



**Western Ridge E52/3448
Desktop Flora and Fauna Assessment**

**Prepared for BHP Western Australia Iron Ore
19 November 2018**



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EXECUTIVE SUMMARY

BHP Western Australia Iron Ore (BHP WAIO) commissioned Onshore Environmental Consultants Pty Ltd (Onshore Environmental) to undertake a desktop flora, vegetation and terrestrial fauna (vertebrate fauna and SRE invertebrate fauna) assessment of the Western Ridge exploration tenement E52/3448 (hereafter referred to as the study area). The study area is located immediately south of the Mt Whaleback Mine and approximately 7 km south-west of Newman. It covers an area of approximately 1,202 ha.

The flora and vegetation desktop assessment identified one Threatened Flora and 37 Priority flora taxa potentially occurring within the vicinity of the study area. Based on the known distributions and habitat preferences of these taxa, four taxa were determined as being “likely” to occur within the study area.

Land unit mapping was completed for the study area, with eight vegetation associations identified occurring on eleven land units that were inferred from detailed descriptions provided in Van Vreeswyk *et al.* (2004). In addition, 13 vegetation associations, classified under six broad floristic formations, were mapped within the study area on the basis of topography, land units and extrapolation from neighbouring baseline mapping.

None of the vegetation associations mapped within the study area were considered to be aligned with Federal or State listed Threatened Ecological Communities (TECs), or State listed Priority Ecological Communities (PECs). However, two vegetation associations supporting Mulga Low Woodland were representative of ‘Valley Floor Mulga’ within the Hamersley subregion, which is considered to be an ‘ecosystem at risk’ by the Department of Conservation and Land Management (now Department of Biodiversity, Conservation and Attractions [DBCA]) (Kendrick 2001).

The terrestrial fauna desktop assessment identified 32 conservation significant vertebrate fauna species potentially occurring within the vicinity of the study area. Four of these taxa were determined to be “likely” to occur within the study area based on available habitat and distance to the nearest known record. A total of 41 Confirmed or Potential short-range endemic (SRE) invertebrate fauna species were identified as potentially occurring within the vicinity of the study area during the desktop assessment. Of these, three taxa were determined as “likely” to occur within the study area based on available habitat and species distribution.

Six vertebrate fauna habitats were mapped within the study area on the basis of land units, vegetation mapping and extrapolation from neighbouring mapping. In addition, three broad SRE invertebrate fauna habitats were identified for the study area, inferred from topography, landforms and fauna habitat mapping. None of the fauna habitats mapped within the study area were considered to be significant.

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1.0 INTRODUCTION

1.1 Preamble

BHP WAIO commissioned Onshore Environmental to undertake a desktop flora, vegetation and terrestrial fauna (vertebrate fauna and SRE invertebrate fauna) assessment of the Western Ridge exploration tenement E52/3448 ('the study area'). The assessment was to include mapping of vegetation associations and land units within the study area, as well as terrestrial fauna habitats. The desktop assessment was required to inform future flora, vegetation and terrestrial fauna surveys, and to identify the potential occurrence of conservation significant species and communities and other associated values in the tenement.

The study area is located immediately south of BHP WAIO's Mt Whaleback Mine and approximately 7 km south-west of Newman in the Pilbara region of Western Australia (Figure 1). It covers an area of approximately 1,202 ha.

1.2 Previous Surveys

At least 44 baseline biological surveys have been completed at BHP WAIO tenements within a 25 km radius of the study area. This includes 37 surveys relating to flora and vegetation, 15 surveys relating to vertebrate fauna, and three surveys relating to SRE invertebrate fauna.

None of the previous biological surveys overlap the study area. The closest previous surveys include:

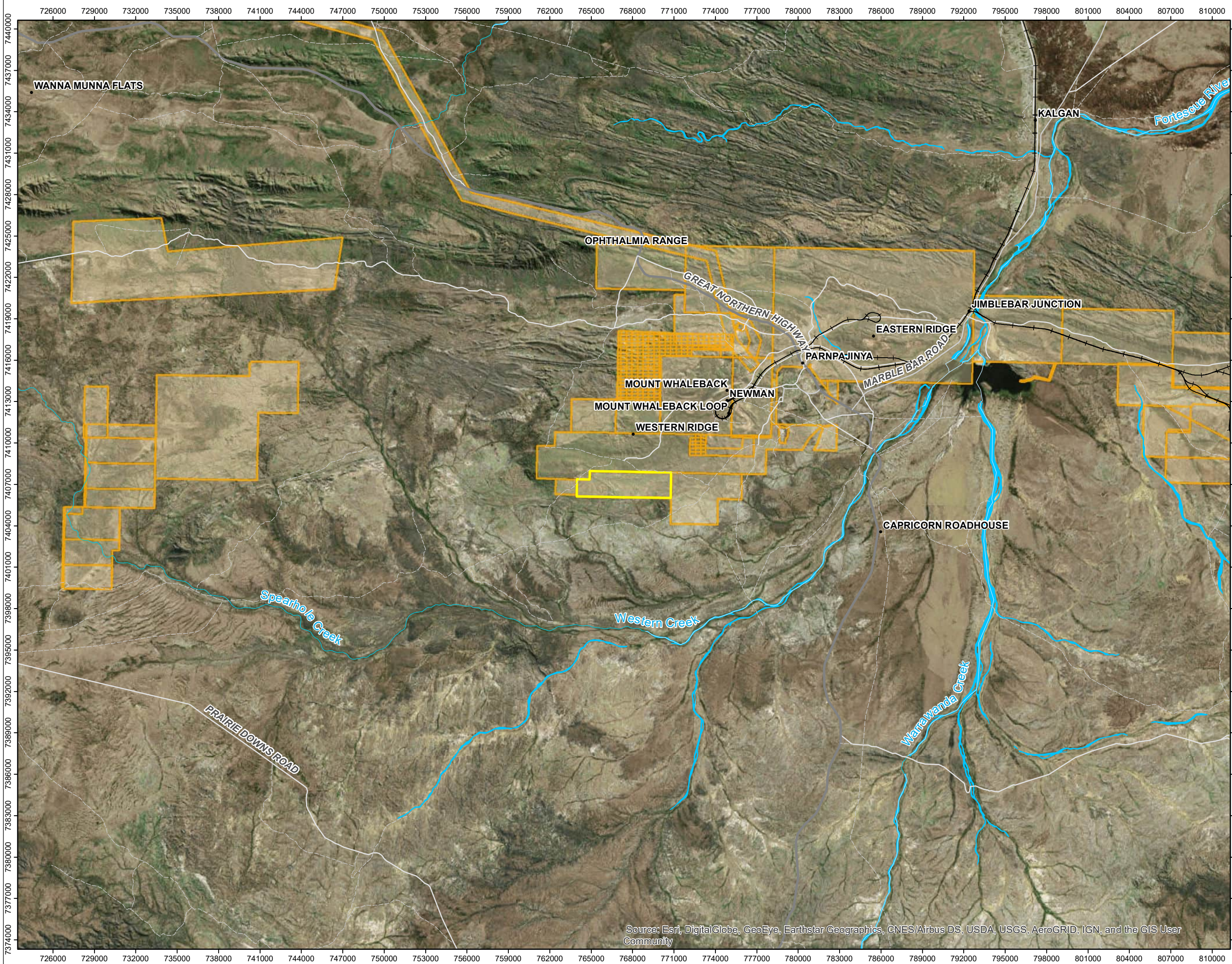
- Desktop assessment and mapping of BHP WAIO's Western Ridge southern exploration tenements E52/3360 and E52/3361, located directly west and east of the study area (Onshore Environmental 2016, Biologic Environmental Survey 2016a and 2016b);
- Surveying of BHP WAIO's Western Ridge tenement E52/2008 that adjoins the northern boundary of the study area (Onshore Environmental 2014a); and
- Surveying of BHP WAIO's Western Ridge and Orebody 35 project area located immediately north of the study area (GHD 2011, Biologic Environmental Survey 2011, ENV 2010, Ecologia 2005 and 2006, ABMS 2011).

Additional vegetation mapping was completed adjacent to the study area by Onshore Environmental in 2013 as part of a regional consolidation of vegetation mapping (Onshore Environmental 2014b).

1.3 Climate

The Pilbara region has an arid to tropical climate with two distinct seasons; a hot summer from October to April, and a mild winter from May to September. The majority of annual rainfall is received during the hot summer months, typically associated with cyclonic activity and thunderstorms, with falls being of higher intensity and shorter duration contributing to an erratic annual range (Sudmeyer 2016).

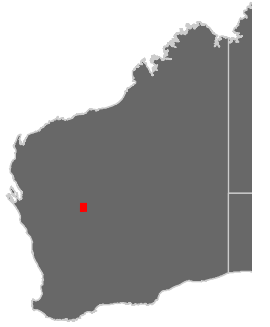
Annual rainfall for Newman ranges from 36 mm to over 619 mm, with a long-term average of 332 mm occurring over 30 rain days (Bureau of Meteorology [BOM] 2018). Most of the annual precipitation occurs during the four summer months from December to March. The average maximum summer temperature ranges between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



BHP
Western Ridge
E52 - 3448

Figure 1
Study Area
Location

- Legend**
- Study Area
 - BHP Tenure



N

0 2.5 5 7.5

Kilometers
 1:250,000
 Datum: GDA94
 Projection: MGA Zone 50

Date:	19/11/2018
Status:	Final
Figure:	1
Sheet Size:	A3
Internal Reference:	WR_Exp_Loc
Drawn by:	GSM
Requested by:	DB



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

1.4 Biogeographic Regions

The Interim Biogeographic Regionalisation for Australia (IBRA7) divides Australia into 89 bioregions and 419 sub-regions based on climate, geology, landform, native vegetation and species information (Department of the Environment and Energy [DoEE] 2018a). The study area is located in the Pilbara bioregion, which consists of four sub-regions: Chichester, Fortescue, Hamersley and Roebourne. The study area is located within the Hamersley sub-region (PIL3).

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

1.5 Existing Land Use

Land tenure in the Pilbara consists of Aboriginal and leasehold reserves, national parks and reserves, and Crown land which falls under a range of pastoral and mining leases. The current use of lands surrounding the study area is predominantly for mineral exploration, iron ore mining and dry land agriculture, specifically pastoralism and cattle grazing.

Conservation lands amount to less than ten percent of the total area of the Pilbara bioregion, with the major reserves being Karijini and Millstream-Chichester National Parks. These parks are supplemented by lesser conservation estates such as Cane River and Meentheena Conservation Parks. Wetlands of National Significance include the permanent pools of Millstream and Karijini National Parks and the Fortescue Marsh. The study area is not within or adjacent to any gazetted conservation reserves. The Collier Range National Park is the nearest reserve, situated approximately 110 km to the south. Karijini National Park is located approximately 120 km west north-west of the study area.

1.6 Landforms

The study area is located south of the Ophthalmia Range, which together with the Hamersley Range encompass the Hamersley Plateau. The Hamersley Plateau is characterised by long strike ridges rising 300 m or more above valley floors and flats. Other characteristic landforms of the general area include stony plains and some alluvial plains and sandplains (Tille 2006). The entire region contains mainly rounded ranges and hills in contrast to the characteristic 'mesa form' hills that are located further to the north-east. Specific landforms occurring within the study area include low hills, stony plains, sandplains and drainage lines.

1.7 Soils

Tille (2006) classified the most recent and detailed mapping of Western Australia's Rangelands and Arid Interior into a hierarchy of soil-landscape mapping units. The study area is located within the following soil unit:

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

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

- 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

- Oc64: Low stony hills and dissected pediments on granite with occasional basic dykes: the chief soils are hard alkaline red soils (Dr2.33) having shallow stony A horizons. Associated are shallow stony (Uc5.11) soils on steep slopes, (Uc1.22) soils along creek lines, and (Um5.11) soils on patches of calcrete (kunkar).

1.8 Geology

The ancient continental Western Shield dominates the geology of Western Australia. The Pilbara region makes up a portion of the Western Shield and consists of pre-Cambrian, Proterozoic and Archaean rocks. Important mineral reserves, including iron ore, which is prevalent in the Pilbara, are associated with these rock formations. The study area is situated in the southern edge of the Pilbara Craton in close proximity to the sedimentary basins that separate the Yilgarn and Pilbara Cratons. These consist of the sandstone and shales of the Collier and Bresnahan Basins and granites of the Sylvania Inlier (Tille 2006).

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

The Fortescue Group dominates the study area and consists mainly of basalt with beds of siltstone, mudstone, shale, dolomite and jaspilite. These rocks form the Chichester Plateau, which lies beneath the Hamersley Plateau.

The Hamersley Group contains both the Brockman Iron Formation and the Marra Mamba Iron Formation, the latter occurring across the northern section of the study area. These formations together provide most of the major iron ore deposits in the Pilbara (O'Brien and Associates 1992). This group forms the Hamersley Range and Plateau and consists of jaspilite and dolomite. The jaspilite produces deposits of haematite and limonite, which are mined for iron ore.

The surface geology of the study area is dominated by the following geological formations (Tyler, Hunter and Williams 1991) (Figure 2):

- Fj, Fjb and Fd: Jeerinah Formation: interbedded shale, chert, sandstone, minor felsic tuff;
- Hm: Marra Mamba Iron Formation: chert, ferruginous chert, minor shale;
- Qa: Alluvium: unconsolidated silt, sand, and gravel; in drainage channels and on adjacent floodplains;
- Qw: Colluvium and alluvium: red-brown sandy and clayey soil; on low slopes and sheetwash areas;
- Qc: Colluvium: unconsolidated quartz and rock fragments in soil; locally derived soil, and scree, and talus deposits; and
- Czir: Hematite: goethite deposits on banded iron-formation and adjacent scree deposits.



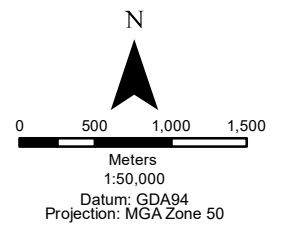
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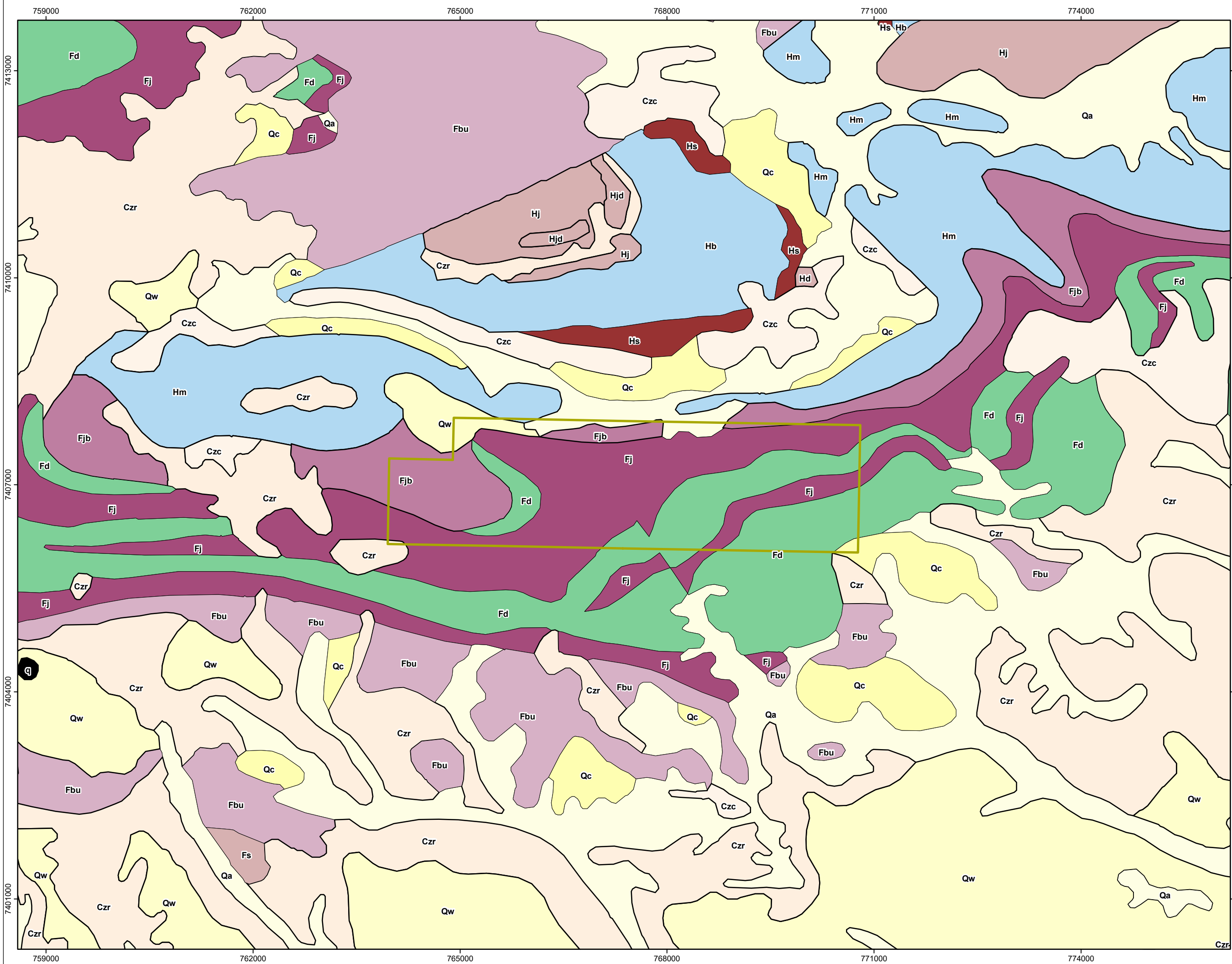
Figure 2
Geology

Legend

- Study Area
- Surface Geology
 - Qa
 - Qw
 - Qc
 - Czc
 - Czr
 - q
 - Hj
 - Hjd
 - Hb
 - Hs
 - Hd
 - Hm
 - Fd
 - Fj
 - Fjb
 - Fbu
 - Fs



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1.9 Hydrology

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

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

1.10 Flora and Vegetation

The study area situated in the Hamersley Plateau, which forms part of the Fortescue Botanical District of the Eremaean Province (Beard 1990). The vegetation of this province is typically open, and dominated by spinifex, wattles and occasional eucalypts.

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

- 18: Low woodland; mulga (*Acacia aneura*); and
- 82: Hummock grasslands, low tree steppe; Snappy gum over *Triodia wiseana*.

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

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

Vegetation Association	Description	Pre-Euro. Extent Remaining (ha)	Remaining area (ha) in IUCN Class I-IV Reserves	% remaining Other Reserves	% remaining DBCA Managed PL
18	Low woodland; mulga (<i>Acacia aneura</i>)	24,659,110 (99.9%)	2.0	0.3	2.5
82	Hummock grasslands, low tree steppe; Snappy gum over <i>Triodia wiseana</i>	2,290,910 (100%)	8.9	0.2	1.0



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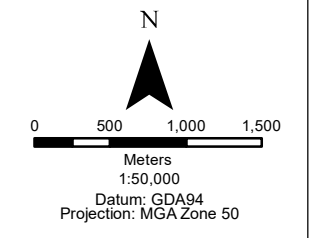
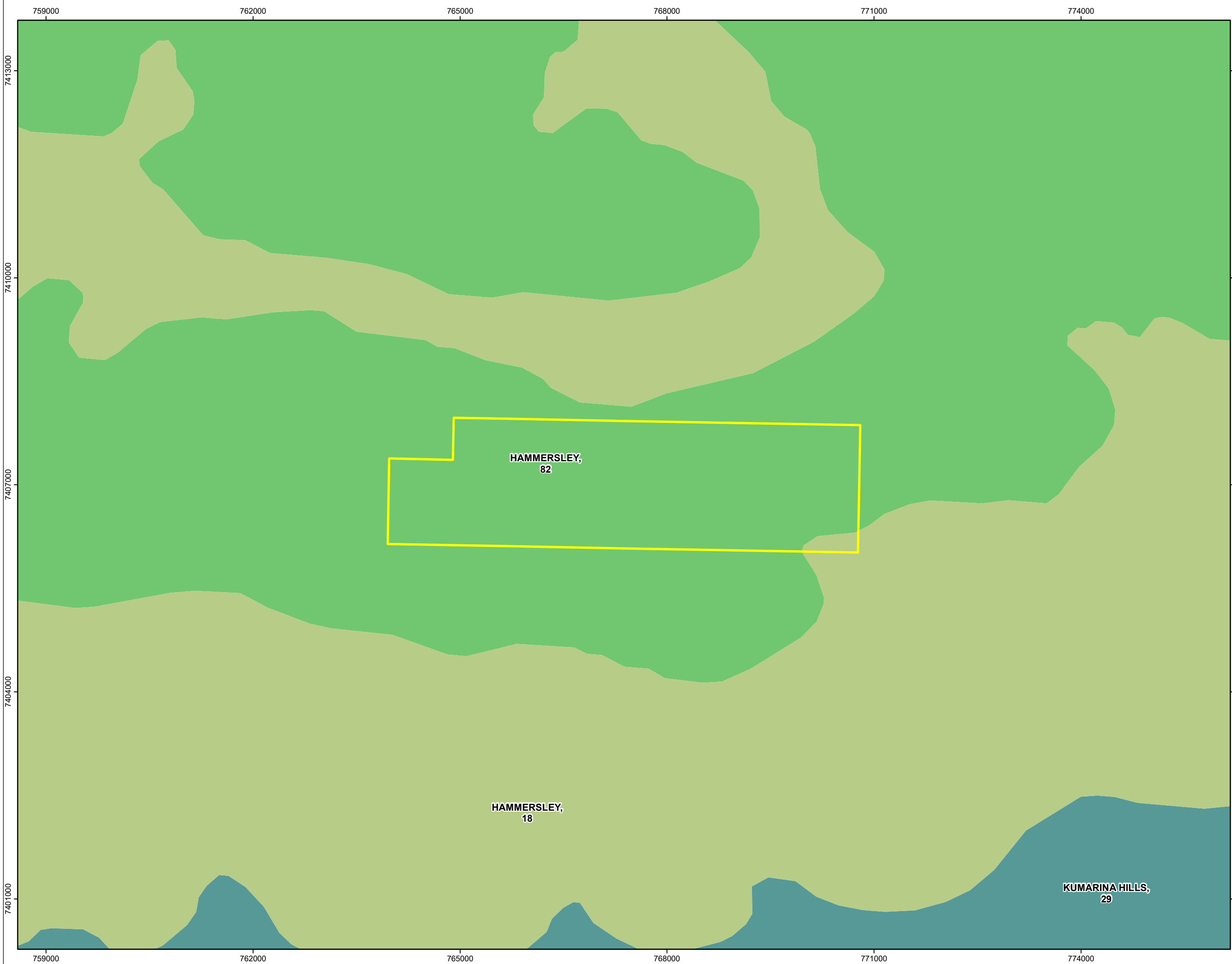
**Figure 3
Beard (1975) vegetation
complexes within the
study area**

Legend

Study

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

- HAMMERSLEY, 18
- HAMMERSLEY, 82
- KUMARINA HILLS, 29



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1.11 Land Systems

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

A total of 102 land systems were defined in the Pilbara at a scale of 1: 250,000 (Van Vreeswyk *et al.* 2004), four of which occur within the study area (Table 2, Figure 4). The study area is dominated by the low hills and stony plains of the Rocklea Land System, with only minor sections of the study area covering the Boolgeeda, Elimunna and Newman Land Systems (Figure 4).

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

Land System	Representation in the Pilbara	Description
Boolgeeda	7,748 km ² or 4.3%	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands.
Elimunna	617 km ² or 0.3%	Stony plains on basalt supporting sparse <i>Acacia</i> and <i>Cassia</i> shrublands and patchy tussock grasslands.
Newman	14,580 km ² or 8.0%	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.
Rocklea	22,993 km ² or 12.7%	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grassland.



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Western Ridge E52 - 3448

Figure 4

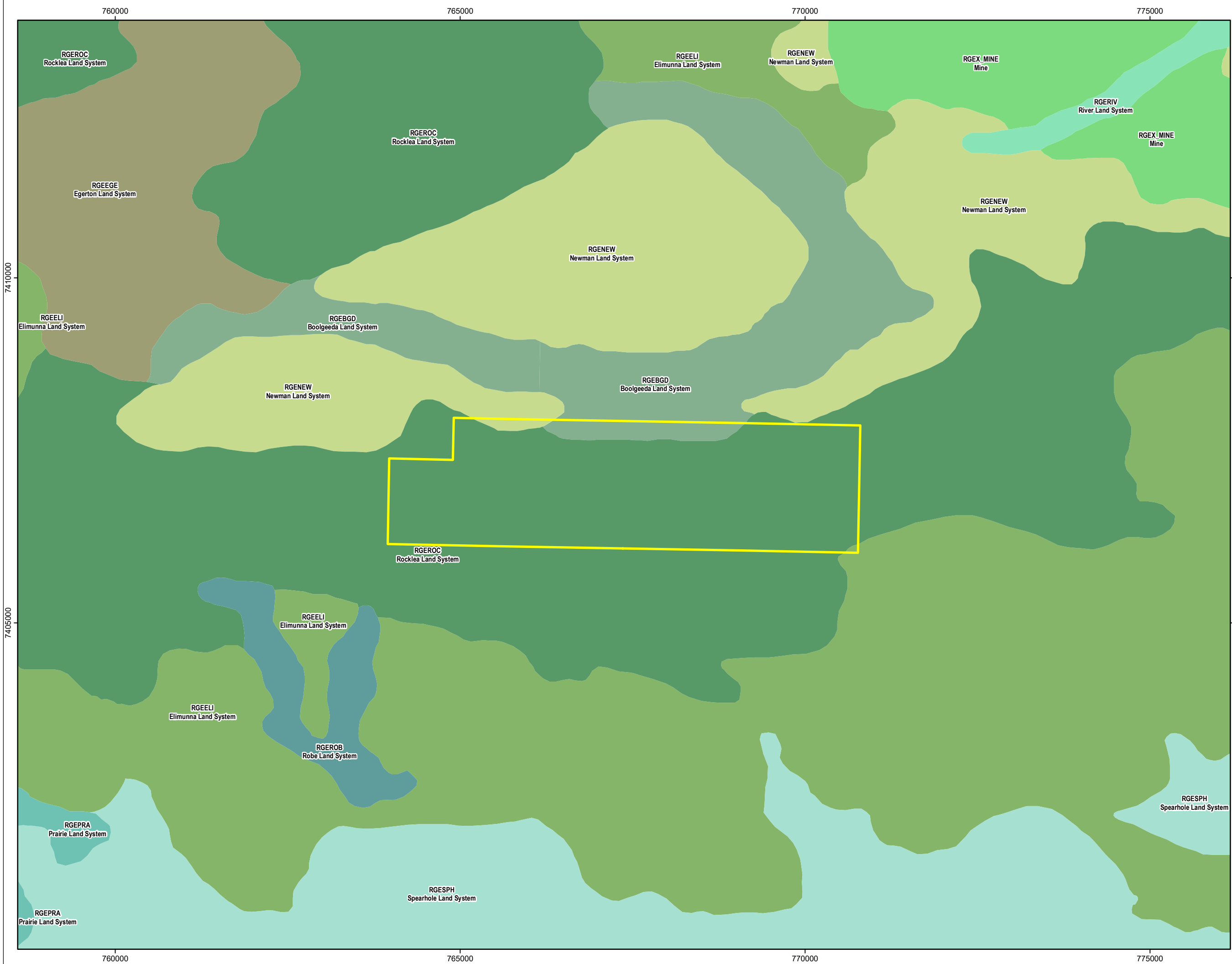
Land systems occurring
within the study area
(descriptions from van
Vreeswyk et al. 2004)

Legend

Study

Land Systems (within)

- RGEBGD, Boolgeeda Land System
- RGEEGE, Egerton Land
- RGEELI, Elimunna Land System
- RGENEW, Newman Land System
- RGEPPRA, Prairie Land
- RGERIV, River Land System
- RGEROB, Robe Land System
- RGEROC, Rocklea Land System
- RGESPH, Spearhole Land System
- RGENEW, Mine



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2.0 METHODOLOGY

2.1 Legislation and Guidance Statements

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

- Statement of Environmental Principles, Factors and Objectives (EPA 2016a);
- Environmental Factor Guideline Flora and Vegetation (EPA 2016b);
- Environmental Factor Guideline Terrestrial Fauna (EPA 2016c);
- Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016d);
- Technical Guidance Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2016e);
- Technical Guidance Terrestrial Fauna Surveys (EPA 2016f); and
- Technical Guidance Sampling of Short Range Endemic Invertebrate Fauna (EPA 2016g).

The survey was also conducted in accordance with the following BHP's procedures:

- Vegetation and Flora Survey Procedure (BHP WAIO 2018);
- Guidance for Terrestrial Vertebrate Fauna Surveys in the Pilbara Procedure (BHP WAIO 2017a); and
- Short-range Endemic Invertebrate Fauna Assessment Methods Procedure (BHP WAIO 2017b).

2.2 Desktop Assessment

2.2.1 Literature Review

A comprehensive literature review of surveys previously completed within or in close proximity to the study area was completed. At least 44 baseline biological surveys (i.e. surveys covering flora, vegetation, vertebrate fauna and SRE invertebrate fauna) have been completed at BHP WAIO tenements within a 25 km radius of the study area.

2.2.2 Database Searches

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

- NatureMap1: This database represents the most comprehensive source of information on the distribution of Western Australia's flora and fauna, comprising records from the DBCA database, and the WA Herbarium Specimen Database (25 km radial search, accessed 13 July 2018) (DPaW 2018);
- DBCA's Threatened Flora Database was searched to confirm the NatureMap results (50 km radial search, accessed 27 July 2018) (DBCA 2018a);
- DBCA's Threatened Fauna Database was searched to confirm the NatureMap results (100 km radial search, accessed 27 July 2018) (DBCA 2018b);
- DBCA's TEC, PEC and Environmentally Sensitive Areas (ESAs) database was searched to identify significant communities (50 km radial search, accessed 1 August 2018) (DBCA 2018c);

- WA Museum (WAM) databases (140km by 140km search area) for Arachnida/ Myriapoda (accessed 23 July 2018), Mollusca (accessed 25 July 2018), Crustacea (accessed 25 July 2018) (WAM 2018a);
- Atlas of Living Australia (ALA) database (accessed 14 August 2018) (ALA 2018);
- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) Protected Matters database (50 km radial search, accessed 13 July 2018) (DoEE 2018b);
- International Union for Conservation of Nature (IUCN) database (accessed 13 July 2018) (IUCN 2018); and
- BHP Billiton Iron Ore's database was searched to identify records of significant flora species, significant vertebrate fauna species and Confirmed or Potential SRE invertebrate fauna species known to be in close proximity of the study area (30 km radial search, accessed 25 July 2018).

2.2.3 Assessment of Conservation Significance

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

International Level:

- IUCN: The IUCN 'Red List' lists species at risk under nine categories (status codes) (Appendix 1).
- International Conventions: Migratory taxa listed under the Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), and Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Commonwealth Level:

- EPBC Act: The DoEE lists Threatened flora, fauna and ecological communities, which are determined by the Threatened Species Scientific Committee according to criteria set out in the Act. The Act lists flora that are considered to be of conservation significance under one of six categories (Appendix 2).

State Level:

- Wildlife and Conservation Act 1950 (WC Act): At a State level, native flora and fauna species are protected under the *WC Act – Wildlife Conservation Notice*. A number of species are assigned an additional level of conservation significance based on a limited number of known populations and the perceived threats to these locations (Appendix 3).
- DBCA Priority list: DBCA produces a list of Priority species and ecological communities that have not been assigned statutory protection under the WC Act. Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added under Priorities 1, 2 or 3. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been removed from the threatened species list for other taxonomic reasons, are placed in Priority 4. These species require regular monitoring (see Appendix 4). The list of PECs identifies those that need further investigation before nomination for TEC status at a State level.

Local Level:

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

The significance of SRE invertebrate fauna is classified based on the WAM SRE categories released in 2013 (Table 3).

Table 3 Western Australian Museum (WAM) categories.

	Taxonomic Certainty	Taxonomic Uncertainty
Distribution < 10,000 km ²	<p>Confirmed SRE</p> <ul style="list-style-type: none"> • A known distribution of < 10,000 km². • The taxonomy is well known. • The group is well represented in collections and/ or via comprehensive sampling. 	<p>Potential SRE</p> <ul style="list-style-type: none"> • Patchy sampling has resulted in incomplete knowledge of geographic distribution. • Incomplete taxonomic knowledge. • The group is not well represented in collections. • Category applies where there are significant knowledge gaps.
Distribution > 10,000 km ²	<p>Widespread (not SRE)</p> <ul style="list-style-type: none"> • A known distribution of > 10,000 km². • The taxonomy is well known. • The group is well represented in collections and/ or via comprehensive sampling. 	

Taxa classified as Potential SRE as allocated one or more sub-category identifying the reason/s why they have been classified as a Potential SRE:

- A) Data Deficient;
- B) Habitat Indicators;
- C) Morphology Indicators;
- D) Molecular Evidence; and
- E) Research and Expertise.

2.2.4 Assessment of Likelihood of Occurrence in the Study Area

A list of conservation significant flora and fauna species occurring within a 50 km radius of the study area was compiled during the literature review and database searches. The likelihood of each taxon occurring within the study area was assessed using a set of rankings and criteria (as described in Table 4). The criteria are based on presence of suitable landform (inferred from aerial imagery with contours overlaid, and from knowledge of the adjacent areas) and distance to known records.

Table 4 Ranking system used to assign the likelihood that a flora or fauna species would occur in the study area.

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

2.3 Vegetation and Habitat Mapping

2.3.1 Land Unit Mapping

Land system mapping has been completed across the entire Pilbara bioregion at a scale of 1:250,000 (Van Vreeswyk *et al.* 2004). There are four land systems represented within the study area. The land system boundaries were overlaid on high resolution aerial photography at a scale of 1:5,000 along with AHD (Australian Height Datum) contours at 2 m intervals, to form the base maps from which to undertake desktop land unit mapping. A total of two base map sheets were required to cover the entire study area.

Land systems are further classified into land units based on the landform, soil and vegetation interactions, as described by Van Vreeswyk *et al.* (2004). The land units occurring within each land system are broadly described according to landform, soil, vegetation, and representation (as a percentage of the total land system area) (Van Vreeswyk *et al.* 2004). However, the distribution of land units within the Pilbara has not previously been mapped.

Within each broad land system polygon represented within the study area, fine scale boundaries were hand drawn to delineate land units. The land units were identified using a combination of shading patterns and colours evident from the high resolution aerial photography, inference of landform (relief and slope), position in landscape, drainage pattern, and field knowledge from the experienced Principal Botanist undertaking the mapping. Following completion of line work, each of the base map sheets was scanned, georeferenced, and the land unit line work digitised and rectified in a Geographic Information System (GIS). Each land unit polygon digitised was then attributed with a specific land unit code.

For each of the land units, vegetation association descriptions were linked to broad 'site type'¹ descriptions made by Van Vreeswyk *et al.* (2004). The site type descriptions were then aligned to vegetation associations from BHP WAIO's Pilbara consolidated vegetation mapping data.

2.3.2 Vegetation Association Mapping

The vegetation mapping utilised the land unit mapping polygons overlaid on high-resolution aerial photography at a scale of 1:5,000, from which there was finer scale delineation of vegetation association polygons based on contrasting shading patterns evident from the aerial photography.

Previous vegetation association mapping completed at the Orebody 35 (GHD 2011), Western Ridge (Onshore Environmental 2014a and 2016) and Mt Whaleback (Onshore Environmental 2013) project areas were used to provide vegetation association descriptions for individual polygons defined. Descriptions of vegetation structure follows the height, life form and density classes of Specht (1970) as modified by Aplin (1979) and Trudgen (2002) (see Appendix 5). This is largely a structural classification suitable for broader scale mapping, but taking all ecologically significant strata into account.

A vegetation association code was applied to each vegetation association. This code is comprised of the dominate landform on which the vegetation association occurs and the dominant plant taxa in each vegetation stratum.

2.3.3 Fauna Habitat Mapping

Land unit and vegetation association mapping was utilised to identify and map fauna habitats of

¹ The interrelationships between the physical environment and the plant communities it supports were described by classifying sampling points (inventory sites) into site types. A total of 44 site types were described within the Pilbara bioregion in terms of the particular combination of land surface, dominant plant species, and vegetation formation.

the study area, with a focus given to attributes such as landform, soil type and vegetation cover. Previous fauna habitat mapping completed at the Orebody 35 (Biologic Environmental Survey 2013), Western Ridge (Onshore Environmental 2014a; Biologic Environmental Survey 2016a) and Mt Whaleback (Biologic Environmental Survey 2013) project areas were used to further classify and describe the habitats of the study area.

2.4 Survey Limitations

The EPA Technical Guidance (EPA 2016d, EPA 2016e, EPA 2016f, EPA2016g) discuss potential limitations that surveys may encounter. Constraints that are relevant to this desktop assessment are addressed in Table 5.

Table 5 Relevant limitations (as identified by the EPA) to the desktop assessment.

Constraint	Relevance
Availability of contextual information at a regional and local scale	Forty-four (44) previous biological surveys occur within a 25 km radius of the study area, with surveys having been completed directly adjacent to the study area on the western, northern and eastern boundaries, providing an extensive local database.
Was the appropriate area fully surveyed (effort and extent)	The entire study area was assessed and mapped, with database searches extending beyond the study area boundaries to provide regional context for results. All allocated tasks detailed in the scope of works were achieved during the desktop assessment.
Competency/experience of the team carrying out the survey, including experience in the bioregion surveyed	The Principal Botanist working on the assessment has over 20 years Pilbara experience; the Senior Botanist has in excess of seven years Pilbara experience; the Senior Zoologist and Senior Environmental Advisor both have over 12 years Pilbara experience. The team has completed numerous baseline surveys and desktop assessments adjacent and in close proximity to the study area over recent years.

3.0 RESULTS

3.1 Literature Review

The flora and vegetation of the Pilbara has been assessed at a broad scale by Burbidge (1959) and Beard (1975). More recently, the Department of Agriculture completed an inventory and condition survey of the Pilbara based on land system mapping (Van Vreeswyk *et al.* 2004). More specific data has been collected as part of DBCA's Pilbara Region Biological Survey 2002-2013. This dataset has recently been published (WAM 2018b) and will provide added regional context that will benefit impact assessment for future development proposals within the Pilbara.

In addition to the larger broad scale surveys, an increasing number of smaller intensive surveys have been completed in recent years associated with resource development projects. These surveys have resulted in the collection of a significant amount of site-specific biological survey data, most of which has been undertaken for formal environmental impact assessment.

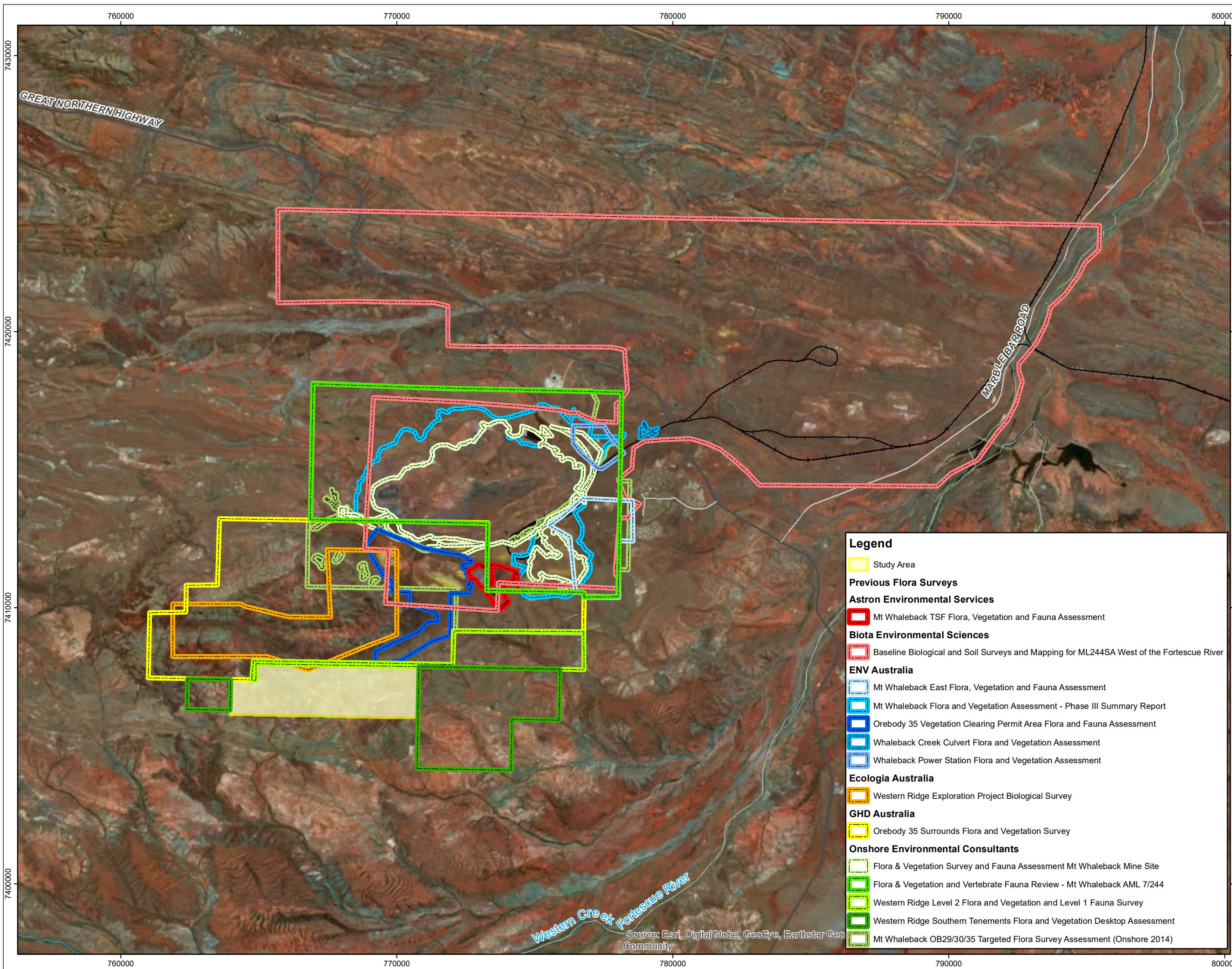
There are 44 relevant biological surveys that have been completed within a 25 km radius of the study area. This includes 37 surveys relating to flora and vegetation, 15 surveys relating to vertebrate fauna and three surveys relating to SRE invertebrate fauna. These surveys are described in Appendix 6.

None of the previous biological surveys overlap the study area. The closest previous surveys include:

- Desktop assessment and mapping of BHP WAIO's Western Ridge southern exploration tenements E52/3360 and E52/3361, located directly west and east of the study area (Onshore Environmental 2016, Biologic Environmental Survey 2016a and 2016b);
- Surveying of BHP WAIO's Western Ridge tenement E52/2008 that adjoins the northern boundary of the study area (Onshore Environmental 2014a); and
- Surveying of BHP WAIO's Western Ridge and Orebody 35 project area located immediately north of the study area (GHD 2011, Biologic Environmental Survey 2011, ENV 2010, Ecologia 2005 and 2006, ABMS 2011).

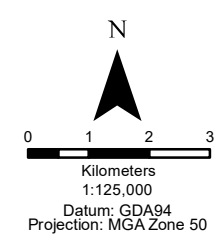
Other nearby surveys have been completed immediately to the north-west at Orebody 35 and surrounding the Mt Whaleback Mine immediately north of the study area (Appendix 6). Those surveys completed closest to the study area as well as larger surveys which provide relevant local context have been mapped for flora and vegetation, vertebrate fauna and SRE invertebrate fauna on Figures 5, 6 and 7, respectively.

Additional vegetation mapping was completed adjacent the study area by Onshore Environmental in 2013 as part of a regional consolidation of vegetation mapping (Onshore Environmental 2014b).

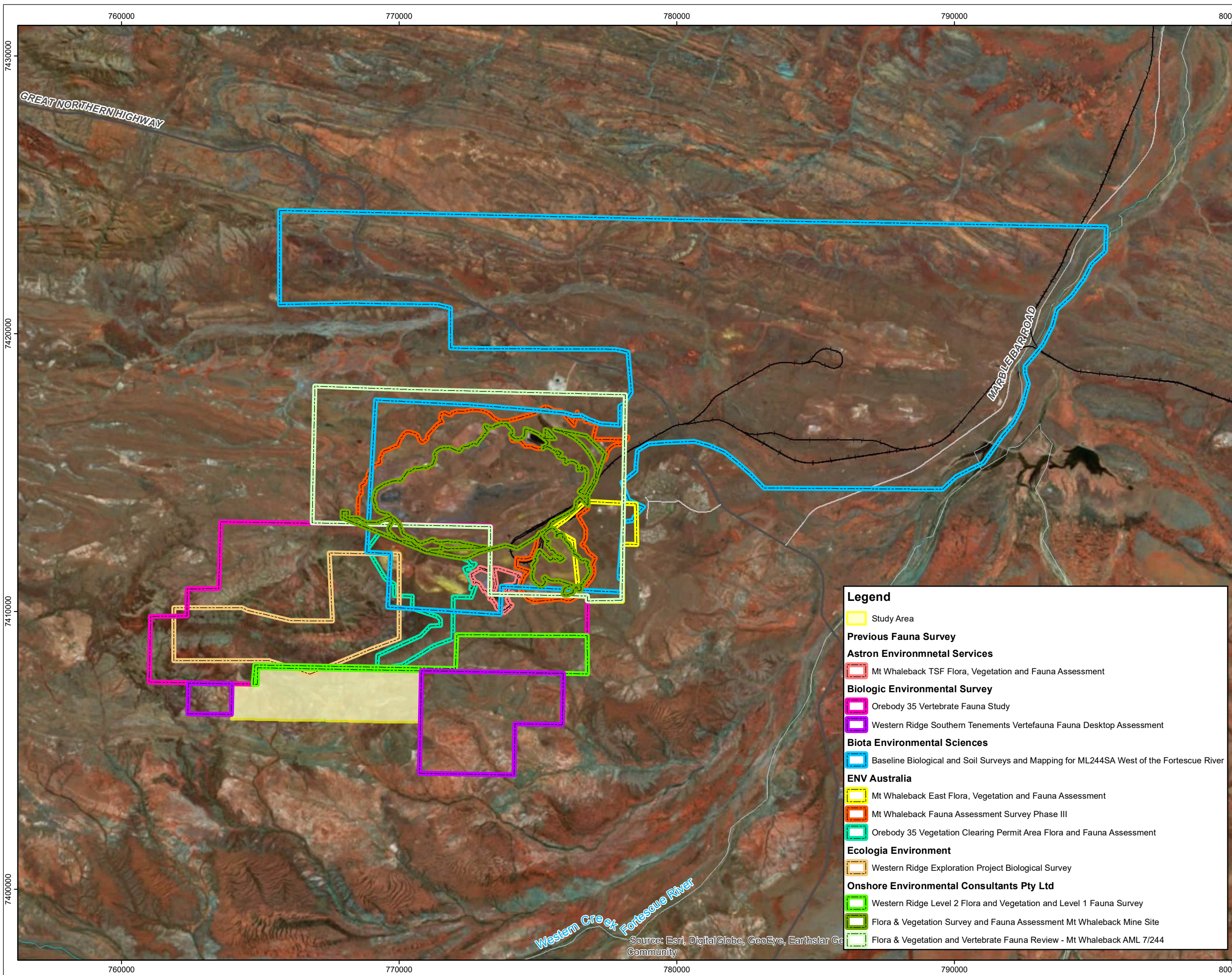


Legend

- Study Area
- Previous Flora Surveys**
- Astron Environmental Services**
- Mt Whaleback TSF Flora, Vegetation and Fauna Assessment
- Biota Environmental Sciences**
- Baseline Biological and Soil Surveys and Mapping for ML244SA West of the Fortescue River
- ENV Australia**
- Mt Whaleback East Flora, Vegetation and Fauna Assessment
- Mt Whaleback Flora and Vegetation Assessment - Phase III Summary Report
- Orebody 35 Vegetation Clearing Permit Area Flora and Fauna Assessment
- Whaleback Creek Culvert Flora and Vegetation Assessment
- Whaleback Power Station Flora and Vegetation Assessment
- Ecologia Australia**
- Western Ridge Exploration Project Biological Survey
- GHD Australia**
- Orebody 35 Surrounds Flora and Vegetation Survey
- Onshore Environmental Consultants**
- Flora & Vegetation Survey and Fauna Assessment Mt Whaleback Mine Site
- Flora & Vegetation and Vertebrate Fauna Review - Mt Whaleback AML 7/244
- Western Ridge Level 2 Flora and Vegetation and Level 1 Fauna Survey
- Western Ridge Southern Tenements Flora and Vegetation Desktop Assessment
- Mt Whaleback OB29/30/35 Targeted Flora Survey Assessment (Onshore 2014)

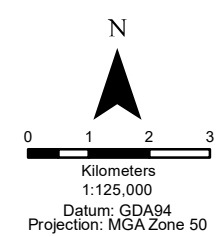


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- Study Area
- Previous Fauna Survey**
- Astron Environmental Services**
- Mt Whaleback TSF Flora, Vegetation and Fauna Assessment
- Biologic Environmental Survey**
- Orebody 35 Vertebrate Fauna Study
- Western Ridge Southern Tenements Vertebrate Fauna Desktop Assessment
- Biota Environmental Sciences**
- Baseline Biological and Soil Surveys and Mapping for ML244SA West of the Fortescue River
- ENV Australia**
- Mt Whaleback East Flora, Vegetation and Fauna Assessment
- Mt Whaleback Fauna Assessment Survey Phase III
- Orebody 35 Vegetation Clearing Permit Area Flora and Fauna Assessment
- Ecologia Environment**
- Western Ridge Exploration Project Biological Survey
- Onshore Environmental Consultants Pty Ltd**
- Western Ridge Level 2 Flora and Vegetation and Level 1 Fauna Survey
- Flora & Vegetation Survey and Fauna Assessment Mt Whaleback Mine Site
- Flora & Vegetation and Vertebrate Fauna Review - Mt Whaleback AML 7/244



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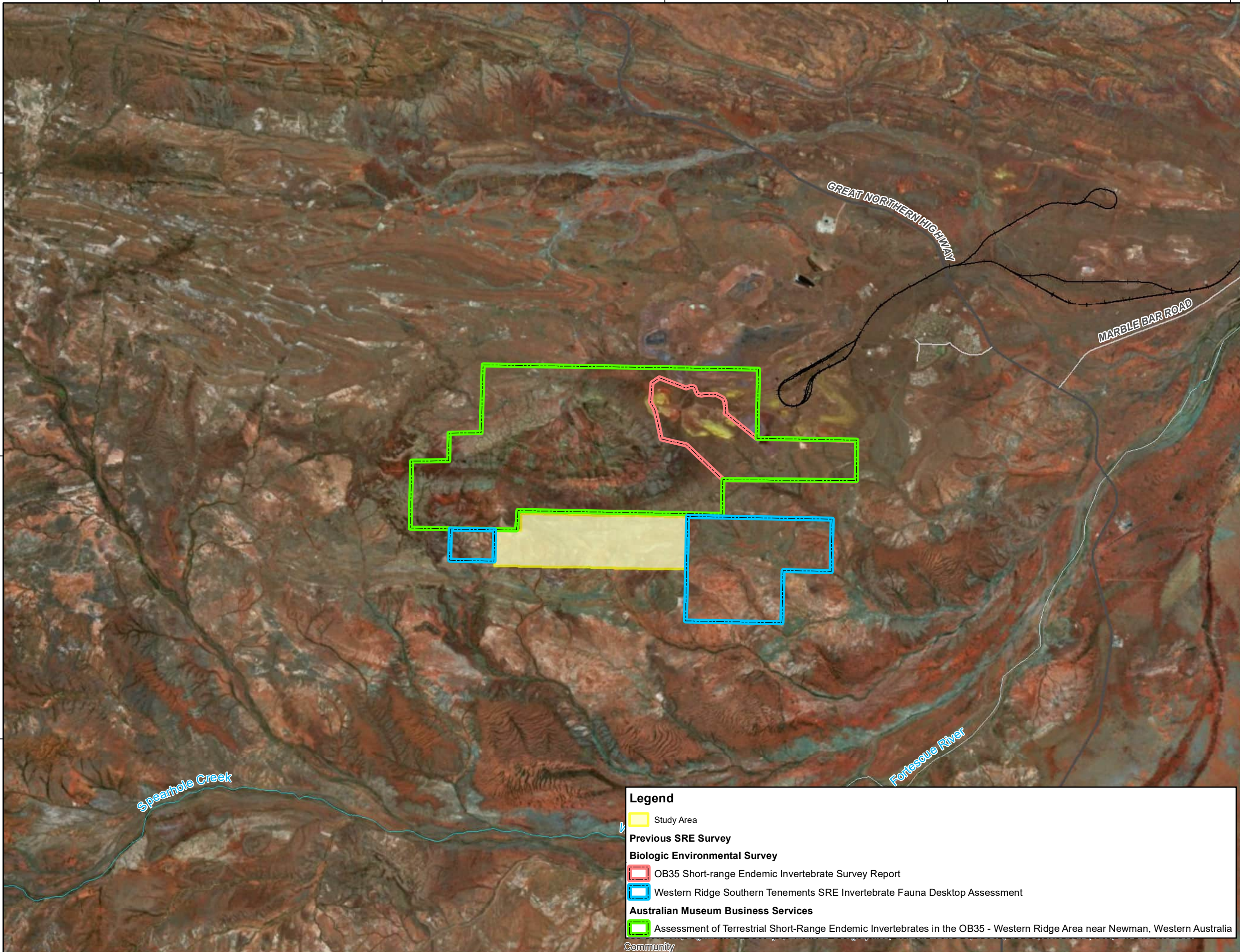
Western Ridge
E52 - 3448

Figure 7

Previous Surveys
SRE

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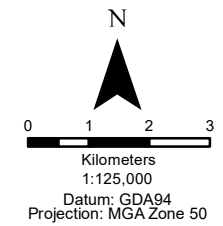
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Legend

- Study Area
- Previous SRE Survey**
- Biologic Environmental Survey**
- OB35 Short-range Endemic Invertebrate Survey Report
- Western Ridge Southern Tenements SRE Invertebrate Fauna Desktop Assessment
- Australian Museum Business Services**
- Assessment of Terrestrial Short-Range Endemic Invertebrates in the OB35 - Western Ridge Area near Newman, Western Australia

Community



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3.2 Database Searches

3.2.1 Flora Species

Threatened Flora listed under the EPBC Act

A search of the EPBC Act Protected Matters database was undertaken for a 50 km buffer around the study area (DoEE 2018b). The database search listed one Threatened Flora or its habitat as likely to occur within the search radius; *Pityrodia augustensis* (Mt Augustus Foxglove).

Threatened Flora listed under the IUCN Red List

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

Threatened Flora listed under the WC Act

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

Priority Flora recognised by the DBCA

The DBCA rare flora database search (DBCA 2018a) identified 35 Priority flora taxa as potentially occurring within a 50 km radius of the study area. The NatureMap search (DPaW 2018) identified 11 Priority flora as potentially occurring within a 25 km radius, one of which was not identified in the DBCA rare flora database search. These taxa are:

- *Acacia bromilowiana* (Priority 4);
- *Acacia* sp. East Fortescue (J. Bull & D. Roberts ONS A 27.01) (Priority 1);
- *Acacia subtiliformis* (Priority 3);
- *Aristida jerichoensis* var. *subspinulifera* (Priority 3);
- *Aristida lazaridis* (Priority 2);
- *Calotis latiuscula* (Priority 3);
- *Crotalaria smithiana* (Priority 3);
- *Dampiera metallorum* (Priority 3);
- *Eremophila magnifica* subsp. *magnifica* (Priority 4);
- *Eremophila magnifica* subsp. *velutina* (Priority 3);
- *Eremophila rhexos* (Priority 1);
- *Eremophila rigida* (Priority 3);
- *Eremophila* sp. Hamersley Range (K. Walker KW 136) (Priority 1);
- *Eremophila* sp. West Angelas (S. van Leeuwen 4068) (Priority 1);
- *Eremophila youngii* subsp. *lepidota* (Priority 4);
- *Euphorbia inappendiculata* var. *inappendiculata* (Priority 2);
- *Goodenia berringbinensis* (Priority 4);
- *Goodenia hartiana* (Priority 2);
- *Goodenia nuda* (Priority 4);
- *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727) (Priority 3);
- *Gymnanthera cunninghamii* (Priority 3);
- *Hibiscus* sp. Gurinbiddy Range (M.E. Trudgen MET 15708) (Priority 2);
- *Hibiscus campanulatus* (Priority 1);
- *Indigofera gilesii* (Priority 3);
- *Ipomoea racemigera* (Priority 2);
- *Isotropis parviflora* (Priority 2);
- *Lepidium catapycnon* (Priority 4);

- *Maireana prosthecochoeta* (Priority 3);
- *Oxalis* sp. Pilbara (M.E. Trudgen 12725) (Priority 2);
- *Rhagodia* sp. Hamersley (M. Trudgen 17794) (Priority 3);
- *Sida* sp. Barlee Range (S. van Leeuwen 1642) (Priority 3);
- *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (Priority 3);
- *Triodia* sp. Mt Ella (M.E. Trudgen 12739) (Priority 3);
- *Vittadinia* sp. Coondewanna Flats (S. van Leeuwen 4684) (Priority 1); and
- *Xerochrysum boreale* (Priority 3).

3.2.2 Vertebrate Fauna Species

Threatened Fauna listed under the EPBC Act

A search of the EPBC Act Protected Matters database was undertaken for a 50 km buffer around the study area (DoEE 2018b). The database search listed nine Threatened fauna species, or species habitat, that may occur in the study area:

Mammals:

- Northern Quoll (*Dasyurus hallucatus*) – listed as Endangered;
- Greater Bilby (*Macrotis lagotis*) – listed as Vulnerable;
- Pilbara Leaf-nosed Bat (*Rhinonictis aurantia*) – listed as Vulnerable;
- Ghost Bat (*Macroderma gigas*) – listed as Vulnerable;

Reptiles:

- Pilbara Olive Python (*Liasis olivaceus barroni*) – listed as Vulnerable;

Birds:

- Australian Painted Snipe (*Rostratula australis*) – listed as Endangered;
- Curlew Sandpiper (*Calidris ferruginea*) – listed as Critically Endangered;
- Night Parrot (*Pezoporus occidentalis*) – listed as Endangered; and
- Princess Parrot (*Polytelis alexandrae*) – listed as Vulnerable.

The database search also identified nine Migratory bird species, or species habitat, that may occur in the study area:

- Barn Swallow (*Hirundo rustica*);
- Common Sandpiper (*Actitis hypoleucos*);
- Curlew Sandpiper (*Calidris ferruginea*);
- Fork-tailed Swift (*Apus pacificus*);
- Grey Wagtail (*Motacilla cinerea*);
- Oriental Plover (*Charadrius veredus*);
- Pectoral Sandpiper (*Calidris melanotos*);
- Sharp-tailed Sandpiper (*Calidris acuminata*); and
- Yellow Wagtail (*Motacilla flava*).

Threatened Fauna listed under the IUCN Red List

A search of the International Union for Conservation of Nature (IUCN) database (IUCN 2018) determined that two Threatened Fauna species had a distribution in the vicinity of the study area:

- Greater Bilby (*Macrotis lagotis*) – listed as Vulnerable; and
- Ghost Bat (*Macroderma gigas*) – listed as Vulnerable.

Threatened Fauna listed under the WC Act

The DBCA Rare Fauna database search (DBCA 2018b) and NatureMap search (DPaW 2018) identified 16 species listed as Scheduled species under the WC Act from a 50 km radius around the study area:

Mammals:

- Northern Quoll (*Dasyurus hallucatus*) – listed as Schedule 2;
- Greater Bilby (*Macrotis lagotis*) – listed as Schedule 3;
- Black-flanked Rock Wallaby (*Petrogale lateralis lateralis*) – listed as Schedule 2;
- Pilbara Leaf-nosed Bat (*Rhinonictoris aurantia*) – listed as Schedule 3;
- Ghost Bat (*Macroderma gigas*) – listed as Schedule 3;

Reptiles:

- Pilbara Olive Python (*Liasis olivaceus barroni*) – listed as Schedule 3;

Birds:

- Glossy Ibis (*Plegadis falcinellus*) – listed as Schedule 5;
- Common Greenshank (*Tringa nebularia*) – listed as Schedule 5;
- Wood Sandpiper (*Tringa glareola*) – listed as Schedule 5;
- Common Redshank (*Tringa totanus*) – listed as Schedule 5;
- Common Sandpiper (*Actitis hypoleucos*) – listed as Schedule 5;
- Long-toed Stint (*Calidris subminuta*) – listed as Schedule 5;
- Pectoral Sandpiper (*Calidris melanotos*) – listed as Schedule 5;
- Sharp-tailed Sandpiper (*Calidris acuminata*) – listed as Schedule 5;
- Grey Falcon (*Falco hypoleucos*) – listed as Schedule 3; and
- Peregrine Falcon (*Falco peregrinus*) – listed as Schedule 7.

Priority Fauna recognised by the DBCA

The DBCA Rare Fauna database search (DBCA 2018b) and NatureMap search (DPaW 2018) identified five Priority fauna species as potentially occurring within a 50 km radius of the study area:

Mammals:

- Long-tailed Dunnart (*Sminthopsis longicaudata*) – listed as Priority 4;
- Spectacled Hare-wallaby (*Lagorchestes conspicillatus*) – listed as Priority 4;
- Western Pebble-mound Mouse (*Pseudomys chapmani*) – listed as Priority 4;

Reptiles:

- Unpatterned robust slider skink (*Lerista macropisthopus* subsp. *remota*) – listed as Priority 2; and
- Gane's blind snake (*Anilius ganei*) – listed as Priority 1.

3.2.3 SRE Invertebrate Fauna Species

SRE Invertebrate Fauna Species recognised by the WAM

The WAM Mollusca database contained five records of SRE molluscs known to occur within the search area:

- Gen. nov. 'Mount Robinson' n.sp. (Family, Camaenidae);
- *Discocharopa* sp.;
- *Austropeplea vinosa*;
- *Leichhardtia sisurnius*; and
- *Leichhardtia* cf. *sisurnius*.

The WAM Arachnida/ Myriapoda database contained nine SRE records within the search area:

- *Austrochthonius* sp.;
- *Beierolpium* sp. 8/2;
- *Beierolpium* sp. 8/3;
- *Euryolpium* sp.;
- *Indolpium* sp.;
- *Synothele* sp. indet. (juvenile);
- *Tyrannochthonius aridus*;
- *Unixenus* sp.; and

- *Urodacus* sp. 'pilbara 12'.

The WAM Crustacea database contained 10 terrestrial SRE records within the search area:

- *Acanthodillo* sp. 'won1';
- *Buddelundia* sp. 14cr;
- *Buddelundia* sp. 49;
- *Buddelundia* sp.;
- *Spherillo* sp. 3;
- *Troglarmadillo* sp. A;
- *Troglarmadillo* sp. ISO005;
- *Troglarmadillo* sp. 'DNA03';
- *Laevophiloscia* sp. 'Wonmunna A'; and
- *Laevophiloscia* sp. 'Wonmunna B'.

SRE Invertebrate Fauna Species recognised by DBCA

A review of the NatureMap database contained no SRE invertebrate fauna species recorded within a 40 km radius, in addition to those listed from the WAM databases.

SRE Invertebrate Fauna Species Atlas of Living Australia

A review of the Atlas of Living Australia database contained no additional SRE invertebrate fauna species to those listed from the WAM databases.

3.2.4 Ecological Communities

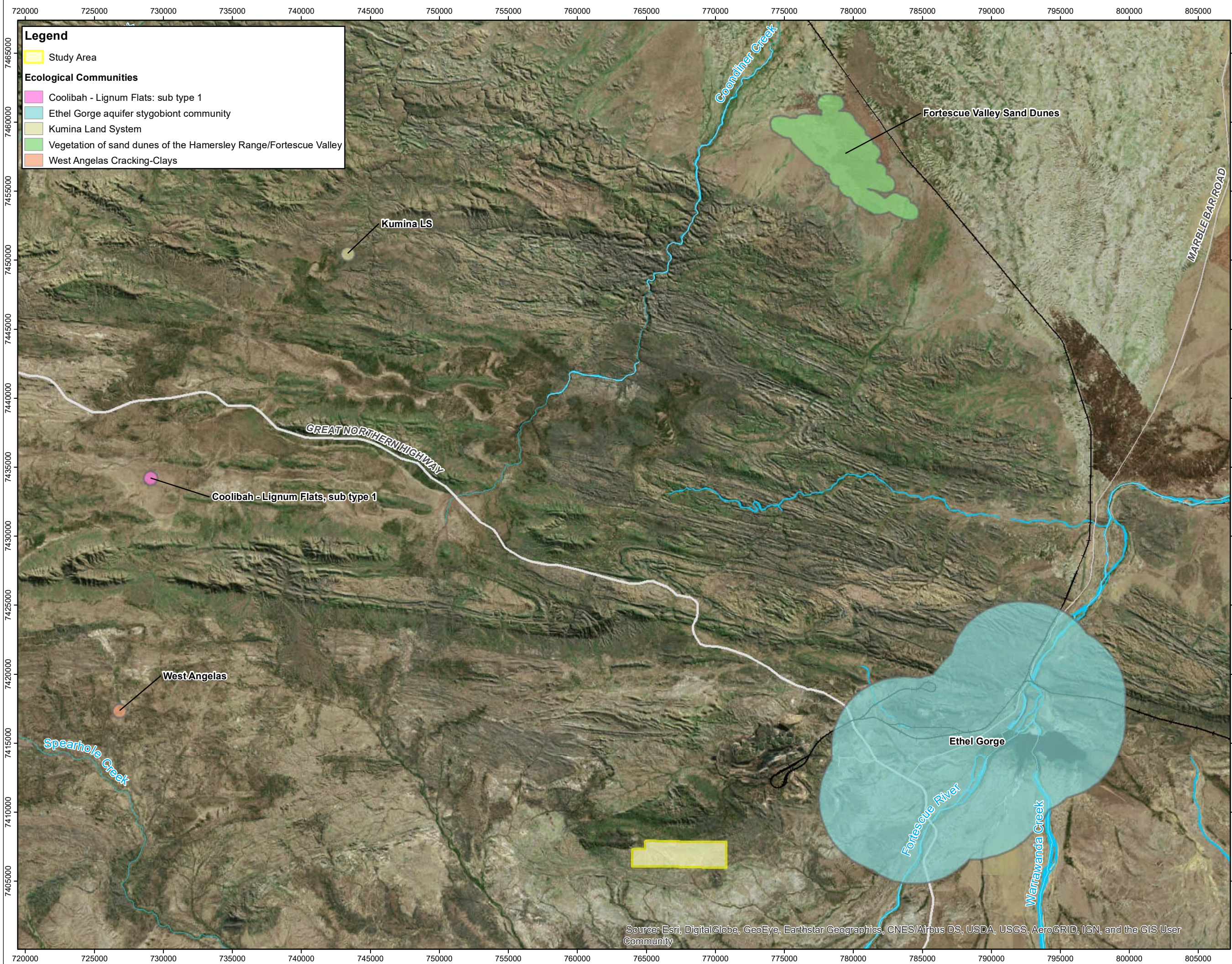
TECs listed under State and Federal Legislation

A search of the EPBC Act Protected Matters database (DoEE 2018b) confirmed there were no Federal listed TECs previously recorded within, or adjacent to, the study area. The nearest known TEC is the Endangered '*Ethel Gorge aquifer stygobiont community*' located approximately 25 km west of the study area (Figure 8).

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

PECs recognised by DBCA

A search of the State database (DBCA 2018b) confirmed there were no PECs within a 25 km radius of the study area.



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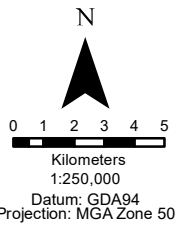
- Study Area

Ecological Communities

- Coolibah - Lignum Flats: sub type 1
- Ethel Gorge aquifer stygobiont community
- Kumina Land System
- Vegetation of sand dunes of the Hamersley Range/Fortescue Valley
- West Angelas Cracking-Clays



BHP
Western Ridge
E52 - 3448
Figure 8
Locations of
Ecological
Communities



Date: 19/11/2018
 Status: Final
 Figure: 8
 Sheet Size: A3
 Internal Reference: WR_Con_TEC
 Drawn by: GSM
 Requested by: DB



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

3.3 Land Unit Mapping

There were eleven land units defined within the four land systems occurring in the study area (Table 6). Eight vegetation associations from BHP WAIO's Pilbara consolidated vegetation mapping were aligned to the eleven land units (Table 6; Figure 9).

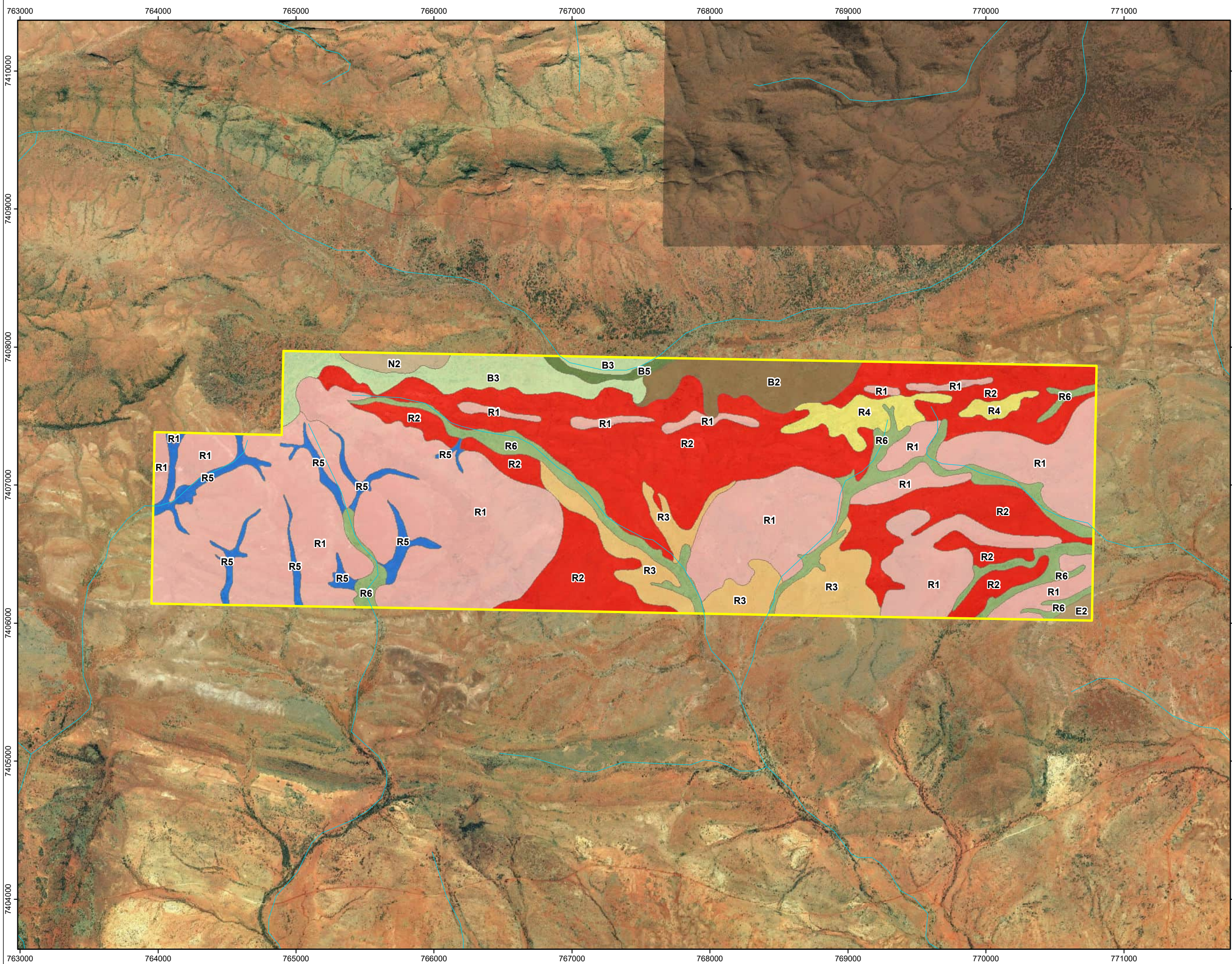
The landforms represented included hill crests/upper hill slopes, lower slopes, stony slopes/plains, upper drainage lines, narrow drainage floors and gilgai plains (Table 6).

Table 6 Land systems and land units occurring within the study area.

Land System	Land Unit	Description	Consolidated Vegetation Code	Broad Floristic Formation	Vegetation Association
Boolgeeda	B2	Stony slopes and upper plains - very gently inclined slopes and upper interfluves immediately downslope from adjacent hill systems, dissected up to 5 m by dendritic or sub-parallel small creeklines, surface mantles of common to very abundant pebbles of chert ironstone, quartz and other rocks.	SP Tlo ExAa AaAsiAk (CP TwTa Es AbPIApy also occurs on calcrete areas)	<i>Triodia</i> Hummock Grassland	Hummock Grassland of <i>Triodia longiceps</i> with Low Woodland of <i>Eucalyptus xerothermica</i> and <i>Acacia aptaneura</i> and High Open Shrubland of <i>Acacia aptaneura</i> , <i>Acacia sibirica</i> and <i>Acacia kempeana</i> on brown clay loam on stony floodplains
Boolgeeda	B3	Stony lower plains - almost level plains downslope from unit 2, surface mantles vary from few to very abundant ironstone and other pebbles; subject to sheet and channelised flow from units 1 and 2.	FP AaAprAcao ErffDopeSie ArcDiaAri (GP ErxErbChf AsyAteVf NedTec, MI AbAdAma Tp TtPamuEua also occur)	<i>Acacia</i> Low Woodland	Low Woodland of <i>Acacia aptaneura</i> , <i>Acacia pruinocarpa</i> and <i>Acacia catenulata</i> subsp. <i>occidentalis</i> over Open Shrubland of <i>Eremophila forrestii</i> subsp. <i>forrestii</i> , <i>Dodonaea petiolaris</i> and <i>Sida ectogama</i> over Open Tussock Grassland of <i>Aristida contorta</i> , <i>Digitaria ammophila</i> and <i>Aristida inaequiglumis</i> on red orange clay loam on floodplains
Boolgeeda	B5	Narrow drainage floors and channels - dendritic and parallel flow zones and creeklines on slopes and plains (units 2 and 3), only 5-10 m wide in upper parts becoming wider on lower plains, larger channels may be braided and incised up to 3 m.	FP AciChAa AancApypPI TtAriCc	<i>Acacia</i> Low Woodland	Low Woodland of <i>Acacia citrinoviridis</i> , <i>Corymbia hamersleyana</i> and <i>Acacia aptaneura</i> over High Shrubland of <i>Acacia ancistrocarpa</i> , <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> and <i>Petalostylis labicheoides</i> over Very Open Tussock Grassland of <i>Themeda triandra</i> , <i>Aristida inaequiglumis</i> and * <i>Cenchrus ciliaris</i> on brown sandy loam on floodplains and medium drainage lines
Elimunna	E2	Stony plains - level to gently undulating plains extending up to 4 km, mantles of abundant pebbles of basalt, quartz and ironstone.	SP Aa ErfrSegl TtArc	<i>Acacia</i> Low Woodland	Low Woodland of <i>Acacia aptaneura</i> over High Shrubland of <i>Eremophila fraseri</i> and <i>Senna glutinosa</i> subsp. <i>x luerssenii</i> over Very Open Tussock Grassland of <i>Themeda triandra</i> and <i>Aristida contorta</i> on red brown clay loam on dolerite stony plains

Land System	Land Unit	Description	Consolidated Vegetation Code	Broad Floristic Formation	Vegetation Association
Newman	N2	Lower slopes - gently inclined concave slopes mostly less than 400 m in extent with mantles of very abundant pebbles and cobbles of ironstone and other rocks.	SP Tp AkAsiAb Ch	<i>Triodia</i> Hummock Grassland	Hummock Grassland of <i>Triodia pungens</i> with High Open Shrubland of <i>Acacia kempeana</i> , <i>Acacia sibirica</i> and <i>Acacia bivenosa</i> and Scattered Trees of <i>Corymbia hamersleyana</i> on brown clay loam on dolerite derived stony plains in broad valleys
Rocklea	R1	Hills, ridges, plateaux and upper slopes - rounded, very gently inclined or undulating crests and plateaux surfaces with moderately inclined to very steep, sometimes benched, upper slopes; surface mantles of very abundant cobbles and pebbles mostly of basalt, also much outcrop of basalt; relief up to 110 m.	HC Tw AiAb InrSeao or HS TsTp AaAprAci AaErIlSegl	<i>Triodia</i> Hummock Grassland	Hummock Grassland of <i>Triodia wiseana</i> with High Open Shrubland of <i>Acacia inaequilatera</i> and <i>Acacia bivenosa</i> over Low Open Shrubland of <i>Indigofera rugosa</i> and <i>Senna artemisioides</i> subsp. <i>oligophylla</i> on red silty loam on dolerite hill crests
Rocklea	R2	Lower slopes - very gently inclined to gently inclined slopes extending up to 1 km downslope from hills (unit 1), surface mantles of abundant to very abundant pebbles and cobbles mostly of basalt, also outcrop of basalt.	HC TbTw Erfr AbAk (MI AbAdAma Tp TtPamuEua also occurs on minor drainage lines within this unit)	<i>Triodia</i> Closed Hummock Grassland	Closed Hummock Grassland of <i>Triodia brizoides</i> and <i>Triodia wiseana</i> with Shrubland of <i>Eremophila fraseri</i> and High Open Shrubland of <i>Acacia bivenosa</i> and <i>Acacia kempeana</i> on brown silty loam on high dolerite hills
Rocklea	R3	Stony plains and interfluves - gently undulating to undulating plains, interfluves and low rises up to 1.5 km in extent, surface mantles of abundant to very abundant pebbles and cobbles of basalt and occasionally shale and other rocks.	HS TbTs AsyAaAte EcuMgSl	<i>Triodia</i> Open Hummock Grassland	Open Hummock Grassland of <i>Triodia basedowii</i> and <i>Triodia</i> sp. Shovelanna Hill (S. van Leeuwen 3835) with Open Shrubland of <i>Acacia synchronicia</i> , <i>Acacia aptaneura</i> and <i>Acacia tetragonophylla</i> over Low Open Shrubland of <i>Eremophila cuneifolia</i> , <i>Maireana georgei</i> and <i>Solanum lasiophyllum</i> on red sandy loam on floodplains and lower hill slopes
Rocklea	R4	Gilgai plains - level plains up to 500 m in extent with gilgai microrelief and variably abundant surface mantles of basalt pebbles and cobbles.	GP ErxErbChf AsyAteVf NedTec	<i>Eragrostis</i> Tussock Grassland	Tussock Grassland of <i>Eragrostis xerophila</i> , <i>Eriachne benthamii</i> and <i>Chrysopogon fallax</i> with Open Shrubland of <i>Acacia synchronicia</i> , <i>Acacia tetragonophylla</i> and * <i>Vachellia farnesiana</i> over Very Open Herbs of <i>Neptunia dimorphantha</i> and <i>Tephrosia clementii</i> on red light clay on gilgai plains

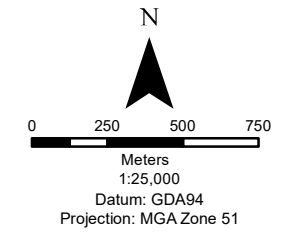
Land System	Land Unit	Description	Consolidated Vegetation Code	Broad Floristic Formation	Vegetation Association
Rocklea	R5	Upper drainage lines - narrow headwater valleys with branching drainage tracts mostly <200 m wide, unchannelled or with central channels up to 10 m wide.	MI AmAancPI ChEII TtAri	Acacia Shrubland	Shrubland of <i>Acacia monticola</i> , <i>Acacia ancistrocarpa</i> and <i>Petalostylis labicheoides</i> with Scattered Low Trees of <i>Corymbia hamersleyana</i> and <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> over Open Tussock Grassland of <i>Themeda triandra</i> and <i>Aristida inaequiglumis</i> on red loamy sand on minor drainage lines
Rocklea	R6	Drainage floors and channels - almost level floors rarely more than 400 m wide, central tracts with braided channels and stony banks; major trunk channels up to 50 m wide.	FP AciChAa AancApypPI TtAriCc (FP AaAprAcao ErffDopeSie ArcDiaAri also occurs)	Acacia Low Woodland	Low Woodland of <i>Acacia citrinoviridis</i> , <i>Corymbia hamersleyana</i> and <i>Acacia aptaneura</i> over High Shrubland of <i>Acacia ancistrocarpa</i> , <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> and <i>Petalostylis labicheoides</i> over Very Open Tussock Grassland of <i>Themeda triandra</i> , <i>Aristida inaequiglumis</i> and * <i>Cenchrus ciliaris</i> on brown sandy loam on floodplains and medium drainage lines



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Figure 9
Land Unit Mapping

Legend

Study Area



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Western Ridge
E52 - 3448
Figure 9

Land Unit Mapping Legend

Legend

Study Area

Land units

Hill Crest

HC Tw AiAb InrSeao (R1) Hummock Grassland of *Triodia wiseana* with High Open Shrubland of *Acacia inaequilatera* and *Acacia bivenosa* over Low Open Shrubland of *Indigofera rugosa* and *Senna artemisioides* subsp. *oligophylla* on red silty loam on dolerite hill crests

HC TbTw Erfr AbAk (R2) Closed Hummock Grassland of *Triodia brizoides* and *Triodia wiseana* with Shrubland of *Eremophila fraseri* and High Open Shrubland of *Acacia bivenosa* and *Acacia kempeana* on brown silty loam on high dolerite hills

Hillslope

HS TbTs AsyAaAte EcuMgSI (R3) Open Hummock Grassland of *Triodia basedowii* and *Triodia vanleeuwenii* with Open Shrubland of *Acacia synchronicia*, *Acacia aptanera* and *Acacia tetragonophylla* over Low Open Shrubland of *Eremophila cuneifolia*, *Maireana georgei* and *Solanum lasiophyllum* on red sandy loam on floodplains and lower hill slopes

Stony Plain

SP Tp AkAsiAb Ch (N2) Hummock Grassland of *Triodia pungens* with High Open Shrubland of *Acacia kempeana*, *Acacia sibirica* and *Acacia bivenosa* and Scattered Trees of *Corymbia hamersleyana* on brown clay loam on dolerite derived stony plains in broad valleys

SP Aa ErfrSegl TtArc (E2) Low Woodland of *Acacia aptanera* over High Shrubland of *Eremophila fraseri* and *Senna glutinosa* subsp. *x luerssenii* over Very Open Tussock Grassland of *Themeda triandra* and *Aristida contorta* on red brown clay loam on dolerite stony plains

SP Tlo ExAa AaAsiAk (B2) Hummock Grassland of *Triodia longiceps* with Low Woodland of *Eucalyptus xerothermica* and *Acacia aptanera* and High Open Shrubland of *Acacia aptanera*, *Acacia sibirica* and *Acacia kempeana* on brown clay loam on stony floodplains

Gilgai Plains

GP ErxErbChf AsyAteVf NedTec (R4) Tussock Grassland of *Eragrostis xerophila*, *Eriachne benthamii* and *Chrysopogon fallax* with Open Shrubland of *Acacia synchronicia*, *Acacia tetragonophylla* and **Vachellia farnesiana* over Very Open Herbs of *Neptunia dimorphantha* and *Tephrosia clementii* on red light clay on gilgai plains

Flood Plain

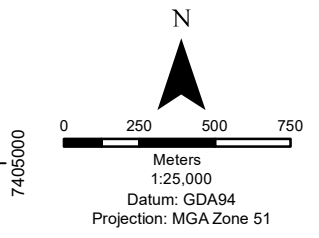
FP AaAprAcao ErffDopeSie ArcDiaAri (B3) Low Woodland of *Acacia aptanera*, *Acacia pruinocarpa* and *Acacia catenulata* subsp. *occidentalis* over Open Shrubland of *Eremophila forrestii* subsp. *forrestii*, *Dodonaea petiolaris* and *Sida ectogama* over Open Tussock Grassland of *Aristida contorta*, *Digitaria ammophila* and *Aristida inaequiglumis* on red orange clay loam on floodplains

FP AciChAa AancApyPI TtAriCc (R6) Low Woodland of *Acacia citrinoviridis*, *Corymbia hamersleyana* and *Acacia aptanera* over High Shrubland of *Acacia ancistrocarpa*, *Acacia pyrifolia* var. *pyrifolia* and *Petalostylis labicheoides* over Very Open Tussock Grassland of *Themeda triandra*, *Aristida inaequiglumis* and **Cenchrus ciliaris* on brown sandy loam on floodplains and medium drainage lines

FP AciChAa AancApyPI TtAriCc (B5) Low Woodland of *Acacia citrinoviridis*, *Corymbia hamersleyana* and *Acacia aptanera* over High Shrubland of *Acacia ancistrocarpa*, *Acacia pyrifolia* var. *pyrifolia* and *Petalostylis labicheoides* over Very Open Tussock Grassland of *Themeda triandra*, *Aristida inaequiglumis* and **Cenchrus ciliaris* on brown sandy loam on floodplains and medium drainage lines

Minor Drainage Line

MI AmAancPI ChEII TtAri (R5) Shrubland of *Acacia monticola*, *Acacia ancistrocarpa* and *Petalostylis labicheoides* with Scattered Low Trees of *Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* over Open Tussock Grassland of *Themeda triandra* and *Aristida inaequiglumis* on red loamy sand on minor drainage lines



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 Sheet Size: A3
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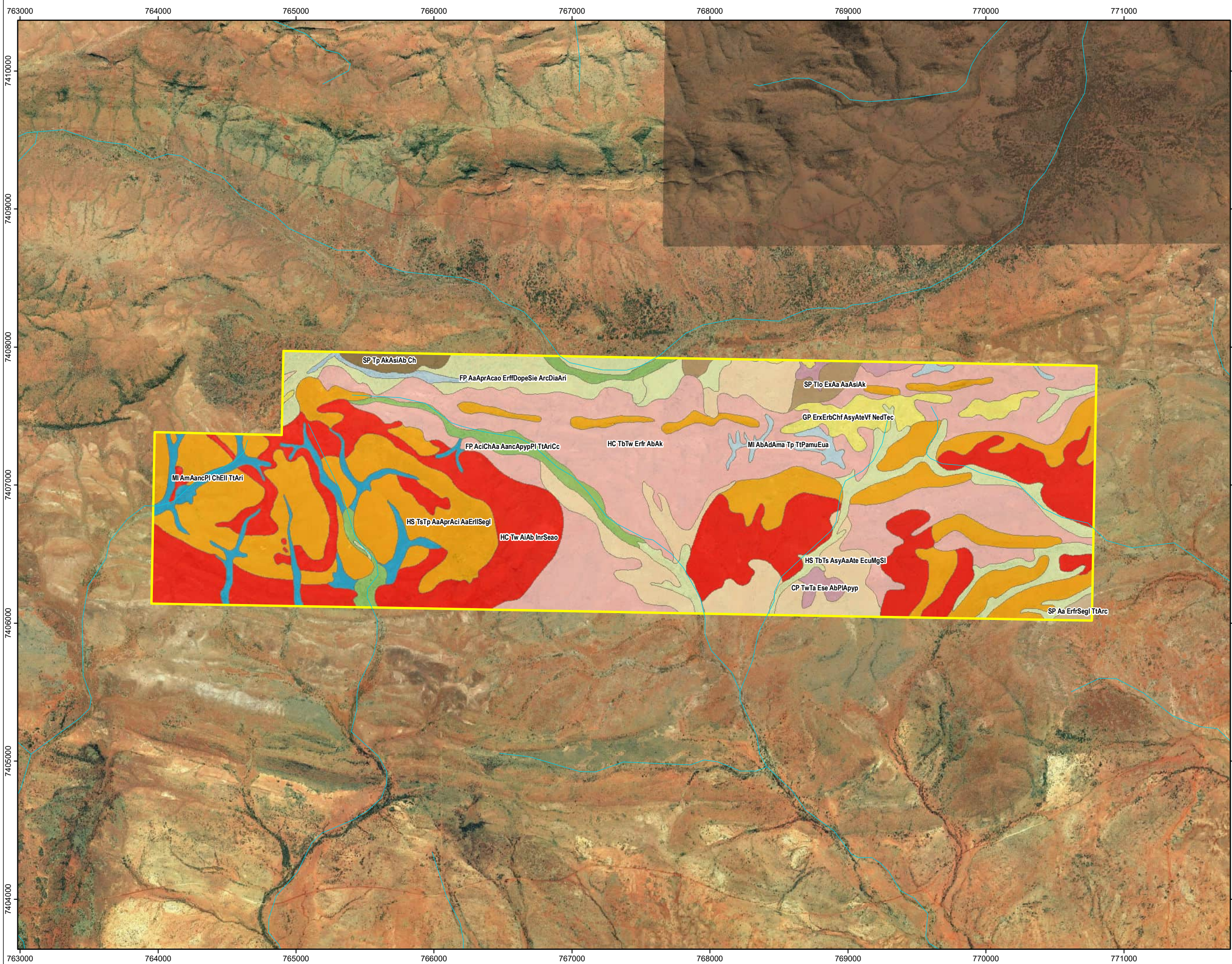
3.4 Vegetation Association Mapping

There were 13 vegetation associations mapped within the study area (Figure 10), classified under seven landforms and six broad floristic formations (Table 7). The landforms represented included hill crests/upper hill slopes, hill slopes, stony plains, calcrete plains, flood plains, gilgai plains, and minor drainage lines (Table 7).

Table 7 Vegetation associations occurring within the study area

Broad Floristic Formation	Consolidated Vegetation Code	Landform	Vegetation Association	Land Unit	Significance
Acacia Low Woodland	FP AaAprAcao ErffDopeSie ArcDiaAri	Flood plain	Low Woodland of <i>Acacia aptaneura</i> , <i>Acacia pruinocarpa</i> and <i>Acacia catenulata</i> subsp. <i>occidentalis</i> over Open Shrubland of <i>Eremophila forrestii</i> subsp. <i>forrestii</i> , <i>Dodonaea petiolaris</i> and <i>Sida ectogama</i> over Open Tussock Grassland of <i>Aristida contorta</i> , <i>Digitaria ammophila</i> and <i>Aristida inaequiglumis</i> on red orange clay loam on floodplains	R6, B3	Representative of 'Valley Floor Mulga'
	FP AciChAa AancApyPI TtAriCc	Flood plain	Low Woodland of <i>Acacia citrinoviridis</i> , <i>Corymbia hamersleyana</i> and <i>Acacia aptaneura</i> over High Shrubland of <i>Acacia ancistrocarpa</i> , <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> and <i>Petalostylis labicheoides</i> over Very Open Tussock Grassland of <i>Themeda triandra</i> , <i>Aristida inaequiglumis</i> and * <i>Cenchrus ciliaris</i> on brown sandy loam on floodplains and medium drainage lines	R6, B2, B5	
	SP Aa ErfrSegl TtArc	Stony plains	Low Woodland of <i>Acacia aptaneura</i> over High Shrubland of <i>Eremophila fraseri</i> and <i>Senna glutinosa</i> subsp. x <i>luerssenii</i> over Very Open Tussock Grassland of <i>Themeda triandra</i> and <i>Aristida contorta</i> on red brown clay loam on dolerite stony plains	E2	Representative of 'Valley Floor Mulga'
Acacia Shrubland	MI AbAdAma Tp TtPamuEua	Minor drainage lines	Shrubland of <i>Acacia bivenosa</i> , <i>Acacia dictyophleba</i> and <i>Acacia maitlandii</i> over Open Hummock Grassland of <i>Triodia pungens</i> over Open Tussock Grassland of <i>Themeda triandra</i> , <i>Paraneurachne muelleri</i> and <i>Eulalia aurea</i> on brown sandy loam on minor drainage lines	R2, B3	
	MI AmAancPI ChEII TtAri	Minor drainage lines	Shrubland of <i>Acacia monticola</i> , <i>Acacia ancistrocarpa</i> and <i>Petalostylis labicheoides</i> with Scattered Low Trees of <i>Corymbia hamersleyana</i> and <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> over Open Tussock Grassland of <i>Themeda triandra</i> and <i>Aristida inaequiglumis</i> on red loamy sand on minor drainage lines	R5	
Triodia Closed Hummock Grassland	HC TbTw Erfr AbAk	Hillcrests	Closed Hummock Grassland of <i>Triodia brizoides</i> and <i>Triodia wiseana</i> with Shrubland of <i>Eremophila fraseri</i> and High Open Shrubland of <i>Acacia bivenosa</i> and <i>Acacia kempeana</i> on brown silty loam on high dolerite hills	R2	
Triodia Hummock Grassland	CP TwTa Ese AbPIApy	Calcrete plain	Hummock Grassland of <i>Triodia wiseana</i> and <i>Triodia angusta</i> with Open Mallee of <i>Eucalyptus socialis</i> subsp. <i>eucentrica</i> and Open Shrubland of <i>Acacia bivenosa</i> , <i>Petalostylis labicheoides</i> and <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> on light brown clay loam on calcrete plains and rises	R2, R3, B2	

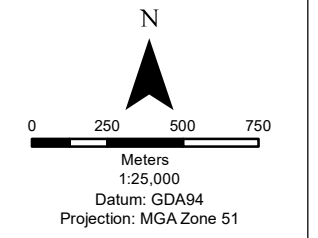
Broad Floristic Formation	Consolidated Vegetation Code	Landform	Vegetation Association	Land Unit	Significance
	HC Tw AiAb InrSeao	Hillcrests	Hummock Grassland of <i>Triodia wiseana</i> and <i>Triodia brizoides</i> with High Open Shrubland of <i>Acacia inaequilatera</i> over Low Open Shrubland of <i>Indigofera rugosa</i> and <i>Senna artemisioides</i> subsp. <i>oligophylla</i> on red silty loam on dolerite hill crests, slopes and valleys	R1	
	HS TsTp AaAprAci AaErlISegl	Hillslopes	Hummock Grassland of <i>Triodia vanleeuwenii</i> and <i>Triodia pungens</i> with High Open Shrubland of <i>Acacia aptaneura</i> , <i>Acacia pruinocarpa</i> and <i>Acacia citrinoviridis</i> and Open Shrubland of <i>Acacia aptaneura</i> , <i>Eremophila latrobei</i> subsp. <i>latrobei</i> and <i>Senna glutinosa</i> subsp. <i>x luerissenii</i> on red loamy sand on upper hill slopes	R1	
	SP Tlo ExAa AaAsiAk	Stony plains	Hummock Grassland of <i>Triodia longiceps</i> with Low Woodland of <i>Eucalyptus xerothermica</i> and <i>Acacia aptaneura</i> and High Open Shrubland of <i>Acacia aptaneura</i> , <i>Acacia sibirica</i> and <i>Acacia kempeana</i> on brown clay loam on stony floodplains	B2	
	SP Tp AkAsiAb Ch	Stony plains	Hummock Grassland of <i>Triodia pungens</i> with High Open Shrubland of <i>Acacia kempeana</i> , <i>Acacia sibirica</i> and <i>Acacia bivenosa</i> and Scattered Trees of <i>Corymbia hamersleyana</i> on brown clay loam on dolerite derived stony plains in broad valleys	N2	
<i>Triodia</i> Open Hummock Grassland	HS TbTs AsyAaAte EcuMgSI	Hillslopes	Open Hummock Grassland of <i>Triodia basedowii</i> and <i>Triodia vanleeuwenii</i> with Open Shrubland of <i>Acacia synchronicia</i> , <i>Acacia aptaneura</i> and <i>Acacia tetragonophylla</i> over Low Open Shrubland of <i>Eremophila cuneifolia</i> , <i>Maireana georgei</i> and <i>Solanum lasiophyllum</i> on red sandy loam on floodplains and lower hill slopes	R3, B2, B3	
<i>Eragrostis</i> Tussock Grassland	GP ErxErbChf AsyAteVf NedTec	Gilgai	Tussock Grassland of <i>Eragrostis xerophila</i> , <i>Eriachne benthamii</i> and <i>Chrysopogon fallax</i> with Open Shrubland of <i>Acacia synchronicia</i> , <i>Acacia tetragonophylla</i> and * <i>Vachellia farnesiana</i> over Very Open Herbs of <i>Neptunia dimorphantha</i> and <i>Tephrosia clementii</i> on red light clay on gilgai plains	B2, B3, R4	



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Figure 10
Vegetation Association
Mapping

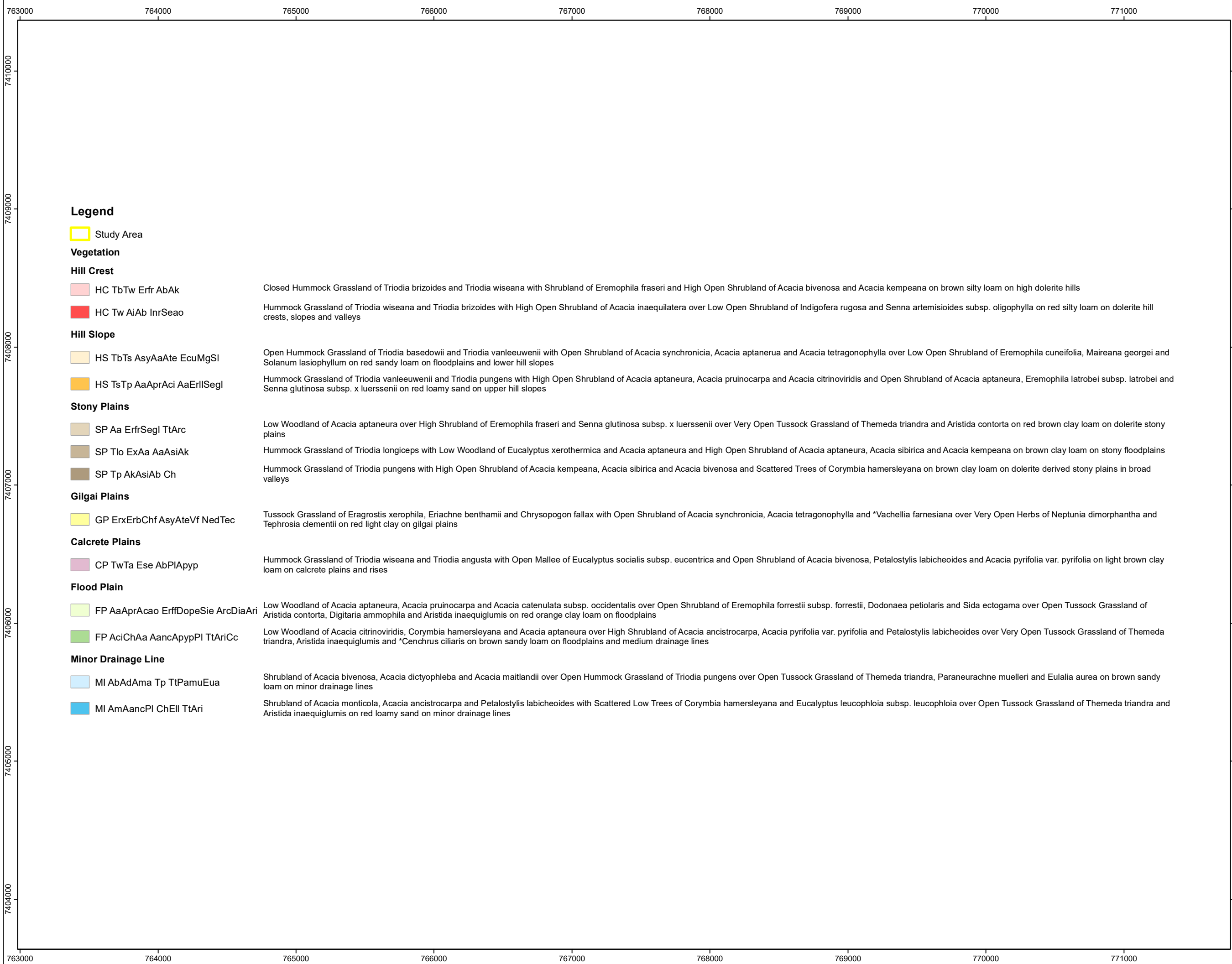
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Study Area



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**Western Ridge
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Figure 10

**Vegetation Association
Mapping Legend**

Legend

Study Area

Vegetation

Hill Crest

- HC TbTw Erfr AbAk Closed Hummock Grassland of *Triodia brizoides* and *Triodia wiseana* with Shrubland of *Eremophila fraseri* and High Open Shrubland of *Acacia bivenosa* and *Acacia kempeana* on brown silty loam on high dolerite hills
- HC Tw AiAb InrSeao Hummock Grassland of *Triodia wiseana* and *Triodia brizoides* with High Open Shrubland of *Acacia inaequilatera* over Low Open Shrubland of *Indigofera rugosa* and *Senna artemisioides* subsp. *oligophylla* on red silty loam on dolerite hill crests, slopes and valleys

Hill Slope

- HS TbTs AsyAaAte EcuMgSI Open Hummock Grassland of *Triodia basedowii* and *Triodia vanleeuwenii* with Open Shrubland of *Acacia synchronicia*, *Acacia aptanera* and *Acacia tetragonophylla* over Low Open Shrubland of *Eremophila cuneifolia*, *Maireana georgei* and *Solanum lasiophyllum* on red sandy loam on floodplains and lower hill slopes
- HS TsTp AaAprAci AaErlSegl Hummock Grassland of *Triodia vanleeuwenii* and *Triodia pungens* with High Open Shrubland of *Acacia aptaneura*, *Acacia pruinocarpa* and *Acacia citrinoviridis* and Open Shrubland of *Acacia aptaneura*, *Eremophila latrobei* subsp. *latrobei* and *Senna glutinosa* subsp. *x luerssenii* on red loamy sand on upper hill slopes

Stony Plains

- SP Aa ErfrSegl TtArc Low Woodland of *Acacia aptaneura* over High Shrubland of *Eremophila fraseri* and *Senna glutinosa* subsp. *x luerssenii* over Very Open Tussock Grassland of *Themeda triandra* and *Aristida contorta* on red brown clay loam on dolerite stony plains
- SP Tlo ExAa AaAsiAk Hummock Grassland of *Triodia longiceps* with Low Woodland of *Eucalyptus xerothermica* and *Acacia aptaneura* and High Open Shrubland of *Acacia aptaneura*, *Acacia sibirica* and *Acacia kempeana* on brown clay loam on stony floodplains
- SP Tp AkAsiAb Ch Hummock Grassland of *Triodia pungens* with High Open Shrubland of *Acacia kempeana*, *Acacia sibirica* and *Acacia bivenosa* and Scattered Trees of *Corymbia hamersleyana* on brown clay loam on dolerite derived stony plains in broad valleys

Gilgai Plains

- GP ErxErbChf AsyAteVf NedTec Tussock Grassland of *Eragrostis xerophila*, *Eriachne benthamii* and *Chrysopogon fallax* with Open Shrubland of *Acacia synchronicia*, *Acacia tetragonophylla* and **Vachellia farnesiana* over Very Open Herbs of *Neptunia dimorphantha* and *Tephrosia clementii* on red light clay on gilgai plains

Calcrete Plains

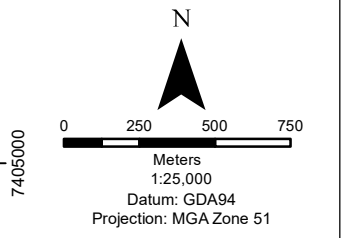
- CP TwTa Ese AbPIAyp Hummock Grassland of *Triodia wiseana* and *Triodia angusta* with Open Mallee of *Eucalyptus socialis* subsp. *eucentrica* and Open Shrubland of *Acacia bivenosa*, *Petalostylis labicheoides* and *Acacia pyrifolia* var. *pyrifolia* on light brown clay loam on calcrete plains and rises

Flood Plain

- FP AaAprAcao ErffDopeSie ArcDiaAri Low Woodland of *Acacia aptaneura*, *Acacia pruinocarpa* and *Acacia catenulata* subsp. *occidentalis* over Open Shrubland of *Eremophila forrestii* subsp. *forrestii*, *Dodonaea petiolaris* and *Sida ectogama* over Open Tussock Grassland of *Aristida contorta*, *Digitaria ammophila* and *Aristida inaequiglumis* on red orange clay loam on floodplains
- FP AciChAa AancApyPI TtAriCc Low Woodland of *Acacia citrinoviridis*, *Corymbia hamersleyana* and *Acacia aptaneura* over High Shrubland of *Acacia ancistrocarpa*, *Acacia pyrifolia* var. *pyrifolia* and *Petalostylis labicheoides* over Very Open Tussock Grassland of *Themeda triandra*, *Aristida inaequiglumis* and **Cenchrus ciliaris* on brown sandy loam on floodplains and medium drainage lines

Minor Drainage Line

- MI AbAdAma Tp TtPamuEua Shrubland of *Acacia bivenosa*, *Acacia dictyophleba* and *Acacia maitlandii* over Open Hummock Grassland of *Triodia pungens* over Open Tussock Grassland of *Themeda triandra*, *Paraneurachne muelleri* and *Eulalia aurea* on brown sandy loam on minor drainage lines
- MI AmAancPI ChEil TtAri Shrubland of *Acacia monticola*, *Acacia ancistrocarpa* and *Petalostylis labicheoides* with Scattered Low Trees of *Corymbia hamersleyana* and *Eucalyptus leucophloia* subsp. *leucophloia* over Open Tussock Grassland of *Themeda triandra* and *Aristida inaequiglumis* on red loamy sand on minor drainage lines



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3.4.1 Vegetation Associations of Significance

None of the vegetation associations mapped within the study area are Federal or State listed TECs, or State listed PECs for the Pilbara.

Two vegetation associations mapped for the study area are representative of 'Valley Floor Mulga' within the Hamersley subregion:

- SP Aa ErfrSegl TtArc; and
- FP AaAprAcao ErffDopeSie ArcDiaAri.

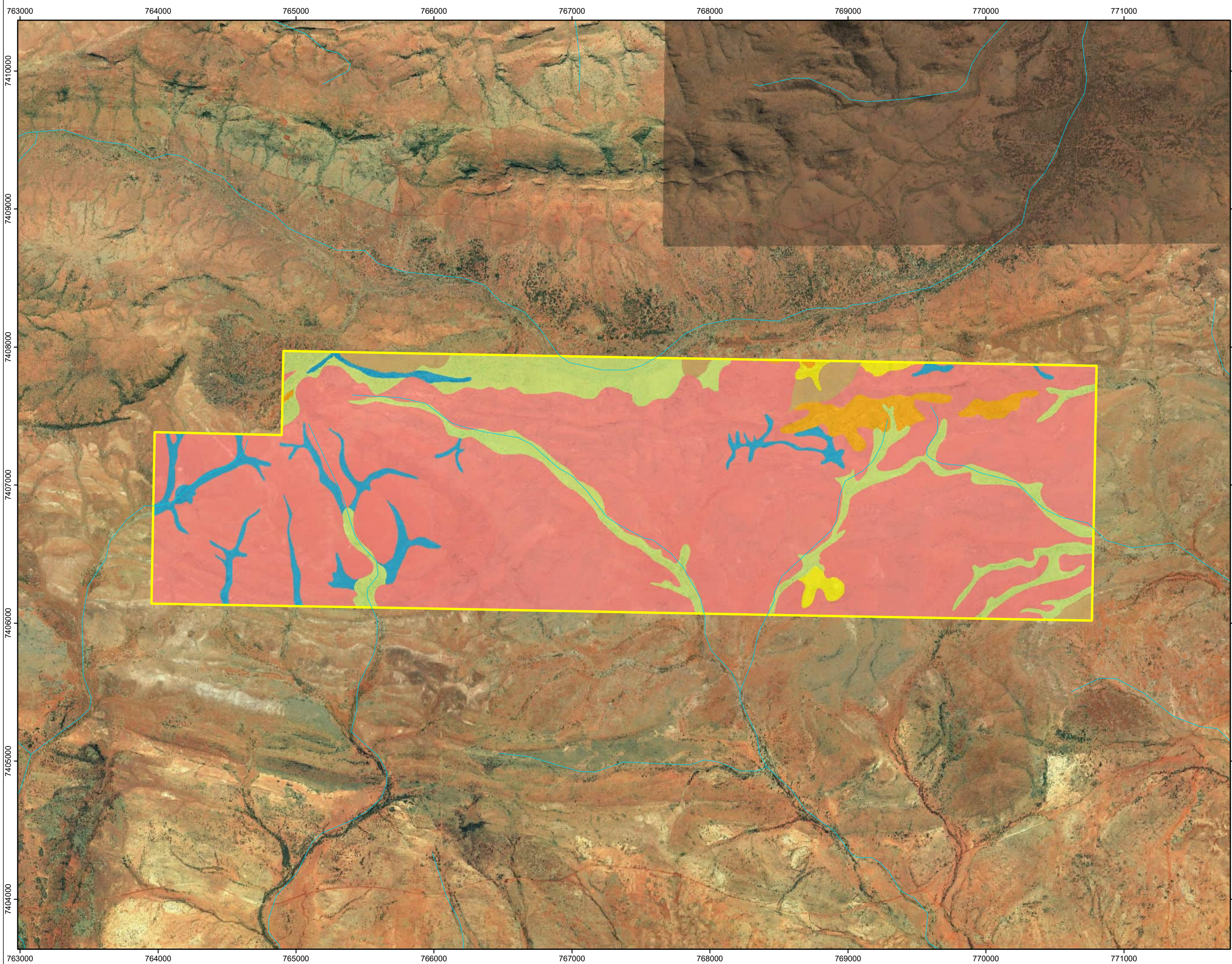
'Valley Floor Mulga' is considered to be an 'ecosystem at risk' by the Department of Conservation and Land Management (now DBCA) (Kendrick 2001). This ecosystem is represented by vegetation associations occurring on valley floors or broad plains, which have a reasonably dense Mulga overstory (i.e. at least 10-30 percent cover).

3.5 Fauna Habitat Mapping

Based on the land units present, and the vegetation associations mapped for the study area, six fauna habitats were identified and mapped within the study area (Figure 11; Table 8). The study area is dominated by Hillcrest/ Hillslope and Stony Plain habitat types.








Table 8 Fauna habitat mapped within the study area.

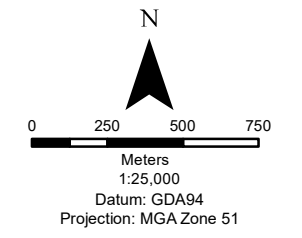
Habitat Type	Description
Calcrete plain	Small isolated pocket of calcrete plain with light brown clay loam dominated by <i>Triodia</i> Hummock Grassland with scattered <i>Eucalypts</i> and <i>Acacia</i> species.
Drainage area/ Floodplain	Flood plains and open unincised drainage channels with sandy loam or clay loam dominated by Low Woodland of <i>Acacia</i> species with scattered tussock grasses.
Gilgai plain	Small pockets of gilgai plain with mixed tussock grasses and scattered <i>Acacia</i> species on clay soil.
Hillcrest/ Hillslope	High dolerite hills, upper hill slopes and lower hill slopes, dominated by <i>Triodia</i> Hummock Grassland and <i>Acacia</i> species occurring on red silty loam or loamy sand.
Minor drainage line	Minor incised drainage lines with sandy loam dominated by <i>Acacia</i> species over open hummock/tussock grasses with scattered <i>Eucalyptus</i> or <i>Corymbia</i> species in some sections of this habitat.
Stony plain	Stony plains adjacent broad valleys and floodplains with brown clay loam dominated by <i>Triodia</i> Hummock Grassland and <i>Acacia</i> species.



BHP
Western Ridge
E52 - 3448
Figure 11
Fauna Habitat Mapping

Legend

-  Study
- Habitat Mapping**
-  Calcrete Plain
-  Drainage Area/
Floodplain
-  Gilgai Plain
-  Hillcrest/ Hillslope
-  Minor Drainage Line
-  Stony Plain



Date: 19/11/2018
Status: Final
Figure: 11
Sheet Size: A3
Internal Reference: WR_Fau_Habitat
Drawn by: GSM
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3.5.1 Fauna Habitats of Significance

None of the fauna habitat types mapped within the study area are of formal conservation significance. Although conservation significant species may utilise the habitat types mapped for the study area, none are expected to be restricted to the study area.

While none of the habitat types within the study area would be considered significant, the calcrete plain and gilgai plain habitat types are both under-represented in the Pilbara region. Both habitat types often occur in small isolated pockets. Species inhabiting these habitat types may also be restricted to them; for example, the Pilbara endemic species, the Pilbara Stone Gecko (*Diplodactylus mitchelli*) occurs in habitats characterised by clay soils such as those of the gilgai plain habitat type.

3.5.2 SRE Invertebrate Fauna Habitats

Based on the land systems present, and habitat assessment work completed in the adjacent tenements (Biologic Environmental 2016b), the fauna habitat of the study area can be largely categorised in three broad habitat types for SRE invertebrate fauna species:

- Hillcrest/ Hillslope;
- Drainage Areas (including Minor Drainage Lines); and
- Stony Plain.

The Hillcrest/ Hillslope habitat type dominates the study area, and is representative of the Rocklea land system occurring across a majority of the study area (Figure 4). This habitat type has some potential to provide suitable habitat for rocky-habitat species, such as pseudoscorpions, isopods, and selenopid spiders. However, this habitat type within the study area is considered to be of low habitat suitability for SRE invertebrate fauna, due to the high exposure and lack of sheltered, rocky or vegetated areas.

The Hillcrest/ Hillslope habitat type is dissected by the drainage area habitat type that includes Minor Drainage Lines and Floodplains. The soils of the drainage area habitat type consist of sandy loam or clay loam which may provide suitable habitat for borrowing species, such as mygalomorph spiders and some scorpion species. This habitat type generally consists of Low Woodland of *Acacia* species, or scattered *Eucalyptus* or *Corymbia* species in some sections. This vegetation would provide shade and areas of leaf litter and detrital microhabitats for invertebrate fauna species. Based on the suitable soils for burrowing and shaded areas of leaf litter providing microhabitats, the drainage area habitat type is considered to be of moderate suitability for SRE invertebrate fauna.

Small sections of Stony Plain habitat occur in the south-eastern corner and along the northern border of the study area. This habitat type aligns with the Boolgeeda, Newman and Elimunna land systems (Figure 4). Due to the flat and open nature, and sparse vegetation of this habitat type, it is considered to provide little to no suitable habitat for SRE invertebrate fauna.

3.6 Species Likelihood of Occurrence

3.6.1 Flora Species

Database searches identified one Threatened Flora potentially occurring within a 50 km radius of the study area. The Threatened Flora *Pityrodia augustensis* (Mt Augustus Foxglove) has been recorded from rocky hillsides near Mt Augustus and the Mt Fraser Range north of Meekatharra. The nearest known records for *Pityrodia augustensis* are over 300 km south of the study area (DoEE 2018b). While suitable habitat may be present surrounding the study area it is considered unlikely to occur due to absence of suitable habitat within the study area and distance to previous records.

A total of 37 Priority flora taxa were identified during the desktop assessment; 35 from database

searches, and two additional species from the literature review (Figure 12²). None of the Priority flora taxa identified had previously been recorded within the study area.

Based on the known distributions and habitat preferences of Priority flora taxa, and comparison with the habitats identified and mapped as expected to be present in the study area, four Priority flora taxa were determined as being “likely” to occur within the study area (Table 9), and are discussed further below. Twenty-two (22) Priority flora taxa were determined as “possible” to occur in the study area, with the remaining taxa identified as “unlikely” to occur (Table 9).

Table 9 Conservation significant flora taxa identified during the desktop assessment.

Taxon	Cons. Code	Life Form	Habitat Preference	Suitable Habitat Present	Likelihood in the Study Area
<i>Acacia bromilowiana</i>	P4	Perennial	Red skeletal stony loam, laterite, banded ironstone, database basalt. Rocky hills, breakaways, scree slopes, gorges, creek beds.	No	Unlikely
<i>Acacia</i> sp. East Fortescue (J. Bull & D. Roberts ONS A 27.01)	P1	Perennial	Red-brown sandy-loam soils on hill crests, ridges, slopes and minor drainage lines.	Yes	Unlikely
<i>Acacia subtiliformis</i>	P3	Perennial	Rocky calcrete plateaus.	Yes	Possible
<i>Aristida jerichoensis</i> var. <i>subspinulifera</i>	P3	Perennial	Hardpan plain.	Yes	Possible
<i>Aristida lazaridis</i>	P2	Perennial	Plains and drainage lines.	Yes	Possible
<i>Bulbostylis burbridgeae</i>	P4	Annual	Granitic soils. Granite outcrops, cliff bases.	No	Unlikely
<i>Calotis latiuscula</i>	P3	Annual	Rocky hillsides, floodplains, rocky creeks or river beds.	Yes	Likely
<i>Crotalaria smithiana</i>	P3	Annual	Floodplains or sand plains.	Yes	Possible
<i>Dampiera metallorum</i>	P3	Perennial	Steep slopes, summits of hills.	No	Unlikely
<i>Eremophila magnifica</i> subsp. <i>magnifica</i>	P4	Perennial	Skeletal soils over ironstone. Rocky screes.	Yes	Likely
<i>Eremophila magnifica</i> subsp. <i>velutina</i>	P3	Perennial	Skeletal soils over ironstone. Summits.	Yes	Possible
<i>Eremophila rhegos</i>	P1	Perennial	Skeletal stony loam over granite.	Yes	Possible
<i>Eremophila rigida</i>	P3	Perennial	Hardpan plains, stony clay depressions.	Yes	Possible
<i>Eremophila</i> sp. Hamersley Range (K. Walker KW 136)	P1	Perennial	Unknown	Yes	Possible
<i>Eremophila</i> sp. West Angelas (S. van Leeuwen 4068)	P1	Perennial	Unknown	Yes	Possible
<i>Eremophila youngii</i> subsp. <i>lepidota</i>	P4	Perennial	Flats plains, floodplains, sometimes semi-saline, clay flats.	No	Unlikely
<i>Euphorbia inappendiculata</i> var. <i>inappendiculata</i>	P2	Annual	Unknown	Yes	Possible
<i>Goodenia berringbinensis</i>	P4	Annual	Watercourses.	No	Unlikely

² Please note that not all species are able to be mapped as some reports or database searches do not provide location data for species.

Taxon	Cons. Code	Life Form	Habitat Preference	Suitable Habitat Present	Likelihood in the Study Area
<i>Goodenia hartiana</i>	P2	Perennial	Sand. Sand dune swales, sandhills.	No	Unlikely
<i>Goodenia nuda</i>	P4	Perennial	Plains and floodplains.	Yes	Likely
<i>Goodenia</i> sp. East Pilbara (A.A. Mitchell PRP 727)	P3	Annual	Low undulating plain, swampy plains.	Yes	Possible
<i>Gymnanthera cunninghamii</i>	P3	Perennial	Sandy soils, creek beds.	Yes	Possible
<i>Hibiscus</i> sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	P2	Perennial	Unknown	Yes	Unlikely
<i>Hibiscus campanulatus</i>	P1	Perennial	Incised ironstone gullies, protected areas below cliffs, rocky creeklines and below breakaways.	No	Unlikely
<i>Indigofera gilesii</i>	P3	Perennial	Amongst boulders & outcrops, hills.	Yes	Possible
<i>Ipomoea racemigera</i>	P2	Annual	Flats and stream channels.	Yes	Likely
<i>Isotropis parviflora</i>	P2	Annual	Valley slope of ironstone plateau.	Yes	Possible
<i>Lepidium catapychnon</i>	P4	Perennial	Skeletal soils. Hillsides.	Yes	Possible
<i>Maireana prosthocochaeta</i>	P3	Perennial	Laterite. Hills, salty places.	No	Unlikely
<i>Oxalis</i> sp. Pilbara (M.E. Trudgen 12725)	P2	Annual	Unknown	Yes	Possible
<i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794)	P3	Perennial	Plains.	Yes	Possible
<i>Rostellularia adscendens</i> var. <i>latifolia</i>	P3	Annual	Ironstone soils. Near creeks, rocky hills.	Yes	Possible
<i>Sida</i> sp. Barlee Range (S. van Leeuwen 1642)	P3	Perennial	Skeletal red soils pockets. Steep slopes and cliffines.	Yes	Unlikely
<i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431)	P3	Perennial	Clay pan, grass plain.	Yes	Possible
<i>Triodia</i> sp. Mt Ella (M.E. Trudgen 12739)	P3	Perennial	Amongst rocks & outcrops, gully slopes.	Yes	Possible
<i>Vittadinia</i> sp. Coondewanna Flats (S. van Leeuwen 4684)	P1	Perennial	Plains.	Yes	Possible
<i>Xerochrysum boreale</i>	P3	Unknown	Unknown	Yes	Possible

Calotis latiuscula (Priority 3) is an erect herb that grows to 0.5 m high and produces yellow flowers from June to October. It occurs in a variety of habitats including rocky hillsides, flood plains, rocky creeks and river beds and is known from 15 records within Western Australia occurring in the southern sector of the Pilbara region and Central Australia (Gibson Desert and Central Ranges bioregions) (Western Australian Herbarium [WAH] 2018). While the Central Ranges populations are found mainly in rocky areas and creeks, the Pilbara populations are from clay plains.

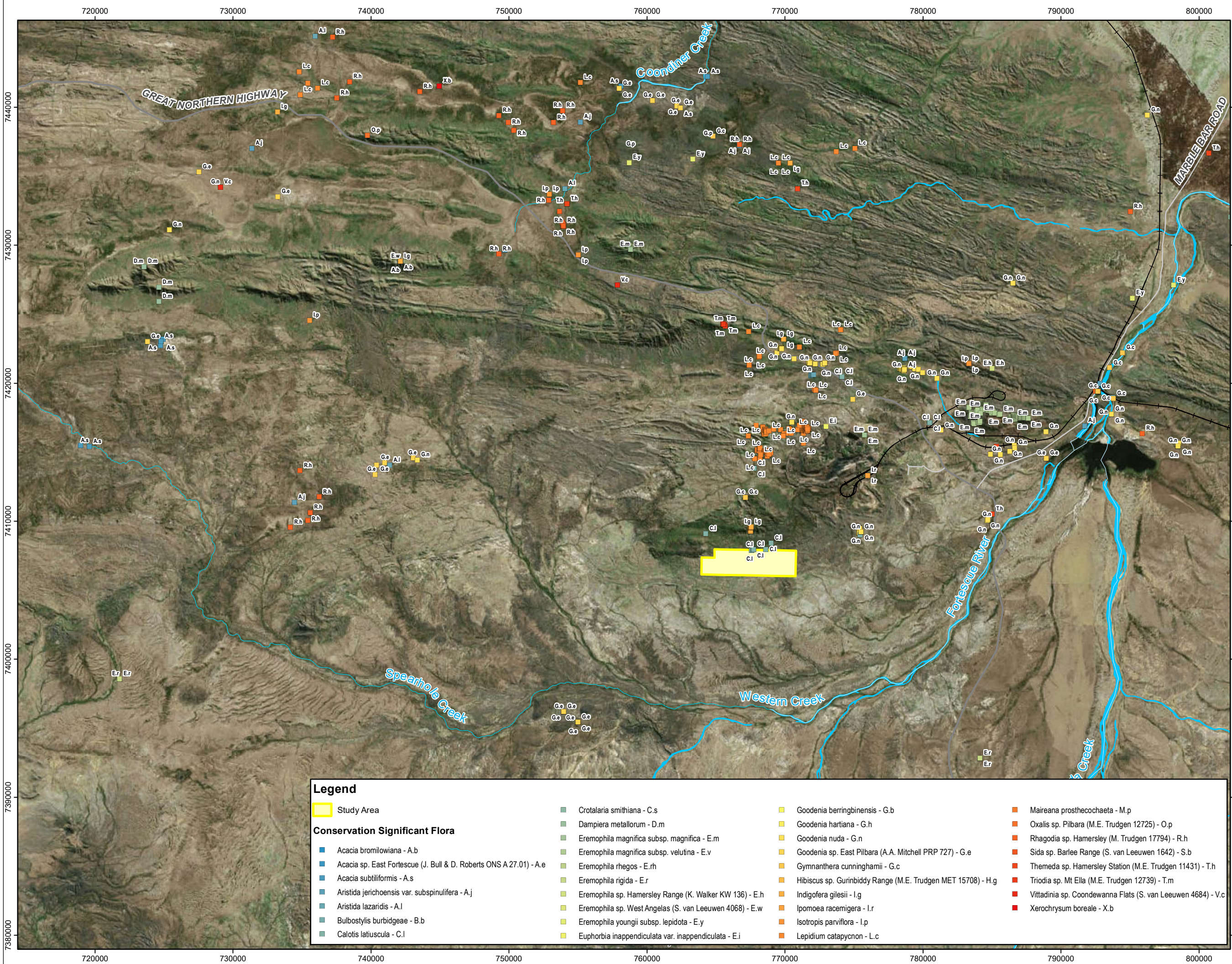
Numerous *Calotis latiuscula* plants were recorded from a single population occurring at the upper reaches of Whaleback Creek during the survey of the adjacent Western Ridge study area (Onshore Environmental 2014a). This species has also been recorded from the Whaleback area (Onshore Environmental 2014c, ENV 2011a, Ecologia 2006a). Due to the close proximity of records and presence of suitable habitat, this species is considered likely to occur within the study area. The vegetation associations this species is most likely to occur within are: MI AmAancPI ChEII TtAri and FP AciChAa AancApyPI TtAriCc.

Eremophila magnifica subsp. *magnifica* (Priority 4) is a shrub that grows to a height of 1.5 m, producing blue or magenta flowers between August and November. It typically occurs on skeletal soils over ironstone and on rocky screes. The survey of the adjacent Western Ridge study area recorded one (dead) plant (Onshore Environmental 2014a). This species has also been recorded from the Whaleback area (Onshore Environmental 2014c, ENV 2011a). Due to the close proximity of records and presence of suitable habitat, this species is considered likely to occur within the study area, and is most likely to occur within areas of *Triodia* Hummock Grasslands on hill crests and hill slopes with sandy loam soils.

Goodenia nuda (Priority 4) occurs on drainage levees, flood plains and sand plains as an erect annual or biennial herb to 0.3 m in height. *Goodenia nuda* is widespread through the Pilbara, with records also from the northern Carnarvon and eastern Gascoyne bioregions. This species is typically recorded from relatively mesic habitats, such as floodplains and drainage areas. Within the south-east Pilbara it has been collected from a number of BHP WAIO areas including the adjacent Western Ridge study area (Onshore Environmental 2014a), Orebody 35 (GHD 2011), Whaleback (Onshore Environmental 2014c), and Newman area (Biologic Environmental Survey 2009, ENV 2009a).

Ipomoea racemigera (Priority 2) is a creeping annual herb or climber with white flowers. It has previously been recorded from Newman, Millstream Chichester National Park and Kununurra. This species has previously been recorded from the Dynasty and West Jimblebar project areas, occurring along the major drainage channel of Shovellana Creek in open *Eucalyptus* woodland vegetation (Onshore Environmental 2015a). This species is also known to occur further north from the Upper Marillana and Munjina project areas.

BHP
Western Ridge
E52 - 3448
Figure 12
Conservation
Significant
Flora Species

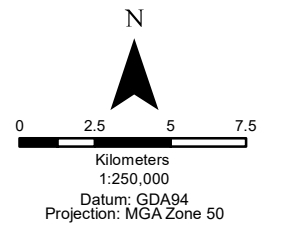


Legend

Study Area

Conservation Significant Flora

- | | | | |
|--|---|--|--|
| <ul style="list-style-type: none"> ■ Acacia bromilowiana - A.b ■ Acacia sp. East Fortescue (J. Bull & D. Roberts ONS A 27.01) - A.e ■ Acacia subtiliformis - A.s ■ Aristida jerichoensis var. subspinulifera - A.j ■ Aristida lazaridis - A.l ■ Bulbostylis burbidgeae - B.b ■ Calotis latiuscula - C.l | <ul style="list-style-type: none"> ■ Crotalaria smithiana - C.s ■ Dampiera metallorum - D.m ■ Eremophila magnifica subsp. magnifica - E.m ■ Eremophila magnifica subsp. velutina - E.v ■ Eremophila rhesos - E.rh ■ Eremophila rigida - E.r ■ Eremophila sp. Hamersley Range (K. Walker KW 136) - E.h ■ Eremophila sp. West Angelas (S. van Leeuwen 4068) - E.w ■ Eremophila youngii subsp. lepidota - E.y ■ Euphorbia inappendiculata var. inappendiculata - E.i | <ul style="list-style-type: none"> ■ Goodenia berringbinensis - G.b ■ Goodenia hartiana - G.h ■ Goodenia nuda - G.n ■ Goodenia sp. East Pilbara (A.A. Mitchell PRP 727) - G.e ■ Gymnanthera cunninghamii - G.c ■ Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708) - H.g ■ Indigofera gilesii - I.g ■ Ipomoea racemigera - I.r ■ Isotropis parviflora - I.p ■ Lepidium catapycnon - L.c | <ul style="list-style-type: none"> ■ Maireana prosthecochoeta - M.p ■ Oxalis sp. Pilbara (M.E. Trudgen 12725) - O.p ■ Rhagodia sp. Hamersley (M. Trudgen 17794) - R.h ■ Sida sp. Barlee Range (S. van Leeuwen 1642) - S.b ■ Themeda sp. Hamersley Station (M.E. Trudgen 11431) - T.h ■ Triodia sp. Mt Ella (M.E. Trudgen 12739) - T.m ■ Vittadinia sp. Coondewanna Flats (S. van Leeuwen 4684) - V.c ■ Xerochrysum boreale - X.b |
|--|---|--|--|



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 Figure: 12
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 Requested by: DB

3.6.2 Vertebrate Fauna Species

A total of 32 conservation significant species were identified during the desktop assessment; 30 from database searches and a further two species during the literature review (Figure 13³). None of the conservation significant fauna species had previously been recorded within the study area.

Based on the known distributions and habitat preferences of the species, and comparison with the habitats identified and mapped as expected to be present in the study area, four species were determined as being “likely” to occur within the study area (Table 10), and are discussed further below. One species was determined as “possible” to occur in the study area, with the remaining species identified as “unlikely” to occur (Table 10).

³ Please note that not all species are able to be mapped as some reports or database searches do not provide location data for species.

Table 10 Conservation significant fauna species identified during the desktop assessment.

Common Name	Scientific Name	Cons. Code				Habitat Preference	Suitable Habitat Present	Likelihood in the Study Area
		EPBC Act	WC Act	IUCN	DFCA			
Mammals								
Brush-tailed Mulgara	<i>Dasyercus blythi</i>			LC	P4	Sand plains	No	Unlikely
Northern Quoll	<i>Dasyurus hallucatus</i>	EN	S2	EN		Gorge/ gully, hillcrest/ hillslope, low hills	Yes	Unlikely ⁴
Long-tailed Dunnart	<i>Sminthopsis longicaudata</i>			LC	P4	Gorge/ gully, hillcrest/ hillslope, low hills	Yes	Unlikely ⁵
Greater Bilby	<i>Macrotis lagotis</i>	VU	S3	VU		Sand plains	No	Unlikely
Spectacled Hare-wallaby	<i>Lagorchestes conspicillatus</i>			LC	P4	Tussock/ hummock sand/stony plains	Yes	Unlikely
Black-flanked Rock Wallaby	<i>Petrogale lateralis</i>	EN	S2	VU		Gorge/ gully, rocky outcrops	No	Unlikely
Pilbara Leaf-nosed Bat	<i>Rhinonictis aurantia</i>	VU	S3	LC		Gorge/ gully, drainage lines	Yes	Unlikely
Ghost Bat	<i>Macroderma gigas</i>	VU	S3	VU		Gorge/ gully, drainage lines	Yes	Likely
Western Pebble-mound Mouse	<i>Pseudomys chapmani</i>			LC	P4	Hillcrest/ hillslope	Yes	Likely

⁴ Although suitable habitat is present in the study area (hillcrest/ hillslope) and there is a record of this species from the Whaleback area (Onshore Environmental 2013); the record is likely to be unreliable as an indication of the species occurrence in the area, as the record was a single roadkill and no other surveys of the area have recorded this species or evidence of it.

⁵ Although suitable habitat is present in the study area (hillcrest/ hillslope) and there is a record of this species from the Whaleback area (Ecologia 1998); the record is likely to be unreliable as an indication of the species occurrence in the area, as the record is from within the mining footprint and no other surveys of the area have recorded this species since the 1998 record.

Common Name	Scientific Name	Cons. Code				Habitat Preference	Suitable Habitat Present	Likelihood in the Study Area
		EPBC Act	WC Act	IUCN	DBCA			
Reptiles								
Unpatterned Robust Slider Skink	<i>Lerista macropisthopus remota</i>			LC	P2	Sand plains	No	Unlikely
Gane's Blind Snake	<i>Anilius ganei</i>			LC	P1	Rocky vegetated areas	Yes	Likely
Pilbara Olive Python	<i>Liasis olivaceus barroni</i>	VU	S3	LC		Gorge/ gully, major drainage lines	No	Unlikely
Birds								
Glossy Ibis	<i>Plegadis falcinellus</i>	MG	S5	LC		Waterbodies, major drainage lines	No	Unlikely
Oriental Plover	<i>Charadrius veredus</i>	MG	S5	LC		Waterbodies, major drainage lines	No	Unlikely
Australian Painted Snipe	<i>Rostratula australis</i>	EN	S2	EN		Waterbodies, major drainage lines	No	Unlikely
Common Greenshank	<i>Tringa nebularia</i>	MG	S5	LC		Waterbodies, major drainage lines	No	Unlikely
Marsh Sandpiper	<i>Tringa stagnatilis</i>	MG	S5	LC		Waterbodies, major drainage lines	No	Unlikely
Wood Sandpiper	<i>Tringa glareola</i>	MG	S5	LC		Waterbodies, major drainage lines	No	Unlikely
Common Redshank	<i>Tringa totanus</i>	MG	S5	LC		Waterbodies, major drainage lines	No	Unlikely
Common Sandpiper	<i>Actitis hypoleucos</i>	MG	S5	LC		Waterbodies, major drainage lines	No	Unlikely
Long-toed Stint	<i>Calidris subminuta</i>	MG	S5	LC		Waterbodies, major drainage lines	No	Unlikely
Pectoral Sandpiper	<i>Calidris melanotos</i>	MG	S5	LC		Waterbodies, major drainage lines	No	Unlikely
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	MG	S5	LC		Waterbodies, major drainage lines	No	Unlikely
Curlew Sandpiper	<i>Calidris ferruginea</i>	CR, MG	S3	NT		Waterbodies, major drainage lines	No	Unlikely

Common Name	Scientific Name	Cons. Code				Habitat Preference	Suitable Habitat Present	Likelihood in the Study Area
		EPBC Act	WC Act	IUCN	DBCA			
Fork-tailed Swift	<i>Apus pacificus</i>	MG	S5	LC		Entirely aerial	N/A ⁶	Unlikely
Grey Falcon	<i>Falco hypoleucos</i>		S3	VU		Stony plains, sand plains, drainage lines	Yes	Unlikely
Peregrine Falcon	<i>Falco peregrinus</i>		S7	LC		Gorge/ gully, hillcrest/ hillslope, low hills	Yes	Likely
Night Parrot	<i>Pezoporus occidentalis</i>	EN	S1	EN		Sand plains	No	Unlikely
Princess Parrot	<i>Polytelis alexandrae</i>	VU		NT	P4	Sand plains	No	Unlikely
Barn Swallow	<i>Hirundo rustica</i>	MG	S5	LC		All habitats	Yes	Possible
Yellow Wagtail	<i>Motacilla flava</i>	MG	S5	LC		Wet habitats with low vegetation	No	Unlikely
Grey Wagtail	<i>Motacilla cinerea</i>	MG	S5	LC		Mountain streams and rivers with exposed rocks, often in forested areas	No	Unlikely

⁶ Species does not utilise terrestrial habitats

The Ghost Bat (*Macroderma gigas*) is listed as Vulnerable under the EPBC Act and IUCN Redlist, and Schedule 3 under the WC Act. This species formerly occurred over a wide area of central, northern and southern Australia but has declined significantly in the southern parts of its range, and is now spatially fragmented across northern Australia (Armstrong and Anstee 2000). In Western Australia, the Ghost Bat is now confined to the Kimberly and Pilbara, where its distribution is influenced by the availability of suitable caves and abandoned mine shafts for roosting. Ghost Bats in the Pilbara roost in deep, complex caves beneath bluffs of low rounded hills composed of Marra Mamba or Banded Iron Formation, granite rock piles and abandoned mines (Armstrong and Anstee 2000).

The Ghost Bat has previously been recorded approximately 3 km to the north of the study area at Orebody 35 (Biologic Environmental Survey 2011, Ecologia 2006a). While there is unlikely to be any suitable roosts within the study area for the Ghost Bat, it may forage over the habitats of the study area, particularly along the minor drainage line habitat type. Due to the presence of suitable foraging habitat and the close proximity of previous records, this species is considered likely to occur (i.e. forage) within the study area.

Western Pebble-mound Mouse (*Pseudomys chapmani*) is listed as a Priority 4 species by DBCA. This species has experienced a significant decline in its range through the Gascoyne and Murchison, and is now considered endemic to the Pilbara (Van Dyck and Strahan 2008). The Western Pebble-mound Mouse occurs almost exclusively on the hillslopes and low hills vegetated by hard spinifex and where the ground is covered with a stony mantle (Van Dyck and Strahan 2008).

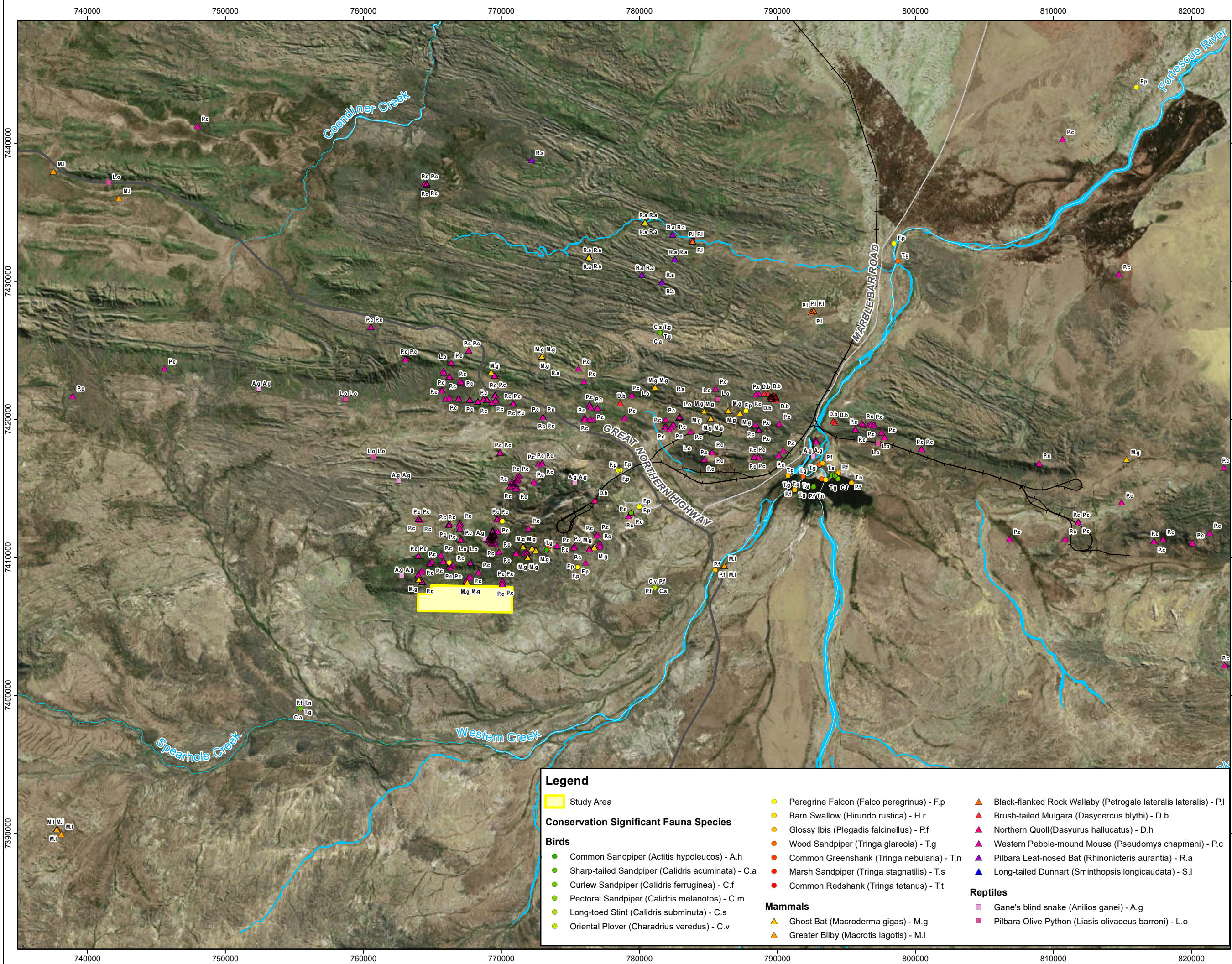
The Western Pebble-mound Mouse has been recorded extensively throughout the Whaleback area and to the north of the study area (Appendix 6). Due to the numerous nearby records of this species and the presence of suitable habitat mapped within the study area (i.e. hillcrest/ hillslope), this species is considered likely to occur in the study area.

The Gane's Blind Snake (*Anilius ganei*) is listed as a Priority 1 species by the DBCA and is considered endemic to the Pilbara. Given its cryptic fossorial habit, this species is rarely encountered. The Gane's Blind Snake is associated with moist gorges and gullies (Wilson and Swan 2010) and potentially with a wide range of other stony habitats.

Based on the known habitat characteristics and distribution, this species has the potential to occur within the gilgai plain, hillcrest/ hillslope and stony plain habitat types mapped for the study area. The Gane's Blind Snake has previously been recorded approximately 8 km the north of the study area at Whaleback/ Orebody 35 (Biologic Environmental Survey 2011). Given the nearby record and expected presence of suitable habitat, this species is considered likely to occur in the study area.

Peregrine Falcon (*Falco peregrinus*) is listed as Schedule 7 under the WC Act. It is considered to be rare or scarce over much of its range, including the Pilbara (Johnstone and Storr 1998). In arid areas it is most often encountered along cliffs above rivers, ranges and wooded watercourses where it hunts birds (Johnstone and Storr 1998). Inland, it is most often encountered along cliffs above rivers, ranges and wooded watercourses and lakes, where it hunts birds (Johnstone and Storr 1998). It typically nests on rocky ledges occurring on tall, vertical cliff faces and tall trees associated with drainage lines (Olsen and Olsen 1989).

The Peregrine Falcon has been recorded to the north of the study area at Orebody 35 (Biologic Environmental Survey 2011), and Whaleback (Ecologia 1998). This species may forage across all of the habitat types mapped for the study area, and coupled with the nearby records, it is therefore considered likely to occur in the study area.

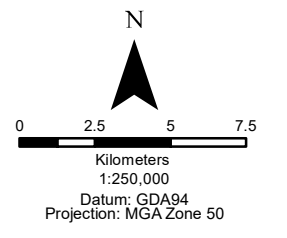


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Study Area

Conservation Significant Fauna Species

<p>Birds</p> <ul style="list-style-type: none"> ● Common Sandpiper (<i>Actitis hypoleucos</i>) - A.h ● Sharp-tailed Sandpiper (<i>Calidris acuminata</i>) - C.a ● Curlew Sandpiper (<i>Calidris ferruginea</i>) - C.f ● Pectoral Sandpiper (<i>Calidris melanotos</i>) - C.m ● Long-toed Stint (<i>Calidris subminuta</i>) - C.s ● Oriental Plover (<i>Charadrius veredus</i>) - C.v 	<ul style="list-style-type: none"> ● Peregrine Falcon (<i>Falco peregrinus</i>) - F.p ● Barn Swallow (<i>Hirundo rustica</i>) - H.r ● Glossy Ibis (<i>Plegadis falcinellus</i>) - P.f ● Wood Sandpiper (<i>Tringa glareola</i>) - T.g ● Common Greenshank (<i>Tringa nebularia</i>) - T.n ● Marsh Sandpiper (<i>Tringa stagnatilis</i>) - T.s ● Common Redshank (<i>Tringa tetanus</i>) - T.t 	<ul style="list-style-type: none"> ▲ Black-flanked Rock Wallaby (<i>Petrogale lateralis lateralis</i>) - P.l ▲ Brush-tailed Mulgara (<i>Dasyurus blythi</i>) - D.b ▲ Northern Quoll (<i>Dasyurus hallucatus</i>) - D.h ▲ Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>) - P.c ▲ Pilbara Leaf-nosed Bat (<i>Rhinonicteris aurantia</i>) - R.a ▲ Long-tailed Dunnart (<i>Sminthopsis longicaudata</i>) - S.l
<p>Mammals</p> <ul style="list-style-type: none"> ▲ Ghost Bat (<i>Macroderma gigas</i>) - M.g ▲ Greater Bilby (<i>Macrotis lagotis</i>) - M.l 	<p>Reptiles</p> <ul style="list-style-type: none"> ■ Gane's blind snake (<i>Anilius ganei</i>) - A.g ■ Pilbara Olive Python (<i>Liasis olivaceus barroni</i>) - L.o 	



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3.6.3 SRE Invertebrate Fauna Species

A total of 41 Confirmed or Potential SRE invertebrate fauna species were identified during the desktop assessment; 24 from database searches and a further 17 species during the literature review (Figure 14⁷). None of the species have previously been recorded within the study area.

The drainage areas habitat type of the study area was identified as offering moderate suitability for SRE invertebrate fauna, such as mygalomorph spiders.

Eight mygalomorph spiders were identified during the desktop assessment, three of which (all categorised as Confirmed SRE species) have been recorded from the adjacent Western Ridge and Orebody 35 area (AMBS 2011) (Figure 14), and are considered “likely” to occur in the study area:

- *Aname* ‘MYG098’;
- *Aname* ‘MYG205’; and
- *Aname* ‘MYG206’.

These species were all recorded in open floodplain habitat during the AMBS (2011) survey, with the drainage area habitat type identified within the study area likely to provide similar habitat attributes.

Aname ‘MYG205’ and *Aname* ‘MYG206’ are both known from the Boolgeeda and Elimunna land systems in the Newman area (Biologic Environmental 2015), both of which only occur in small sections of the study area (Figure 4). *Aname* ‘MYG098’ is known from the Newman and Boolgeeda land systems in the Newman area (Biologic Environmental 2015), both of which also occur only in small sections of the study area (Figure 4). This taxon is also known from the Platform land system of the Jinidi area (Biologic Environmental 2015), which is not present in the study area.

One additional mygalomorph spider was identified as “possible” to occur in the study area, *Cethegus* ‘MYG299-DNA’ (categorised as a Potential SRE species). This species was recorded from the Orebody 24 area and is known to inhabit moderately open Mulga vegetation along drainage lines (Biologic Environmental 2016b). The drainage area habitat type of the study area may provide suitable habitat for this species, however due to the distance of the record from the study area, it is not considered likely to occur.

Eight isopod species from the genus *Buddelundia* and sub-family Buddelundiinae were identified during the desktop assessment. Five of these species (all categorised as Potential SRE species) were reported from the Orebody 24 area approximately 15 km north-east of the study area (Biologic Environmental 2016b):

- *Buddelundia* 16NM;
- *Buddelundia* 78;
- *Buddelundia* 79;
- *Buddelundia* 80; and
- Buddelundiinae OB24.

These five species are considered “possible” to occur within the study area as they are known from open sandy/ stony plain habitats, and therefore the stony plain habitats of the study area may provide possible habitat for these species. In addition, there is anecdotal evidence that an isopod specimen aligning to *Buddelundia* 16NM was detected at Orebody 35 (S. Judd pers. comm. 2013, as reported in Biologic Environmental 2016b).

Other species recorded from the nearby Western Ridge and Orebody 35 area (i.e. *Urodacus* ‘pilbara 12’, *Antichiropus* ‘DIP014’ and *Antichiropus* ‘DIP015’) were all recorded from either gullies or steep rocky slopes habitats, which are absent from the study area (AMBS 2011) and therefore

⁷ Please note that not all species are able to be mapped as some database searches do not provide location data for species.

these taxa are considered “unlikely” to occur.

The majority of the study area offers habitat considered to be of low suitability for SRE invertebrate fauna. This coupled with the known distributions of taxa, it is determined that the remaining SRE invertebrate fauna species identified during the desktop assessment are considered “unlikely” to occur.

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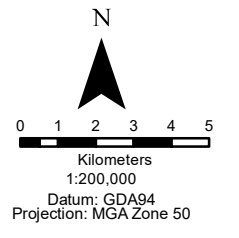


BHP

Western Ridge
E52 - 3448
Figure 14

Significant SRE
Invertebrate Fauna
Species

- Legend**
- Study Area
- Potential SRE Invertebrate Fauna**
- Buddelundia 16NM (B.16)
 - Buddelundia 49 (B.49)
 - Buddelundia 78 (B.78)
 - Buddelundia 79 (B.79)
 - Buddelundia 80 (B.80)
 - Buddelundiinae OB24 (B.24)
 - Cethegus sp. MYG299-DNA (C.299)
 - Conothele sp. MYG385-DNA (C.385)
 - Karaops sp. ARA005-DNA (K.5)
 - Urodacus sp. pilbara12 (U.p)
- Confirmed SRE Invertebrate Fauna**
- Aname sp. MYG098 (A.98)
 - Aname sp. MYG205 (A.205)
 - Aname sp. MYG206 (A.206)
 - Antichiropus sp. DIP014 (A.D14)
 - Antichiropus sp. DIP015 (A.D15)
 - Aureococrypta, sp., MYG315-DNA (A.315)
 - Feaella callani (F.c)
- Confirmed / Potential SRE (WAM Data)**
- Mollusca**
- Austropeplea vinosa (A.v)
 - Discocharopa sp. (D.i)
- Arachnida/ Myriapoda**
- Austrochthonius sp. (A.u)
 - Beierolpium sp. '8/2' (B.8/2)
 - Beierolpium sp. '8/3' (B.8/3)
 - Euryolpium sp. (E.u)
 - Indolpium sp.(l.n)
 - Synothele sp. indet. (juvenile) (S.i)
 - Tyrannochthonius aridus (T.a)
 - Unixenus sp. (U.n)
 - Urodacus sp. 'pilbara12' (U.p12)
- Crustacea**
- Buddelundia sp. 14cr (B.14cr)
 - Buddelundia sp. 49 (B.49)
 - Troglarmadillo sp. ISO005 (T.005)



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



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4.0 SUMMARY

BHP WAIO commissioned Onshore Environmental to undertake a desktop flora, vegetation and terrestrial fauna (vertebrate fauna and SRE invertebrate fauna) assessment of the Western Ridge exploration tenement E52/3448 (the study area). The assessment was to include mapping of vegetation associations and land unit within the study area, as well as terrestrial fauna habitats. The study area is located immediately south of the Mt Whaleback Mine and approximately 7 km south-west of Newman, and covers an area of approximately 1202 ha.

At least 44 baseline biological surveys have been completed at BHP WAIO tenements within a 25 km radius of the study area. This includes 37 surveys relating to flora and vegetation, 15 relating to vertebrate fauna and three relating to SRE invertebrate fauna. None of the previous biological surveys overlap the study area, however the adjacent areas have been surveyed. The closest previous surveys include a desktop assessment and mapping of BHP WAIO's Western Ridge southern exploration tenements E52/3360 and E52/3361, located directly west and east of the study area, and surveying of BHP WAIO's Western Ridge tenement E52/2008 that adjoins the northern boundary of the study area.

The flora and vegetation desktop assessment identified one Threatened Flora and 37 Priority flora species potentially occurring within the vicinity of the study area. None of conservation significant flora species identified had previously been recorded within the study area. Based on the known distributions and habitat preferences of the taxa, four Priority flora species were determined as being "likely" to occur within the study area:

- *Calotis latiuscula* (Priority 3);
- *Eremophila magnifica* subsp. *magnifica* (Priority 4);
- *Goodenia nuda* (Priority 4); and
- *Ipomoea racemigera* (Priority 2).

Land unit mapping completed for the study area identified 11 land units defined within the four land systems occurring in the study area. Eight vegetation associations from BHP WAIO's Pilbara consolidated vegetation mapping were aligned to the 11 land units based on detailed descriptions provided in van Vreeswyk *et al.* (2004).

In addition, 13 vegetation associations, classified under six broad floristic formations, were mapped within the study area on the basis of topography, land units and extrapolated from neighbouring baseline mapping. The landforms represented included hill crests/upper hill slopes, hill slopes, stony plains, calcrete plains, flood plains, gilgai plains, and minor drainage lines.

None of the vegetation associations mapped within the study area were considered to be aligned with Federal or State listed TECs, or State listed PECs. However, two vegetation association supporting Mulga Low Woodland were representative of 'Valley Floor Mulga' within the Hamersley subregion, which is considered to be an 'ecosystem at risk' by the Department of Conservation and Land Management (now DBCA).

The terrestrial fauna desktop assessment identified 32 conservation significance fauna species potentially occurring within the vicinity of the study area. Four of these taxa were determined to be "likely" to occur within the study area based on available habitat and distance to the nearest known record:

- Ghost Bat (*Macroderma gigas*) – Vulnerable (EPBC Act and IUCN Redlist) and Schedule 3 (WC Act);
- Western Pebble-mound Mouse (*Pseudomys chapmani*) – Priority 4 (DBCA);
- Gane's Blind Snake (*Anilius ganei*) – Priority 1 (DBCA); and
- Peregrine Falcon (*Falco peregrinus*) – Schedule 7 (WC Act).

A total of 41 Confirmed or Potential SRE invertebrate fauna species were identified during the

desktop assessment as potentially occurring within the vicinity of the study area. Of which, three Confirmed SRE invertebrate fauna taxa were determined to “likely” occur within the study area based on available habitat and species distribution:

- *Aname* ‘MYG098’;
- *Aname* ‘MYG205’; and
- *Aname* ‘MYG206’.

Six vertebrate fauna habitats were mapped within the study area on the basis of land units, vegetation mapping and extrapolated from neighbouring baseline mapping. In addition, three broad SRE invertebrate fauna habitats were identified for the study area, inferred from topography, landforms and vegetation mapping. None of the habitat types within the study area would be considered significant, however the calcrete plain and gilgai plain habitat types are both under-represented in the Pilbara region.

5.0 STUDY TEAM

The desktop assessment was planned, co-ordinated and executed by the following personnel:

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Mr Michael Brown	BSc	Senior Zoologist
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APPENDIX 1

Status codes for species listed on the IUCN 'Red List'

Category	Description
Extinct (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Extinct in the Wild (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (CR)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
Least Concern (LC)	A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
Data Deficient (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.
Not Evaluated (NE)	A taxon is Not Evaluated when it has not yet been evaluated against the criteria.

APPENDIX 2

Conservation categories for species listed 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 3

Conservation categories for species listed under the WC Act

Flora Species - Wildlife Conservation (Rare Flora) Notice 2017

Category	Description
Schedule 1	Flora that are considered likely to become extinct or rare, as critically endangered flora.
Schedule 2	Flora that are considered likely to become extinct or rare, as endangered flora.
Schedule 3	Flora that are considered likely to become extinct or rare, as vulnerable flora.
Schedule 4	Flora presumed to be extinct.

Fauna Species - Wildlife Conservation (Specially Protected Fauna) Notice 2017

Category	Description
Schedule 1	Fauna that is rare or is likely to become extinct as critically endangered fauna.
Schedule 2	Fauna that is rare or is likely to become extinct as endangered fauna.
Schedule 3	Fauna that is rare or is likely to become extinct as vulnerable fauna.
Schedule 4	Fauna presumed to be extinct.
Schedule 5	Migratory birds protected under an international agreement.
Schedule 6	Fauna that is of special conservation need as conservation dependent fauna.
Schedule 7	Other specially protected fauna.

APPENDIX 4

Conservation codes for Western Australian flora and fauna

Threatened Species

Published as Specially Protected under the *Wildlife Conservation Act 1950*, and listed under Schedules 1 to 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna* and *Wildlife Conservation (Rare Flora) Notice for Threatened Flora* (which may also be referred to as Declared Rare Flora).

Threatened fauna is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the *Wildlife Conservation Act*.

Threatened flora is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the *Wildlife Conservation Act*.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria.

Priority One: Poorly-known species

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

Priority Two: Poorly-known species

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

Priority Three: Poorly-known species

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

Priority Four: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

APPENDIX 5

Vegetation classifications for the Pilbara based on Specht (1970), as modified by Aplin (1979) and Trudgen (2002)

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

Source: S. Van Leeuwen (DBCA)

APPENDIX 6

Results from previous flora and vegetation, vertebrate fauna, and SRE invertebrate fauna surveys completed in the vicinity of the study area

Flora and Vegetation Surveys

Project	Survey Timing	Season	Survey Type	No. Taxa	Significant Flora	Introduced Flora
Western Ridge Southern Tenements Flora and Vegetation Desktop Assessment (Onshore Environmental 2016)	N/A	N/A	Desktop	N/A	Identified from desktop assessment as likely to occur in the study area: <i>Aristida lazaridis</i> (P2), <i>Calotis latiuscula</i> (P3), <i>Eremophila magnifica</i> subsp. <i>magnifica</i> (P4), <i>Eremophila magnifica</i> subsp. <i>velutina</i> (P3), <i>Goodenia nuda</i> (P4), <i>Gymnanthera cunninghamii</i> (P3), <i>Indigofera gilesii</i> (P3), <i>Ipomoea racemigera</i> (P2), <i>Isotropis parviflora</i> (P2), <i>Lepidium catapycnon</i> (P4), <i>Triodia</i> sp. Mt Ella (M.E. Trudgen 12739) (P3)	N/A
Newman Shopping Centre Powerline Extension (Onshore Environmental 2015b)	Nov 2015	Poor	Single-season Reconnaissance	136	None	* <i>Aerva javanica</i> , * <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Coryza bonariensis</i> , * <i>Flaveria trinerva</i> , * <i>Lactuca serriola</i> forma <i>serriola</i> , * <i>Rumex vesicarius</i>
Western Ridge Biological Survey (Onshore Environmental 2014a)	Jun 2014	Good	Single-season Detailed	199	<i>Calotis latiuscula</i> (P3), <i>Aristida</i> cf. <i>nitidula</i> (species of interest)	* <i>Aerva javanica</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Malvastrum americanum</i> , * <i>Setaria verticillata</i> , * <i>Vachellia farnesiana</i>
Mt Whaleback OB29/30/35 Targeted Flora Survey Assessment (Onshore Environmental 2014c)	Feb 2014	Good	Targeted	N/A	<i>Calotis latiuscula</i> (P3), <i>Eremophila magnifica</i> subsp. <i>magnifica</i> (P4), <i>Gymnanthera cunninghamii</i> (P3), <i>Goodenia nuda</i> (P4), <i>Lepidium catapycnon</i> (P4)	N/A
Flora and Vegetation and Vertebrate Fauna Review Mt Whaleback AML 7/244 (Onshore Environmental 2013)	N/A	N/A	Desktop	352	<i>Calotus latiuscula</i> (P3), <i>Eremophila magnifica</i> subsp. <i>magnifica</i> (P4), <i>Lepidium catapycnon</i> (P4)	* <i>Aerva javanica</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Chloris barbata</i> , * <i>Chloris virgata</i> , * <i>Coryza bonariensis</i> , * <i>Cucumis melo</i> subsp. <i>agrestis</i> , * <i>Cynodon dactylon</i> , * <i>Echinochloa colona</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Schinus molle</i> , * <i>Sisymbrium orientale</i> , * <i>Solanum nigrum</i> , * <i>Sonchus oleraceus</i> , * <i>Tribulus terrestris</i> , * <i>Vachellia farnesiana</i>

Project	Survey Timing	Season	Survey Type	No. Taxa	Significant Flora	Introduced Flora
Orebody 35 and Surrounds Flora and Vegetation Survey (GHD 2011)	May 2010 Aug 2010	Poor	Two-season Detailed	347	<i>Indigofera gilesii</i> (P3), <i>Gymnanthera cunninghamii</i> (P3), <i>Goodenia nuda</i> (P4)	* <i>Aerva javanica</i> , * <i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cynodon dactylon</i> , * <i>Flaveria trinervia</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Sisymbrium orientale</i> , * <i>Solanum nigrum</i> , * <i>Sonchus oleraceus</i> , * <i>Vachellia farnesiana</i>
Mt Whaleback East Flora, Vegetation and Fauna Survey (ENV 2011b)	Jan 2011	Poor	Single-season Detailed	127	None	* <i>Agave americana</i> , * <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i> , * <i>Schinus molle</i> , * <i>Tamarindus indica</i>
Mt Whaleback Flora and Vegetation Assessment (ENV 2011a)	May - Jun 2011	Good	Single-season Detailed	272	<i>Calotis latiuscula</i> (P3), <i>Eremophila magnifica</i> subsp. <i>magnifica</i> (P4), <i>Lepidium catapycnon</i> (P4)	* <i>Aerva javanica</i> , * <i>Agave americana</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Chloris barbata</i> , * <i>Chloris virgata</i> , * <i>Conyza bonariensis</i> , * <i>Cucumis melo</i> subsp. <i>agrestis</i> , * <i>Cynodon dactylon</i> , * <i>Echinochloa colona</i> , * <i>Flaveria trinervia</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Schinus molle</i> , * <i>Solanum nigrum</i> , * <i>Sonchus oleraceus</i> , * <i>Tamarindus indica</i> , * <i>Tribulus terrestris</i> , * <i>Vachellia farnesiana</i> , * <i>Washingtonia filifera</i>
Mt Whaleback Mine Site Weed Inspection, August 2010 (Astron 2010a)	Aug 2010	Poor	Targeted (weeds)	N/A	N/A	* <i>Aerva javanica</i> , * <i>Argemone ochroleuca</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cynodon dactylon</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Setaria verticillata</i> , * <i>Sonchus oleraceus</i> , * <i>Sisymbrium orientale</i> , * <i>Tamarix aphylla</i>
Mt Whaleback TSF Flora, Vegetation and Fauna Assessment (Astron 2010b)	Mar 2010	Poor	Single-season Detailed	71	None	* <i>Cenchrus ciliaris</i> , * <i>Vachellia farnesiana</i>
Orebody 35 Vegetation Clearing Permit Area Flora and Fauna Assessment (ENV 2010)	Dec 2009	Poor	Single-season Detailed	189	None	* <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i>

Project	Survey Timing	Season	Survey Type	No. Taxa	Significant Flora	Introduced Flora
Newman Power Network, Level 2 Flora and Level 1 Fauna Survey (Biologic Environmental Survey 2009)	Jul 2009	Good	Single-season Reconnaissance	319	<i>Goodenia nuda</i> (P4)	* <i>Aerva javanica</i> , * <i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Cucumis lanatus</i> , * <i>Cynodon dactylon</i> , * <i>Datura leichhardtii</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Schinus molle</i> , * <i>Solanum nigrum</i> , * <i>Sonchus oleraceus</i> , * <i>Vachellia farnesiana</i>
Flora and Vegetation Survey and Fauna Assessment Mt Whaleback Mine Site (Onshore Environmental 2009)	Jun 2009	Poor	Single-season Detailed	201	None	* <i>Aerva javanica</i> , * <i>Argemone ochroleuca</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Chloris barbata</i> , * <i>Cynodon dactylon</i> , * <i>Echinochloa colona</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Setaria verticillata</i> , * <i>Sisymbrium orientale</i> , * <i>Solanum nigrum</i> , * <i>Sonchus oleraceus</i> , * <i>Vachellia farnesiana</i>
Newman to Jimblebar Transmission Line and Newman Town Substation Flora and Vegetation Assessment (ENV 2009a)	Apr 2009	Poor	Single-season Detailed	365	<i>Goodenia nuda</i> (P4)	* <i>Aerva javanica</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cenchrus setiger</i> , * <i>Cynodon dactylon</i> , * <i>Datura leichhardtii</i> , * <i>Echinochloa colona</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Setaria verticillata</i> , * <i>Sonchus oleraceus</i> , * <i>Tribulus terrestris</i> , * <i>Vachellia farnesiana</i>
Mount Whaleback Power Station Flora and Vegetation Assessment (ENV 2009b)	Apr 2009	Good	Single-season Detailed	124	None	* <i>Aerva javanica</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i>
Newman Water Pipeline Enhancement Project: Flora and Vegetation Assessment (Ecologia 2008)	Apr 2008	Good	Single-season Reconnaissance	353	<i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431) (P3)	* <i>Aerva javanica</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Centaureum erythraea</i> , * <i>Chloris virgata</i> , * <i>Citrullus colocynthis</i> , * <i>Citrullus lanatus</i> , * <i>Conyza bonariensis</i> , * <i>Cynodon dactylon</i> , * <i>Datura leichhardtii</i> , * <i>Echinochloa colona</i> , * <i>Malvastrum americanum</i> , * <i>Vachellia farnesiana</i>

Project	Survey Timing	Season	Survey Type	No. Taxa	Significant Flora	Introduced Flora
Rail RGP5 Repeater 9 Access Road Flora and Vegetation Assessment (ENV 2008a)	Jun 2008	Good	Single-season Detailed	163	<i>Rostellularia adscendens</i> var. <i>latifolia</i> (P3)	* <i>Aerva javanica</i> , * <i>Brassica tournefortii</i> , * <i>Cenchrus ciliaris</i> , * <i>Citrullus lanatus</i> , * <i>Cynodon dactylon</i> , * <i>Datura leichhardtii</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Setaria verticillata</i> , * <i>Sonchus asper</i> , * <i>Sonchus oleraceus</i> , * <i>Vachellia farnesiana</i>
Rail RGP5 Summary of Important Findings from RGP5 Railway Project Biological Assessments (ENV 2008b)	Apr 2008	Good	Single-season Detailed	N/A	<i>Rostellularia adscendens</i> var. <i>latifolia</i> (P3)	* <i>Aerva javanica</i> , * <i>Cenchrus ciliaris</i> , * <i>Cynodon dactylon</i> , * <i>Malvastrum americanum</i> , * <i>Bidens bipinnata</i> , * <i>Setaria verticillata</i> , * <i>Tribulus terrestris</i>
Mount Whaleback Newman Kurra Village Extension Area Flora and Vegetation Assessment (ENV 2006a)	Sep 2006	Good	Single-season Detailed	117	None	* <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Conyza bonariensis</i> , * <i>Cynodon dactylon</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Solanum nigrum</i>
Newman Ammonium Nitrate Storage Facility Conservation Significant Flora Survey (Ecologia 2006b)	Jan 2006	Very Good	Targeted	64	None	* <i>Cenchrus ciliaris</i>
Newman Ammonium Nitrate Storage Facility Phase II Conservation Significant Flora Survey (Ecologia 2006c)	Apr 2006	Very Good	Targeted	122	None	* <i>Aerva javanica</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i>
Mount Whaleback Flora and Vegetation Assessment Phase III Summary Report (ENV 2006b)	Aug 2006	Very Good	Single-season Detailed	243	<i>Lepidium catapycnon</i> (P4)	* <i>Aerva javanica</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Sisymbrium orientale</i> , * <i>Solanum nigrum</i>

Project	Survey Timing	Season	Survey Type	No. Taxa	Significant Flora	Introduced Flora
Western Ridge Exploration Project Biological Survey (Ecologia 2006a)	May - Jun 2006	Very Good	Single-season Detailed	152	<i>Calotis latiuscula</i> (P3)	* <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i>
RGP4 Newman Hub Infrastructure Area Flora and Vegetation Assessment (ENV 2006c)	Sep 2006	Good	Single-season Detailed	168	None	* <i>Argemone ochroleuca subsp. ochroleuca</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Conyza bonariensis</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Sisymbrium orientale</i> , * <i>Solanum nigrum</i>
Newman Hub Rail Corridor Declared Rare and Priority Flora Survey (ENV 2006d)	Sep 2006	Good	Targeted	N/A	None	* <i>Cenchrus ciliaris</i>
RGP4 Newman Hub Topsoil Stockpile and Borrow Areas for Construction Flora and Vegetation Assessment (ENV 2006e)	Oct 2006	Good	Single-season Detailed	285	<i>Acacia kenneallyi</i> (P3) ⁸	* <i>Argemone ochroleuca subsp. ochroleuca</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Conyza bonariensis</i> , * <i>Euphorbia hirta</i> , * <i>Malvastrum americanum</i> , * <i>Helichrysum luteoalbum</i> , * <i>Rumex crispus</i> , * <i>Rumex vesicarius</i> , * <i>Schinus molle</i> , * <i>Sisymbrium orientale</i> , * <i>Solanum nigrum</i> , * <i>Sonchus oleraceus</i>
Western Ridge Exploration Project Biological Survey (Ecologia 2005)	May 2005	Good	Single-season Detailed	152	None	None
BHP Billiton Ongoing Works Newman Hub (Ecologia 2004a)	Jun 2004	Poor	Targeted	N/A	None	* <i>Aerva javanica</i> , * <i>Amaranthus caudatus</i> , * <i>Cenchrus setiger</i> , * <i>Rumex vesicarius</i>
Newman Village Declared Rare and Priority Flora and Weed Survey (Ecologia 2004b)	Jun - Jul 2004	Poor	Targeted	N/A	None	* <i>Cenchrus setiger</i>

⁸ *Acacia kenneallyi* is restricted to the northern Kimberley region of Western Australia and the Whaleback record was a misidentification (Onshore Environmental 2014).

Project	Survey Timing	Season	Survey Type	No. Taxa	Significant Flora	Introduced Flora
Mt Whaleback Priority Flora Species Survey (BHP Billiton Iron Ore 2000)	Jul 2000	Good	Targeted	N/A	None	N/A
Baseline Biological and Soil Surveys and Mapping for ML244SA West of the Fortescue River (Biota 2001)	Sep 2000	Very Good	Single-season Level 2	380	None	* <i>Argemone ochroleuca</i> , * <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Cenchrus echinatus</i> , * <i>Cenchrus setiger</i> , * <i>Coryza bonariensis</i> , * <i>Cynodon dactylon</i> , * <i>Hypochaeris glabra</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i> , * <i>Sisymbrium erysimoides</i> , * <i>Solanum nigrum</i> , * <i>Sonchus oleraceus</i>
Follow-Up Survey of Mt Whaleback <i>Lepidium catapycnon</i> population (Halpern Glick Maunsell 1999a)	May 1999	Good	Targeted	N/A	<i>Lepidium catapycnon</i> (P4)	N/A
Orebody 30 and Orebody 35 Soil and Biological Survey (Halpern Glick Maunsell 1999b)	Nov 1996	Poor	Single-season Detailed	206	None	* <i>Bidens bipinnata</i> , * <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i> , * <i>Rumex vesicarius</i>
Field Search and Observations of <i>Lepidium catapycnon</i> Population Near Mt Whaleback, Newman (BHP Billiton Iron Ore 1999a)	Jun - Aug 1999	Good	Targeted	N/A	<i>Lepidium catapycnon</i> (P4)	N/A
Regional Search for <i>Lepidium catapycnon</i> in the greater Newman Area (Pilbara), Western Australia (BHP Billiton Iron Ore 1999b)	Jun - Nov 1999	Good	Targeted	N/A	<i>Lepidium catapycnon</i> (P4)	N/A

Project	Survey Timing	Season	Survey Type	No. Taxa	Significant Flora	Introduced Flora
Mt Whaleback Soil and Vegetation Mapping (Halpern Glick Maunsell 1997)	Nov 1996	Poor	Targeted	N/A	<i>Lepidium catapycnon</i> (P4)	None
Newman Lease Environmental Appraisal (Maunsell and Partners 1984)	Oct 1984	Poor	N/A	N/A	None	None

Vertebrate Fauna Surveys

Project	Survey Timing	Survey Type	No. Taxa	Significant Fauna
Western Ridge Southern Tenements Vertebrate Fauna Desktop Assessment (Biologic Environmental Survey 2016a)	N/A	Desktop	N/A	Identified from desktop assessment as likely to or may occur in the study area: Barn Swallow (<i>Hirundo rustica</i>) (MG, S5), Brush-tailed Mulgara (<i>Dasyercus blythi</i>) (P4), Fork-tailed Swift (<i>Apus pacificus</i>) (MG, S5), Gane's Blind Snake (<i>Anilius ganei</i>) (P1), Ghost Bat (<i>Macroderma gigas</i>) (Vu, S3), Peregrine Falcon (<i>Falco peregrinus</i>) (S7), Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>) (P4).
Western Ridge Biological Survey (Onshore Environmental 2014)	Jun 2014	Single-season Level 1	62	None
Flora and Vegetation and Vertebrate Fauna Review Mt Whaleback AML 7/244 (Onshore Environmental 2013)	N/A	Desktop	323	Identified from desktop assessment previously recorded from the study area: Common Greenshank (<i>Tringa nebularia</i>) (MG, S5), Common Redshank (<i>Tringa totanus</i>) (MG, S5), Common Sandpiper (<i>Actitis hypoleucos</i>) (MG, S5), Ghost Bat (<i>Macroderma gigas</i>) (Vu, S3), Long-tailed Dunnart (<i>Sminthopsis longicaudata</i>) (P4), Marsh Sandpiper (<i>Tringa stagnatilis</i>) (MG, S5), Northern Quoll (<i>Dasyurus hallucatus</i>) (En), Peregrine Falcon (<i>Falco peregrinus</i>) (S7), Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>) (P4), Wood Sandpiper (<i>Tringa glareola</i>) (MG, S5).
Mt Whaleback East Flora, Vegetation and Fauna Survey (ENV 2011b)	Jan 2011	Single-season Level 1	46	None
Orebody 35 and Western Ridge Vertebrate Fauna Study (Biologic Environmental Survey 2011)	Mar and Aug 2010	Two-season Level 2	165	Common Greenshank (<i>Tringa nebularia</i>) (MG, S5), Gane's Blind Snake (<i>Anilius ganei</i>) (P1), Ghost Bat (<i>Macroderma gigas</i>) (Vu, S3), Peregrine Falcon (<i>Falco peregrinus</i>) (S7), Pilbara Olive Python (<i>Liasis olivaceous barroni</i>) (Vu, S3), Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>) (P4), Wood Sandpiper (<i>Tringa glareola</i>) (MG, S5).
Mt Whaleback TSF Flora, Vegetation and Fauna Assessment (Astron 2010b)	Mar 2010	Single-season Level 1	3	Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>) (P4).
Orebody 35 Vegetation Clearing Permit Area Flora and Fauna Assessment (ENV 2010)	Dec 2009	Single-season Level 1	Not recorded	None
Newman Power Network, Level 2 Flora and Level 1 Fauna Survey (Biologic Environmental Survey 2009)	Jul 2009	Single-season Level 1	82	None

Project	Survey Timing	Survey Type	No. Taxa	Significant Fauna
Flora and Vegetation Survey and Fauna Assessment Mt Whaleback Mine Site (Onshore Environmental 2009)	Jun 2009	Single-season Level 1	65	None
Western Ridge Exploration Project Biological Survey (Ecologia 2006a)	May - Jun 2006	Single-season Level 1	77	Ghost Bat (<i>Macroderma gigas</i>) (Vu, S3), Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>) (P4).
Mount Whaleback Fauna Assessment Survey Phase III (ENV 2006f)	Sep 2006	Single-season Level 2	97	None
Western Ridge Exploration Project Biological Survey (Ecologia 2005)	May 2005	Single-season Level 1	37	Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>) (P4).
Baseline Biological and Soil Surveys and Mapping for ML244SA West of the Fortescue River (Biota 2001)	Sep 2000	Single-season Level 1	193	Identified from desktop assessment as potentially occurring: Ghost Bat (<i>Macroderma gigas</i>) (Vu, S3), Grey Falcon (<i>Falco hypoleucos</i>) (S3), Long-tailed Dunnart (<i>Sminthopsis longicaudata</i>) (P4), Peregrine Falcon (<i>Falco peregrinus</i>) (S7), Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>) (Vu, S3), Pilbara Olive Python (<i>Morelia olivacea barroni</i>) (Vu, S3), Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>) (P4).
Orebody 30 and Orebody 35 Soil and Biological Survey (Halpern Glick Maunsell 1999b)	Aug 1999	Desktop with Reconnaissance	N/A	Identified from desktop assessment as potentially occurring: Ghost Bat (<i>Macroderma gigas</i>) (Vu, S3), Grey Falcon (<i>Falco hypoleucos</i>) (S3), Long-tailed Dunnart (<i>Sminthopsis longicaudata</i>) (P4), Peregrine Falcon (<i>Falco peregrinus</i>) (S7), Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>) (Vu, S3), Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>) (P4).
Mt Whaleback Fauna Monitoring Programme: Baseline Sampling 1997-1998 (Ecologia 1998)	Jul - Aug 1997 and Mar 1998	Two-season Level 2	180	Common Greenshank (<i>Tringa nebularia</i>) (MG, S5), Long-tailed Dunnart (<i>Sminthopsis longicaudata</i>) (P4), Peregrine Falcon (<i>Falco peregrinus</i>) (S7), Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>) (P4), Wood Sandpiper (<i>Tringa glareola</i>) (MG, S5).

SRE Invertebrate Fauna Surveys

Project	Survey Timing	Survey Type	No. Taxa	Significant Species
Western Ridge Southern Tenements SRE Invertebrate Fauna Desktop Assessment (Biologic Environmental Survey 2016b)	Oct 2016	Desktop with Reconnaissance	N/A	Confirmed SRE (from desktop assessment): <i>Aname</i> 'MYG001 grp (fem.)' ⁹ , <i>Aname</i> 'MYG205', <i>Aname</i> 'MYG206', <i>Aureocrypta</i> 'MYG315', <i>Kwonkan</i> 'MYG098' ¹⁰ , <i>Feaella callani</i> , <i>Antichiropus</i> 'DIP014' ¹¹ , and <i>Antichiropus</i> 'DIP015' ¹² . Potential SRE (from desktop assessment): <i>Cethegus</i> 'MYG299-DNA', <i>Conothele</i> sp. 'MYG385-DNA', <i>Karaops</i> 'ARA005-DNA', <i>Urodacus</i> 'pilbara12', <i>Lychas</i> 'hairy tail' group, <i>Antichiropus</i> indet., <i>Buddelundia</i> 16NM, <i>Buddelundia</i> 78, <i>Buddelundia</i> 79, <i>Buddelundia</i> 80, and <i>Buddelundiinae</i> OB24
Orebody 35 Short-range Endemic Invertebrate Survey Report (Biologic Environmental Survey 2012)	Sep 2011	Single-season Level 2	7	None
Assessment of Terrestrial Short-range Endemic Invertebrates in the OB35 - Western Ridge Area near Newman, Western Australia (AMBS 2011)	Mar & May 2010 Aug 2010	Two-season Level 2	27	Potential SRE: <i>Urodacus</i> 'pilbara 12', <i>Aname</i> 'MYG098', <i>Aname</i> 'MYG205', <i>Aname</i> 'MYG206', <i>Antichiropus</i> 'OB_1', and <i>Antichiropus</i> 'OB_2'

⁹ This species was reported by Biologic (2016) as a Confirmed SRE which was recorded during the AMBS (2011) survey; however this is believed to be an error and this species is considered to be widespread, as was reported in AMBS (2011) and as per the WAM Arachnid database search results completed for this assessment.

¹⁰ This species was recorded as *Aname* 'MYG098' during the AMBS (2011) survey.

¹¹ This species was recorded as *Antichiropus* 'OB_1' during the AMBS (2011) survey, and is now known as *Antichiropus* 'DIP014'.

¹² This species was recorded as *Antichiropus* 'OB_2' during the AMBS (2011) survey, and is now known as *Antichiropus* 'DIP015'.