Report for follow up targeted Acacia sp, East Fortescue is included at the end of this report.

ONSHORE ENVIRONMENTAL

Orebody 31
Targeted Significant Flora Survey

Prepared for BHP Billiton Iron Ore Pty Ltd
June 2014

Document Status						
Rev No.	Authors	Reviewer/s	Date	Approved for Issue		
				Name	Distributed To	Date
1	D.Brearley, J. Waters	D.Brearley	03/06/14	D.Brearley	B.Menezies	06/06/14
2	D.Brearley	B.Menezies	06/06/14	D.Brearley	B.Menezies	16/06/14
3	D.Brearley	B.Menezies	18/06/14	D.Brearley	B.Menezies	19/06/14

Onshore Environmental Consultants Pty Ltd
ACN 095 837 120
PO Box 227
YALLINGUP WA 6282
Telephone / Fax (08) 9756 6206
E-mail: onshoreenv@westnet.com.au

Executive Summary

Onshore Environmental Consultants Pty Ltd (Onshore Environmental) was commissioned by BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) to undertake a single season targeted flora survey of the Orebody 31 (OB31) deposit, herein referred to as the study area (Figure 1). The study area is situated approximately 40 kilometres (km) east of Newman and directly east of the existing Orebody 17/18 (OB17/18) Mine, within Mineral Lease ML244SA.

No plant taxon gazetted as Threatened Flora (T) 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) was recorded from the study area.

There were five significant flora taxa recorded from the study area including three Priority flora taxa, one taxon of interest, and one significant range extension:

- *Rhagodia* sp. Hamersley (M. Trudgen 17794) (Priority 3) was recorded as scattered individuals from two locations in the north-west sector;
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (Priority 3) was recorded from two major populations in the south-west and central southern sectors of the study area, with scattered individuals recorded on a floodplain in the central west;
- *Goodenia nuda* (Priority 4) was recorded as 13 plants from two locations on a floodplain in the central western sector;
- *Acacia* sp. nov (reticulate/anastomosing) is a species of interest recorded as 534 plants from five populations in the north-west sector; and
- *Acacia clelandii* represented a significant range extension 400 km north of the nearest known records, and was recorded from 12 locations scattered across the northern half of the study area.

Previous records for *Aristida ?jerichoensis* subsp. *subspinulifera* (Priority 1) and *Hibiscus* aff. *apodus* (range extension from the Kimberley) made by Syrinx Environmental (2012) were re-visited and confirmed to be the common taxa *Aristida inaequiglumis* and *Hibiscus haynaldii* respectively.

ABBREVIATIONS

Abbreviation	Definition
BHP Billiton Iron Ore	BHP Billiton Iron Ore Pty Ltd
BoM	Bureau of Meteorology
DPaW	Department of Parks and Wildlife
DEWHA	Department of the Environment, Water, Heritage and the Arts
DoE	Department of Environment
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EP Act	*Environmental Protection Act (1986)*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act (1999)*
ha	hectares
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for Conservation of Nature
km	kilometre
m	metre
OB31	Orebody 31
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
PECs	Priority Ecological Communities
T	Threatened Flora
TECs	Threatened Ecological Communities
WA	Western Australia
WC Act	*Wildlife Conservation Act (1950)*

Table of Contents

LIST OF PLATES

LIST OF TABLES

LIST OF FIGURES

1.0 Introduction

1.1 Preamble

Onshore Environmental was commissioned by BHP Billiton Iron Ore to undertake a single season targeted flora survey at the OB31 study area to address conditions on Native Vegetation Clearing Permits. OB31 is located approximately 40 km east of Newman Township in the Pilbara region of Western Australia (Figure 1). The study area is situated to the east of the existing Orebody 17/18 (OB17/18) Mine within Mineral Lease ML244SA, which is subject to the *Iron Ore (Mount Newman) Agreement Act 1964* (Newman Agreement Act). OB31 has not previously been developed and as such is considered a greenfields development.

At least 31 previous flora and vegetation surveys have been completed within a 25 km radius of the study area, including two baseline surveys that cover the entire extent of the study area. Flora of conservation significance previously recorded within the study area include three Priority flora taxa, *Aristida ?jerichoensis* subsp. *subspinulifera* (Priority 1), *Rhagodia* sp. Hamersley (M. Trudgen 17794) (Priority 3) and *Triodia* sp. Mt Ella (M.E. Trudgen 12739 (Priority 3), one species of interest, *Acacia* sp. nov (reticulate/anastomosing), and two taxa exhibiting significant range extensions, *Acacia clelandii* and *Hibiscus* aff. *apodus.*

During April 2014 botanists from Onshore Environmental re-surveyed all known locations of significant flora previously recorded within the study area to confirm plant identification and update population data. At the same time additional targeted searches were completed to record new populations of conservation significant plant taxa.

180000 190000 200000 210000 220000 230000

7430000

7420000

7410000

KALGAN

KALGAN CREEK

MARBLE BAR ROAD

BHP OREBODY 23

JIMBLEBAR CREEK

BHP JIMBLEBAR

JIMBLEBAR

SHOVELANNA CREEK

CARAMULLA CREEK

LOCATION MAP

ONSHORE ENVIRONMENTAL

Figure:	1	Date:	06 June 2014
Sheet Size:	A3	Status:	FINAL
Drawn by GSM	Requested by GSM	GSM Reference OB31_Location	

N

0 0.5 1 2 3 4 5

Kilometers

1:150,000

Datum: GDA94

Projection: MGA Zone 51

BHPBIO

OB31
LOCATION OF THE STUDY AREA

FIGURE 1

Legend

- Study Area
- Places
- Operating Mines
- Watercourses
- Roads
- Railways

GRIFFIN SPATIAL & MAPPING
PO Box 7215
Eaton WA 6232
admin@griffinspatial.com.au
+61 8 9725 3213

1.2 Climate

The climate of the south-eastern Pilbara is arid-tropical with hot summers extending from October to April and mild winters from May to September. The climate is dry and rainfall variable and unreliable. Rainfall occurs in both summer and winter months with the major falls received during summer months. Cyclones that develop over the Indian Ocean bring heavy summer rainfall, especially from January to March. Winter rainfall is generally lighter and typically associated with cold fronts extending from southern parts into the Pilbara region. Annual average rainfall for the Pilbara ranges from 180 mm to over 400 mm (Beard 1975) with a long-term average of 325.9 mm for the town of Newman (recorded from the years 1971 to 2013, Bureau of Meteorology (BOM) 2014). Long term rainfall and temperature data for Newman is illustrated in Figure 2 below.

Average maximum summer temperatures are typically between 35°C to 40°C and winter maximum temperatures range from 22°C and 30°C. Summer temperatures can reach 49°C with frosts occurring occasionally during winter months. The prevailing wind direction for Newman is east-south-east between May and August, with stronger west-north-west winds dominant between September and March.

Rainfall for the three months prior to the April 2014 field survey totalled 241.4 mm which is above the long term average of 180.9 mm. Heavy summer rainfall was experienced in December 2013 (72.6 mm) and January 2014 (220.2 mm) with a further 18.2 mm recorded for February 2014 (Figure 2). The excellent summer rains prior to field assessment provided optimum seasonal conditions to complete the targeted searches.

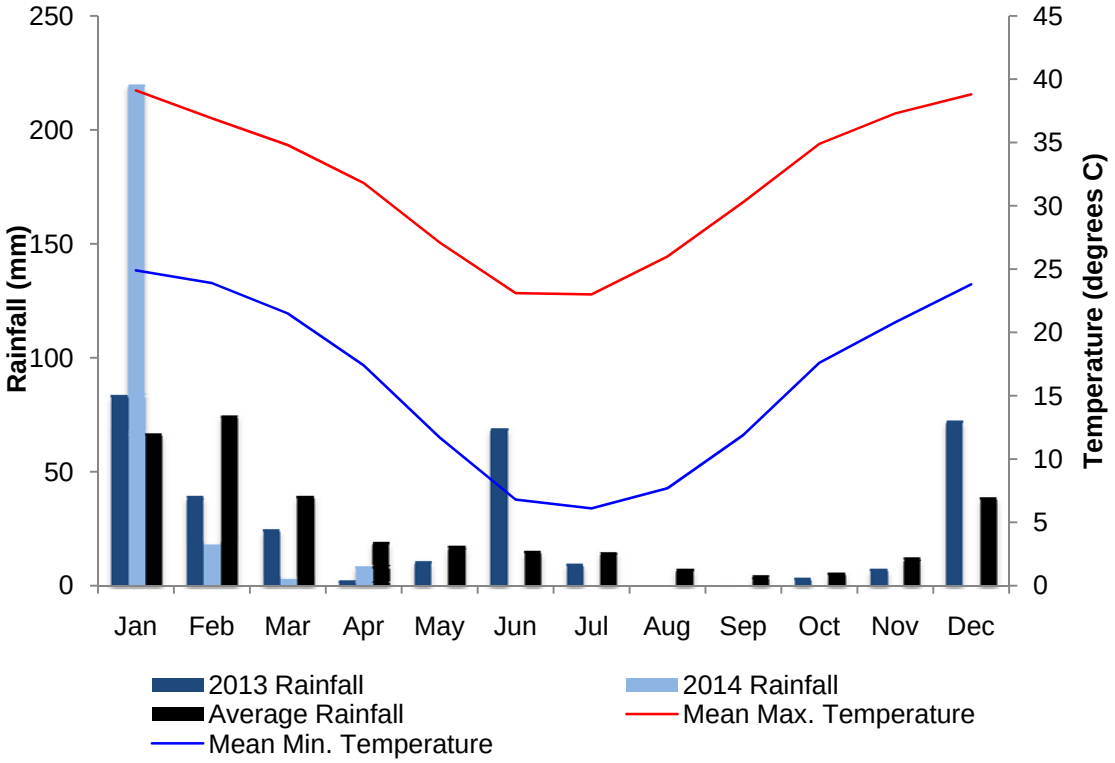


Figure 2 **Climate and rainfall data for Newman during 2013 and January to April 2014 (the four months prior to survey). Long-term temperature averages are from 1996 to 2013, while long-term rainfall data are calculated from 1971 to 2013 (Bureau of Meteorology 2014).**

1.3 Biogeographic Regions

The Interim Biogeographic Regionalisation for Australia (IBRA) describes a system of 89 'biogeographic regions' (bioregions) and 419 subregions covering the entire Australian continent (IBRA7, Department of Environment 2014a). Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna. The study area is situated in the Hamersley subregion (PIL3) of the Pilbara bioregion (Thackway and Cresswell 1995). The Hamersley subregion (PIL3) is 6,215,095 hectares (ha) in size and is described as:

"Mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite). 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 climate is semi-desert tropical, average 300 mm rainfall, usually in summer cyclonic or thunderstorm events. Winter rain is not uncommon. Drainage into either the Fortescue (to the north), the Ashburton to the south, or the Robe to the west." (Kendrick 2001).

1.4 Soils

The following CSIRO Atlas of Australia soil types occur within the study area:

- 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
- 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.

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 near the boundary of the following two soil units:

- 285 – Hamersley Plateaux Zone, located in the Fortescue Province is described as having stony soils with red shallow loams and some red/brown non-cracking clays and red loamy earths; and
- 290 – Bulloo Plains and Hills Zone, located in the Ashburton Province is described as having red shallow loams (often with hardpans), red loamy earths, stony soils and red deep sands with some red shallow sands.

1.5 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 (Australian Natural Resource Atlas 2008). Important mineral reserves, including iron ore, which is prevalent in the Pilbara, are associated with these rock formations.

The surface geology of the study area contains the geological formations outlined below (Tyler and Williams, 1991):

- Brockman Iron Formation (Hb), which consists of iron band formation, chert and shale deposits that forms prominent strike ridges and is mainly located in the southern portion of the site, which consists of a series of low hills;
- Weeli Wolli Formation (Hj), which is mainly present in the central part of the Study area conformably overlies the Brockman Iron Formation and is made up of inter-bedded banded ironstone formation (often jaspilitic), chert and shale;
- Boolgeeda Iron Formation (Ho) that occupies the northern extent of the Study area and is characterized by low hills consisting of fine grained, finely laminated dark grey brown to black flaggy iron formation, minor chert jaspilite shale, it is the uppermost unit of the Hamersley Group. Trendall and Blockley (1970) as cited in Williams and Tyler (1991) suggested that the unit could be divided into an upper and lower iron-formation with the layers separated by a poorly exposed shaly unit. This unit is approximately 200 m thick, but the top of the formation is not exposed;
- Woongarra Volcanic (Hw) is located adjacent to, and north of the Weeli Wolli Formation in the central part of the Study area. This 260 m thick formation typically consists of rhyolite and rhyodacite as sills or flows and is commonly porphyritic and contains phenocrysts of quartz, feldspar and minor tuff and jaspilitic iron formation;
- Alluvium (Qa) is located in the low-lying areas of the site, mainly in the northern and southern sections of the Study area. This formation is characterized by deposits of silt, sand and gravel which are typical of floodplains and drainage channels in the region; and
- Colluvium (CzC) is located in the small section to the northeast and southeast corner of the Study area in the low-lying scree slopes. This formation is typically characterized by partly consolidated and consolidated ferrugenised silt, sand and gravel; valley-fill deposits dissected by present drainage.

1.6 Flora and Vegetation

The study area is located within the Fortescue Botanical District and close to the border of the Hamersley Botanical District (both within the Pilbara IBRA region), 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 aneura*) occur within valley areas and short grass plains occur on alluvia.

The original vegetation mapping was undertaken by Beard (1975) and refined by Shepherd *et al.* (2001). There were two vegetation associations described from the study area (Table 1). While the Pre-European extent for each vegetation association is 100 %, less than 10 % 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.* 2001).

Vegetation Sub-Association	Description	Pre-Euro. Extent Remaining	% remaining IUCN Class I-IV Reserves	% remaining Other Reserves	% remaining DPaW Managed PL
Fortescue - Valley 82	Hummock grasslands, low tree steppe; Snappy gum over *Triodia wiseana*	2,290,910 ha (100 %)	8.9 ha	0.2 ha	1.0 ha
Fortescue - Valley 216	Low woodland; mulga (with spinifex) on rises	298,549 ha (100 %)	0.0 ha	0.0 ha	0.0 ha

In recent years there has been numerous small-scale surveys completed throughout the Pilbara, predominantly associated with mining approvals. A literature review confirmed three previous flora and vegetation surveys covering at least part of the study area were completed between 2011 and 2014. An additional 28 surveys have been completed at surrounding BHP Billiton Iron Ore tenements.

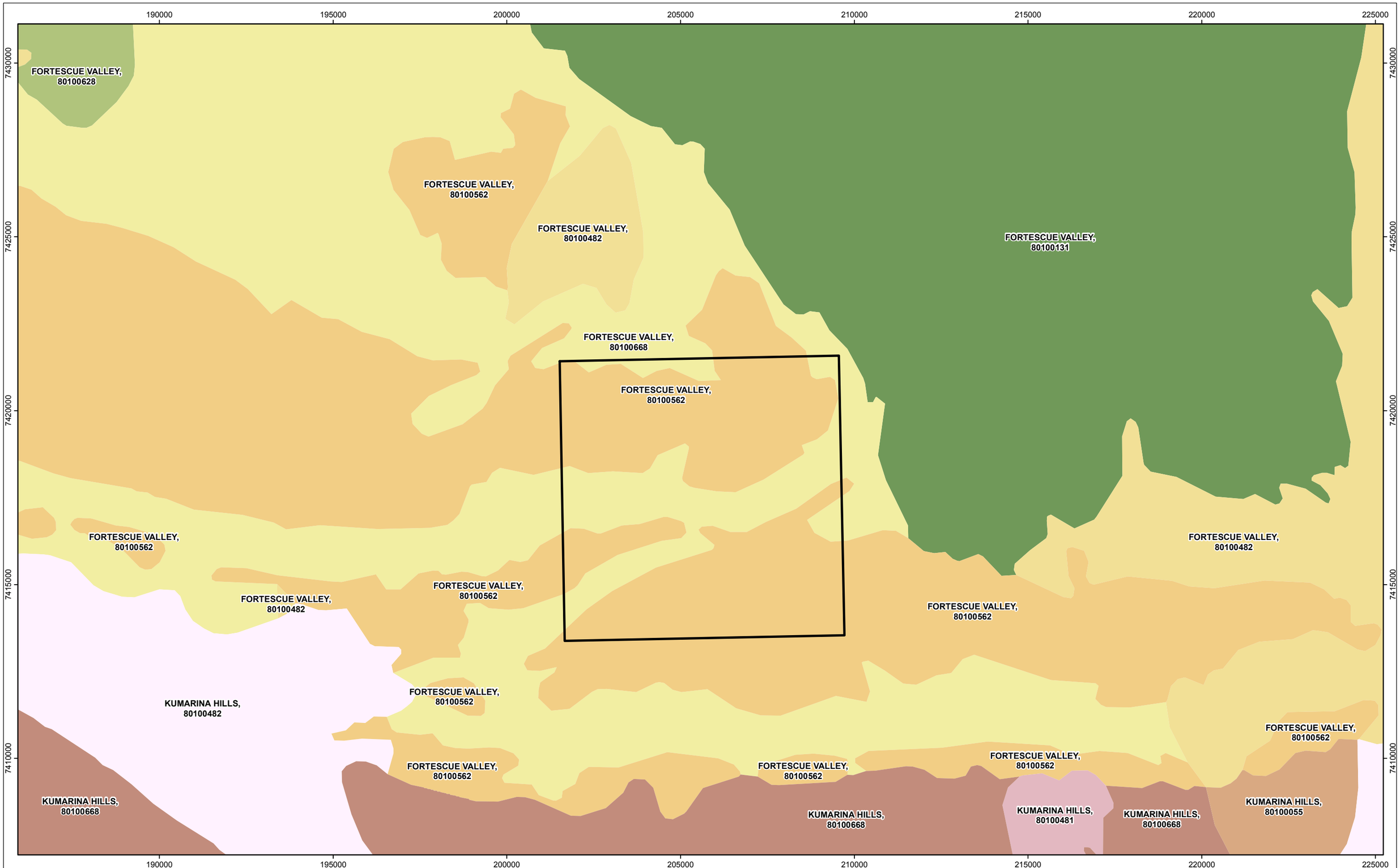
1.7 Land Systems

The Department of Agriculture has 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. The mapping is based on patterns in topography, 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), with four land systems occurring within the study area (Table 2). The Boolgeeda, McKay and Newman Land Systems are all well represented in the Pilbara covering between 2.3% and 8.0% of the Pilbara bioregion. The Washplain Land System is restricted to the south-east Pilbara and covers 0.5% of the Pilbara bioregion. It is characterised by hardpan plains that support groved Mulga shrublands.

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

Land System	Description	Distribution in the Pilbara	Area in Pilbara (km²)	% of Pilbara
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands	Wide, common	7,748	4.3
McKay	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands	Wide, common	4,202	2.3
Newman	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands	Southern half, very common	14,580	8.0
Washplain	Hardpan plains supporting groved mulga shrublands	Restricted to southeast Pilbara	917	0.5



ONSHORE ENVIRONMENTAL

Figure:	3	Date:	6 June 2014
Sheet Size:	A3	Status:	FINAL
Drawn by GSM	Requested by GSM	GSM Reference OB31_Beard	

N

0 0.5 1 2 3 4 5

Kilometers
1:100,000

Datum: GDA94
Projection: MGA Zone 51

BHPBIO

OB 31
VEGETATION OF THE STUDY AREA, AS MAPPED BY BEARD (1975)

FIGURE 3

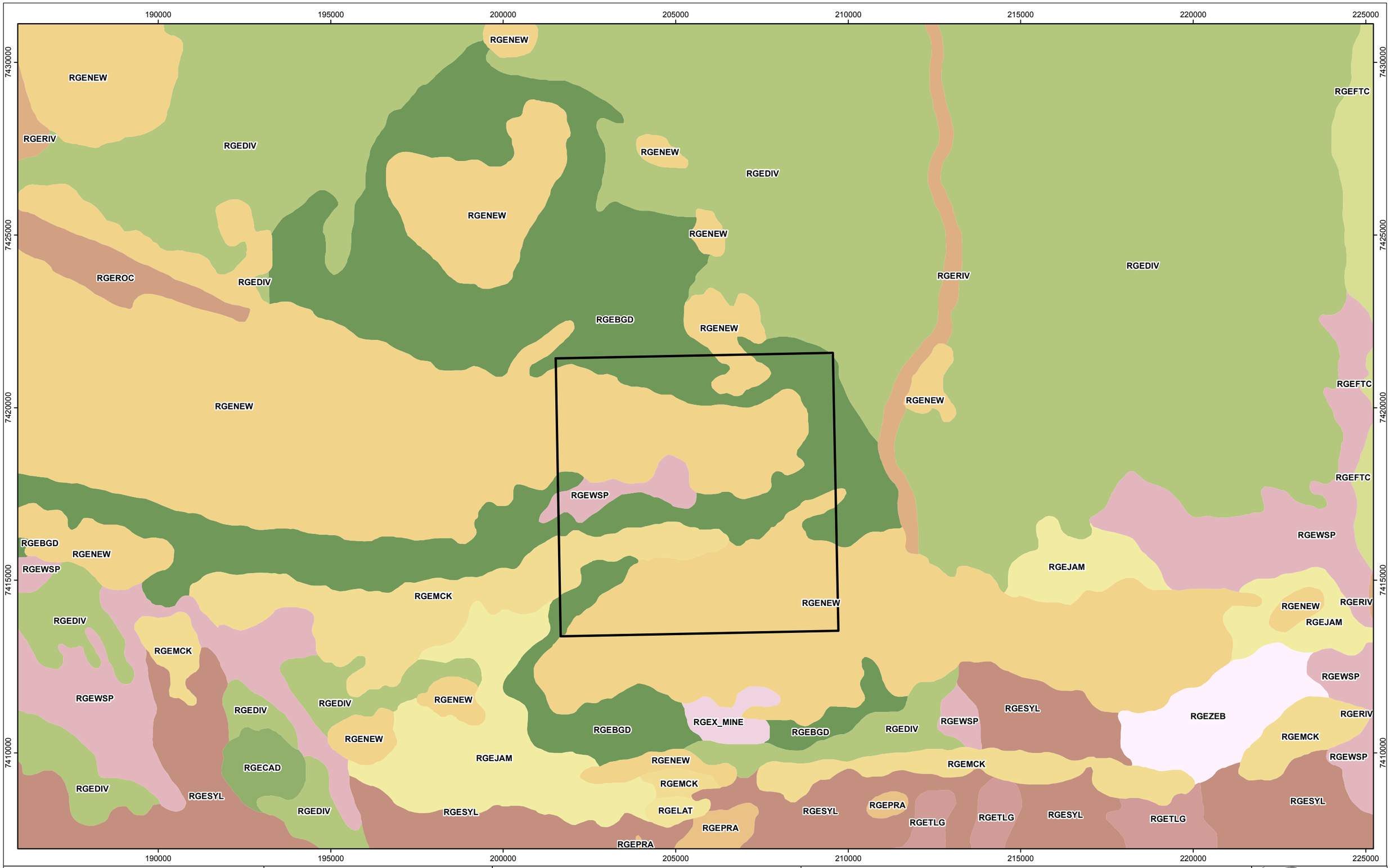
Legend

Study Area

Pre-European Vegetation (Beard 1975)
SYSTEM, VEGETATION ASSOCIATION

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

GRIFFIN SPATIAL & MAPPING
PO Box 7215
Eaton WA 6232
admin@griffinspatial.com.au
+61 8 9725 3213



ONSHORE ENVIRONMENTAL

Figure:	4	Date:	6 June 2014
Sheet Size:	A3	Status:	FINAL
Drawn by GSM	Requested by GSM	GSM Reference OB31_Land	

N

0 0.5 1 2 3 4 5

Kilometers
1:100,000

Datum: GDA94
Projection: MGA Zone 51

BHPBIO

OB 31
LAND SYSTEM REPRESENTED WITHIN THE STUDY AREA
(AS MAPPED BY VAN VREESWYK et al 2004)

FIGURE 4

Legend

Study Area

Land Systems

Mapping Unit, Land Systems

- RGEBGD, Boolgeeda 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
- RGEPRA, Prairie Land System
- RGERIV, River Land System
- RGEROC, Rocklea Land System
- RGESYL, Sylvania Land System
- RGETLG, Talga Land System
- RGEWSP, Washplain Land System
- RGEX_MINE, Mine
- RGEZEB, Zebra Land System

GRIFFIN SPATIAL & MAPPING
PO Box 7215
Eaton WA 6232
admin@griffinspatial.com.au
+61 8 9725 3213

2.0 Methodology

2.1 Legislation and Guidance Statements

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

- Terrestrial Biological Surveys as an Element of Environmental Protection. Position Statement No. 3 (EPA 2002); and
- EPA Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia No. 51 (EPA 2004).

The survey was also conducted in accordance with BHP Billiton Iron Ore's *Guidance for Flora and Vegetation Surveys in the Pilbara* (BHP Billiton Iron Ore 2010).

Conservation categories for flora described under the EPBC Act and WC Act are provided in Appendices 1 and 2 respectively.

2.2 Desktop Searches

Desktop searches of three databases were completed for information relating to rare flora (DPaW 2013a), TECs and PECs (DPaW 2013b) previously collected or described within, or in close proximity to, the study area. For this report a database search covering the entire study area was completed. The search was extended beyond the immediate survey limits to place flora values into a local and regional context. The search co-ordinate used was a 50 km radius around the central point of the study area; 193000mE 7417000mN (Zone 51 GDA94). The State database search investigated three DPaW databases:

- The DPaW Threatened Flora Database (DPaW 2013a);
- The DPaW Threatened and Priority Flora List (DPaW 2013b); and
- The Western Australian Herbarium Specimen Database for priority species opportunistically collected in the area of interest.

A search of the EPBC Act Protected Matters database was undertaken (DoE 2014b), as well as a search of the International Union for Conservation of Nature (IUCN) database (IUCN 2014). A comprehensive literature review of surveys previously completed within or in close proximity to the study area was also undertaken.

2.3 Field Survey Methodology

2.3.1 Timing and Personnel

The survey was completed by Principal Botanist Dr Jerome Bull and Field Botanist Mr Daniel Roberts between the 24th and 30th April 2014. A total of ten person days were spent in the field completing targeted searches.

2.3.2 Targeted Surveys for Conservation Significant Flora

The known location of previously recorded Threatened Flora (T) and Priority flora taxa occurring within and surrounding the study area was determined during the literature and desktop review. A 1 km grid was overlayed on to high resolution aerial

photography of the study area, and the entire area was ground truthed at this scale to determine flora and vegetation values. Geological maps were also utilised to identify potential habitats where targeted flora may occur. Previous significant flora points identified within the study area were re-visited in the field to confirm accurate identification and the current status of populations. Where significant flora was located an intensive search of the local area was conducted and similar habitats were subsequently targeted across the wider study area.

The botanists working in a pair traversed the study area walking along north-south and east-west transects spaced at between 500 m and 1 km. This allowed for appropriate coverage of the study area and landforms, while allowing for more specific assessment of habitats where appropriate, or more thorough assessment of conservation significant flora populations where encountered. Flora of conservation significance was recorded in the field by hand held GPS, and species distribution mapped.

2.3.3 Vouchering

Voucher specimens were taken for all significant flora recorded, along with additional plant taxa that could not be identified in the field, to verify identification by expert taxonomists utilising resources at the Western Australian Herbarium (WAH). Voucher specimens were provided to Mr Steve Dillon, BHP Billiton Iron Ore's sponsored botanist at the WAH. The species names were checked against FloraBase (WAH 2014) to ensure currency. Nomenclature follows the WAH census.

2.3.4 Field Survey Constraints

The EPA Guidance Statement for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004) list twelve potential constraints that field surveys may encounter. These constraints are addressed in Table 3.

Table 3 Relevance of constraints, as identified by EPA (2004), to the flora and vegetation survey.

Constraint	Relevance
Scope	The scope was established by BHP Billiton Iron Ore in compliance with relevant EPA Guidance Statements.
Proportion of flora collected and identified	The targeted survey followed three months of very high summer rainfall and seasonal conditions were rated as excellent. Targeted searches were completed along strategic field transects aimed at assessing the majority of landforms and habitats present within the study area. It is estimated that greater than 98% of specimens collected by Onshore Environmental were positively identified, with some sterile material resulting from seasonality.
Sources of information	Onshore Environmental (2014) has recently completed a Level 2 flora and vegetation survey of the northern half of the area. Additionally a first season flora and vegetation survey was previously completed within the same study area during February / March 2011 by Syrinx Environmental (Syrinx Environmental 2011). A two season flora and vegetation survey was completed of the southern half of the area in May and October 2011 by Syrinx Environmental (Syrinx Environmental 2012). There has been additional high intensity sampling from at least 30 neighboring BHP Billiton Iron Ore tenements (25 km radius around the study area), providing an extensive local database. This is confirmed by the intensity of records for the area on FloraBase.

Constraint	Relevance
The proportion of the task achieved and further work which might be needed	A comprehensive desktop review of the previous survey work completed within, and in close proximity to the study area, supported an extensive targeted search within the study area. All allocated tasks were achieved during the investigation and no further work is needed at this site.
Timing / weather / season / cycle	The summer rainfall recorded for months preceding the targeted survey were higher than the long term annual average. This resulted in excellent seasonal conditions supporting a diverse suite of plant life forms. The timing of sampling was optimum.
Disturbances, e.g. fire, flood	Minor disturbances related to fire, mine exploration and grazing by domestic stock were noted within the study area, but did not impact on survey results.
Intensity	The entire study area was ground truthed at between 500 m and 1 km intervals. There was more intensive surveying completed around previous location records and habitats where significant flora were most likely to occur.
Completeness	Relevant tasks related to assessing the presence of conservation significant flora were completed.
Resources	Appropriate resources have been applied to surveying the study area for conservation significant flora species during the April 2014 survey.
Access problems	The entire study area was accessed on foot walking from exploration tracks.
Availability of contextual information	More than 30 flora and vegetation surveys have been undertaken within a 25 km radius of the study area, providing an extensive local database.
Experience levels	The Principal Botanist working on the survey has over 10 years experience completing vegetation surveys and flora taxonomy in the Pilbara. All botanists involved in the study have completed numerous surveys within the Pilbara area over recent years.

3.0 Results

3.1 Desktop Review

3.1.1 Previous Flora and Vegetation Surveys within the study area

The flora and vegetation of the Pilbara has been mapped and described at broad scale by Burbidge (1959) and Beard (1975). More recently, the Department of Agriculture compiled an inventory and condition survey of the Pilbara (van Vreeswyk *et al.* 2004), which provides an inventory of flora and a description of land resources in terms of land systems. Data from the Pilbara Region Biological Survey 2002-2013 by DPaW are currently being analysed; except for weed information (Keighery 2010), vegetation and native flora data have not yet been published. The DPaW survey will provide a regional context that is necessary to assess the likely impact of future development proposals. The survey will provide information on patterns in the distribution of flora and fauna to help the stakeholders make decisions about conservation requirements and the sustainable use of natural resources.

Since the 1970s, large-scale resource developments of iron ore projects have resulted in the collection of significant amount of site-specific biological survey data in the region, most of which is undertaken for formal environmental impact assessment. Onshore Environmental completed a Level 2 flora and vegetation survey of the northern half of the study area in March 2014. There has also been a single season flora and vegetation survey previously completed within the same area (Syrinx Environmental 2011). A two season Level 2 flora and vegetation survey of the southern half of the study area was completed by Syrinx Environmental in May and October 2011 (Syrinx Environmental 2012). In addition, at least 30 other surveys were completed on BHP Billiton Iron Ore tenements within a 25 km radius of the study area. The key findings from all of the previous surveys have been summarised in Table 4.

Table 4 Summary of background and results for previous flora and vegetation surveys completed within, or in close proximity to, the study area.

Report	Proximity to Study Area	Survey Timing & Intensity	Vegetation Associations	Floristics	Significant Flora
Onshore Environmental (2014b) Orebody 31 Level 2 Flora and Vegetation Survey	Overlays the northern-most three quarters of the study area.	1-14 October 2013 45 quadrats and 146 relevés	35 vegetation associations within 15 broad floristic formations	280 plant taxa from 35 families and 110 genera. Most commonly recorded families were Fabaceae, Poaceae, Malvaceae and Chenopodiaceae. The dominant genus was *Acacia* (40 taxa) followed by *Senna* (11 taxa), *Sida* (11 taxa) and *Eremophila* (10 taxa). There were two introduced species recorded; **Cenchrus ciliaris, *Malvastrum americanum*	*Rhagodia* sp. Hamersley (M. Trudgen 17794) (P3), *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (P3), *Acacia* sp. nov (reticulate/anastomosing)
Syrinx (2011) OB 31 Flora and Vegetation Assessment	The same location as the current study area.	10-15 February and 9-13 March 2011 29 quadrats	21 vegetation associations classified into 12 broad floristic formations	206 plant taxa from 36 families and 93 genera, with dominant families being the Fabaceae (10 taxa), Malvaceae (20 taxa) and Chenopodiaceae (12 taxa). Four introduced weed species*; *Bidens bipinnata, *Cenchrus ciliaris, *Malvastrum americanum, *Portulaca oleracea*	No Threatened or Priority flora

Report	Proximity to Study Area	Survey Timing & Intensity	Vegetation Associations	Floristics	Significant Flora
Syrinx (2012) Wheelarra Hill North Level 2 Flora and Vegetation Assessment	Northern portion overlaps with the study area.	Two season survey. First season from 17-29 May 2011 and second season from 4-12 October 2011 83 quadrats and 19 relevés	25 vegetation associations were recorded within nine broad floristic formations	411 taxa from 49 families and 145 genera. The most commonly recorded families were Fabaceae (78 taxa), Poaceae (58 taxa) and Malvaceae (47 taxa). The dominant genera were *Acacia* (40 taxa), *Ptilotus* (16 taxa) and *Senna* (15 taxa). Four introduced species; **Bidens bipinnata, *Cenchrus ciliaris, *Malvastrum americanum, *Portulaca oleracea*	No Threatened Flora. One Priority 1 flora *Aristida ?jerichoensis* var. *subspinulifera* Nine range extensions: *Sclerolaena minuta, Eragrostis olida, Oldenlandia galioides, Evolvulus alsinoides* var. *decumbens, Phyllanthus erwinii, Phyllanthus maderaspatensis, Santalum spicatum, Cyperus ixiocarpus, Abultilon cunninghamii,* and two possible range extensions; *Tephrosia* aff. *sphaerospora*, *Hibiscus* aff. *apodus*
Onshore (2013) Orebody 17/18 Derived Vegetation Association Mapping Report	Small area of OB 17/18 located in the Eastern Pilbara, west of the Jimblebar Mine. It is located directly north-west of the study area.	Desktop survey	Five of the 27 vegetation associations described by ENV (2007)	N/A	No Threatened or Priority Flora

Report	Proximity to Study Area	Survey Timing & Intensity	Vegetation Associations	Floristics	Significant Flora
Syrinx (2012) South West Jimblebar Flora and Vegetation Survey	South West Jimblebar is located 40 km east of Newman, and is adjacent to the existing Jimblebar Mine. It is approximately 8 km south-west of the study area.	14-8 March 2011 19 quadrats and four relevés.	17 vegetation associations within ten broad floristic formations	202 plant taxa from 33 families and 93 genera. Most commonly recorded families were Poaceae (42 taxa), Fabaceae (38 taxa) and Malvaceae (14 taxa). The dominant genus was *Acacia* (23 taxa) followed by *Eremophila* (10 taxa) and *Ptilotus* (9 taxa). There were four introduced species recorded; **Bidens bipinnata, *Cenchrus ciliaris, *Cucumis melo, *Portulaca oleracea*	No Threatened Flora. Two Priority flora taxa; *Aristida ?jerichoensis* var. subspinulifera (P1), *Goodenia ?nuda* (P4) Five range extensions: *Alloteropsis cimicina, Brachyscome ciliaris* var. *ciliaris, Evolvulus alsinoides* var. *decumbens, Tephrosia sphaerospora*, *Tribulopis angustifolia*
Astron (2012) Eastern Mines Weed Survey, Jimblebar	Situated immediately south of the study area.	22-30 May 2012 25 project monitoring sites and 6 reference monitoring sites	N/A	13 weed species; **Acetosa vesicaria, *Aerva javanica, *Bidens bipinnata, *Cenchrus ciliaris, *Chloris barbata, *Chloris virgata, *Citrullus colocynthis, *Cynodon dactylon, *Malvastrum americanum, *Portulaca oleracea, *Solanum nigrum, *Sochus asper, *Vachellia farnesiana*	N/A
Eco Logical (2012) Level 1 flora and fauna surveys along the Great Northern Highway for Jimblebar mine module transport.	Boodarie Staging Yard in Port Hedland south to Jimblebar Mine along the Great Northern Highway near Newman.	18-19 August 2011 three quadrats	Seven vegetation associations	52 flora taxa comprising 14 families; the most commonly occurring families were: Poaceae, (12 taxa), Fabaceae (12 taxa), Amaranthaceae (8 taxa) and Myrtaceae (5 taxa). One introduced weed species, **Cenchrus ciliaris*	No Threatened or Priority flora

Report	Proximity to Study Area	Survey Timing & Intensity	Vegetation Associations	Floristics	Significant Flora
ENV (2010a) RGP6 Jimblebar Hub (Water Pipeline) Flora and Vegetation Assessment	Situated immediately south of the study area.	November 2009 16 quadrats and seven relevés	14 vegetation associations	166 plant taxa comprising 33 families and 81 genera. The most common families were Poaceae (29 taxa), Mimosaceae (25 taxa) and Malvaceae (15 taxa). The common genera were *Acacia* (25 taxa), *Senna* (10 taxa) and *Ptilotus* (8 taxa). Two introduced flora species were recorded; **Cenchrus ciliaris, *Malvastrum americanum*	No Threatened or Priority flora
ENV (2010b) Jimblebar Wye Targeted Declared Rare Flora and Priority Listed Flora Assessment	Situated approximately 20 km directly west of the study area.	3-5 March 2010 and 8-11 June 2010 Transects in habitats known to support targeted flora	N/A	N/A	No Threatened flora One Priority flora; *Gymnanthera cunninghamii* (P3)
ENV (2009a) Ammonium Nitrate Storage Facility Flora and Vegetation Assessment	Situated approximately 15 km to the southeast of the study area.	17 September 2009 seven quadrats and one relevé	Eight vegetation associations	123 taxa comprising 34 families and 70 genera. Common families were Poaceae (23 taxa), Mimosaceae (16 taxa), Malvaceae (10 taxa). The most common genera were *Acacia* (16 taxa), *Ptilotus* (7 taxa) and *Senna* (6 taxa). Two introduced flora species; **Cenchrus ciliaris, *Portulaca oleracea*	No Threatened or Priority flora

Report	Proximity to Study Area	Survey Timing & Intensity	Vegetation Associations	Floristics	Significant Flora
ENV (2009b) Construction Water Supply Pipeline and Ammonium Nitrate Storage Facility Flora and Vegetation Assessment	Situated approximately 15 km south-east of the study area.	17 September and 4-6 November 2009 23 quadrats and 8 relevés	19 vegetation associations	213 taxa comprising 38 families and 91 genera The most common families were Poaceae (38 taxa), Mimosaceae (32 taxa) and Malvaceae (20 taxa). The most common genera were *Acacia* (32 taxa), *Senna* (11 taxa) and *Ptilotus* (10 taxa). Three introduced flora species were recorded; **Cenchrus ciliaris, *Malvastrum americanum, *Portulaca oleracea*	No Threatened Flora One current Priority flora *Goodenia nuda* (P4)
Outback Ecology (2009a) Eastern Pilbara Accommodation Camp Flora and Fauna Assessment	Situated approximately 15 km south-east of the study area.	30 October – 4 November 2008 15 quadrats	16 vegetation associations	115 taxa from 23 families and 44 genera; dominant families were: Mimosaceae (23 taxa), Poaceae (17 taxa), Caesalpinaceae (13 taxa), Myrtaceae (9 taxa), Papilionaceae (7 taxa), Myoporaceae (8 taxa) and Chenopodiaceae (7 taxa); dominant genera were *Acacia* (23 taxa), *Senna* (12 taxa) and *Eremophila* (8 taxa); no weed species	No Threatened or Priority flora
Outback Ecology (2009b) Wheelarra Hill Iron Ore Mine Modification Flora and Fauna Assessment	Situated approximately 8 km south-east of the study area.	This report documents the results of supplementary flora and vegetation surveys conducted in October and November 2008 and January 2009. 22 quadrats	Five broad vegetation associations	146 plant taxa from 29 families and 62 genera; one introduced weed, **Cenchrus ciliaris*	No Threatened Flora One current Priority 4 flora, *Goodenia nuda,* recorded from one location

Report	Proximity to Study Area	Survey Timing & Intensity	Vegetation Associations	Floristics	Significant Flora
ENV (2008a) Rapid Growth Project 5: Repeater 9 Access Road Flora and Vegetation Assessment	Situated approximately 20 km directly west of the study area.	12-13 June 2008 six quadrats and one relevé	Six broad vegetation communities were mapped	163 taxa comprising 95 genera; most common families were Poaceae (28 taxa), Mimosaceae (14 taxa), Amaranthaceae (11 taxa) and Malvaceae (11 taxa); the most common genera were *Acacia* (13 taxa), *Eremophila* (9 taxa) and *Senna* (7 taxa); 14 introduced species were recorded: **Acetosa vesicaria, *Aerva javanica, *Brassica tournefortii, *Cenchrus ciliaris, *Citrullus lanatus, *Cucumis melo* subsp. *agrestis, *Cynodon dactylon, *Datura leichhardtii, *Malvastrum americanum, *Portulaca oleracea, *Setaria verticillata, *Sonchus asper, *Sonchus oleraceus* and **Vachellia farnesiana*	No Threatened Flora recorded One current Priority flora species, *Rostellularia adscendens* var. *latifolia* (P3) A second Priority 1 flora recorded *Eremophila* sp. Ophthalmia Range (R. Brearley s.n. 20/3/2004) has since been renamed *Eremophila margarethae* (not Threatened)
GHD (2008a) Draft Report for Wheelarra Hill (Jimblebar Mine Site) Priority Species Verification – *Goodenia hartiana*	Situated immediately south of the study area.	25-26 September 2007 12 quadrats	Not recorded	Not recorded	No Threatened or Priority flora
ENV (2008b) Jimblebar Access Road Flora and Vegetation Assessment	Situated 15 km southwest of the study area.	20-23 May 2007 22 quadrats	Ten distinct vegetation communities were described	112 taxa were recorded from 28 families; three introduced weed species were **Cenchrus ciliaris, *Aerva javanica* and **Citrullus lanatus*	No Threatened or Priority flora
GHD (2008b) Mesa Gap Biological Survey	Situated between OB 18 and Jimblebar Mines, directly south of the study area.	October 2007 40 quadrats	Eight vegetation associations from 7 landforms	133 plant taxa from 32 families with dominant families being the Fabaceae (15 species), Poaceae (9 species) and Myrtaceae (6 species); there were no introduced weed species	No Threatened or Priority flora

Report	Proximity to Study Area	Survey Timing & Intensity	Vegetation Associations	Floristics	Significant Flora
Pilbara Flora (2008) OB17 Flora and Vegetation Survey	Situated approximately 5 km southwest of the study area.	October 2008	Six vegetation associations from four landforms	61 plant taxa from 39 genera and 23 families, with dominant families being the Fabaceae (35 species), Poaceae (20 species) and Myrtaceae (8 species). There were no introduced weed species	No Threatened or Priority flora
ENV (2007a) West Jimblebar Exploration Lease Flora and Vegetation Assessment – Management Recommendations	Situated approximately 15 km southeast of the study area.	14-18 May 2007 29 quadrats	Not recorded	318 taxa were recorded from 113 genera and 44 families. Most frequently represented families were Poaceae, Mimosaceae and Malvaceae Three introduced weeds were recorded	No Threatened flora One current Priority flora species, *Goodenia nuda* (P4) One range extension was recorded, *Thyridolepis xerophila*
ENV (2007b) OB 18 Flora and Vegetation Assessment Phase II	Situated directly southeast of the study area.	July and August 2006 71 quadrats and relevés	A total of 27 vegetation associations classified into six broad landforms - Hill crests, Hill slopes, Gorges and Gullies, Drainage lines, Footslopes and Flood plains.	276 plant taxa including 46 families; dominant families were Poaceae (41 taxa), Mimosaceae (30 taxa), Amaranthaceae (19 taxa) and Malvaceae (18 taxa); two weed species were recorded, **Acetosa vesicaria* and **Cenchrus ciliaris*	No Threatened or Priority flora
Ecologia (2007) Hashimoto Exploration Project Biological Survey: Flora and Vegetation	Situated directly southeast of the study area.	August/September 2005 and February 2006 44 quadrats	Nine vegetation / landform associations.	372 species, representing 42 families and 129 genera were recorded. Thirty eight (38) collections could not be identified beyond family level. The most commonly recorded genera were *Acacia* (26 species), *Ptilotus* (20 species), *Eremophila* (16 species), and *Sida* (15 species). Three introduced species were recorded: **Cenchrus ciliaris, *Bidens bipinnata* and **Sonchus oleraceus*	No Threatened Flora One current Priority 4 flora, *Goodenia nuda.* A Priority 2 flora taxon *Goodenia hartiana* has since been split into a number of new entities including *Goodenia* sp. Sandy Creek (not Threatened).

Report	Proximity to Study Area	Survey Timing & Intensity	Vegetation Associations	Floristics	Significant Flora
ENV (2007c) Jimblebar Stage 2, Levee Banks and Communications Tower Redevelopment Flora and Vegetation Assessments	Situated immediately south of the study area.	April – June 2007 Four quadrats	Six vegetation associations	103 plant taxa from 24 families; most common families were Poaceae (30 taxa), Mimosaceae (17 taxa) and Papilionaceae (8 taxa)' five weed species were **Cenchrus ciliaris, *Cenchrus setiger, *Citrullus lanatus, *Bidens bipinnata* and **Cynodon dactylon*	No Threatened or Priority flora
ENV (2007d) RGP4 Jimblebar Rail Loop Flora and Vegetation Assessment	Situated approximately 5 km south of the study area.	27 November – 1 December 2006 Four quadrats	Four vegetation associations classified into three landform types; creekline, floodplain and plain.	65 plant taxa (44 genera) with most common families being Poaceae (14 taxa), Mimosaceae (11 taxa) and Malvaceae (5 taxa); two introduced weeds were **Bidens bipinnata* and **Cenchrus ciliaris*	No Threatened or Priority flora
Ecologia (2006) Jimblebar Marra Mamba Exploration Biological Survey	Situated approximately 5 km south of the study area.	22-28 May 2006 105 quadrats	Four vegetation types	267 plant taxa with most common families being Poaceae (33 species) and Malvaceae (22 species); two introduced weeds were **Acetosa vesicaria* and **Cenchrus ciliaris*	No Threatened Flora recorded. One current Priority 4 flora *Goodenia nuda.* A second Priority 3 flora recorded, *Triumfetta leptacantha* is no longer Threatened
Ecologia (2005) Jimblebar East Exploration Project Biological Survey	Situated approximately 15 km southeast of the study area.	8-14 Feb 2005 26 quadrats	Seven vegetation / landform associations	155 plant taxa with most common families being Poaceae (27 taxa), Caesalpiniaceae (13 taxa) and Mimosaceae (12 taxa); one weed species was **Cenchrus ciliaris*	No Threatened or Priority flora
Ecologia (2004a) OB 18 Flora and Fauna Review	Situated directly southwest of the study area.	Targeted searches in July 2004	Not recorded	Not recorded	No Threatened Flora One Priority 2 Flora *Rhodanthe frenchii* identified from one gorge site[1].

[1] It is noted that the original identification was not confirmed through the WAH and 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.

Report	Proximity to Study Area	Survey Timing & Intensity	Vegetation Associations	Floristics	Significant Flora
Ecologia (2004b) Jimblebar-Wheelarra Hill Expansion Biological Study	Situated approximately 10 km directly south of the study area.	9 Feb - 4 March 2004 A total of 44 quadrats were sampled, each measuring 100 x 100 m.	Nine vegetation associations	181 plant species from 47 families and 80 genera; dominant genera were *Acacia* (30 species), *Senna* (10 species) and *Eremophila* (7 species); one weed species, **Cenchrus ciliaris*	No Threatened or Priority flora *Goodenia hartiana* (P2) recorded but this taxon later split and now determined to be *Goodenia* sp. Sandy Creek (not Threatened).
Biota (2004) Jimblebar - Wheelarra Hill 3 Flora and Fauna Assessment	Situated approximately 10 km directly south of the study area.	August 2003. The survey was conducted to review and update existing botanical information and recording supplementary floristic data.	Six vegetation types described were based on the Ecologia (1999) flora survey of the area	227 taxa from 42 families and 99 genera; dominant genera were *Acacia* (29 taxa), *Senna* (15 taxa) and *Ptilotus* (9 taxa); one weed species was **Acetosa vesicaria*	No Threatened or Priority flora One Priority species, *Tephrosia* sp. Pilbara Ranges (P3). This species has been re-named *Tephrosia* sp. Cathedral Gorge (F.H. Molleman 2420) and is no longer Threatened
Ecologia (1996) Jimblebar Rail Spur Biological Assessment Survey	Situated approximately 5 km directly south of the study area.	6-8 June 1995 Two detailed floristic survey sites were assessed (100 m x 100 m in size) with additional opportunistic vegetation sampling.	The survey area encompassed the breadth of a creekline, but did not extend to surrounding hills. Two vegetation types were recorded.	106 taxa from 32 families and 71 genera; common families were Poaceae (13 taxa), Mimosaceae and Chenopdiaceae (9 taxa each) and Caesalpiniaceae and Malvaceae (7 taxa each); common genera were *Acacia* (9 taxa), *Senna* (6 taxa), *Eucalyptus* (5 taxa) and *Ptilotus* (4 taxa); four weed species were **Cenchrus ciliaris, *Acetosa vesicaria, *Malvastrum americanum* and **Sonchus oleraceus.*	No Threatened or Priority flora

Report	Proximity to Study Area	Survey Timing & Intensity	Vegetation Associations	Floristics	Significant Flora
BHP IO (1994) Jimblebar Mine Site Biological Survey	Situated approximately 5 km directly south of the study area.	11-22 June 1994 22 plotless sampling areas (covering approx. 100m^2 each)	Five broad vegetation assemblages	132 species, representing 30 families; dominant families were Mimosaceae (19 taxa), Poaceae (10 taxa), Myrtaceae (9 taxa) and Caesalpiniaceae (8 taxa); dominant genera were *Triodia, Acacia, Senna* and *Eremophila*. One weed species, **Rumex vesicarius* (now **Acetosa vesicaria)*	No Threatened Flora One Priority 3 taxon, *Cryptandra* sp. Mt Meharry (S. van Leeuwen 682). This is now known as *Cryptandra monticola* and no longer considered to be Threatened
Dames and Moore (1993) Ecological Observations Jimblebar Railway Line	Situated approximately 5 km directly south of the study area.	19 - 22 November 1992 39 borrow pits and 2 control areas	The report assessed disturbed borrow pit areas the vegetation data provided is not applicable.	Not recorded	No Threatened or Priority Flora

3.1.2 Threatened Flora listed under the EPBC Act

A search of the EPBC Act Protected Matters database was undertaken (DoE 2014b) within a 50 km buffer of the study area (EPBC Act 1999 Protected Matters Tool 2013). The database search listed two Threatened Flora or their habitat as likely to occur within the study area; *Lepidium catapycnon* (Hamersley Lepidium) and *Pityrodia augustensis* (Mt Augustus Foxglove). No Threatened Ecological Communities (TECs) were recorded in the search.

3.1.3 Threatened Flora listed under the IUCN Red List database

A search of the International Union for Conservation of Nature (IUCN) database was also conducted (IUCN 2014). No Threatened Flora was listed as likely to occur within the study area from this search.

3.1.4 Threatened Flora listed under the WA Wildlife Conservation (Rare Flora) Notice 2014

The DPaW search identified one Threatened Flora as occurring within a 50 km radius of the study area; *Lepidium catapycnon.*

3.1.5 Priority Flora recognised by DPaW

The DPaW rare flora database search (DPaW 2013a) identified 88 Priority flora taxa as potentially occurring within a 50 km radius of the study area. The likelihood of these 88 taxa occurring within the study area is indicated in Table 5.

Table 5 Significant flora species recorded in or around the survey area from the federal and state database searches, literature and local knowledge.

Taxon	Conservation Status	Habitat	Previously Recorded	Suitable Habitat Present	Likelihood in the study area[2]
Acacia bromilowiana	P4	Red skeletal stony loam, orange-brown pebbly, gravel loam, laterite, banded ironstone, basalt. Rocky hills, breakaways, scree slopes, gorges, creek beds.	No	Yes	Likely
Acacia daweana	P3	Stony red loamy soils. Low rocky rises, along drainage lines.	No	Yes	Possible
Acacia effusa	P3	Screeslopes of low ranges	No	Yes	Possible
Acacia subtiliformis	P3	Rocky calcrete plateau.	No	No	Unlikely
Adiantum capillus-veneris	P2	Moist, sheltered sites in gorges and on cliff walls.	No	Yes	Possible
Amaranthus centralis	P3	Ephemeral watercourses, sandy to clayey loam on river banks and edges of permanent pools in eucalypt lined channels,	No	Yes	Possible
Aristida jerichoensis var. *subspinulifera*	P1	Hardpan plains.	Yes	Yes	Likely
Astrebla lappacea	P3	Clay loam plains.	No	No	Unlikely
Atriplex flabelliformis	P3	Clay loam, loam. Saline flats or marshes.	No	No	Unlikely
Atriplex lindleyi subsp. *conduplicata*	P3	Gilgai plains.	No	No	Unlikely
Barbula ehrenbergii	P1	Iron rich weathered conglomerate on gorge walls.	No	Yes	Possible
Bothriochloa decipiens var. *cloncurrensis*	P1	-	No	Yes	Possible
Brachyscome sp. Wanna Munna Flats (S. van Leeuwen 4662)	P1	Sump, low in landscape, flat terrain, red-brown loamy soil with some stone, ironstone hardpan outcropping occasionally.	No	Yes	Possible
Brunonia sp. Long hairs (D.E. Symon 2440)	P1	Along creeklines.	No	Yes	Possible
Calotis latiuscula	P3	Rocky hillsides, floodplains, rocky creeks or river beds.	No	Yes	Possible
Calotis squamigera	P1	Pebbly loam.	No	Yes	Possible
Cochlospermum macnamarae	P1	Low hills underlain by granite bedrock.	No	Yes	Possible
Crotalaria smithiana	P3	Floodplain.	No	Yes	Possible
Dampiera anonyma	P3	Skeletal red-brown to brown gravelly soil over banded ironstone, basalt, shale and jaspilite. Hill summits, upper slopes (above 1000m).	No	No	Unlikely

Taxon	Conservation Status	Habitat	Previously Recorded	Suitable Habitat Present	Likelihood in the study area[2]
Dampiera metallorum	P3	Skeletal red-brown gravelly soil over banded ironstone. Steep slopes, summits of hills.	No	No	Unlikely
Dicladanthera glabra	P2	Along watercourses, near rock pools.	No	No	Unlikely
Eragrostis sp. Mt Robinson (S.van Leeuwen 4109)	P1	Red-brown skeletal soils, ironstone. Steep slopes, summits.	No	No	Unlikely
Eremophila appressa	P1	Ironstone gravel. Ridge slopes.	No	Yes	Possible
Eremophila forrestii subsp. Pingandy (M.E. Trudgen 2662)	P2	Flat plain with thin soil underlain by partly consolidated colluvium.	No	Yes	Possible
Eremophila magnifica subsp. *magnifica*	P4	Skeletal soils over ironstone.	No	Yes	Possible
Eremophila magnifica subsp. *velutina*	P3	Skeletal soils over ironstone. Summits.	No	Yes	Possible
Eremophila pilosa	P1	Plains.	No	Yes	Possible
Eremophila rigida	P3	Hardpan plains, stony clay depressions.	No	Yes	Possible
Eremophila sp. Hamersley Range (K. Walker KW 136) PN	P1	Undulating hills.	No	Yes	Possible
Eremophila sp. Rudall River (P.G. Wilson 10512) PN	P2	Drainage line.	No	No	Unlikely
Eremophila sp. Snowy Mountain (S. van Leeuwen 3737)	P1	Undulating hills.	No	Yes	Possible
Eremophila sp. West Angelas (S. van Leeuwen 4086)	P1	High in landscape, summit of hill, gently undulating to steep terrain, skeletal red gritty soil over massive banded iron of the Brockman Iron Formation.	No	Yes	Possible
Eucalyptus lucens	P1	Ironstone. Rocky slopes and mountain tops, high in the landscape.	No	No	Unlikely
Eucalyptus rowleyi	P3	-	No	No	Unlikely
Euphorbia parvicaruncula	P1	-	No	No	Unlikely
Fimbristylis sieberiana	P3	Mud, skeletal soil pockets. Pool edges, sandstone cliffs.	No	No	Unlikely
Geijera salicifolia	P3	Skeletal soils, stony soils. Massive rock scree, gorges.	No	No	Unlikely
Genus sp. Hamersley Range hilltops (S van Leeuwen 4345)	P1	Skeletal, brown gritty soil over ironstone. Hill summit.	No	No	Unlikely
Glycine falcata	P3	Drainage depressions in crabhole plains on river floodplains.	No	No	Unlikely
Goodenia hartiana	P2	Sand. Sand dune swales, sandhills.	No	No	Unlikely
Goodenia lyrata	P3	Red sandy loam. Near claypan.	No	Yes	Possible
Goodenia nuda	P4	Floodplains, drainage lines.	Yes	Yes	Likely

Taxon	Conservation Status	Habitat	Previously Recorded	Suitable Habitat Present	Likelihood in the study area[2]
Goodenia sp. East Pilbara (AA Mitchell PRP 727)	P3	Red-brown clay soil, calcrete pebbles. Low undulating plain, swampy plains.	No	No	Unlikely
Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) PN	P1	Ironstone ridges, upper slopes, breakaway and scree slopes.	No	No	Unlikely
Gymnanthera cunninghamii	P3	Drainage lines.	No	Yes	Possible
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	P2	Ironstone hills.	No	Yes	Possible
Hibiscus sp. Mt Brockman (E. Thoma ET 1354) PN	P1	Ironstone hills.	No	Yes	Possible
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	P3	Rocky drainage lines.	No	Yes	Possible
Indigofera sp. Gilesii (M.E. Trudgen 15869)	P3	Pebbly loam amongst boulders & outcrops. Hills.	No	Yes	Possible
Iotasperma sessilifolium	P3	Cracking clay, black loam. Edges of waterholes, plains.	No	No	Unlikely
Ipomoea racemigera	P1	-	No	Yes	Possible
Isotropis parviflora	P2	Valley slope of ironstone plateau, disturbed areas.	No	Yes	Possible
Lepidium catapycnon	T	Skeletal soils. Hillsides.	No	Yes	Possible
Maireana prosthecochaeta	P3	Gibber plains.	No	No	Unlikely
Myriocephalus scalpellus	P1	Clay. Depressions on flood plain.	No	No	Unlikely
Nicotiana heterantha	P1	Black clay. Seasonally wet flats.	No	Yes	Possible
Nicotiana umbratica	P3	Shallow soils. Rocky outcrops.	Yes	Yes	Possible
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	P3	Cracking clay, basalt. Gently undulating plain with large surface rocks, flat crabholed plain.	No	No	Unlikely
Olearia mucronata	P3	Schistose hills, along drainage channels.	No	No	Unlikely
Oxalis sp. Pilbara (M.E. Trudgen 12725)	P2	Shaded gully on the lower slopes of a large hill, in the flowline in the gully. Soil: pebbly/gravelly red-brown loam amongst boulders.	No	Yes	Unlikely
Pentalepis trichodesmoides subsp. *hispida*	P2	Skeletal soils, sand, loam. Stony grounds, along watercourses.	No	Yes	Possible
Peplidium sp. fortescue marsh (S. van Leeuwen 4865)	P1	Clay. Marsh.	No	No	Unlikely
Pilbara trudgenii	P2	Skeletal, red stony soil over ironstone. Hill summits, steep slopes, screes, cliff faces.	No	Yes	Possible
Polymeria distigma	P3	Sandy soils. Plains.	No	Yes	Unlikely
Ptilotus subspinescens	P3	Gentle rocky slopes, screes and the bases of screes.	No	Yes	Unlikely

Taxon	Conservation Status	Habitat	Previously Recorded	Suitable Habitat Present	Likelihood in the study area[2]
Rhagodia sp. Hamersley (M. Trudgen 17794)	P3	Floodplains, hardpan plains.	Yes	Yes	Likely
Rhynchosia bungarensis	P4	Pebbly, shingly coarse sand amongst boulders. Banks of flow line in the mouth of a gully in a valley wall.	No	Yes	Unlikely
Rostellularia adscendens var. *latifolia*	P3	Ironstone soils. Near creeks, rocky hills.	Yes	Yes	Likely
Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675)	P2	Skeletal, brown gritty soil over basalt. Summits of hills, steep hills.	No	No	Unlikely
Sida sp. Barlee Range (S van Leeuwen 1642)	P3	Skeletal red soils pockets. Steep slope.	No	Yes	Possible
Sida sp. Hamersley Range (K. Newbey 10692)	P1	Ironstone hills.	No	No	Unlikely
Solanum albostellatum	P3	-	No	Yes	Unlikely
Solanum kentrocaule	P3	Ironstone hills.	No	Yes	Unlikely
Spartothamnella puberula	P2	Rocky loam, sandy or skeletal soils, clay. Sandplains, hills.	Yes	Yes	Likely
Stemodia sp. Battle Hill (A.L. Payne 1006)	P1	Cracking clay. Floodplain.	No	No	Unlikely
Swainsona thompsoniana	P3	Floodplains. Seasonally wet flats.	No	Yes	Unlikely
Tecticornia medusa	P3	Clay. Marsh.	No	No	Unlikely
Tecticornia sp. Christmas Creek (K.A. Shepherd & T. Colmer et al. KS 1063)	P1	Clay. Marsh.	No	No	Unlikely
Tetratheca fordiana	P1	Shale pocket amongst ironstone.	No	Yes	Unlikely
Teucrium pilbaranum	P1	Clay. Crab hole plain in a river floodplain, margin of calcrete table.	No	No	Unlikely
Stylidium weeliwolli	P2	Gritty sand soil, sandy clay. Edge of watercourses.	No	No	Unlikely
Tetratheca fordiana	P1	Shale pocket amongst ironstone.	No	No	Unlikely
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3	Red clay. Clay pan, grass plain.	No	Yes	Unlikely
Thryptomene wittweri	DRF	Skeletal red stony soils. Breakaways, stony creek beds.	No	Yes	Unlikely
Triodia sp. Karijini (S. van Leeuwen 4111) PN	P1	Ironstone hills.	No	Yes	Possible
Triodia sp. Mt. Ella (ME Trudgen 12739)	P3	Light orange-brown, pebbly loam. Amongst rocks & outcrops, gully slopes.	Yes	Yes	Possible

Taxon	Conservation Status	Habitat	Previously Recorded	Suitable Habitat Present	Likelihood in the study area[2]
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	P3	Ironstone undulating hills.	No	Yes	Unlikely
Triodia triticoides	P1	Rocky sandstone and limestone hillslopes.	No	No	Unlikely
Vittadinia sp. Coondewanna Flats (S van Leeuwen 4684)	P1	Floodplains, hardpan plains.	No	Yes	Unlikely
Whiteochloa capillipes	P3	Floodplains.	No	Yes	Unlikely

2 Likely – suitable habitat, close (<10 km) records and/or field survey completed in sub-optimal season, suggest species is likely to occur;
Possible – suitable habitat, records (<50 km) and/or field survey completed in sub-optimal season, suggests species possibly occurs; and
Unlikely – lack of suitable habitat, no records (<50 km) and/or field survey completed in optimal season, suggest species is unlikely to occur.

3.2 Conservation Significant Flora

3.2.1 Threatened Flora

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 Priority Flora

There were two Priority 3 flora and one Priority 4 flora recorded from the study area; *Rhagodia* sp. Hamersley (M. Trudgen 17794), *Triodia* sp. Mt Ella (M.E. Trudgen 12739) and *Goodenia nuda* (Table 6). The location of all records for the three Priority flora are provided in Figure 5 and Appendix 3.

Previous records for *Aristida ?jerichoensis* subsp. *subspinulifera* (Priority 1) and *Hibiscus* aff. *apodus* (range extension from the Kimberley) made by Syrinx Environmental (2012) were re-visited and confirmed to be the common taxa *Aristida inaequiglumis* and *Hibiscus haynaldii* respectively.

Table 6 Significant flora recorded from the study area.

Taxon	Photograph	Description	Occurrence in study area
Rhagodia sp. Hamersley (M. Trudgen 17794) (Priority 3)		*Rhagodia* sp. Hamersley (M. Trudgen 17794) is a perennial chenopod species growing to a height of 2 m in orange to red loam soils on flood plains. 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 adjacent to BHP Billiton Iron Ore's Mining Area C operations, near the Packsaddle Village (Onshore Environmental 2011a), at South Flank exploration tenements (Onshore Environmental 2012), and at the Jinidi tenements (Onshore Environmental 2011b). It was recently recorded during a review of vegetation mapping at BHP Billiton Iron Ore's Carramulla tenements, situated approximately 25 km east of the study area (Onshore Environmental 2014b), representing the most south-eastern extent of the known distribution.	*Rhagodia* sp. Hamersley (M. Trudgen 17794) was recorded from two point locations just inside the northern boundary of the north-west sector of the study area (Figure 5). Plants occurred as scattered tall shrubs on flood plains in association with *Acacia ancistrocarpa* and *Acacia aptaneura* High Shrubland over *Triodia basedowii* Hummock Grassland.
Triodia sp. Mt Ella (M.E. Trudgen 12739) (Priority 3)		The undescribed *Triodia* sp. Mt Ella (M.E. Trudgen 12739) was first discovered on Mt Ella (west of Mining Area C) in 1995, where it occurs on upper hill slopes below mulga and in an east to south-east facing gully (Trudgen 1998). It is a perennial hummock grass to 1.0 m in height, which could be easily confused with *Triodia pungens*. It occurs amongst rocks and outcrops on hill slopes and gullies on light orange brown pebbly loam. *Triodia* sp. Mt. Ella (M.E. Trudgen 12739) is considered to be geographically restricted and uncommon, but unlikely to be rare (Trudgen 1998).	*Triodia* sp. Mt Ella (M.E. Trudgen 12739) was recorded as six scattered plants from four spot locations on a floodplain in the central western fringe of the study area (Figure 5). These plants likely originated from seeds washed down from main populations situated on elevated scree slopes further south. Two larger populations comprising 50 spot location points were associated with steep scree slopes, cliff lines and gorges in the south-west and central southern sectors of the study area (Figure 5). Within these main populations, *Triodia* sp. Mt Ella (M.E. Trudgen 12739) was recorded as >10,000 plants and providing up to 80 % ground coverage.

Taxon	Photograph	Description	Occurrence in study area
Goodenia nuda (Priority 4)		*Goodenia nuda* is an erect annual or biennial herb to 0.3 m in height that occurs on drainage levees, flood plains and sand plains. *Goodenia nuda* is widespread throughout the Pilbara, with records also from the northern Carnarvon and eastern Gascoyne bioregions. It is typically recorded from relatively mesic habitats, such as floodplains and drainage zones. Within the south-east Pilbara it has been collected from a number of BHP Billiton Iron Ore tenements including Tandanya (Onshore Environmental 2013b), South Flank (Onshore Environmental 2012a), Area C and Surrounds (Onshore Environmental 2011a), Jinidi (Onshore Environmental 2011b) and Mount Whaleback (Onshore Environmental 2014c).	*Goodenia nuda* was recorded as 13 plants from two points in the central western fringe of the study area (Figure 5). It was associated with sandy loam soils on a floodplain. Vegetation was described as 'Tussock Grassland of *Aristida inaequiglumis* and *Themeda triandra* with Low Open Woodland of *Corymbia aspera, Corymbia hamersleyana* and *Acacia aptaneura* over Open Shrubland of *Acacia aptaneura* and *Acacia ancistrocarpa'.*

3.2.3 Flora of Interest

Acacia sp. nov (reticulate/anastomosing) was first identified as a species of interest from the study area during the Onshore Environmental October 2013 survey (Onshore Environmental 2014). This taxon is an interesting yellow - green leaved *Acacia* occurring to approximately 1.5 m to 2 m in height (Plate 1) and with distinct anastomosing veins in the leaves (Plate 2). *Acacia* specialist at the WAH Mr Bruce Maslin has been unable to identify the taxon on the basis of photographs, and has requested the field specimens for further analysis. The field collections were submitted to BHP Billiton Iron Ore sponsored botanist Mr Steve Dillon who confirmed "although this specimen lacks flowers and fruits it is almost certainly an undescribed species as it does not match anything in either Western Australia or other states. It needs pods (flowers would also be good but pods more important) before this taxon can be phrase-named or formally described. It is so odd that its affinities are unknown (B. Maslin, pers. comm.). This should be regarded as a species of significance." At the time of this survey the taxon was in the early stages of flowering and likely to produce pods and seeds within approximately two months. Additional collections are proposed to allow further description of this taxon to occur.

Acacia sp. nov (reticulate/anastomosing) was recorded as 534 plants from five populations occurring across approximately 8 ha in the north-west sector of the study area (Figure 5). It occurred on rocky low hill crests amongst low undulating hills that had been burnt within the past three years. Associated vegetation was described as 'Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. Van Leeuwen 3835) with Open Shrubland of *Grevillea berryana* and *Acacia* sp. nov (reticulate/anastomosing) over Low Open Shrubland of *Senna stricta, Ptilotus rotundifolius* and *Ptilotus calostachyus'.*

Plate 1 Habit of *Acacia* sp. nov (reticulate/anastomosing).

Plate 2 Close-up view of the reticulate/anastomosing venation in the phyllode.

One additional plant taxon recorded from the study area was determined to be a significant range extension, *Acacia clelandii. Acacia clelandii* is a spreading multi-stemmed and rounded shrub reaching 5 m in height, occurring in sandy soils on dunes or rocky hills (Plate 3). It has characteristic terete or subterete phyllodes, occasionally flat, straight or slightly curved. It is know from populations situated approximately 150km east of Wiluna (WAH 2014). The recent collections made from the study area represent a 400 km range extension north of the nearest known populations.

Acacia clelandii was recorded from 12 points scattered across the northern sector of the study area (Figure 5), occurring between 1.5 m and 3.5 m in height. Plants were generally represented as scattered shrubs, providing less than two percent ground coverage. Two points supported greater than 50 individuals with ground coverage estimated at 2-10% and 10-30% respectively. Plants occurred on highly weathered ironstone on stony undulating low hills, footslopes and rocky drainage lines. *Acacia clelandii* occurred with a variety of vegetation associations including:

- Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. Van Leeuwen 3835) with Low Open Shrubland of *Acacia hilliana, Halgania solanacea* var. Mt Doreen (G.M. Chippendale 4206) and *Acacia adoxa* var. *adoxa* over Scattered Tussock Grasses of *Amphipogon sericeus* and *Eriachne lanata;*
- Hummock Grassland of *Triodia angusta* and/or *Triodia* sp. Shovelanna Hill with Shrubland of *Acacia sibirica, Acacia bivenosa* and *Acacia wanyu* over Open Shrubland of *Eremophila exilifolia, Senna stricta* and *Acacia sibirica* with Low Open Woodland of *Acacia aptaneura*; and
- Low Open Mallee of *Eucalyptus gamophylla* over Open Scrub of *Acacia bivenosa* (with minor component of *Acacia wanyu, Acacia ancistrocarpa* and *Acacia adsurgens)* over Hummock Grassland of *Triodia basedowii*.

Plate 3 Habit of *Acacia clelandii* within the study area.

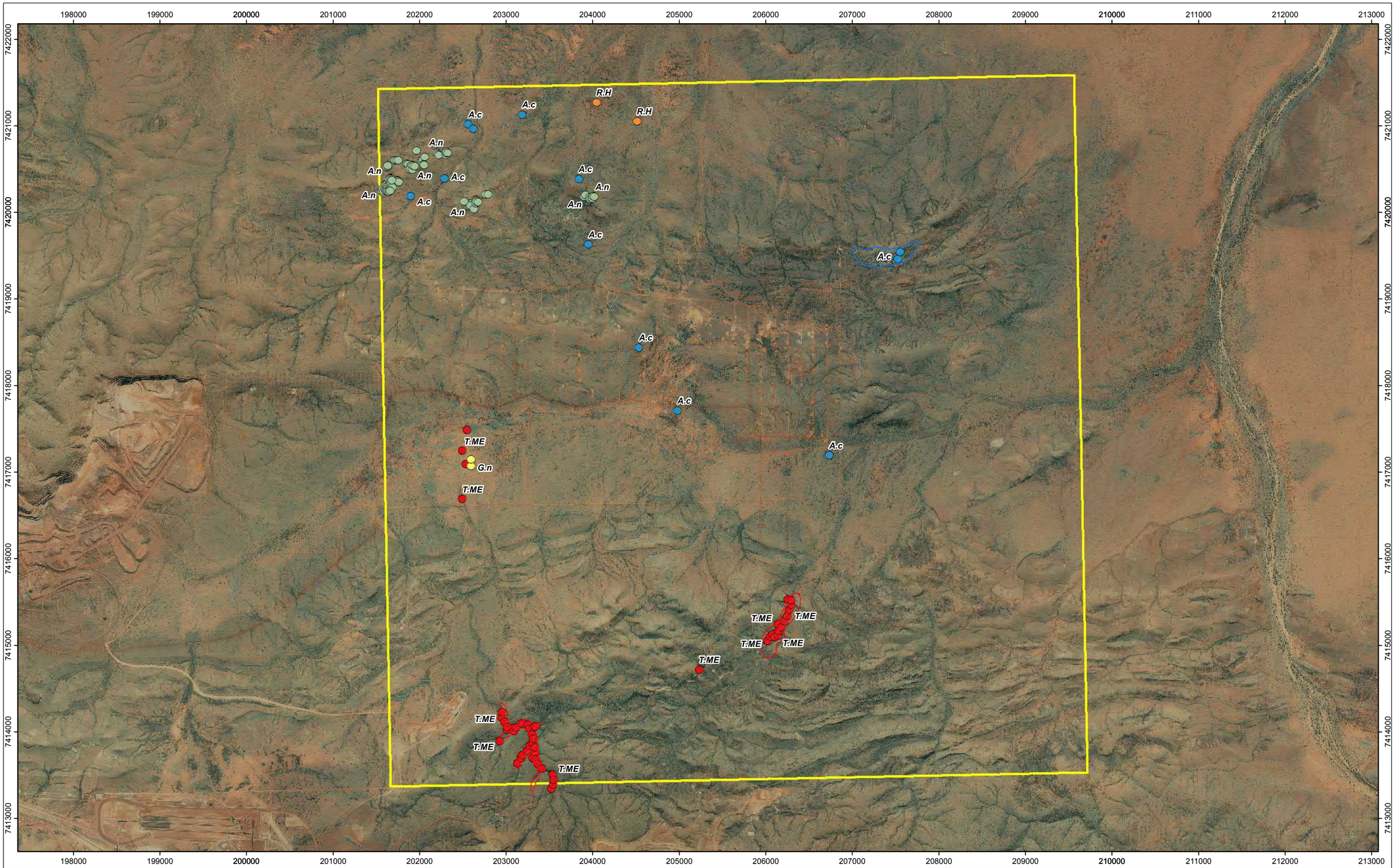


Figure:	5	Date:	6 June 2014
Sheet Size:	A3	Status:	FINAL
Drawn by GSM	Requested by GSM	GSM Reference OB31_Targeted_FM	

N

0 250 500 1,000 1,500 2,000

Meters
1:40,000

Datum: GDA94
Projection: MGA Zone 51

BHPBIO

OB31
LOCATION OF SIGNIFICANT FLORA WITHIN THE STUDY AREA

FIGURE 5

Legend

- Study Area

Significant Species

- *Acacia clelandii* (A.c)
- *Acacia* sp. nov (reticulate/anastomosing) *(A.n)*
- *Goodenia nuda* (G.n)
- *Rhagodia* sp Hamersley (M.E. Trudgen 17794) *(R.H)*
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) *(T.ME)*

Significant Flora Populations

- *Acacia clelandii*
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739)

GRIFFIN SPATIAL & MAPPING
PO Box 7215
Eaton WA 6232
admin@griffinspatial.com.au
+61 8 9725 3213

4.0 Summary

A targeted significant flora survey was completed at OB31 in late April 2014 following three months of very high summer rainfall and under optimum seasonal conditions.

No plant taxon gazetted as Threatened Flora (T) under the WC Act or EPBC Act was recorded from the study area.

A total of three Priority flora taxa were confirmed to occur from within the study area:

- *Rhagodia* sp. Hamersley (M. Trudgen 17794) (Priority 3) was recorded from two locations along the northern fringe in the north-west sector of the study area;
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (Priority 3) was recorded as scattered plants from four locations on a floodplain in the central west of the study area, and as two larger populations on steep hill slopes and gorges in the south-west and central southern sectors of the study area; and
- *Goodenia nuda* (Priority 4) was recorded as 13 plants from two points associated with a floodplain in the central western sector of the study area.

An undescribed species considered likely to be of conservation significance, *Acacia* sp. nov (reticulate / anastomosing), was recorded as 534 individuals from five populations in the north-west sector of the study area. *Acacia* sp. nov (reticulate / anastomosing) was unable to be identified by Mr Steve Dillon (BHP Billiton Iron Ore sponsored botanist) or *Acacia* specialist at the WAH Mr Bruce Maslin. Further collections of flowers and fruit will be necessary to confirm this taxon as a new species and allow for more detailed description to occur.

Acacia clelandii was recorded from 12 point locations scattered across the northern half of the study area. These records represent a significant range extension approximately 400 km north of its nearest known location.

Previous records for *Aristida ?jerichoensis* subsp. *subspinulifera* (Priority 1) and *Hibiscus* aff. *apodus* (range extension from the Kimberley) made by Syrinx Environmental (2012) were re-visited and confirmed to be the common taxa *Aristida inaequiglumis* and *Hibiscus haynaldii* respectively.

5.0 References

Astron Environmental Services (2012) *Eastern Mines Weed Survey, Jimblebar*. Consultants report prepared for BHP Billiton Iron Ore.

Australian Natural Resource Atlas (2008). Biodiversity Assessment - Pilbara. Australian Natural Resources Atlas, website.

Beard J. S. (1975). Pilbara. Explanatory Notes and Map Sheet 5, 1:1 000 000 series Vegetation Survey of Western Australia. University of Western Australia Press: Nedlands.

Beard J. S. (1990) *Plant Life of Western Australia*. Kangaroo Press, Perth.

BHP Billiton Iron Ore (2010). *Guidance for Vegetation and Flora Surveys in the Pilbara Region*. BHP Billiton. BHP Billiton Iron Ore, Perth, Western Australia.

BHP Iron Ore (1994) *Jimblebar Mine Site Biological Survey*. Unpublished internal report prepared by BHP Iron Ore.

Biota (2004) *Jimblebar - Wheelarra Hill 3 Flora and Fauna Assessment*. Consultant report prepared for BHP Billiton Iron Ore.

Burbidge, NT (1959). *Notes on Plants and Plant Habitats Observed in the Abydos-Woodstock Area, Pilbara District, Western Australia.* CSIRO Div. Plant Ind. Tech. Paper 12.

Bureau of Meteorology (2014) *Climate Data Online - Newman.* Available from: http://www.bom.gov.au/climate/data/

Dames and Moore (1993) *Ecological Observations Jimblebar Railway Line.* Consultant report prepared for BHP Iron Ore.

Department of Environment (2014a) *Maps: Australia's Bioregions (IBRA)* Available from: <www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html

Department of Environment (2014b) *EPBC Act Protected Matters Report.* Report created online at http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf

Department of Parks and Wildlife (DPaW) (2013a) Threatened and Priority Flora Database Search.

Department of Parks and Wildlife (DPaW) (2013b) *List of Threatened Ecological Communities on the Department of Parks and Wildlife's Threatened Ecological Community (TEC) Database endorsed by the Minister for the Environment.* WA Threatened Species and Communities Unit, Department of Parks and Wildlife.

Ecologia Environment (1996) *Jimblebar Rail Spur Biological Assessment Survey*. Report prepared for BHP Billiton Iron Ore.

Ecologia Environment (2004a*) OB 18 Flora and Fauna Review*. Report prepared for BHP Billiton Iron Ore.

Ecologia Environment (2004b) *Jimblebar-Wheelarra Hill Expansion Biological Study*. Report prepared for BHP Billiton Iron Ore.

Ecologia Environment (2005) *Jimblebar East Exploration Project Biological Survey*. Report prepared for BHP Billiton Iron Ore.

Ecologia Environment (2006) *Jimblebar Marra Mamba Exploration Biological Survey.* Prepared for BHP Billiton Iron Ore.

Ecologia Environment (2007) *Hashimoto Exploration Project Biological Survey: Flora and Vegetation.* Prepared for BHP Billiton Iron Ore.

EcoLogical (2012) *Level 1 flora and fauna surveys along the Great Northern Highway for Jimblebar mine module transport.* Prepared for BHP Billiton Iron Ore.

ENV Australia (2007a) *West Jimblebar Exploration Lease Flora and Vegetation Assessment – Management Recommendations*. Prepared for BHP Billiton Iron Ore.

ENV Australia (2007b) *OB 18 Flora and Vegetation Assessment Phase II*. Prepared for BHP Billiton Iron Ore.

ENV Australia (2007c) *Jimblebar Stage 2, Levee Banks and Communications Tower Redevelopment Flora and Vegetation Assessments*. Prepared for BHP Billiton Iron Ore.

ENV Australia (2007d) *RGP4 Jimblebar Rail Loop Flora and Vegetation Assessment*. Prepared for BHP Billiton Iron Ore.

ENV Australia (2008a) *Rapid Growth Project 5: Repeater 9 Access Road Flora and Vegetation Assessment.* Report prepared for BHP Billiton Iron Ore.

ENV Australia (2008b) *Jimblebar Access Road Flora and Vegetation Assessment.* Report prepared for BHP Billiton Iron Ore.

ENV Australia (2009a) *Ammonium Nitrate Storage Facility Flora and Vegetation Assessment.* Report prepared for BHP Billiton Iron Ore.

ENV Australia (2009b) *Construction Water Supply Pipeline and Ammonium Nitrate Storage Facility Flora and Vegetation Assessment.* Report prepared for BHP Billiton Iron Ore.

ENV Australia (2010a) *RGP6 Jimblebar Hub (Water Pipeline) Flora and Vegetation Assessment.* Report prepared for BHP Billiton Iron Ore.

ENV Australia (2010b) *Jimblebar Wye Targeted Declared Rare Flora and Priority Listed Flora Assessment.* Report prepared for BHP Billiton Iron Ore.

Environmental Protection Authority (EPA) (2002) Terrestrial Biological Surveys as an Element of Biodiversity Protection, Position Statement No. 3, EPA, Perth.

Environmental Protection Authority (EPA) (2004) EPA Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, No. 51, EPA, Perth.

GHD (2008a) *Draft Report for Wheelarra Hill (Jimblebar Mine Site) Priority Species Verification* – Goodenia hartiana. Report prepared for BHP Billiton Iron Ore.

GHD (2008b) *Mesa Gap Biological Survey*. Report prepared for BHP Billiton Iron Ore.

International Union for Conservation of Nature (IUCN) (2014) Interactive Environmental Database Reporting Tool Search. www.iucnredlist.org

Keighery, G. (2010). *The Naturalised Vascular Plants of the Pilbara Region, Western Australia.* Records of the Western Australian Museum, Supplement **78:** 299-311

Kendrick (2001) Bioregion: Pilbara 3 Subregion (PIL3). Department of Conservation and Land Management, Perth.

Onshore Environmental (2011a) *Area C and Surrounds Study Area – Review of Flora and Vegetation.* Confidential Report prepared for BHP Billiton Iron Ore.

Onshore Environmental (2011b) *Jinidi Study Area – Review of Flora and Vegetation.* Prepared for BHP Billiton Iron Ore.

Onshore Environmental (2012) *South Flank Study Area Level 2 Flora and Vegetation Survey.* Consultants report prepared for BHP Billiton Iron Ore.

Onshore Environmental (2013b) *Tandanya - Level 2 Flora and Vegetation Survey*. Confidential report to BHP Billiton Iron Ore.

Onshore Environmental (2014a) *OB 31 Level 2 Flora and Vegetation Assessment.* Consultants report prepared for BHP Billiton Iron Ore.

Onshore Environmental (2014b) *Consolidation of Regional Vegetation Mapping.* Consultants report prepared for BHP Billiton Iron Ore.

Onshore Environmental (2014e) *Mt Whaleback Targeted Significant Flora Survey.* Consultants report prepared for BHP Billiton Iron Ore.

Outback Ecology (2009a) *Eastern Pilbara Accommodation Camp Flora and Fauna Assessment.* Consultants report prepared for BHP Billiton Iron Ore.

Outback Ecology (2009b) *Wheelarra Hill Iron Ore Mine Modification Flora and Fauna Assessment.* Consultants report prepared for BHP Billiton Iron Ore.

Pilbara Flora (2008) *OB17 Flora and Vegetation Survey*. Prepared for BHP Billiton Iron Ore.

Shepherd, D., Beeston, G and Hopkins, A. (2001) Native Vegetation in Western Australia. Extent, Type and Status. *Resource Management Technical Report 249*. Department of Agriculture, South Perth.

Syrinx Environmental (2011) *OB 31 Flora and Vegetation Assessment.* Prepared for BHP Billiton Iron Ore.

Syrinx Environmental (2012) *Wheelarra Hill North Level 2 Flora and Vegetation Assessment.* Prepared for BHP Billiton Iron Ore.

Thackway and Cresswell (1995) *An Interim Biogeographic Regionalisation for Australia: A framework for setting priorities in the National Reserves System Cooperative Program Version 4.* Australian Nature Conservation Agency, Canberra.

Tille, P. (2007) Resource Management Technical Report 313. *Soil-Landscapes of Western Australia's Rangelands and Arid Interior.* Department of Agriculture and Food Government of Western Australia.

Trudgen, M.E. and Casson, N. (1998) Flora and Vegetation Surveys of Orebody A and Orebody B in the West Angela Hill area and area surrounding them, and of rail route options considered to link them to the existing Robe River Iron Associates rail line. Unpublished report prepared for Robe River Iron Associates, Volume 1, March 1998.

Tyler, I. M. and Williams, W. M. (1991) Newman, Western Australia. 1:250 000 Geological Series – Explanatory Notes, Geological Survey of Western Australia, Perth, Western Australia.

van Vreeswyk, A.M.E, Payne, A.L, Leighton, K.A. and Hennig, P. (2004) An inventory and condition survey of the Pilbara region, Western Australia. Western Australian Department of Agriculture Technical Bulletin No. 92.

Western Australian Herbarium [WAH] (2014). *Florabase - Information on the Western Australian Flora*. Department of Parks and Wildlife, Perth, Western Australia. Online: *http://florabase.dpaw.wa.gov.au/*

6.0 Study Team

The targeted significant flora survey was planned, coordinated and executed by the following personnel:

Onshore Environmental Consultants P/L
ABN 41 095 837 120
PO Box 227
YALLINGUP WA 6282
pf 08 9756 6206 m 0427 339 842
email onshoreenv@westnet.com.au

Project Staff

Dr Darren Brearley	PhD	Project Manager
Dr Jerome Bull	PhD	Principal Botanist
Mr Daniel Roberts	BSc	Botanist
Ms Jessica Waters	Bsc	Botanist
Mrs Kerry Keenan		Data Analyst
Mr Todd Griffin		GIS Specialist

Licences

The field survey was conducted under the authorisation of the following licences issued by the Department of Parks and Wildlife:

- Jerome Bull, Onshore Environmental Consultants 'Licence to take flora for scientific & other prescribed purposes' Licence No. SL009579.

APPENDIX 1

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 2

Conservation Codes for Western Australian Flora.

T: Threatened (previously Declared Rare Flora (DRF)) - 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

Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa 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.

2: Priority Two - Poorly Known Taxa

Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa 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.

3: Priority Three - Poorly Known Taxa

Taxa 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. Taxa 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.

4: Priority Four - Rare, Near Threatened and other taxa in need of monitoring

(a) **Rare.** Taxa 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**. Taxa 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) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

5: Priority Five - Conservation Dependent taxa

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

APPENDIX 3

Location points for significant flora recorded within the study area by Onshore Environmental at April 2014

MGA_EAST	MGA_NORTH	GENUS	SPECIES
120.085536	-23.300704	*Acacia*	*clelandii*
120.089375	-23.298925	*Acacia*	*clelandii*
120.092184	-23.293318	*Acacia*	*clelandii*
120.09277	-23.293799	*Acacia*	*clelandii*
120.098281	-23.29243	*Acacia*	*clelandii*
120.104512	-23.299269	*Acacia*	*clelandii*
120.105469	-23.3061	*Acacia*	*clelandii*
120.110931	-23.31695	*Acacia*	*clelandii*
120.115117	-23.32357	*Acacia*	*clelandii*
120.13217	-23.328586	*Acacia*	*clelandii*
120.140326	-23.308266	*Acacia*	*clelandii*
120.140596	-23.307513	*Acacia*	*clelandii*
120.082267	-23.30015	*Acacia*	sp. nov (reticulate/anastomosing)
120.082383	-23.299917	*Acacia*	sp. nov (reticulate/anastomosing)
120.082467	-23.30035	*Acacia*	sp. nov (reticulate/anastomosing)
120.082483	-23.300183	*Acacia*	sp. nov (reticulate/anastomosing)
120.0826	-23.299467	*Acacia*	sp. nov (reticulate/anastomosing)
120.082633	-23.299933	*Acacia*	sp. nov (reticulate/anastomosing)
120.0827	-23.299517	*Acacia*	sp. nov (reticulate/anastomosing)
120.082733	-23.29995	*Acacia*	sp. nov (reticulate/anastomosing)
120.08275	-23.300133	*Acacia*	sp. nov (reticulate/anastomosing)
120.082833	-23.29945	*Acacia*	sp. nov (reticulate/anastomosing)
120.082833	-23.300067	*Acacia*	sp. nov (reticulate/anastomosing)
120.08285	-23.297683	*Acacia*	sp. nov (reticulate/anastomosing)
120.082883	-23.3002	*Acacia*	sp. nov (reticulate/anastomosing)
120.0829	-23.2996	*Acacia*	sp. nov (reticulate/anastomosing)
120.082917	-23.299783	*Acacia*	sp. nov (reticulate/anastomosing)
120.082967	-23.3001	*Acacia*	sp. nov (reticulate/anastomosing)
120.082983	-23.297617	*Acacia*	sp. nov (reticulate/anastomosing)
120.083	-23.297467	*Acacia*	sp. nov (reticulate/anastomosing)
120.083067	-23.30025	*Acacia*	sp. nov (reticulate/anastomosing)
120.083117	-23.299567	*Acacia*	sp. nov (reticulate/anastomosing)
120.083117	-23.2999	*Acacia*	sp. nov (reticulate/anastomosing)
120.083133	-23.2989	*Acacia*	sp. nov (reticulate/anastomosing)
120.08315	-23.30005	*Acacia*	sp. nov (reticulate/anastomosing)
120.0832	-23.299417	*Acacia*	sp. nov (reticulate/anastomosing)
120.083217	-23.29875	*Acacia*	sp. nov (reticulate/anastomosing)
120.083267	-23.299717	*Acacia*	sp. nov (reticulate/anastomosing)
120.083317	-23.299233	*Acacia*	sp. nov (reticulate/anastomosing)
120.083317	-23.29985	*Acacia*	sp. nov (reticulate/anastomosing)
120.083333	-23.298817	*Acacia*	sp. nov (reticulate/anastomosing)
120.083333	-23.299317	*Acacia*	sp. nov (reticulate/anastomosing)
120.083417	-23.298933	*Acacia*	sp. nov (reticulate/anastomosing)
120.0835	-23.299733	*Acacia*	sp. nov (reticulate/anastomosing)
120.083833	-23.296983	*Acacia*	sp. nov (reticulate/anastomosing)
120.084	-23.29695	*Acacia*	sp. nov (reticulate/anastomosing)
120.084033	-23.299017	*Acacia*	sp. nov (reticulate/anastomosing)
120.084083	-23.299117	*Acacia*	sp. nov (reticulate/anastomosing)

MGA_EAST	MGA_NORTH	GENUS	SPECIES
120.084233	-23.299233	*Acacia*	sp. nov (reticulate/anastomosing)
120.084233	-23.29695	*Acacia*	sp. nov (reticulate/anastomosing)
120.085167	-23.297333	*Acacia*	sp. nov (reticulate/anastomosing)
120.0853	-23.297433	*Acacia*	sp. nov (reticulate/anastomosing)
120.08545	-23.297933	*Acacia*	sp. nov (reticulate/anastomosing)
120.085567	-23.297583	*Acacia*	sp. nov (reticulate/anastomosing)
120.0856	-23.297767	*Acacia*	sp. nov (reticulate/anastomosing)
120.085683	-23.2975	*Acacia*	sp. nov (reticulate/anastomosing)
120.08575	-23.297967	*Acacia*	sp. nov (reticulate/anastomosing)
120.08585	-23.297567	*Acacia*	sp. nov (reticulate/anastomosing)
120.086067	-23.2976	*Acacia*	sp. nov (reticulate/anastomosing)
120.0863	-23.295967	*Acacia*	sp. nov (reticulate/anastomosing)
120.08685	-23.297017	*Acacia*	sp. nov (reticulate/anastomosing)
120.086867	-23.29715	*Acacia*	sp. nov (reticulate/anastomosing)
120.086883	-23.29725	*Acacia*	sp. nov (reticulate/anastomosing)
120.08695	-23.296933	*Acacia*	sp. nov (reticulate/anastomosing)
120.087033	-23.297433	*Acacia*	sp. nov (reticulate/anastomosing)
120.087133	-23.297517	*Acacia*	sp. nov (reticulate/anastomosing)
120.087183	-23.296633	*Acacia*	sp. nov (reticulate/anastomosing)
120.088617	-23.29625	*Acacia*	sp. nov (reticulate/anastomosing)
120.088717	-23.29635	*Acacia*	sp. nov (reticulate/anastomosing)
120.088783	-23.2965	*Acacia*	sp. nov (reticulate/anastomosing)
120.08955	-23.29615	*Acacia*	sp. nov (reticulate/anastomosing)
120.08955	-23.296533	*Acacia*	sp. nov (reticulate/anastomosing)
120.089567	-23.296283	*Acacia*	sp. nov (reticulate/anastomosing)
120.089667	-23.29635	*Acacia*	sp. nov (reticulate/anastomosing)
120.089667	-23.296167	*Acacia*	sp. nov (reticulate/anastomosing)
120.089783	-23.29625	*Acacia*	sp. nov (reticulate/anastomosing)
120.0921	-23.30185	*Acacia*	sp. nov (reticulate/anastomosing)
120.0921	-23.30165	*Acacia*	sp. nov (reticulate/anastomosing)
120.09215	-23.301783	*Acacia*	sp. nov (reticulate/anastomosing)
120.092217	-23.30165	*Acacia*	sp. nov (reticulate/anastomosing)
120.09225	-23.301817	*Acacia*	sp. nov (reticulate/anastomosing)
120.092633	-23.302167	*Acacia*	sp. nov (reticulate/anastomosing)
120.092867	-23.301217	*Acacia*	sp. nov (reticulate/anastomosing)
120.092867	-23.3016	*Acacia*	sp. nov (reticulate/anastomosing)
120.0929	-23.3013	*Acacia*	sp. nov (reticulate/anastomosing)
120.0929	-23.301433	*Acacia*	sp. nov (reticulate/anastomosing)
120.093133	-23.301467	*Acacia*	sp. nov (reticulate/anastomosing)
120.093983	-23.300717	*Acacia*	sp. nov (reticulate/anastomosing)
120.094233	-23.300667	*Acacia*	sp. nov (reticulate/anastomosing)
120.105117	-23.301133	*Acacia*	sp. nov (reticulate/anastomosing)
120.1052	-23.300983	*Acacia*	sp. nov (reticulate/anastomosing)
120.105717	-23.301183	*Acacia*	sp. nov (reticulate/anastomosing)
120.105733	-23.301383	*Acacia*	sp. nov (reticulate/anastomosing)
120.105867	-23.301283	*Acacia*	sp. nov (reticulate/anastomosing)
120.106033	-23.301217	*Acacia*	sp. nov (reticulate/anastomosing)
120.106033	-23.301367	*Acacia*	sp. nov (reticulate/anastomosing)

MGA_EAST	MGA_NORTH	GENUS	SPECIES
120.106083	-23.301083	*Acacia*	sp. nov (reticulate/anastomosing)
120.1062	-23.301183	*Acacia*	sp. nov (reticulate/anastomosing)
120.083184	-23.300118	*Acacia*	sp. nov (reticulate/anastomosing)
120.083413	-23.299004	*Acacia*	sp. nov (reticulate/anastomosing)
120.091549	-23.301393	*Acacia*	sp. nov (reticulate/anastomosing)
120.0917	-23.328967	*Goodenia*	*nuda*
120.0917	-23.3283	*Goodenia*	*nuda*
120.106668	-23.291321	*Rhagodia*	sp. Hamersley (M.E. Trudgen 17794)
120.111216	-23.293364	*Rhagodia*	sp. Hamersley (M.E. Trudgen 17794)
120.090667	-23.332383	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.090733	-23.32735	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.0911	-23.328767	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.0913	-23.325217	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.0943	-23.357683	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.094567	-23.355217	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.09465	-23.354667	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.0949	-23.355683	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.095117	-23.3565	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.095167	-23.3562	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.095817	-23.35635	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.095967	-23.356633	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.096233	-23.356317	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.096283	-23.36005	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.096683	-23.3594	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.096733	-23.3595	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.096833	-23.3592	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.09685	-23.35585	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.09735	-23.358733	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.09745	-23.356033	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.097667	-23.358233	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.09775	-23.356433	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.097967	-23.359483	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.097983	-23.357033	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.098033	-23.35795	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.098083	-23.358	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.0981	-23.3575	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.098217	-23.35625	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.098267	-23.358983	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.0983	-23.358433	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.0983	-23.359617	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.0984	-23.356233	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.098583	-23.36015	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.099017	-23.360617	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.100017	-23.362717	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.100217	-23.361267	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.10025	-23.362317	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.10035	-23.361833	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.117	-23.350633	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)

MGA_EAST	MGA_NORTH	GENUS	SPECIES
120.124783	-23.347783	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.125067	-23.347367	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.12535	-23.347117	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.125633	-23.3474	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.12595	-23.346067	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.126	-23.347233	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.126083	-23.346783	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.126333	-23.346383	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.126683	-23.3458	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.127017	-23.345233	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.127133	-23.34355	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.12728	-23.344658	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.12755	-23.344083	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.12755	-23.343617	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)
120.091304	-23.325233	*Triodia*	sp. Mt Ella (M.E. Trudgen 12739)

Targeted Flora Survey

Acacia sp. East Fortescue

Prepared for BHP Billiton Iron Ore Pty Ltd
November 2015

Document Status						
Rev No.	**Authors**	**Reviewer/s**	**Date**	**Approved for Issue**		
				Name	**Distributed To**	**Date**
1	D.Brearley	J.Waters	29/07/15	D.Brearley	G.Watson	30/07/15
2	D.Brearley	G.Watson	31/07/15	D.Brearley	G.Watson	31/07/15
3	D.Brearley	J.Waters	08/10/15	D.Brearley	C.Mounsey	03/11/15
4	D.Brearley	C.Mounsey	09/11/15	D.Brearley	C.Mounsey	25/11/15

Onshore Environmental Consultants Pty Ltd
ACN 095 837 120
PO Box 227
YALLINGUP WA 6282
Telephone / Fax (08) 9756 6206
E-mail: onshoreenv@westnet.com.au

Table of Contents

1.0 INTRODUCTION

A recent baseline flora and vegetation survey at the Orebody 31 project area by Onshore Environmental (2014a) recorded a new *Acacia* species, known as *Acacia* sp. East Fortescue [previously referred to as *Acacia* sp. nov (reticulate/anastomosing)]. A follow-up targeted flora survey defined numbers of plants and population boundaries (Onshore Environmental 2014b).

Acacia sp. East Fortescue occurs as a woody shrub with rounded growth form, ranging between 1.5 m and 5.0 m in height and 1.0 m to 5.0 m in width. However burnt stags suggest mature plants may reach up to 7.0 m in height. It has five diagnostic characters:

- flat phyllodes with anastomosing nerves;
- cylindrical spike;
- calyx lobes separated;
- gland about 10 mm above the pulvinus; and
- dense red brown glandular trichomes on new growth and edges of phyllodes (small hairlets).

It is so odd that its affinities are unknown (B. Maslin, pers. comm.). It is currently listed as a Priority 1 flora, but the conservation code may be increased to the status of Threatened Flora in the near future.

In 2015 BHP Billiton Iron Ore committed to undertaking targeted surveys aimed at recording and documenting the distribution and population sizes(s) of *Acacia* sp. East Fortescue, and furthering the understanding of its habitat and ecological requirements. This work was required to inform the conservation status and future management requirements for this recently discovered taxon.

2.0 METHODOLOGY

2.1 Phase 1 - Defining local populations at OB31

Targeted searches for *Acacia* sp. East Fortescue commenced by re-surveying known populations at OB31 to update population data and collate similarities in geology, landform, soil and vegetation across populations. The local survey effort was extended over 64 km^2 of BHP Billiton Iron Ore tenure surrounding the known populations (Figure 1). The area was divided into a 1 km^2 grid and transects were ground truthed at this scale. Binoculars were used to scan surrounding landforms during the field survey, and there was intensive survey of landform and vegetation associations that reflected the known populations.

2.2 Phase 2 - Targeted searches based on geology

Within the OB31 tenement, *Acacia* sp. East Fortescue appeared to be habitat specific, occurring on orange rock exposed from the weathering of eroded BIF ironstone present on low undulating hills (typically with overhangs and cave formations). More specifically, populations were positioned along the boundary of two geological formations, the Boolgeeda Iron Formation and Woongarra Rhyolite [1]. The intersection of these two geological formations (i.e. the alignment where the two formations meet) was used as the parameter to define the first regional phase of targeted searches. Broad scale geological mapping confirmed the distribution of the Boolgeeda Iron Formation and Woongarra Rhyolite across three broad areas (Figure 2):

[1] Interestingly, plants did not occur consistently across the entire range of this geology but was restricted to six localised populations.

1. South-east Pilbara - extending along an approximate 100 km strike aligned north-west to south-east from north of Newman to south-east of the Jimblebar Mine;
2. Karijini National Park - extending east-west (75 km strike) along the southern sector of Karijini National Park and fyrther south into the Mt Channar, Snowy Mountain and Turee Creek East region; and
3. Western Pilbara - extending north-west (175 km strike) from BHPBIOs Rocklea tenement to west of Pannawonica.

Given the wide extent of the target geology, it was proposed to focus the second phase of targeted seaches within the south-east Pilbara (Figure 3), with ground truthing commencing at the OB31 tenement and moving outwards following the favoured geological strikes. Fine scale geology mapping was sourced to provide accurate refinement of target areas and local road and track layers were overlayed to determine potential access by vehicle and on foot.

The first phase targeted survey was completed by two botanists working over a seven day period (25-31 March 2015). Targets identified during the desktop review (Figure 3) were accessed as close as possible by vehicle, however poor vehicular access into the majority of targets restricted thorough coverage on foot. Ground truthing of defined targets occurred along transects following the target geology. The area covered during the Phase 2 targeted survey is represented in Figure 4, noting that restricted access prevented coverage of the wider target areas.

2.3 Phase 3 - Targeted searches based on landform

The Phase 3 targeted field survey utilised a species distribution model (Atlas of Living Australia 2015) that linked records from known populations of *Acacia* sp. East Fortescue at the OB31 tenement with relevant environmental data, to predict areas that may be suitable for the species. The parameters selected for the model were elevation, slope, soil depth, and lithology age, along with temperature and rainfall. The models provided a number of targets with >80 percent similarity to the OB31 tenement (Figure 5). Five of the targets were situated within a 150 km radius of the OB31 tenement and intersected by the Great Northern Highway or arterial roads and tracks, providing access by vehicle and foot. The five targets were referred to as Jigalong, Balfour, Newman South East, Newman South West and Karijini (Figure 5).

The Phase 3 targeted survey was completed by two botanists from Onshore Environmental working over a five day period from the 2nd to the 6th August 2015. Where possible, target areas were accessed by vehicle. At locations determined worthwhile and prospective for *Acacia* sp. East Fortescue, transects were then completed on foot for up to 3 km in length. The area covered during the Phase 3 targeted survey is represented in Figure 4, noting that access restricted coverage of the wider target areas.

3.0 RESULTS

3.1 Description of *Acacia* sp. East Fortescue

Acacia sp. East Fortescue is a spreading rounded shrub, 1.5-4.0 m tall, branching at ground level into a number of spreading main stems, with rounded crowns which are bushy, dark green (Plate 1), and 1.0-4.0 m wide. Older plants have slightly gnarled appearance (not dissimilar to *A.levata, A.xiphophylla* and *A.cuthbertsonii).* Bark grey to dark grey, longitudinally fissured and fibrous towards the base of mature stems (Plate 2), becoming smoorth towards the ends of branches (Plate 3).

Branchlets terete, slightly angular at extremities, dense indumentum of appressed, short, flattened hairs, finely ribbed, ribs with a dense indumentum of red-brown, glandular trichomes, indumentum obscured by a moderately thick layer of yellow translucent resin, aging glabrous and grey. New shoots resinous with a dense indumentum of pale yellow to white appressed hairs, expanding phyllodes with a dense indumentum of red-brown glandular trichomes on the margin. Stipules triangular, red-brown, (0.4-)0.5–0.65 mm long. Phyllodes narrowly elliptic, (36-)38-72 mm long (occasionally interspersed with a few less than 35 mm long), 4.1-8.7 mm wide, l: w = 5.0-13.4, ascending to erect, straight to shallowly incurved or shallowly recurved, moderate indumentum of short, appressed hairs, green, resinous, indumentum and resin becoming sparse with age; longitudinal nerves numerous, 1-3 slightly more pronounced with longitudinal anastomosing minor nerves in between (Plate 4); marginal nerve pale yellow to white with a thin layer of translucent, red-brown resin becoming scattered to absent with age; apices acute to acuminate, straight to curved; pulvinus 2.0-5.3 mm long. Gland on upper margin of phyllode (2.9-)3.4-13.4 mm above the pulvinus, not prominent. Inflorescences simple or vestigial racemes 0.5-0.8 mm long, initiated in the axils of young phyllodes; peduncles 3.0-6.2 mm long, sparse to moderate indumentum of short, appressed hairs, resinous; basal peduncular bract single, ovate, 1.0-1.4(-1.65) mm long, yellow to red-brown, moderate indumentum of appressed, simple hairs; spike cylindrical, (10-)11.5-25(-27) mm long, flowers dense (Plate 5). Bracteoles 0.9-1.1 mm long; claws narrowly oblong to linear, glabrous; lamina ovate, thickened proximally, ciliolate and with scattered glandular trichomes. Flowers 5-merous; sepals united for up to ¼ (-almost ½) of their length, 0.5-1.1 mm long, narrowly ovate, slightly expanded at the apex, sparsely papillose on margins becoming denser at apex along with simple hairs, abaxial face at apex papillose; petals 1.3-1.8(-1.9) mm long, glabrous, 1-nerved; ovary densely sericeous. Pods (few seen, see Plates 6-7)[2] narrowly oblong, flat, scarcely raised over seeds and shallowly to moderately constricted between them, 17-32.5 mm long, 2.7-4.0 mm wide, coriaceous-crustaceous, straight, resinous but not sticky, green to brown, sparse indumentum of appressed, white hairs, numerous anastomosing longitudinal nerves; marginal nerve discrete, yellow. Seeds (1 seen, see Plates 8-9) longitudinal in pods, obloid-ellipsoid, 4.3 mm long, 2.2 mm wide, brown; areole ‘u-’ shaped, very small (0.3 mm long); funicle expanded into a small, terminal aril.

3.2 Flowering Period

Flowers have been recorded from the OB31 population between late April and early August (Plate 5). Pods containing one viable seed were first collected in September 2014 (Plate 6 and 7), with additional pods and seeds collected in mid October 2015.

3.3 Affinities

Initial inspection of specimens by *Acacia* specialist at the WAH, Mr Bruce Maslin, suggests the affinities are unknown (B. Maslin, pers. comm.).

Based on comparisons by Onshore Environmental it is aligned to *Acacia levata* and *Acacia cuthbertsonii* subsp. *cuthbertsonii. Acacia levata* is restricted to the central eastern sector of the Pilbara (around Marble Bar) occurring on undulating low rocky hills. It is differentiated by longer and wider phyllodes. *Acacia cuthbertsonii* subsp. *cuthbertsonii,* which does not appear to occur in the Pilbara[3], is differentiated by smaller and narrower phyllodes. However, neither of these two taxa occur within the vicinity of Orebody 31.

[2] The unattached pod was opened to examine the seed. Only one seed was present but there were also 12 aborted/unfertilised ovules. It can be assumed that had the ovules formed mature seeds then the pod would be much longer and possibly may not have been constricted between the seeds.
[3] There is one specimen of *A. cuthbertsonii* subsp. *cuthbertsonii* at the WAH collected from the Hamersley Range, but this record has not been verified despite intensive collecting over the past 20 years.

Field observation confirms that *Acacia ancistrocarpa* occurs with *Acacia* sp. East Fortescue at OB31 and has similar coloured phyllodes with variable anastomosing longitudinal nerves (not as prominent as *Acacia* sp. East Fortescue). *Acacia adsurgens* was recorded growing alongside *Acacia* sp. East Fortescue on breakway ridges and slopes, and has a similar growth form. Similarly, variable specimens within the *Acacia sibirica / kempeana* complex were recorded on target landforms during the field survey. Hybridisation within this group is known to occur and likely contributing to variability observed in the field.

3.4 Population Statistics

Acacia sp. East Fortescue (J. Bull & D. Roberts ONS A 27.01) was recorded as 567 plants from three populations[4] occurring across approximately 8.1 ha situated along the north-west boundary of BHP Billiton Iron Ore's OB31 tenement (Figure 6, Table 1). Populations ranged from 0.6 ha to 5.5 ha in area and supported between 105 plants and 348 plants.

Table 1 Representation of *Acacia* sp. East Fortescue (J. Bull & D. Roberts ONS A 27.01) at OB31.

Population	MGA94 Easting	MGA94 Northing	No. sub-popns	No. plants	Approx. area (m)	Approx. area (ha)
1a	201663	7420296	3	209	200 by 100	2.0
1b	201922	7420539	5	105	300 by 100	3.0
1c	202307	7420698	2	34	100 by 50	0.5
2	202763	7420207	4	114	200 by 100	2.0
3a	204014	7420180	2	72	100 by 50	0.5
3b	204116	7420271	3	33	50 by 20	0.1

3.5 Habitat

Acacia sp. East Fortescue was recorded from low undulating hills at elevations ranging between 518 m and 555 m AHD (Plate 10). Approximately 44 percent of recorded plants occurred where slope angle was less than ten degrees, 49 percent of plants occurred where slope angle was between 10 and 20 degrees, and seven percent occurred where slope angle was between 20 and 28 degrees. Aspect did not appear to be a contributing factor.

Plants were concentrated around the breakaway slopes of relatively low undulating hills (overhangs and small caves were characteristic) and along adjacent minor drainage lines dissecting the low hills. Plants were less commonly recorded on neighbouring hill crests and larger unicised drainage lines supporting Mulga Forest. Soil was consistently a red to orange sandy loam.

Acacia sp. East Fortescue appeared to be habitat specific within the OB31 area, occurring along a fault line at the intersection of two geological formations that occur within the Hamersley Group BIFs; Boolgeeda Iron Formation and Woongarra Rhyolite (Plate 11). The Boolgeeda Iron Formation typically overlies the Woongarra Rhyolite. However, at OB31 *Acacia* sp. East Fortescue was recorded in areas where the Boolgeeda Iron Formation was heavily weathered, exposing the underlying Woongarra Rhyolite at surface.

The Boolgeeda Iron Formation is the youngest BIF in the Hamersley Group and consists predominantly of interbedded shaly BIF. It is described by Trendall (1995) as fine-grained,

[4] In biological terms, a population is a discrete group of interbreeding individuals of a species. For the purposes of this report, plants more than 500 m from a known population are considered to be a new population.

finely laminated, dark grey-brown to black flaggy iron-formation, minor chert, jaspilite, shale. Rhyolite is an igneous, volcanic rock, of felsic composition with a mineral assemblage of quartz, sanidine and plagioclase. Woongarra Rhyolite has been described as rhyolite, rhyodacite, rhyolitic volcaniclastic breccia and banded iron formation (Trendall 1995).

3.6 Vegetation Associations

Acacia sp. East Fortescue was recorded from breakaway ridges and minor ephemeral drainage lines dissecting relatively low undulating hills. At one site plants were recorded as established trees with dense Mulga along a medium drainage line. At all locations there was clear evidence of surface weathering of the Boolgeeda Iron Formation exposing the underlying Woongarra Rhyolite. Vegetation within the majority of populations had been subjected to a hot burn within the past three years. The following vegetation descriptions were made across the three populations:

- Hummock Grassland of *Triodia pungens* with Open Shrubland (to Shrubland) of *Dodonaea petiolaris, Eremophila latrobei* and *Acacia* sp. East Fortescue and Scattered Tall Shrubs of *Grevillea berryana* and *Acacia* sp. East Fortescue on breakaway hill slopes;
- Hummock Grassland of *Triodia pungens* and *Triodia* sp. Shovelanna Hill (S. Van Leeuwen 3835) with Low Open Shrubland of *Mirbelia viminalis, Solanum lasiophyllum* and *Solanum centrale* and High Open Shrubland of *Acacia* sp. East Fortescue and *Acacia adsurgens* on breakaway hill slopes;
- Open Hummock Grassland of *Triodia* sp. Shovelanna Hill (S. Van Leeuwen 3835) with Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and Low Open Shrubland of *Acacia hilliana* and *Acacia adoxa* subsp. *adoxa* on lower hill slopes fringing minor drainage lines;
- Hummock Grassland of *Triodia pungens* and *Triodia* sp. Shovelanna Hill (S. Van Leeuwen 3835) with High Open Shrubland of *Acacia* sp. East Fortescue and *Grevillea berryana* and Open Shrubland of *Eremophila latrobei* subsp. *latrobei, Senna stricta* and *Acacia* sp. East Fortescue on minor drainage lines dissecting undulating low hills;
- Closed Scrub of *Acacia monticola, Acacia bivenosa* and *Grevillea wickhamii* over Hummock Grassland of *Triodia pungens* with Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* on minor drainage lines dissecting undulating low hills;
- Hummock Grassland of *Triodia pungens* and *Triodia* sp. Shovelanna Hill (S. Van Leeuwen 3835) with Shrubland of *Acacia* sp. East Fortescue, *Acacia aptaneura* and *Eremophila latrobei* subsp. *latrobei* and Low Open Woodland of *Eucalyptus leucophloia* subsp. *leucophloia* on upper reaches of minor drainage lines; and
- Low Closed Woodland of *Acacia aptaneura* over Hummock Grassland of *Triodia pungens* and *Triodia* sp. Shovelanna Hill (S. Van Leeuwen 3835) with Open Shrubland of *Acacia wanyu, Senna stricta* and *Eremophila latrobei* subsp. *latrobei* on unincised medium drainage lines at the base of low hills.

4.0 SUMMARY

Acacia sp. East Fortescue is a new taxon recorded as 567 plants from three populations occurring across approximately 8.1 ha situated along the north-west boundary of BHP Billiton Iron Ore's OB31 tenement. Populations ranged from 0.6 ha to 5.5 ha in area and supported between 105 plants and 348 plants.

Plants were concentrated along breakaway slopes of relatively low undulating hills (518 m and 555 m AHD) where overhangs and small caves were characteristic of the landform. The population typically extended onto lower hill slopes and into minor drainage lines dissecting the low hills.

The three known populations of *Acacia* sp. East Fortescue occur along a fault line at the intersection of two geological formations within the Hamersley Group BIFs; Boolgeeda Iron Formation and Woongarra Rhyolite. Plants were growing in areas where the Boolgeeda Iron Formation had been heavily weathered, exposing the underlying Woongarra Rhyolite at surface.

An intensive targeted survey covering 65 km^2 surrounding the three known populations of *Acacia* sp. East Fortescue at Orebody 31 failed to record any additional plants. Geological and landform modelling identified broad regional targets that were difficult to access by vehicle and on foot. Areas that could be accessed as part of targeted searches completed during 2015 did not record any additional populations of *Acacia* sp. East Fortescue. It is noted that there were significant limitations that restricted access during the regional targeted surveys. There are additional targets situated further east and south-east that are also of interest but cannot be safely accessed.

PLATES

Plate 1 Habit

Plate 2 Bark at base of mature stems

Plate 3 Bark at ends of branches

Plate 4 Phyllodes

Plate 5 Influorescence

Plate 6 Sub mature pod

Plate 7 **Open pod. Note the number of aborted / unfertilized ovules.**

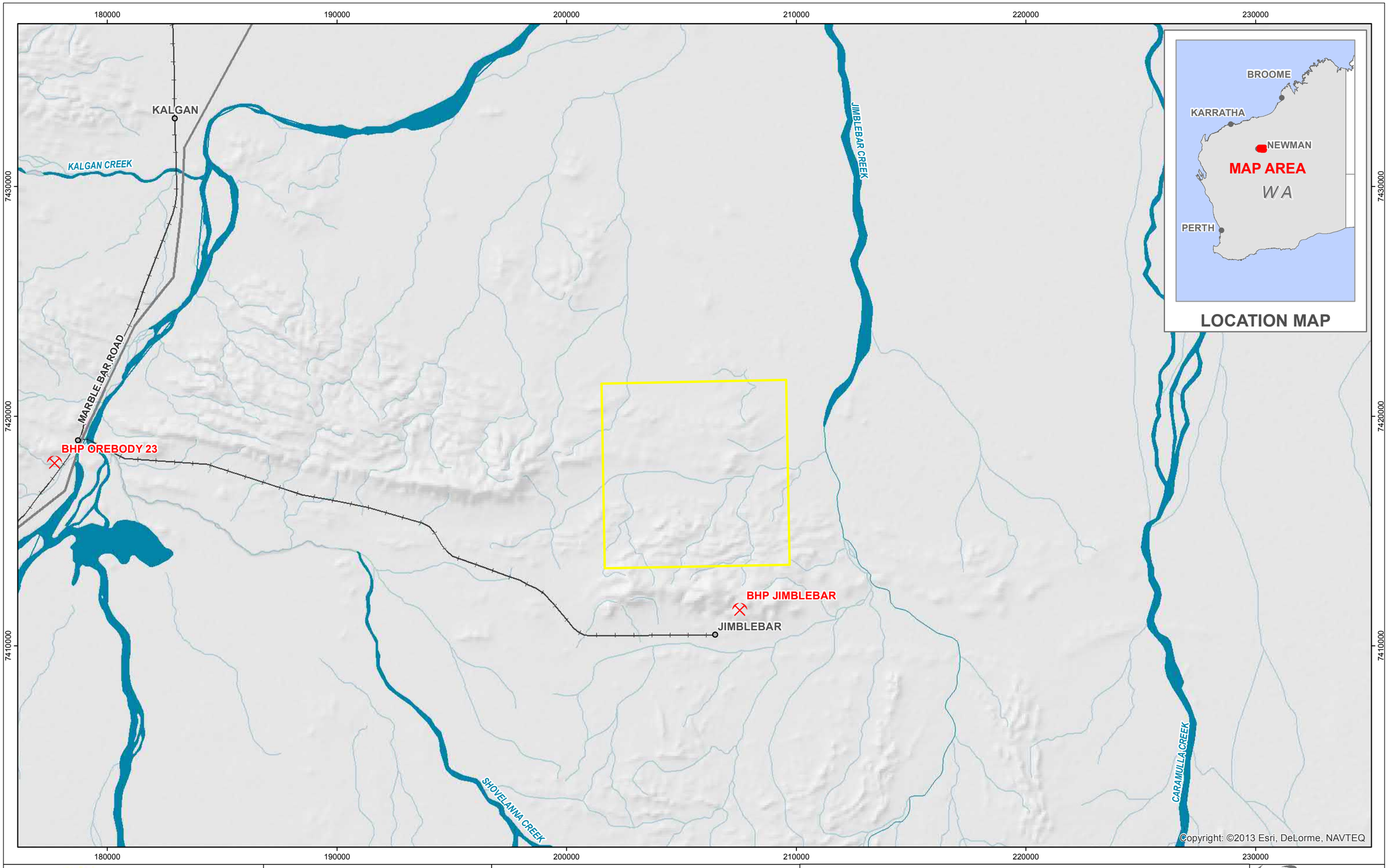
Plate 8 **Seed. Note the small, obscure areole near the centre of the seed.**

Plate 9 Aborted / unfertilized ovules.

Plate 10 Landform

Plate 11 Surface geology

FIGURES



ONSHORE ENVIRONMENTAL

Figure:	1	Date:	06 June 2014
Sheet Size:	A3	Status:	FINAL
Drawn by GSM	Requested by GSM	GSM Reference OB31_Location	

N

0 0.5 1 2 3 4 5

Kilometers

1:150,000

Datum: GDA94

Projection: MGA Zone 51

BHPBIO

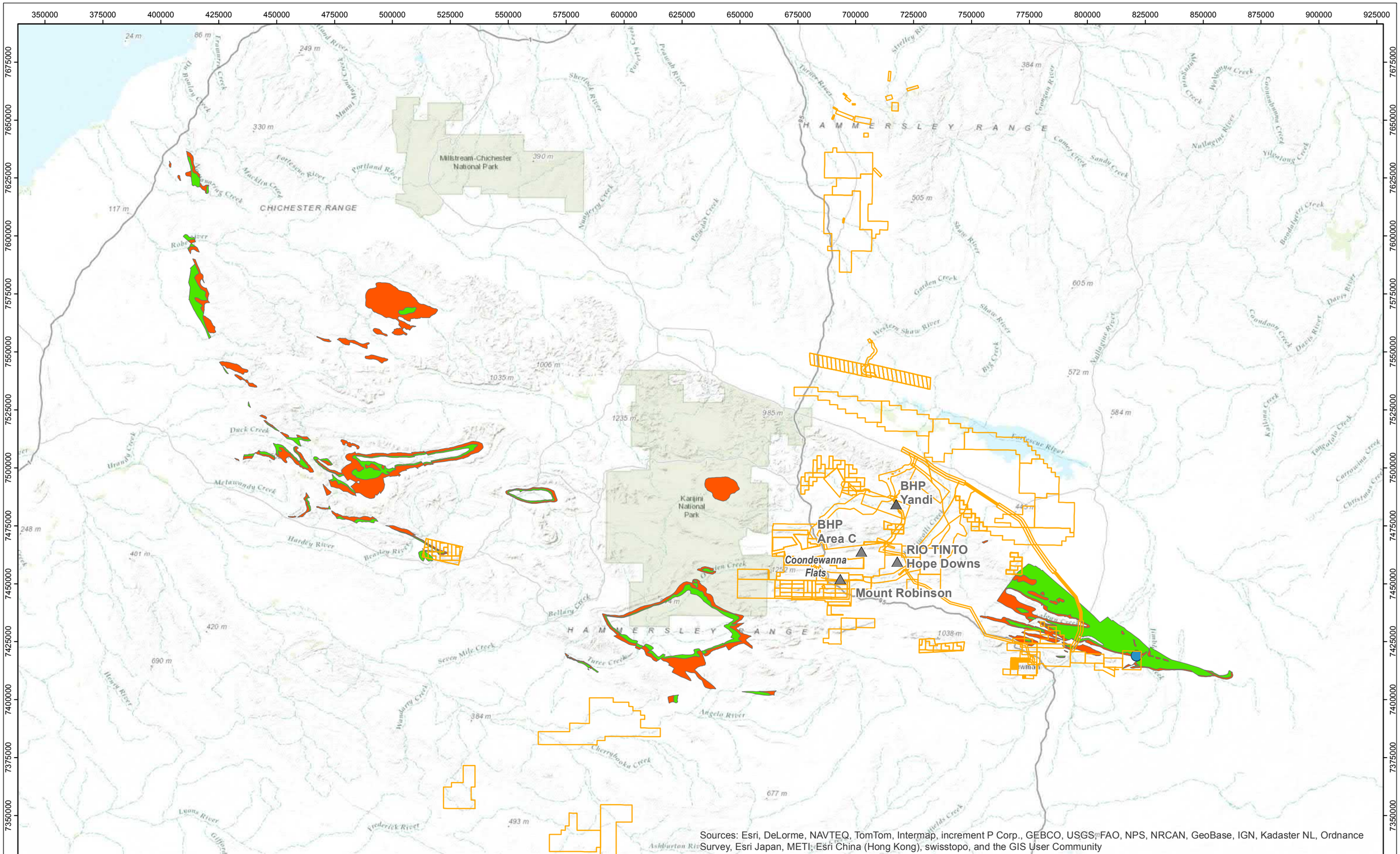
FIGURE 1

Phase 1 targeted survey area for *Acacia* sp. East Fortescue, surrounding Orebody 31

Legend

- Study Area
- Places
- Operating Mines
- Watercourses
- Roads
- Railways

GRIFFIN SPATIAL & MAPPING
PO Box 7215
Eaton WA 6232
admin@griffinspatial.com.au
+61 8 9725 3213



ONSHORE ENVIRONMENTAL

Figure:	2	Date:	17/02/2015
Sheet Size:	A3	Status:	DRAFT
Drawn by GSM	Requested by GSM	GSM Reference Geology	

N

0 10 20 40 60 80

Kilometers
1:1,500,000

Datum: GDA94
Projection: MGA Zone 51

BHPBIO

FIGURE 2
Distribution of the Boolgeeda Iron Formation and Woongarra Rhyolite

Legend

- BHP Tenure

500k Geology

- BOOLGEEDA IRON FORMATION
- WOONGARRA RHYOLITE

Significant

- *Acacia* sp. East Fortescue

GRIFFIN SPATIAL & MAPPING
PO Box 7215
Eaton WA 6232
admin@griffinspatial.com.au
+61 8 9725 3213

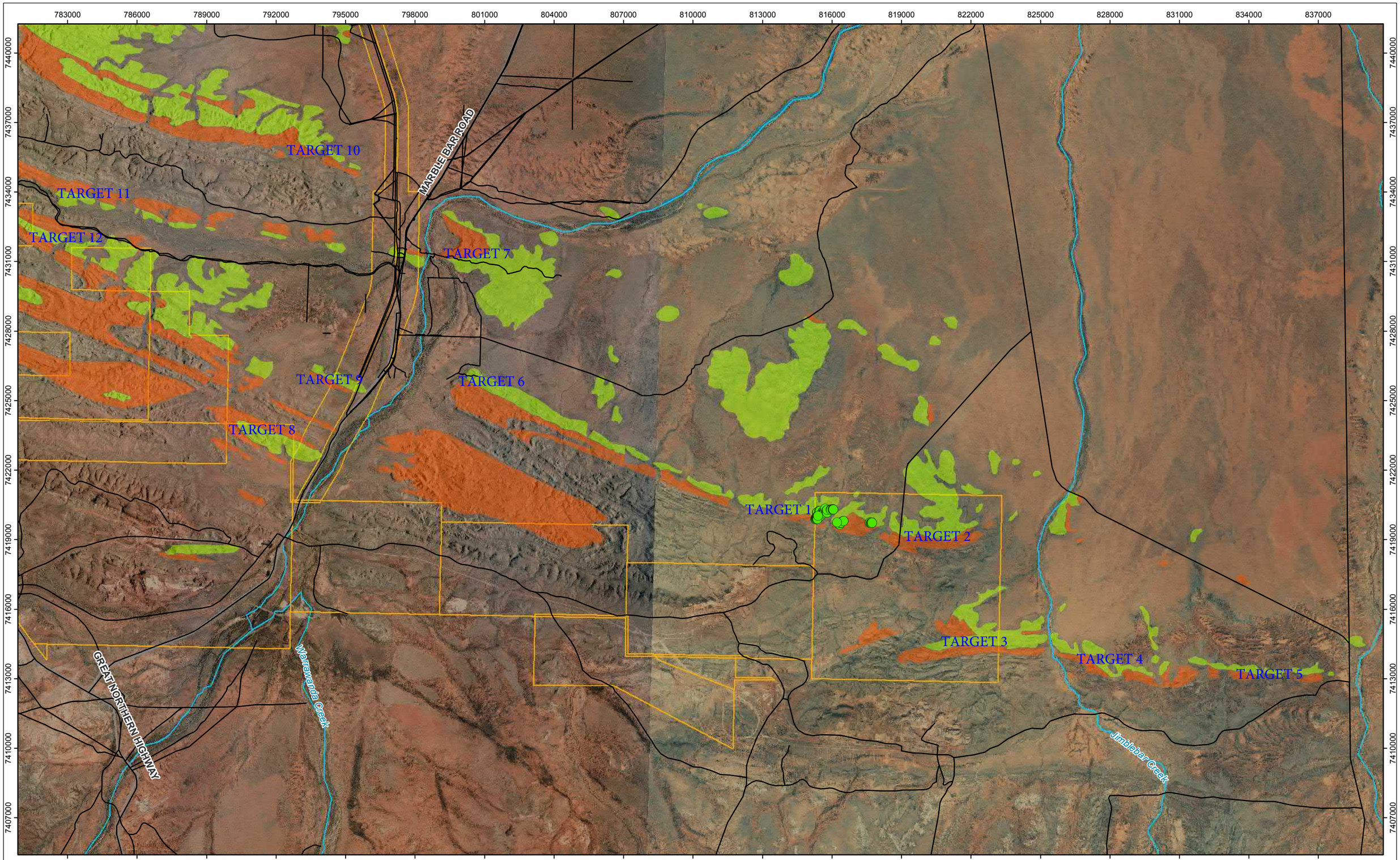


Figure:	3	Date:	13/03/2015
Sheet Size:	A3	Status:	DRAFT
Drawn by GSM	Requested by GSM	GSM Reference Geology Newman Target	

N

0 1 2 4 6 8

Kilometers
1:150,000

Datum: GDA94
Projection: MGA Zone 51

BHPBIO

FIGURE 3

Phase 2 Targeted survey locations for *Acacia* sp. East Fortescue

Legend

BHP Tenure

Significant

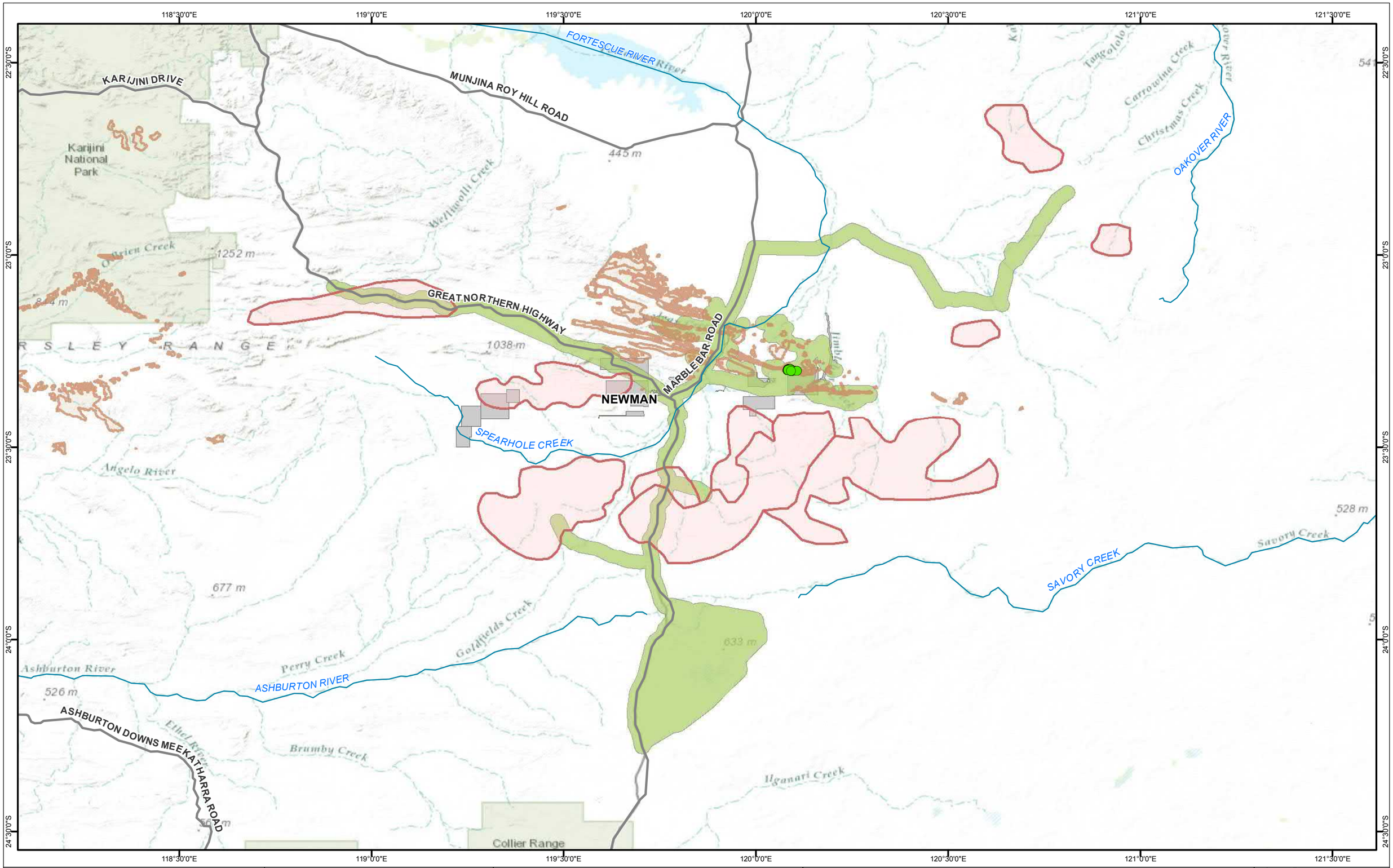
Acacia sp. East Fortescue

Target Geology

Boolgeeda Iron Formation

Woongarra Rhyoloite

GRIFFIN SPATIAL & MAPPING
PO Box 7215
Eaton WA 6232
admin@griffinspatial.com.au
+61 8 9725 3213



ONSHORE ENVIRONMENTAL

Figure:	4	Date:	15/10/2015
Sheet Size:	A3	Status:	DRAFT
Drawn by: GSM	Requested by: DB	GSM Reference: Acacia_Targeted_survey_effort	

N

0 10 20 30 40 50

Kilometers
1:1,000,000

Datum: GDA94

BHPBIO

FIGURE 4
Overview of Phase 1, 2 and 3 targeted survey areas defined, and actual area surveyed in the field

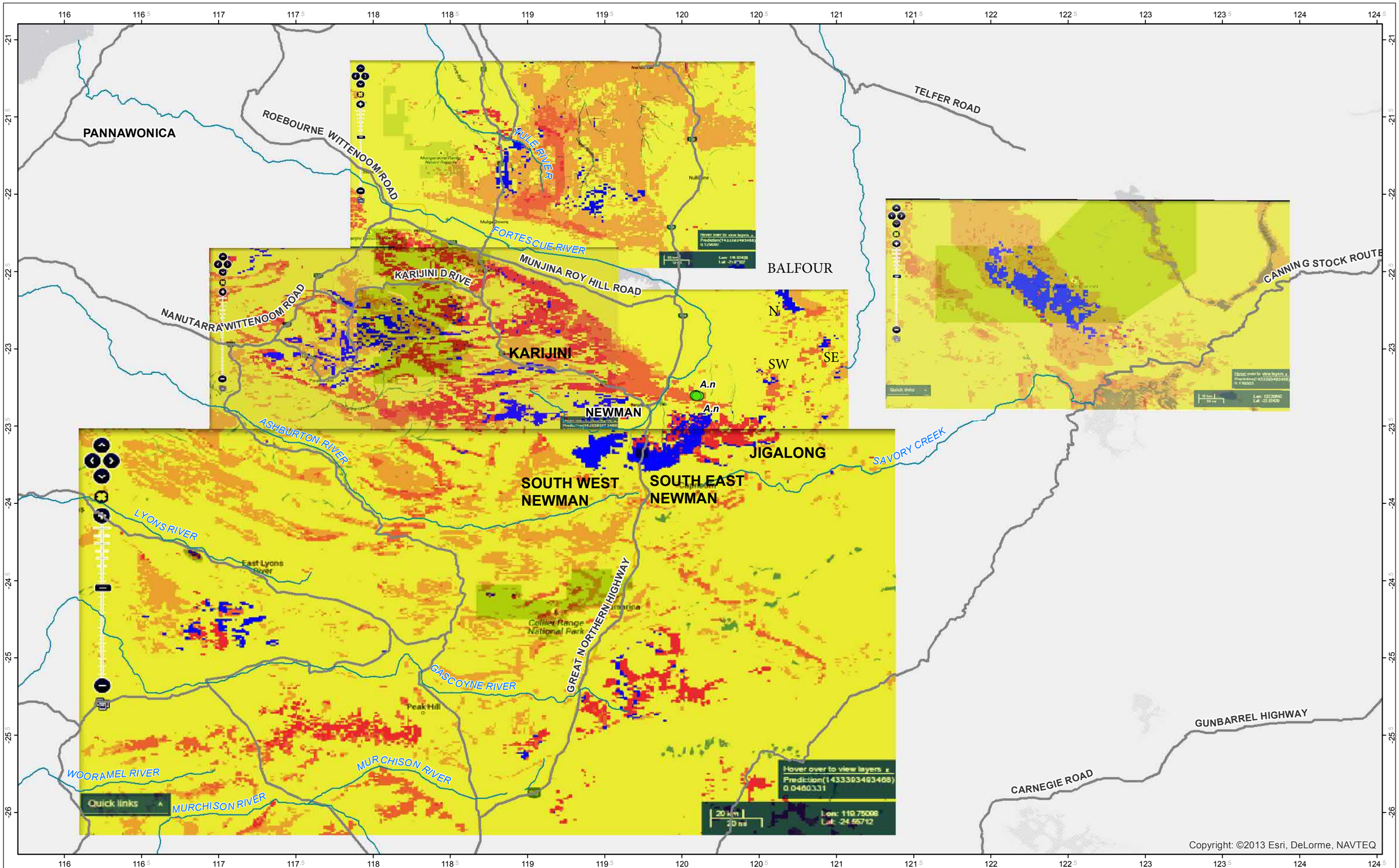
Legend

- Survey Effort
- Phase 2 target areas - geology
- Phase 3 target areas - elevation, slope, soil depth
- Previous Surveyed Areas

Genus / Species

- *Acacia* sp. East Fortescue

GRIFFIN SPATIAL & MAPPING
PO Box 7215
Eaton WA 6232
admin@griffinspatial.com.au
+61 8 9725 3213



ONSHORE ENVIRONMENTAL			
Figure:	5	Date:	06/07/2015
Sheet Size:	A3	Status:	DRAFT
Drawn by: GSM	Requested by: GSM	GSM Reference: Acacia Targeted Overview	

N

0 12.5 25 50 75 100 125

Kilometers

1:2,500,000

Datum: GDA94

BHPBIO

FIGURE 5

Phase 3 Targeted survey locations for *Acacia* sp. East Fortescue (circled pink)

Legend

Significant Species

- *Acacia* sp. East Fortescue

GRIFFIN SPATIAL & MAPPING
PO Box 7215
Eaton WA 6232
admin@griffinspatial.com.au
+61 8 9725 3213

200000 201000 202000 203000 204000 205000 206000

7422000

7421000

7420000

7419000

Population 1

Population 2

Population 3

ML 244SA

Figure:	6	Date:	3/11/2015
Sheet Size:	A3	Status:	DRAFT
Drawn by GSM	Requested by GSM	GSM Reference Acacia Targeted	

N

0 100 200 400 600 800

Meters
1:17,500

Datum: GDA94
Projection: MGA Zone 51

BHPBIO

FIGURE 6

Distribution of the three populations of *Acacia* sp. East Fortescue

Legend

Tenement Boundary AML244SA

Significant Species

*Acacia*sp. East Fortescue (J. Bull and D. Roberts ONS A 27.01)

GRIFFIN SPATIAL & MAPPING
PO Box 7215
Eaton WA 6232
admin@griffinspatial.com.au
+61 8 9725 3213

REFERENCES

Atlas of Living Australia (2015) http://www.ala.org.au/spatial-portal-help/predict/

Onshore Environmental (2014a) *OB 31 Level 2 Flora and Vegetation Assessment.* Consultants report prepared for BHP Billiton Iron Ore.

Onshore Environmental (2014b) *OB 31 / Wheelarra Hill North Targeted Significant Flora Survey.* Consultants report prepared for BHP Billiton Iron Ore.