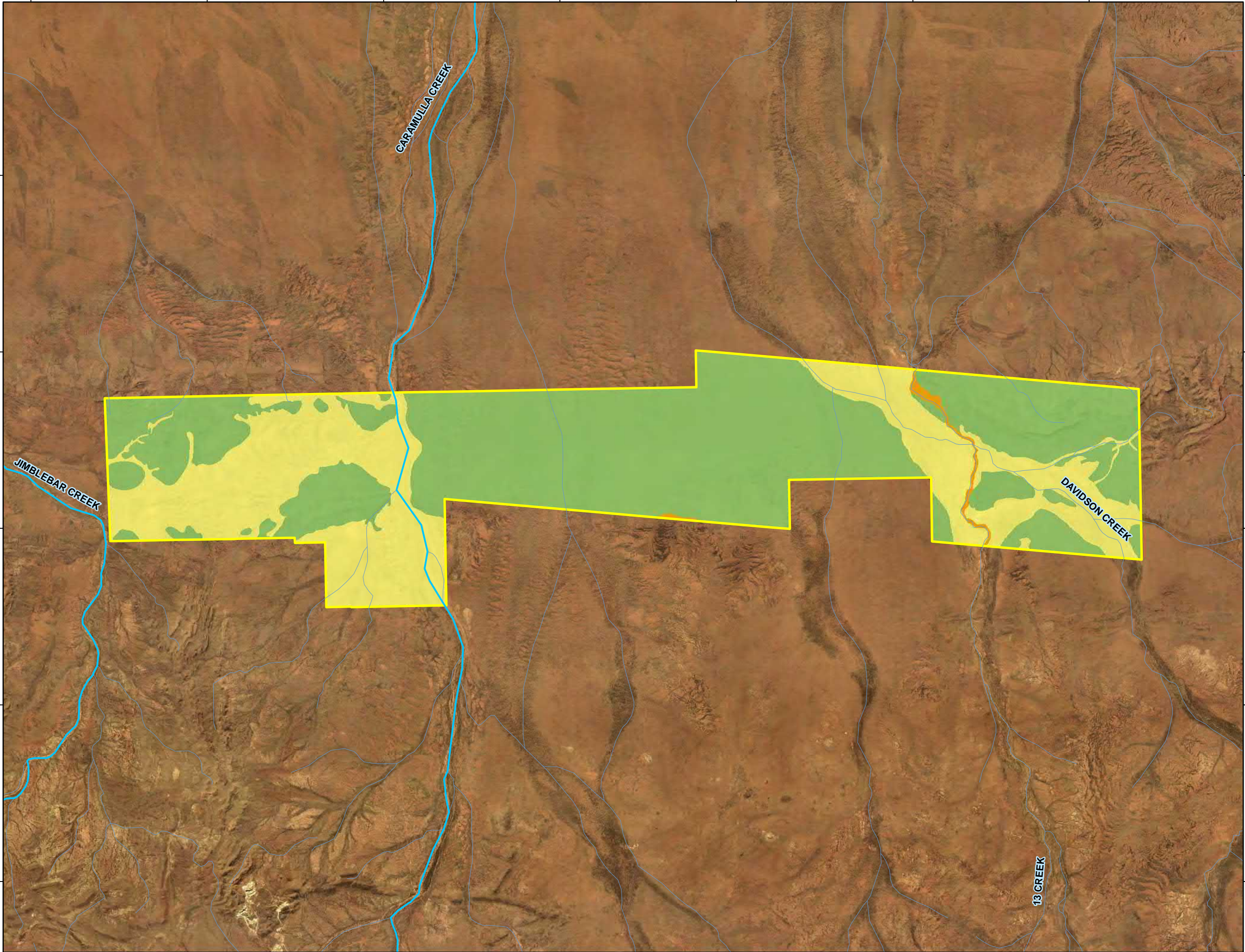
Study Area

Vegetation Condition

- Good
- Very Good
- Excellent

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Date: 04/04/2018  
 Status: Final  
 Figure: 8  
 Sheet Size: A3  
 Internal Reference: Carr\_18\_VC  
 Drawn by: GSM  
 Requested by: DB



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## 4.0 Assessment of Flora and Vegetation Values Against the Ten Clearing Principles

There are ten clearing principles that apply to the clearing of native vegetation in Western Australia, nine of which apply to native flora and vegetation. An assessment of the likely impacts to native flora and vegetation in regard to these nine clearing principles (excluding clearing principle B which addresses native fauna) are addressed below. At the time of this report no specific areas were proposed to be cleared, therefore the assessment follows a precautionary approach considering the entire study area and all 30 vegetation associations mapped.

**a) *Native vegetation should not be cleared if it comprises a high level of biological diversity***

A reconnaissance flora and vegetation survey covering the study area has determined that vegetation does not comprise a high level of biological diversity. A total of 30 vegetation associations classified into 12 broad floristic formations were described and mapped from the study area. This is comparable with previous surveys completed within a 25 km radius, particularly given the relative large size of the study area.

Vegetation represented within the study area was not aligned with any TECs or PECs, and is well represented within the bioregion. The flora includes five Priority flora taxa; one Priority 1 taxon, one Priority 2 taxon, two Priority 3 taxa and one Priority 4 taxon. All five Priority flora have been recorded from nearby locations outside of the study area.

Clearing within the study area would be considered unlikely to be at variance with this clearing principle (Table 8).

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

There were no plant taxa gazetted as Threatened Flora listed under the WC Act or EPBC Act recorded from the study area. Five Priority flora taxa were recorded from the study area; *Eremophila capricornica* (Priority 1), *Ipomoea racemigera* (Priority 2), *Crotalaria smithiana* (Priority 3), *Rhagodia* sp. Hamersley (M. Trudgen 17794) (Priority 3) and *Goodenia nuda* (Priority 4). None of the plant taxa recorded was determined to represent a range extension based on the current known distribution of the species. An additional two species of interest were recorded from the study area; *Indigofera* sp. indet and *Tephrosia* sp. Willowra (G.M. Chippendale 4809). In the instance that these taxa were disturbed as part of future project development, the impact would not influence the continued existence of these taxa.

Clearing within the study area would be considered not at variance with this clearing principle (Table 8).

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

None of the 30 vegetation associations mapped within the study area were aligned with either Federal or State listed TECs, or State listed PECs. Furthermore, there were no TECs or PECs recorded from a 50 km radius around the study area.

Clearing within the study area would be considered not at variance with this clearing principle (Table 8).

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

Vegetation within the study area is classified as the following seven vegetation associations, as mapped by Beard (1975) and later refined by Shepherd *et al.* (2002):

- 18: Low woodland; mulga (*Acacia aneura*);
- 29: Sparse low woodland; mulga, discontinuous in scattered groups;
- 82: Hummock grasslands, low tree steppe; Snappy gum over *Triodia wiseana*;
- 111: Hummock grasslands, shrub steppe; *Eucalyptus gamophylla* over hard spinifex;
- 157: Hummock grasslands, grass steppe; hard spinifex *Triodia wiseana*;
- 199: Hummock grasslands, shrub steppe; mulga over soft spinifex on rises; and
- 216: Low woodland; mulga (with spinifex) on rises.

The Pre-European extent for the seven vegetation associations remains close to 100 percent, and is not considered to represent a remnant of native vegetation. Within the study area existing clearing is restricted to the main access track and localised areas of historical exploration drill lines. The proportion of the study area impacted by clearing at present is estimated to be less than one percent.

Clearing within the study area would be considered not at variance with this clearing principle (Table 8).

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

There were two vegetation associations recorded within the study area that occur along major and medium ephemeral watercourses:

- Vegetation association 1: MA Ec AciAcp CyaEuaCc, 'Woodland of *Eucalyptus camaldulensis* over Low Woodland of *Acacia citrinoviridis* and *Acacia coriacea* subsp. *pendens* over Open Tussock Grassland of *Cymbopogon ambiguus*, *Eulalia aurea* and \**Cenchrus ciliaris* on brown sand on major drainage lines'; and
- Vegetation association 5: ME EcAptEv TtThaEua BbChsi, 'Low Woodland of *Eucalyptus camaldulensis*, *Acacia pteraneura* and *Eucalyptus victrix* over Open Tussock Grassland of *Themeda triandra*, *Themeda avenacea* and *Eulalia aurea* over Very Open Herbs of \**Bidens bipinnata* and *Cheilanthes sieberi* on orange clayey sand on medium drainage lines'.

These vegetation associations occur along Caramulla Creek (in the west) and Davidson Creek (in the east), both of which are ephemeral creeklines that discharge into the Fortescue River approximately 20 km north-west of the study area. The creeklines are ephemeral watercourses with no permanent water pools.

Only a small proportion of each creekline occurs within the study, and therefore any clearing within the study area is unlikely to have any significant impact on the vegetation associations of the creeklines, other riparian vegetation within the vicinity of the study area, or local or regional groundwater levels.

Clearing within the study area would be considered unlikely to be at variance with this principle (Table 8).

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

Land degradation may include impacts such as erosion, changes to pH, water logging, salinisation or spread of weeds. Given the flat relief and relatively low number of introduced flora species within the study area, it is considered unlikely that clearing would cause any appreciable land degradation. There are numerous examples at surrounding mining operations where clearing on similar landforms has been effectively managed to ensure there is no appreciable land degradation.

Clearing within the study area would be considered not at variance with this clearing principle (Table 8).

***h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of a conservation area.***

The study area is not within or adjacent to any gazetted conservation reserves. The Collier Range National Park is the nearest reserve, situated approximately 125 km to the south. Karijini National Park is located approximately 150 km west north-west of the study area. Any clearing within the study area is not expected to impact on the environmental values of a conservation area.

Clearing within the study area would be considered not at variance with this clearing principle (Table 8).

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

The study area is not located within a Public Drinking Water Source Area (PDWSA).

There are two ephemeral creeklines dissecting the western sector (Caramulla Creek) and eastern sector (Davidson Creek) of the study area. While the creeklines support two tree species that are potentially phreatophytic (*Eucalyptus camaldulensis* and *Eucalyptus victrix*), clearing of vegetation in the study area would not alter the groundwater levels and hence there would be no impact to either of these species.

There are no permanent water bodies present along the ephemeral creeklines or elsewhere within the study area. Vegetation clearing within the study area is considered unlikely to impact on local or regional surface water.

Clearing within the study area would be considered not at variance with this clearing principle (Table 8).

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

There are two ephemeral creeklines dissecting the western and eastern sectors of the study area. The region is subject to cyclonic activity and sporadic thunderstorms during summer. It is likely that the creeklines may experience seasonal flooding during high rainfall periods in summer months, however it is unlikely that clearing would increase the incidence or intensity of this flooding.

Clearing within the study area would be considered not at variance with this clearing principle (Table 8).



**Table 8 Summary assessment of flora and vegetation values against the ten clearing principles.**

<b>Principle</b>	<b>Criteria</b>	<b>Assessment</b>	<b>Outcome</b>
a) Native vegetation should not be cleared if it comprises a high level of biological diversity.	a1) Native vegetation should not be cleared if it is representative of an area of outstanding biodiversity in the Bioregion.	Vegetation associations showed modest species richness of mostly cosmopolitan plant taxa. Vegetation within the study area is not representative of an area of outstanding biodiversity and is well represented in the Pilbara bioregion.	Unlikely to be at variance with the clearing principle.
	a2) Native vegetation should not be cleared if it has higher diversity of indigenous aquatic or terrestrial plant or fauna species than native vegetation of that ecological community in good or better condition in the Bioregion.	The native vegetation within the study area is not considered to contain a higher diversity of flora species than similar vegetation within the Hamersley region. The native vegetation within the study area is not considered to contain vegetation in good or better condition than similar vegetation within the vicinity of the study area.	Not at variance with the clearing principle.
	a3) Native vegetation should not be cleared if it has higher diversity of indigenous aquatic or terrestrial plant or fauna species than the remaining vegetation of that ecological community in the local area.	The native vegetation within the study area is not considered to contain a higher diversity of flora species than similar vegetation within the local area. The vegetation associations within the study area are contiguous with the surrounding areas, and vegetation within the Pilbara region is considered largely intact with most of the pre-European vegetation communities still present.	Unlikely to be at variance with the clearing principle.
	a4) Native vegetation should not be cleared if it has higher ecosystem diversity than other native vegetation of that local area.	Vegetation within the study area is well represented in the surrounding area and does not have higher ecosystem diversity.	Not at variance with the clearing principle.
	a5) Native vegetation should not be cleared if it has higher genetic diversity than the remaining native vegetation of that ecological community.	Not able to be assessed but considered unlikely given the lack of isolation of habitats within the study area compared to the surrounding areas.	Not at variance with the clearing principle.

Principle	Criteria	Assessment	Outcome
	a6) Native vegetation should not be cleared if it is necessary for the continued in situ existence of significant habitat for Priority flora species published by the Department of Biodiversity, Conservation and Attractions.	Five Priority flora are known from the study area, and all have been recorded from nearby locations outside of the study area.  Habitat that may support the five Priority flora taxa recorded from within the study area is well represented in the wider region, and clearing within the study area will have no impact on the existence of these Priority flora.	Not at variance with the clearing principles
c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	c1) Native vegetation should not be cleared if it is necessary for the continued in situ existence of populations of Threatened (Declared Rare) Flora under the <i>Wildlife Conservation Act 1950</i> .	No Federal or State listed Threatened Flora were recorded from the study area.	Not at variance with the clearing principles
	c2) Native vegetation should not be cleared if it is necessary for the continued in situ existence of other significant flora.	No species listed under the EPBC Act or other significant flora species were recorded in the study area.  None of the plant taxa recorded were determined to represent a range extension based on the current known distribution of the species.	Not at variance with the clearing principles
d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened community.	d1) Native vegetation should not be cleared if Threatened Ecological Communities listed under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> are present.	No EPBC Act TECs are present in the study area.	Not at variance with the clearing principles
	d2) Native vegetation should not be cleared if it is necessary for the maintenance of Threatened Ecological Communities listed under the Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .	No EPBC Act TECs occur within a 50 km radius of the study area.	Not at variance with the clearing principles
	d3) Native vegetation should not be cleared if other significant ecological communities are present.	No other significant ecological communities are present in the study area.	Not at variance with the clearing principles
	d4) Native vegetation should not be cleared if it is necessary for the maintenance of other significant ecological communities.	No other significant ecological communities are known from a 50 km radius of the study area.	Not at variance with the clearing principles

Principle	Criteria	Assessment	Outcome
	d5) Native vegetation should not be cleared if it is necessary for the continued in situ existence of significant examples of priority threatened ecological communities published by the Department of Biodiversity Conservation and Attractions.	No DBCA listed TECs, PECs or other significant communities are known from within, or from a 50 km radius, of the study area.	Not at variance with the clearing principles
e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	e1) Native vegetation should not be cleared if the remaining native vegetation represents less than 30%, or the clearing would reduce the representation of remaining native vegetation to less than 30% in the Bioregion (or sub-region where applicable).	Clearing native vegetation within the study area will not significantly reduce the pre-European extent, which is close to 100% for the seven vegetation complexes mapped by Beard (1975) and later refined by Shepherd <i>et al.</i> (2002).	Not at variance with the clearing principles
	e2) Native vegetation should not be cleared if an ecological community represents less than 30% of its original extent or clearing would reduce the representation of any ecological community to less than 30% of its original extent in the Bioregion (or sub-region where applicable).	Clearing native vegetation within the study area will not significantly reduce the pre-European extent, which is close to 100% for the seven vegetation complexes mapped by Beard (1975) and later refined by Shepherd <i>et al.</i> (2002).	Not at variance with the clearing principles
	e3) Native vegetation should not be cleared if clearing would reduce a community to less than 1% of the Bioregion (or sub-region where applicable)	Clearing native vegetation within the study area will not significantly reduce the pre-European extent, which is close to 100% for the seven vegetation complexes mapped by Beard (1975) and later refined by Shepherd <i>et al.</i> (2002).	Not at variance with the clearing principles
	e4) Native vegetation should not be cleared if the remaining native vegetation represents less than 30% or the clearing would reduce the representation of remaining native vegetation to less than 30% in the Local Area.	Clearing native vegetation within the study area will not significantly reduce the pre-European extent, which is close to 100% for the seven vegetation complexes mapped by Beard (1975) and later refined by Shepherd <i>et al.</i> (2002).	Not at variance with the clearing principles
	e5) Native vegetation should not be cleared if an ecological community represents less than 30% of its original extent or clearing reduce the representation of any ecological community to less than 30% of its original extent in the Local Area.	Clearing native vegetation within the study area will not significantly reduce the pre-European extent, which is close to 100% for the seven vegetation complexes mapped by Beard (1975) and later refined by Shepherd <i>et al.</i> (2002).	Not at variance with the clearing principles

Principle	Criteria	Assessment	Outcome
	e6) Native vegetation should not be cleared if clearing would reduce any ecological community to less than 1% of the Local Area.	Clearing native vegetation within the study area will not significantly reduce the pre-European extent, which is close to 100% for the seven vegetation complexes mapped by Beard (1975) and later refined by Shepherd <i>et al.</i> (2002).	Not at variance with the clearing principles
f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	f1) Native vegetation should not be cleared if it is growing in a watercourse or wetland that has been identified as having significant environmental values.	Native vegetation associations within the study area growing in ephemeral watercourses do not have significant environmental values.	Not at variance with the clearing principles
	f2) Native vegetation should not be cleared if it provides a buffer area for watercourses and wetlands identified in criteria (f1) and (f2).	There are no vegetation associations within the study area that provide a set-back (buffer) to watercourses or wetlands.	Not at variance with the clearing principles
	f3) Native vegetation should not be cleared if water tables are likely to change and adversely affect ecological communities that are wetland or groundwater dependent.	Water tables will not change post-disturbance, and as such will not impact on any ecological communities that are wetland or groundwater dependent.	Not at variance with the clearing principles
	f4) Native vegetation should not be cleared if it is growing in other watercourses or wetlands.	There are no wetlands within the study area. There are two ephemeral drainage lines present in the west and east sectors of the study area (Vegetation associations 1 and 5).	Unlikely to be at variance with the clearing principles
g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	g1) Native vegetation should not be cleared if wind or water erosion of soil is likely to be increased (on or off site).	Short-term soil erosion may be associated with clearing. Soil erosion can be mitigated by use of appropriate water management and rehabilitation regimes.	Not at variance with the clearing principles
	g2) Native vegetation on land with soils with high or low pH should not be cleared.	The study area is not considered to contain soils at risk of having Acid Sulphate Soils present.	Not at variance with the clearing principles
	g3) Native vegetation should not be cleared if water logging is likely to be increased (on or off site).	The clearing of native vegetation is not expected to increase waterlogging within or beyond the study area.	Not at variance with the clearing principles
	g4) Native vegetation should not be cleared if land salinisation is likely to be increased (on or off site).	The clearing of native vegetation is not expected to increase soil salinity within or beyond the study area.	Not at variance with the clearing principles



Principle	Criteria	Assessment	Outcome
h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of a conservation area.	h1) Native vegetation should not be cleared if it contributes significantly to the environmental values of a conservation area.	There are no conservation areas within the vicinity of the study area.	Not at variance with the clearing principles
	h2) Native vegetation should not be cleared if that vegetation provides a buffer to a conservation area.	There are no conservation areas within the vicinity of the study area.	Not at variance with the clearing principles
	h3) Native vegetation should not be cleared if the land contributes to an ecological linkage to a conservation area.	There are no conservation areas within the vicinity of the study area.	Not at variance with the clearing principles
	h4) Native vegetation should not be cleared if it provides habitats not well represented on conservation land.	There are no habitats within the study area that are not well represented on conservation land.	Not at variance with the clearing principles
i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	i1) Native vegetation should not be cleared if clearing the vegetation will reduce the quality of surface or underground water in proclaimed, gazetted or declared areas or catchments.	The clearing of native vegetation is not considered likely to alter the quality of surface or groundwater within the study area.	Not at variance with the clearing principles
	i2) Native vegetation should not be cleared if sedimentation, erosion, turbidity or eutrophication of water bodies on or off site is likely to be caused or increased.	No permanent water bodies are present within, or in the vicinity of, the study area.	Not at variance with the clearing principles
	i3) Native vegetation should not be cleared if water tables are likely to change significantly altering salinity or pH.	The clearing of native vegetation is not considered likely to alter the quality of surface or ground water within the study area.	Not at variance with the clearing principles
	i4) Native vegetation should not be cleared if the clearing is likely to alter the water regimes of groundwater dependent ecosystems on or off site, causing degradation to the biological associations associated with these systems.	The clearing of native vegetation is not considered likely to alter the regimes of surface or groundwater dependent ecosystems within, or in the vicinity of, the study area.	Not at variance with the clearing principles
j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.	j1) Native vegetation should not be cleared if it is likely to lead to an incremental increase in peak flood height.	The clearing of native vegetation is not considered likely to cause any alteration to flood height.	Not at variance with the clearing principles
	j2) Native vegetation should not be cleared if it is likely to lead to an incremental increase in duration of flood peak.	The clearing of native vegetation is not considered likely to cause any alteration to flood duration.	Not at variance with the clearing principles

## 5.0 SUMMARY

The reconnaissance flora and vegetation survey was completed under *poor* seasonal conditions between the 17<sup>th</sup> and 21<sup>st</sup> of February 2018, with a follow-up targeted flora survey of six bore holes in the western sector of the larger study area completed on the 23<sup>rd</sup> June 2018.

There were no plant taxa gazetted as Threatened Flora pursuant to subsection (2) of section 23F of the WC Act, or listed under the EPBC Act recorded from the study area. Five Priority flora taxa were recorded from the study area; *Eremophila capricornica* (Priority 1), *Ipomoea racemigera* (Priority 2), *Crotalaria smithiana* (Priority 3), *Rhagodia* sp. Hamersley (M. Trudgen 17794) (Priority 3) and *Goodenia nuda* (Priority 4). An additional two species were determined to represent species of interest: *Indigofera* sp. indet and *Tephrosia* sp. Willowra (G.M. Chippendale 4809).

A total of 30 vegetation associations from 12 broad floristic formations were described and mapped within the study area. None of the vegetation associations were aligned with Federal or State listed TECs, or State listed PECs. The total flora included five introduced species. None of these taxa were listed as a Declared Pest under the BAM Act. Vegetation condition within the study area ranged from *excellent* to *good*, with the majority of the vegetation present at higher relief rated as *excellent*. The major disturbances were related to grazing by domestic cattle on drainage lines and floodplains resulting in altered vegetation structure.

Assuming that all 30 vegetation associations may potentially be impacted by future clearing to some degree, the study area is unlikely to be at variance with nine of the ten clearing principles which address native flora and vegetation (as listed under Schedule 5 of the *Environmental Protection Act 1986*).

## 6.0 STUDY TEAM

The reconnaissance flora and vegetation survey and follow-up targeted flora survey were planned, co-ordinated and executed by the following personnel:

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### Project Staff

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Dr Jerome Bull	PhD	Principal Botanist
Ms Jessica Waters	BSc	Senior Botanist
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# APPENDIX 1

Results from previous flora and vegetation surveys completed  
in the vicinity of the study area

Project	Survey Timing	Season	Survey Type	Area (ha)	No. Sites	No. Taxa	Significant Flora	Introduced Flora
Surveys completed within, or partly within, the study area								
Onshore Environmental (2016) Level 2 Riparian & Aquatic Flora & Vegetation Survey Jimblebar Creek and Innawally Pool	25 <sup>th</sup> -29 <sup>th</sup> May 2016	Poor	Single season detailed and riparian vegetation monitoring	744	15	242	<i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794) (P3), <i>Goodenia nuda</i> (P4)	* <i>Cenchrus ciliaris</i> , * <i>Cynodon dactylon</i> , * <i>Echinochloa colona</i> , * <i>Malvastrum americanum</i> , * <i>Tribulus terrestris</i>
Onshore Environmental (2014a) Consolidation of Regional Vegetation Mapping BHP Billiton Iron Ore Pilbara Tenure	24 <sup>th</sup> -30 <sup>th</sup> July 2013, 20 <sup>th</sup> -30 <sup>th</sup> August 2013	Good	Vegetation mapping assessment	5,300	NR	NR	<i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794) (P3), <i>Goodenia nuda</i> (P4)	NR
Outback Ecology (2010) Jimblebar Iron Ore Project Flora and Vegetation Assessment	July and September 2008, January and March 2009	Poor	Two season detailed	6,685	128	326	<i>Josephinia</i> sp. Marandoo (M.E. Trudgen 1554) (P1), <i>Goodenia nuda</i> (P4)	* <i>Acetosa vesicaria</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cucumis melo</i> , * <i>Cucumis myriocarpus</i> , * <i>Malvastrum americanum</i>
GHD (2009) Caramulla Exploration Area Flora and Vegetation Survey	December 2008	Poor	Single season detailed	5,300	26	225	<i>Crotalaria smithiana</i> (P3)	* <i>Malvastrum americanum</i> , * <i>Cenchrus ciliaris</i>
Ecologia (2007) Hashimoto Exploration Project Biological Survey: Flora and Vegetation	24 <sup>th</sup> August-1 <sup>st</sup> September 2005, 15 <sup>th</sup> -21 <sup>st</sup> February 2006	Good	Two season detailed	NR	44	372	<i>Goodenia nuda</i> (P4), <i>Goodenia</i> sp. Rudall River (R.P. Hart 972) <sup>1</sup>	* <i>Cenchrus ciliaris</i> , * <i>Bidens bipinnata</i> , * <i>Sonchus oleraceus</i> , * <i>Pseudognaphalium luteoalbum</i> <sup>2</sup>
Ecologia (2005) Jimblebar East Exploration Project Biological Survey	February 2005	Good	Single season detailed	NR	26	155	None	* <i>Cenchrus ciliaris</i>

<sup>1</sup> Later confirmed as *Goodenia* sp. Sandy Creek (R.D. Royce 1653) which is not threatened

<sup>2</sup> No longer considered a weed in the Pilbara (naturalised)



Project	Survey Timing	Season	Survey Type	Area (ha)	No. Sites	No. Taxa	Significant Flora	Introduced Flora
Surveys completed in close proximity to the study area								
Onshore Environmental (2015a) Dynasty and West Jimblebar Flora and Vegetation Survey	February-March 2015	Good	Single season detailed	3,358	29	263	<i>Ipomoea racemigera</i> (P2), <i>Goodenia nuda</i> (P4), <i>Goodenia berringbinensis</i> (P4) Five Range extensions: <i>Eragrostis speciosa</i> , <i>Hibiscus verdcourtii</i> , <i>Goodenia berringbinensis</i> , <i>Eleocharis pallens</i> , <i>Tribulus cf. eichlerianus</i>	* <i>Aerva javanica</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i>
Onshore Environmental (2015b) OB31 Jimblebar Access Track VCP Level 1 Flora & Vegetation Survey and Vertebrate Fauna Assessment	15 <sup>th</sup> -16 <sup>th</sup> July 2015	Excellent	Reconnaissance	62	NR	NR	<i>Acacia clelandii</i> (range extension)	* <i>Cenchrus ciliaris</i>
Onshore Environmental (2015c) Jimblebar Creek Riparian Flora and Vegetation Baseline Survey	8 <sup>th</sup> -12 <sup>th</sup> September 2014	Poor	Single season detailed and riparian vegetation monitoring	1,227	13	167	<i>Chamaecrista symonii</i> , <i>Eragrostis speciosa</i> , <i>Halgania erecta</i> (range extensions)	* <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Bidens bipinnata</i>
Onshore Environmental (2014b) Tenement E52/2238 Level 1 Flora and Vegetation Level 1 Vertebrate Fauna Survey	8 <sup>th</sup> -10 <sup>th</sup> July 2014	Good	Reconnaissance	167	NR	NR	None recorded	* <i>Cenchrus ciliaris</i> , * <i>Vachellia farnesiana</i>
Onshore Environmental (2014c) OB 19 Level 2 Flora and Vegetation Assessment	19 <sup>th</sup> -27 <sup>th</sup> March 2013, 9 <sup>th</sup> - 22 <sup>nd</sup> September 2013	Good	Two season detailed	1,795	30	276	<i>Isotropis parviflora</i> (P2), <i>Triodia</i> sp. Mt Ella (M.E. Trudgen 12739) (P3)	* <i>Cenchrus ciliaris</i> , * <i>Bidens bipinnata</i>

Project	Survey Timing	Season	Survey Type	Area (ha)	No. Sites	No. Taxa	Significant Flora	Introduced Flora
Onshore Environmental (2014d) OB 31 Targeted Significant Flora Survey	April 2014	Excellent	Targeted Survey	3,754	NR	NR	<i>Acacia</i> sp. East Fortescue (J. Bull & D. Roberts ONS A 27.01) (P1), <i>Rhagodia</i> sp. Hamersley (M. Trudgen 12739) (P3), <i>Triodia</i> sp. Mt Ella (M.E. Trudgen 12739) (P3), <i>Goodenia nuda</i> (P4), <i>Acacia cleilandii</i> (Range extension)	Not Recorded
Onshore Environmental (2014e) Level 2 Flora and Vegetation Assessment Orebody 31	October 2013	Good	Two season detailed	3,754	45	280	<i>Triodia</i> sp. Mt Ella (M.E. Trudgen 12739) (P3), <i>Rhagodia</i> sp. Hamersley (M. Trudgen 12739) (P3), <i>Acacia</i> sp. East Fortescue (J. Bull & D. Roberts ONS A 27.01) (P1)	* <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i>
Syrinx (2014) South West Jimblebar Level 2 Flora And Vegetation Survey	14 <sup>th</sup> -18 <sup>th</sup> March 2011 and 27 <sup>th</sup> August-4 <sup>th</sup> September 2013	Good	Single season detailed	2,050	38	330	<i>Aristida jerichoensis</i> subsp. <i>subspinulifera</i> (P1), <i>Vittadinia</i> sp. Coondewanna Flats (S. van Leeuwen 4684) (P1), <i>Euphorbia inappendiculata</i> var. <i>inappendiculata</i> (P1), Range extensions: <i>Abutilon malvifolium</i> , <i>Brachyscome ciliaris</i> , <i>Euphorbia porcata</i> , <i>Diplachne fusca</i> subsp. <i>muelleri</i> , <i>Tephrosia sphaerospora</i>	* <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Cucumis melo</i> , * <i>Malvastrum americanum</i> , * <i>Taraxacum khatoonae</i> <sup>3</sup> , * <i>Vachellia farnesiana</i>

<sup>3</sup> Recorded as \**Taraxacum officinale*

Project	Survey Timing	Season	Survey Type	Area (ha)	No. Sites	No. Taxa	Significant Flora	Introduced Flora
Onshore Environmental (2013b) Orebody 17/18 Derived Vegetation Association Mapping Report	No field survey	NR	Desktop	250	NR	NR	None	NR
Onshore Environmental (2014c) OB18 to OB31 Infrastructure Corridor Targeted Flora Survey	September 2014	Good	Targeted flora survey	200	NR	NR	<i>Triodia</i> sp. Mt Ella (M.E. Trudgen 12739) (P3), <i>Goodenia nuda</i> (P4)	* <i>Cenchrus ciliaris</i>
Astron (2012) Eastern Mines Weed Survey, Jimblebar	May 2012	Good	Targeted weed survey	7,650	31	NR	NR	* <i>Acetosa vesicaria</i> , * <i>Aerva javanica</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Chloris barbata</i> , * <i>Chloris virgata</i> , * <i>Citrullus colocynthis</i> , * <i>Cynodon dactylon</i> , * <i>Malvastrum americanum</i> , <i>Portulaca oleracea</i> <sup>4</sup> , * <i>Solanum nigrum</i> , * <i>Sonchus asper</i> , * <i>Vachellia farnesiana</i>
Syrinx (2012a) South West Jimblebar Flora and Vegetation Survey	March 2011	Good	Single season detailed	2,050	19	202	<i>Aristida ?jerichoensis</i> var. <i>subspinulifera</i> (P1), <i>Goodenia ?nuda</i> (P4) Five range extensions: <i>Alloteropsis cimicina</i> , <i>Brachyscome ciliaris</i> var. <i>ciliaris</i> , <i>Evolvulus alsinoides</i> var. <i>decumbens</i> , <i>Tephrosia sphaerospora</i> , <i>Tribulopsis angustifolia</i>	* <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cucumis melo</i> , <i>Portulaca oleracea</i> <sup>5</sup>

<sup>4</sup> No longer considered a weed in the Pilbara (naturalised)

Project	Survey Timing	Season	Survey Type	Area (ha)	No. Sites	No. Taxa	Significant Flora	Introduced Flora
Syrinx (2012b) Wheelarra Hill North Level 2 Flora and Vegetation Assessment	May 2011 and October 2011	Good	Two season detailed	4,972	83	321	<i>Aristida ?jerichoensis</i> var. <i>subspinulifera</i> <sup>5</sup>	* <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i> , <i>Portulaca oleracea</i> <sup>6</sup>
Eco Logical (2012) Level 1 flora and fauna surveys along the Great Northern Highway for Jimblebar mine module transport.	August 2011	Good	Reconnaissance	NR	3	52	None	* <i>Cenchrus ciliaris</i>
Syrinx (2011) OB 31 Flora and Vegetation Assessment	February and March 2011	Good	Two season, detailed	NR	29	206	None	* <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i> , <i>Portulaca oleracea</i> <sup>7</sup>
ENV (2010a) RGP6 Jimblebar Hub (Water Pipeline) Flora and Vegetation Assessment	November 2009	Poor	Single season detailed	NR	16	166	None	* <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i>
ENV (2010b) Jimblebar Wye Targeted Declared Rare Flora and Priority Listed Flora Assessment	March 2010, June 2010	Good	Targeted flora survey	NR	NR	NR	<i>Gymnanthera cunninghamii</i> (P3)	Not recorded
ENV (2009a) Ammonium Nitrate Storage Facility Flora and Vegetation Assessment	September 2009	Poor	Single season detailed	NR	7	123	None	* <i>Cenchrus ciliaris</i> , <i>Portulaca oleracea</i> <sup>7</sup>
ENV (2009b) Construction Water Supply Pipeline and Ammonium Nitrate Storage Facility Flora and Vegetation Assessment	September and November 2009	Poor	Two season detailed	NR	23	213	<i>Goodenia nuda</i> (P4)	* <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i> , <i>Portulaca oleracea</i> <sup>7</sup>
Outback Ecology (2009a) Eastern Pilbara Accommodation Camp Flora and Fauna Assessment	October - November 2008	Poor	Single season detailed	493	15	115	None	None
Outback Ecology (2009b) Wheelarra Hill Iron Ore Mine Modification Flora and Fauna Assessment	October and November 2008, January 2009	October: Poor January: Good	Two season detailed	NR	22	146	<i>Goodenia nuda</i> (P4)	* <i>Cenchrus ciliaris</i>

<sup>5</sup> Targeted searches by Onshore Environmental (2014b) confirmed this taxon to be *Aristida inaequiglumis* (not Threatened or Priority flora)

<sup>6</sup> No longer considered a weed in the Pilbara (naturalised)



Project	Survey Timing	Season	Survey Type	Area (ha)	No. Sites	No. Taxa	Significant Flora	Introduced Flora
GHD (2008a) Draft Report for Wheelarra Hill (Jimblebar Mine Site) Priority Species Verification – Goodenia hartiana Species Verification	September 2007	Poor	Targeted flora survey	NR	12	NR	None	Not recorded
GHD (2008b) Mesa Gap Biological Survey	October 2007	Poor	Single season detailed	NR	40	133	None	None
ENV (2008a) Rapid Growth Project 5: Repeater 9 Access Road Flora and Vegetation Assessment	June 2008	Poor	Single season detailed	12	6	163	<i>Rostellularia adscendens</i> var. <i>latifolia</i> (P3)	* <i>Acetosa vesicaria</i> , * <i>Aerva javanica</i> , * <i>Brassica tournefortii</i> , * <i>Cenchrus ciliaris</i> , * <i>Citrullus lanatus</i> , * <i>Cucumis melo</i> subsp. <i>agrestis</i> , * <i>Cynodon dactylon</i> , * <i>Datura leichhardtii</i> , * <i>Malvastrum americanum</i> , <i>Portulaca olearcea</i> <sup>7</sup> , * <i>Setaria verticillata</i> , * <i>Sonchus asper</i> , * <i>Sonchus oleraceus</i> , * <i>Vachellia farnesiana</i>
ENV (2008b) Jimblebar Access Road Flora and Vegetation Assessment	May 2007	Poor	Single season detailed	NR	22	112	None	* <i>Cenchrus ciliaris</i> , * <i>Aerva javanica</i> , * <i>Citrullus lanatus</i>
Pilbara Flora (2008) OB17 Flora and Vegetation Survey	October 2008	Poor	Single season detailed	NR	NR	61	None	None
ENV (2007a) West Jimblebar Exploration Lease Flora and Vegetation Assessment - Management Recommendations	May 2007	Average	Single season detailed	NR	29	318	<i>Goodenia nuda</i> (P4) One range extension: <i>Thyridolepis xerophila</i>	* <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i>
ENV (2007b) OB 18 Flora and Vegetation Assessment Phase II	July and August 2006	Good	Single season detailed	NR	71	276	None	* <i>Acetosa vesicaria</i> , * <i>Cenchrus ciliaris</i>

<sup>7</sup> No longer considered a weed in the Pilbara (naturalised)

Project	Survey Timing	Season	Survey Type	Area (ha)	No. Sites	No. Taxa	Significant Flora	Introduced Flora
ENV (2007c) Jimblebar Stage 2, Levee Banks and Communications Tower Redevelopment Flora and Vegetation Assessments	16 <sup>th</sup> -17 <sup>th</sup> April and 6 <sup>th</sup> June 2007	Average	Two season detailed	30	4	103	None	* <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Citrullus lanatus</i> , * <i>Bidens bipinnata</i> , * <i>Cynodon dactylon</i>
ENV (2007d) RGP4 Jimblebar Rail Loop Flora and Vegetation Assessment	November - December 2006	Good	Single season detailed	NR	4	65	None	* <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i>
Ecologia (2006) Jimblebar Marra Mamba Exploration Biological Survey	22 <sup>nd</sup> -28 <sup>th</sup> May 2006	Good	Single season detailed	NR	105	267	<i>Goodenia nuda</i> (P4)	* <i>Acetosa vesicaria</i> , * <i>Cenchrus ciliaris</i>
Ecologia (2004a) OB 18 Flora and Fauna Review	July 2004	Good	Targeted	NR	NR	155	<i>Rhodanthe frenchii</i> (P2) <sup>8</sup>	* <i>Cenchrus ciliaris</i>
Ecologia (2004b) Jimblebar-Wheelarra Hill Expansion Biological Study	9 <sup>th</sup> -13 <sup>th</sup> February 2004	Good	Single season detailed	NR	44	181	None	* <i>Cenchrus ciliaris</i>
Biota (2004) Jimblebar - Wheelarra Hill 3 Flora and Fauna Assessment	28 <sup>th</sup> -29 <sup>th</sup> August 2003	Poor	Single season detailed	450	2	227	None	* <i>Acetosa vesicaria</i>
Ecologia (1996) Jimblebar Rail Spur Biological Assessment Survey	6 <sup>th</sup> -8 <sup>th</sup> June 1995	Good	Single season detailed	NR	2	106	None	* <i>Cenchrus ciliaris</i> , * <i>Acetosa vesicaria</i> , * <i>Malvastrum americanum</i> , * <i>Sonchus oleraceus</i>
BHP IO (1994) Jimblebar Mine Site Biological Survey	June 1994	Good	Single season detailed	588	22	132	None	* <i>Acetosa vesicaria</i>
Dames and Moore (1993) Ecological Observations Jimblebar Railway Line	November 1992	Poor	Borrow pit survey	NR	41	-	None	Not recorded

<sup>8</sup> It is noted that the original identification was not confirmed through the WAH and the collection represents a 300 km range extension to the east. It has not been recorded locally during numerous surveys over a 17 year period since the original record

# APPENDIX 2

Vegetation condition scale  
(as developed by Keighery 1994)

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



# APPENDIX 3

Vegetation Classifications for the Pilbara based on Specht (1970), as modified by Aplin (1979) and Trudgen (2009).

Height Class	Canopy Cover				
	100 - 70%	70 - 30%	30 - 10%	10 - 2%	< 2%
Trees > 30 m	High Closed Forest	High Open Forest	High Woodland	High Open Woodland	Scattered Tall Trees
Trees 10-30m	Closed Forest	Open Forest	Woodland	Open Woodland	Scattered Trees
Trees < 10 m	Low Closed Woodland	Low Open Forest	Low Woodland	Low Open Woodland	Scattered Low Trees
Mallee	Closed Mallee	Mallee	Open Mallee	Very Open Mallee	Scattered Mallees
Shrubs > 2 m	Closed Scrub	Open Scrub	High Shrubland	High Open Shrubland	Scattered Tall Shrubs
Shrubs 1-2 m	Closed Heath	Open Heath	Shrubland	Open Shrubland	Scattered Shrubs
Shrubs < 1 m	Low Closed Heath	Low Open Heath	Low Shrubland	Low Open Shrubland	Low Scattered Shrubs
Hummock Grass	Closed Hummock Grassland	Hummock Grassland	Open Hummock Grassland	Very Open Hummock Grassland	Scattered Hummock Grass
Tussock Grass	Closed Tussock Grassland	Tussock Grassland	Open Tussock Grassland	Very Open Tussock Grassland	Scattered Tussock Grass
Bunch Grass	Closed Bunch Grassland	Bunch Grassland	Open Bunch Grassland	Very Open Bunch Grassland	Scattered Bunch Grass
Sedges	Closed Sedges	Sedges	Open Sedges	Very Open Sedges	Scattered Sedges
Herbs	Closed Herbs	Herbs	Open Herbs	Very Open Herbs	Scattered Herbs

Source: S. Van Leeuwen (DBCA)

# APPENDIX 4

Conservation categories for flora described  
under the EPBC Act.

Category	Description
Extinct	A species is extinct if there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild	A species is categorised as extinct in the wild if it is only known to survive in cultivations, in captivity, or as a naturalised population well outside its past range; or if it has not been recorded in its known/expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	The species is facing an extremely high risk of extinction in the wild and in the immediate future.
Endangered	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival, or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Conservation Dependent	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.



# APPENDIX 5

Conservation Codes for Western Australian Flora.

## **T: Threatened (Declared Rare) Flora - Extant Taxa**

Taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

### **1: Priority One - Poorly Known Taxa**

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

### **2: Priority Two - Poorly Known Taxa**

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

### **3: Priority Three - Poorly Known Taxa**

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

### **4: Priority Four - Rare, Near Threatened and other taxa 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 taxa 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) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

# APPENDIX 6

Records for conservation significant species recorded  
from the study area

Genus	Species	Infra Rank	Infra Name	# Plants	Count or Estimate	% Coverage	Height (m)	Northing	Easting
<i>Crotalaria</i>	<i>smithiana</i>			1	Count	<1	0.35	7411658	243831.4
<i>Crotalaria</i>	<i>smithiana</i>			3	Count	<1	0.35	7411741	241997.3
<i>Crotalaria</i>	<i>smithiana</i>			4	Count	<1	0.3	7410109	243093
<i>Crotalaria</i>	<i>smithiana</i>			1	Count	<1	0.3	7413338	240383.7
<i>Crotalaria</i>	<i>smithiana</i>			1	Count	<1	0.3	7409805	245780
<i>Eremophila</i>	<i>capricornica</i>			1	Count	<1	1	7411568	244584.8
<i>Eremophila</i>	<i>capricornica</i>			1	Count	<1	1	7413650	220853.5
<i>Eremophila</i>	<i>capricornica</i>			1	Count	<1	1	7413523	223453.1
<i>Eremophila</i>	<i>capricornica</i>			40	Estimate	1	0.4	223591	7413622
<i>Eremophila</i>	<i>capricornica</i>			40	Estimate	1	0.4	223324	7413598
<i>Eremophila</i>	<i>capricornica</i>			21	Count	0.5	0.4	222893	7413585
<i>Eremophila</i>	<i>capricornica</i>			20	Count	<1	0.4	222802	7413574
<i>Eremophila</i>	<i>capricornica</i>			6	Count	<1	0.4	222715	7413579
<i>Eremophila</i>	<i>capricornica</i>			7	Count	<1	0.4	222718	7413609
<i>Eremophila</i>	<i>capricornica</i>			15	Count	<1	0.4	218351	7412882
<i>Eremophila</i>	<i>capricornica</i>			85	Count	<1	0.4	218347	7412850
<i>Eremophila</i>	<i>capricornica</i>			35	Count	<1	0.4	218293	7412805
<i>Eremophila</i>	<i>capricornica</i>			120	Estimate	2	0.4	218265	7412754
<i>Eremophila</i>	<i>capricornica</i>			>150	Estimate	5	0.5	218136	7412730
<i>Eremophila</i>	<i>capricornica</i>			75	Count	2	0.4	218174	7412692
<i>Eremophila</i>	<i>capricornica</i>			16	Count	<1	0.4	219010	7413186
<i>Eremophila</i>	<i>capricornica</i>			40	Count	1	0.4	218899	7413150
<i>Eremophila</i>	<i>capricornica</i>			10	Count	<1	0.4	218592	7412958
<i>Eremophila</i>	<i>capricornica</i>			150	Estimate	3	0.4	224151	7413436
<i>Eremophila</i>	<i>capricornica</i>			3	Count	<1	0.35	223709	7413546
<i>Eremophila</i>	<i>capricornica</i>			10	Count	<1	0.35	221784	7413427
<i>Eremophila</i>	<i>capricornica</i>			1	Count	<1	0.5	221806	7413416
<i>Eremophila</i>	<i>capricornica</i>			1	Count	<1	0.4	221097	7412849
<i>Eremophila</i>	<i>capricornica</i>			7	Count	<1	0.4	222552	7413554
<i>Eremophila</i>	<i>capricornica</i>			1	Count	<1	0.5	220245	7413208
<i>Eremophila</i>	<i>capricornica</i>			1	Count	<1	0.5	220132	7413196
<i>Eremophila</i>	<i>capricornica</i>			60	Count	<1	0.5	220083	7413160



Genus	Species	Infra Rank	Infra Name	# Plants	Count or Estimate	% Coverage	Height (m)	Northing	Eastings
<i>Eremophila</i>	<i>capricornica</i>			70	Count	2	0.4	220161	7413092
<i>Eremophila</i>	<i>capricornica</i>			1	Count	<1	0.4	220141	7413257
<i>Eremophila</i>	<i>capricornica</i>			14	Count	<1	0.4	220116	7413314
<i>Eremophila</i>	<i>capricornica</i>			80	Count	2	0.5	220114	7413523
<i>Eremophila</i>	<i>capricornica</i>			70	Count	2	0.4	220056	7413237
<i>Eremophila</i>	<i>capricornica</i>			70	Count	2	0.4	219961	7413236
<i>Eremophila</i>	<i>capricornica</i>			20	Count	<1	0.4	219965	7413199
<i>Eremophila</i>	<i>capricornica</i>			30	Count	<1	0.4	219863	7413200
<i>Eremophila</i>	<i>capricornica</i>			2	Count	<1	0.4	219663	7413202
<i>Eremophila</i>	<i>capricornica</i>			50	Count	<1	0.4	219528	7413120
<i>Eremophila</i>	<i>capricornica</i>			60	Count	3	0.5	221791	7413473
<i>Goodenia</i>	<i>nuda</i>			2	Count	<1	0.3	7411663	243817.7
<i>Goodenia</i>	<i>nuda</i>			2	Count	<1	0.2	7411762	241957.7
<i>Goodenia</i>	<i>nuda</i>			15	Count	<1	0.2	7408462	849745
<i>Goodenia</i>	<i>nuda</i>			15	Count	<1	0.3	7410202	236255.6
<i>Goodenia</i>	<i>nuda</i>			20	Count	<1	0.3	7410193	236446.7
<i>Goodenia</i>	<i>nuda</i>			5	Count	<1	0.3	7410217	236173.5
<i>Goodenia</i>	<i>nuda</i>			20	Count	<1	0.2	7410236	236510.7
<i>Goodenia</i>	<i>nuda</i>			10	Count	<1	0.3	7411972	851769
<i>Goodenia</i>	<i>nuda</i>			10	Count	<1	0.25	7412606	230308
<i>Ipomoea</i>	<i>racemigera</i>			>50	Estimate	0.5	Climber	7410772	241545.5
<i>Ipomoea</i>	<i>racemigera</i>			2	Count	<1	Climber	7413713	240298.7
<i>Ipomoea</i>	<i>racemigera</i>			1	Count	<1	Climber	7413666	240354.1
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	7408972	859153
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	7409279	858809
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.5	7411408	245472.3
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	3	Count	<1	1.5	7411596	244591.1
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	3	Count	<1	1-2	7411659	243863.8
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1-2	7411620	243777.5
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.5	7410425	242361.3
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	7410418	242414.2
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	7408851	849800

Genus	Species	Infra Rank	Infra Name	# Plants	Count or Estimate	% Coverage	Height (m)	Northing	Easting
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	7414268	240345.2
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	10	Count	0.5	1-2	7410202	236255.6
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	7410312	236083.2
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.5	7412062	846357
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	5	Count	<1	1.2	7412606	230308
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.5	7413162	229172.4
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	7413523	223453.1
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	1	1-2	7412788	223729.5
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1-2	7412480	223598.9
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	7412079	223647.3
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	7412354	223076
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	5	Count	<1	2	223232	7412222
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	223166	7412219
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	222809	7412124
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	222579	7411949
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.5	222317	7411915
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.5	222239	7411940
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1	222240	7411956
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	222174	7411957
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	222169	7411936
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	222184	7411922
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	2	222264	7411412
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.5	222242	7411210
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1-2	223692	7412264
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1-2	223644	7412269
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1-2	223606.2	7412272
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1-2	223574	7412258
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	3	Count	<1	1-2	223520	7412252
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2.5	223439	7412267
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	223430	7412302
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	225185	7412491
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1	225148	7412426

Genus	Species	Infra Rank	Infra Name	# Plants	Count or Estimate	% Coverage	Height (m)	Northing	Eastings
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	224222	7412418
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.5	224230	7412396
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	224238	7412435
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	2	224269	7412375
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	3	Count	<1	1.5	224269	7412375
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	224287	7412389
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	224296	7412405
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	224226	7412387
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	224230	7412368
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	224256	7412347
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	224318	7412424
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	3	Count	<1	1-2	224192	7412419
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.2	224104	7412396
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1	224072	7412376
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1	224007	7412384
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	223882	7412358
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1	223843	7412335
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	223765	7412331
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	2	223721	7412325
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	6	Count	<1	2	223666	7412326
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	2	223628	7412329
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	5	Count	<1	2	223607	7412328
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.5	223570	7412321
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1	223539	7412302
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	3	Count	<1	2	223519	7412286
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.5	223479	7412276
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2.5	223454	7412285
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1-2	224066	7412319
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	223982	7412323
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1-2	223843	7412272
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1-2	223768	7412260
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	3	Count	<1	3.5	224238	7411946

Genus	Species	Infra Rank	Infra Name	# Plants	Count or Estimate	% Coverage	Height (m)	Northing	Eastings
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	224280	7411983
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	224331	7411986
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.8	224315	7412023
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	224464	7412066
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	2	224452	7412092
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	224509	7412145
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1	224546	7412128
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.5	224786	7412309
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	0.5	224648	7412260
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1	224722	7412322
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	224756	7412349
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	2	224931	7412485
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	223218	7412165
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	222951	7412115
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	5	Count	<1	1.4	222546	7411905
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.8	222546	7411905
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	4	Count	<1	1-2	222483	7411863
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1-2	222417	7411845
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	5	Count	<1	2	222374	7411864
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	3	222342	7411875
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	3	Count	<1	1.6	222294	7411876
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.6	222236	7411891
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.1	222213	7411898
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	3	Count	<1	1.9	222211	7411904
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.7	222201	7411918
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.1	222194	7411913
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.6	222190	7411866
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.8	222207	7411863
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	222228	7411756
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	5	Count	<1	1.4	222210	7411520
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.8	222235	7411444
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	3	Count	<1	1.5	222218	7411387



Genus	Species	Infra Rank	Infra Name	# Plants	Count or Estimate	% Coverage	Height (m)	Northing	Eastings
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	3	222286	7411129
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.4	222292	7411057
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.4	222894	7411348
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1.9	223160	7411500
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	2	223663	7411612
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1	223979	7411588
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	2	222257	7411118
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	2	222560	7410983
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1	223010	7411426
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	3	Count	<1	1-2	223978	7411619
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	1	Count	<1	1-2	223971	7411639
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	2.5	223928	7411593
<i>Rhagodia</i>		sp.	Hamersley (M. Trudgen 17794)	2	Count	<1	1.8	220132	7413196
<i>Tephrosia</i>		sp.	Willowra (G.M. Chippendale 4809)	1	Count	<1	0.15	7411697	242037.3
<i>Tephrosia</i>		sp.	Willowra (G.M. Chippendale 4809)	13	Count	<1	0.4	7410335	242325.3
<i>Tephrosia</i>		sp.	Willowra (G.M. Chippendale 4809)	5	Count	<1	0.2	7413888	238372.3
<i>Indigofera</i>		sp.	indet	100	Estimate	<1	0.2	7413278	230294

# APPENDIX 7

Records for introduced weed species recorded  
from the study area

Genus	Species	Infra Rank	Infra Name	# Plants	Count or Estimate	% Coverage	Height (m)	Northing	Easting
* <i>Bidens</i>	<i>bipinnata</i>			30	Count	<1	0.1	7411605	243859.6
* <i>Bidens</i>	<i>bipinnata</i>			>100	Estimate	1	0.1	7410772	241545.5
* <i>Cenchrus</i>	<i>ciliaris</i>			100	Estimate	2	0.5	7413228	240326
* <i>Cenchrus</i>	<i>ciliaris</i>			2	Count	<1	0.8	7411697	242059.5
* <i>Cenchrus</i>	<i>ciliaris</i>			500	Estimate	10	0.5	7413486	240435.7
* <i>Cenchrus</i>	<i>ciliaris</i>			500	Estimate	10	0.5	7411711	853795
* <i>Cenchrus</i>	<i>ciliaris</i>			>500	Estimate	10	0.5	7410763	225605.4
* <i>Cenchrus</i>	<i>ciliaris</i>			10	Count	<1	0.3	7408834	225789.6
* <i>Cenchrus</i>	<i>ciliaris</i>			25	Count	0.25	0.3	7413632	224743.7
* <i>Cenchrus</i>	<i>ciliaris</i>			22	Count	<1	0.35	225227	7412431
* <i>Cenchrus</i>	<i>ciliaris</i>			60	Count	<1	0.5	223817	7411623
* <i>Cenchrus</i>	<i>ciliaris</i>			30	Count	<1	0.5	223928	7411593
* <i>Citrullus</i>		sp.	indet	1	Count	<1	0.1	7411718	243796.3
* <i>Citrullus</i>		sp.	indet	5	Count	<1	0.1	7410772	241545.5
* <i>Malvastrum</i>	<i>americanum</i>			25	Count	<1	1	7411587	243858.2
* <i>Malvastrum</i>	<i>americanum</i>			100	Estimate	3	0.4	7411711	853795
* <i>Vachellia</i>	<i>farnesiana</i>			1	Count	<1	1.5	7411751	243326.9
* <i>Vachellia</i>	<i>farnesiana</i>			1	Count	<1	1.5	7411839	853592